TRansition paths to sUstainable legume-based systems in Europe

Continental Legume Innovation and Networking Workshop

21-22 November, 2017

University of Hohenheim, Stuttgart, Germany

Application of sustainability indicators to legume based – TRUE approach

(14:40-15:00)

Marko Debeljak

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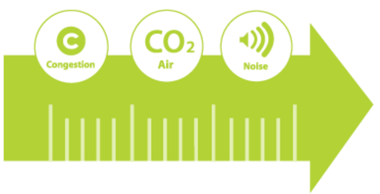
Outline

Application of sustainability indicators to legume based – TRUE approach

1. SUSTAINABILITY

2. INDICATORS



3. APPLICATION

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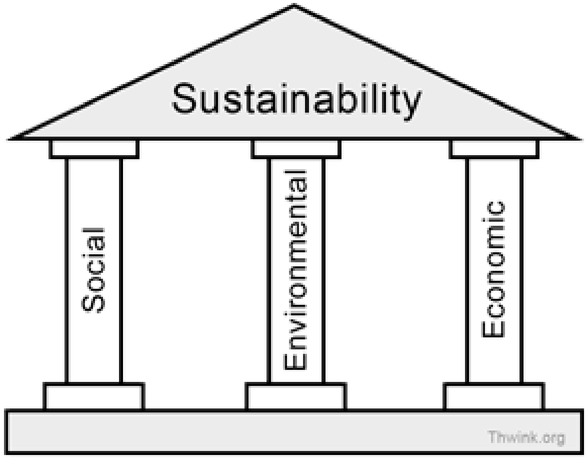
Application of sustainability indicators to legume based – TRUE approach

1. SUSTAINABILITY

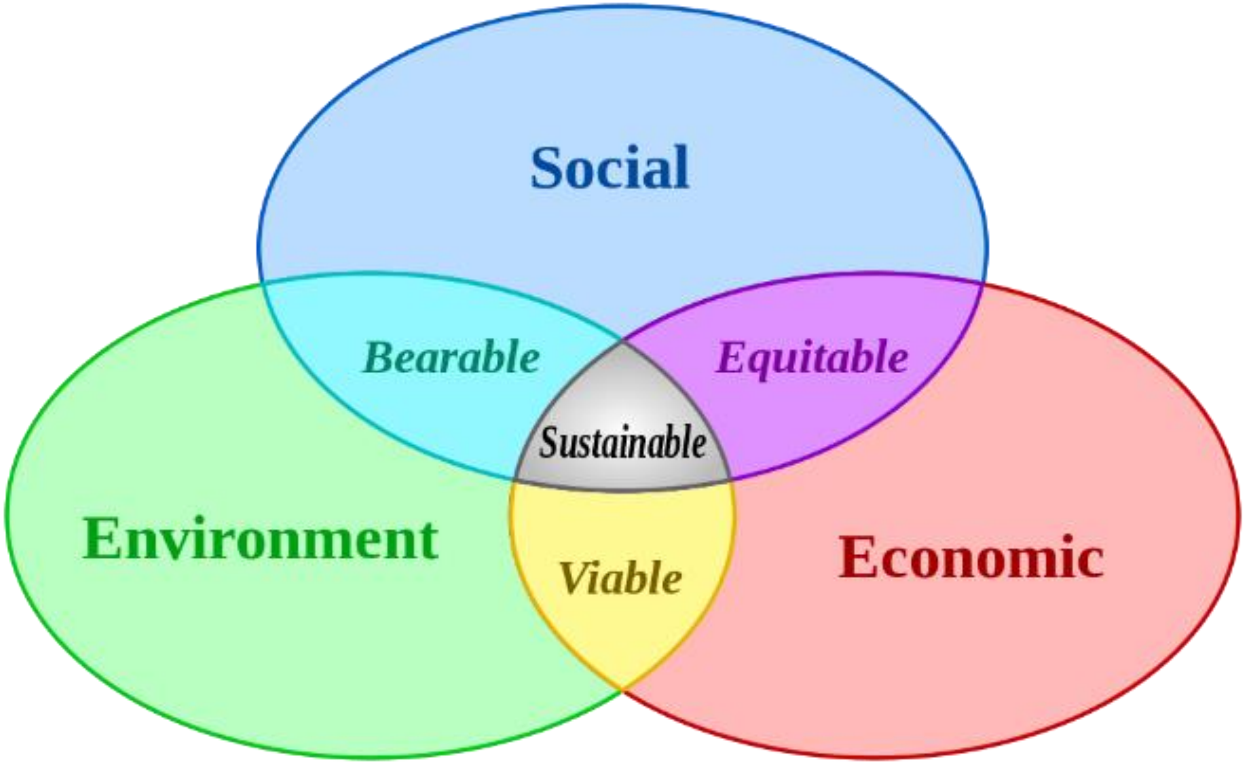
1.1 Sustainability - bakground

- **1964: Sustainability** (Latin *sustinere*): to hold up, '**maintaining**' some level of optimal development **path**.
- **1987: Sustainable development** "**meets the needs of the present generation without compromising the ability of future generations to meet their own needs** "the report (**Bruntland**), Our Common Future: World Commission on Environment and Development .
- **2002: three pillars (social, environmental and economic : people, planet, prosperity**): new description of sustainable development World Summit on Sustainable Development **triple bottom line concept (TBL, 3BL, PPP)**



1.1 Sustainability - background

- 1997, 2005, 2007: **integrated concept:** comprising **social**, **environmental** and **economic** sustainability



1.2 Definition of INDIVIDUAL sustainability pillars

Environmental pillar

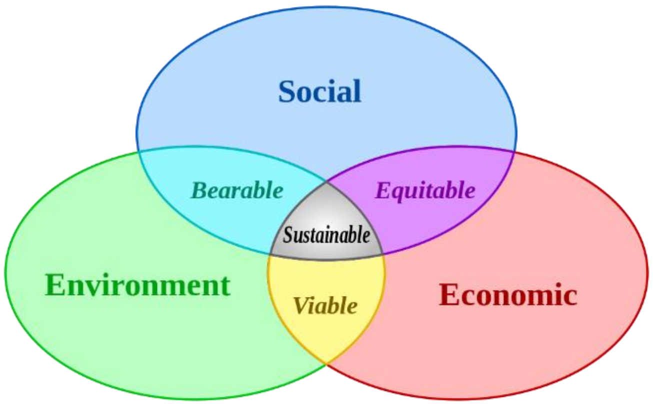
environmental functions that are connected with the **management** and **conservation** of **natural resources** and fluxes within and between these resources. **Natural resources** provided by ecosystems are water, air, soil, energy and biodiversity (habitat and biotic resources).

Economic pillar

represents the **economic functions** of the (agro)(eco)system which should provide **prosperity (wealth)** to the (farming) community and thus refers to the economic viability of the (agro-eco)system.

Social pillar

represents several **social functions**, both at the level of the (farming) **community** and at the level of **society**.



1.3 Definition of INTERSECTIONS of sustainability pillars

Equitable :

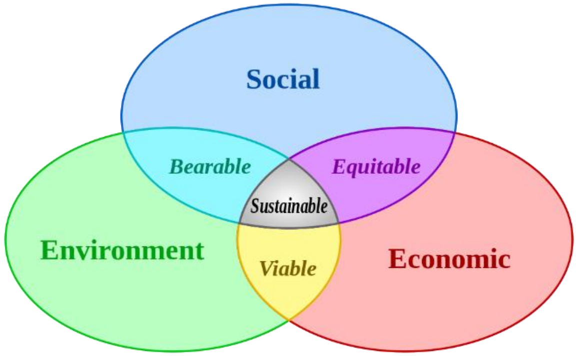
- strong **economic and social** development
- **neglects** issues about **environment**
- the environment is **over exploited** and at risk
- *An example*: urban cultural tourism which places economic emphasis away from troubled environments.

Viable:

- strong **economy and environment**,
- **neglects** issues relating to **society**.
- Areas relating to resource efficiency, stewardship, and carrying capacity.
- *An example*: large numbers of visitors in park where environmental impacts are monitored, however traditional societies have been forcibly removed

Bearable :

- **environment** and **society** are well established,
- **economic** activity is not defined
- *An example*: traditional economies.



1.4 INTEGRATION of sustainability pillars AND intersections

Environment

- Biodiversity management
- Emissions to air (greenhouse gasses, ozone depletion)
- Water, chemicals discharge
- Habitats and landscape (fragmentation, loss)

Enviro+Policy: Bearability

- Health and safety
- Legislation and regulation
- Climate change
- Clean air (O_3, NO_2, PM10, NO_x, VOC)
- Noise (residence, working place, recreation, protected areas)

Enviro + Economic: Viability

- Resource efficiency (energy, soil, water)
- Consumption of fossil fuels
- Proportion of renewable energy sources
- Coverage of operational costs
- External costs of damage of environment

SUSTAINABILITY
An integrated approach to environmental, social and economic impact issues leads to long term sustainability

Social (Policy and Governance)

- Respect for the individual
- Equality opportunity to participation
- Human rights, education
- Standard of living

Economy

- Consistent growth
- Prices, cost savings
- Risk management
- Total Shareholder return
- Research and development

Economic+Policy: Equitability

- Business ethics
- Fair trade
- Workers right

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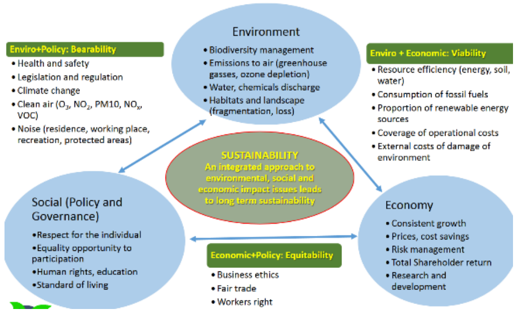
1.5 Sustainability systems

- **AGRICULTURAL SYSTEM:**

  Sustainable agriculture production maintains its biological diversity, productivity, regeneration capacity, vitality, and ability to function of agricultural ecosystems, so that it can fulfil – today and in the future – significant ecological, economic and social functions at the local, national and global levels and does not harm other ecosystems.



- **INDUSTRIAL SYSTEM:**

  Sustainable industrial production means an industrial production resulting in **products** that meet the needs and wishes of the present society without compromising the ability of future generations to meet their needs and wishes, and **all phases** during the lifetime of a product have to be considered".

Both challenged to manufacture products which are sustainable and therefore require appropriate decision-making tools to apply principles of sustainable production

1.5 Sustainability levels

- Sustainability is a **multidimensional concert**:
  - Normative dimensions of sustainability
    - ecological,
    - economic and
    - social aspects
  - Spatial dimensions of sustainability
    - Local
    - Regional
    - National
  - Temporal dimensions of sustainability
    - Short-term
    - Long-term

1.5 Sustainability levels

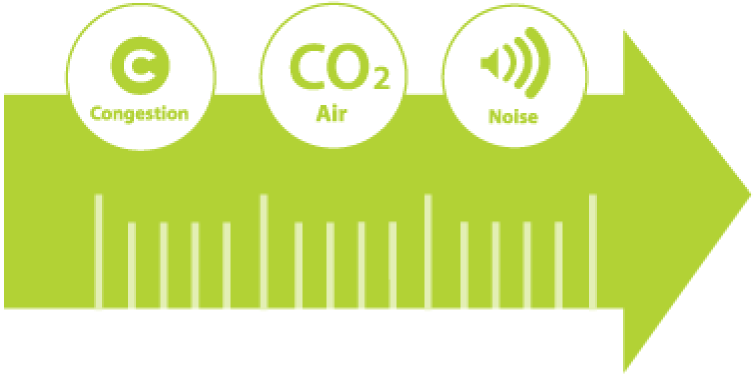
- **Sustainability** is a **dynamic** rather than static concept
  - It **does not** by itself result in a final fixed product
  - It implies a system of **infinite** duration
  - **System level** approach to its:
    - Description
    - Assessment
    - Management

- To trace progress made toward sustainable development UN(1996) states that **indicators can** provide useful means.

- (WB 1997) made statement that **we need indicators** to measure **sustainable development and its progress**

Application of sustainability indicators to legume based – TRUE approach

2. INDICATORS



2.1 Formulation of sustainability indicators

Sustainability indicators:

- have to **reflect definition** of sustainability
- be abele **to connect** practical conditions to policy options for **implementation** of sustainable development and for **monitoring** its progress.

Formation of sustainability indicators **should follow formulation** steps:

1. **Principles**
2. **Criteria**
3. **Indicators**
4. **Reference values**

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2.2 Formulation of sustainability indicators:
1. Principles of Sustainability

- Principles are **general conditions** for achieving sustainability.

- Principles must consider **all di**mensions of sustainability (**ecological, economic, social**):
    - Socio-ecological system **integrity**
    - Livelihood sufficiency and **opportunity**
    - Intragenerational **equity**
    - Intergenerational **equity**
    - Resource maintenance and **efficiency**
    - Socio-ecological civility and democratic **governance**
    - **Precaution and adaptation**
    - Immediate and long term **integration**

2.2 Formulation of sustainability indicators:
2. Criteria of Sustainability

Criteria are **specific objectives** relating to a **state** of the system, and therefore easier to assess and to link indicators to.

Criteria have to be clustered into **three** levels:

- **Global**
- **Regional**
- **Local**

differentiated downward to regional level
aggregated upward to regional level

Criteria should be **categorized** by **resources involved** in the investigated system: Agro-ecosystems

- **air**
- **soil**
- **water**
- **biodiversity**
- **energy**
- **man-made capital**
- **human capital**
- **social capital**
- **cultural capital**

2.2 Formulation of sustainability indicators:
2. Criteria of Sustainability

Example: **Categorization** of agricultural **sustainability criteria** into **sustainability dimensions and measures**

Criteria	Environmental pillar
	Air
Air quality is maintained or enhanced.	Supply (flow) of quality air function
Wind speed is adequately buffered.	Air flow buffering function
	Soil
Soil loss is minimized.	Supply (stock) of soil function
	Economic pillar
	Viability
Farm income is ensured.	Economic function
Dependency on direct and indirect subsidies is minimized.	
	Social pillar
	Food security and safety
Production capacity is compatible with society's demand for food.	Production function
Quality of food and raw materials is increased.	

2.2 Formulation of sustainability indicators:
3. Sustainability indicators

- **Indicators** are **variables** of any type that can be induced from **sustainability criteria**

- **Indicators:**
  - **reduce the complexity** of system description
  - **integrate information** about process, trend or state into a more readily understandable form at intra and inter local, regional, and global levels

- Indicators **can be used**:
  - to **assess** the environmental, economic and social conditions of a system,
  - to **monitor** trends in conditions over time,
  - to **provide an early warning** signal of change
  - to **provide solid bases to decision making processes** consistent with sustainable development principles at **all levels**

2.2 Formulation of sustainability indicators:
3. Sustainability indicators

- Indicators have **different roles** at different hierarchical level:

  - **Local level: measure progress** of the system toward sustainability .

  - **Regional level**: **comparisons between** systems' performance in the economic, social and environmental aspects

  - **National/International level**: **inform policy makers** about the current **state and trends** in sector performance and facilitate public participation in sustainability discussions

2.2 Formulation of sustainability indicators:
3. Sustainability indicators

Classification of sustainability indicators

- **trend indicators** describe dynamic aspect of sustainability over time
- **state indicators** reflect the condition of the respective assessed system
- **driving (force) indicators** refer to the factors that cause changes in management practices and inputs use
- **response indicators** that show the response of a system to the changes of state of environment
- **specific single indicators**, characterising single parts of the system of concern
- **systemic or composite indicators (indices),** aggregate environmental, social, and economic indicators into a unique measure describing functions and processes of a system as a whole

2.2 Formulation of sustainability indicators:
3. Sustainability indicators

Principles for induction of sustainability indicators from sustainability criteria:

1. Social and policy **relevance** (economic viability, social structure, etc.)
2. **Cover** ecosystem processes
3. **Analytical** soundness and measurability
4. Suitable for **different scales** (e.g. farm, district, country, etc.)
5. **Sensitive to variations** in management and climate
6. **Accessible** to many users (e.g. acceptability)

2.2 Formulation of sustainability indicators:
3. Sustainability indicators

- **Measures for the selection of sustainability indicators**

Scientific quality

- **Measure** what it is supposed to detect
- Measure significant **aspect**
- **Problem** specific
- **Distinguish** between causes and effects
- **Reproduced** and **repeated** over time
- **Uncorrelated** and independent
- **Statistically** validated

System relevance

- Identify as the system moves **away - from** sustainability (sensitivity and responsivity)
- Identify **key factors leading** to sustainability
- Warning of **irreversible degradation** processes
- Covers **full cycle** of the system through time
- Permit **assessment** between system components and levels
- Can be related to **other** indicators

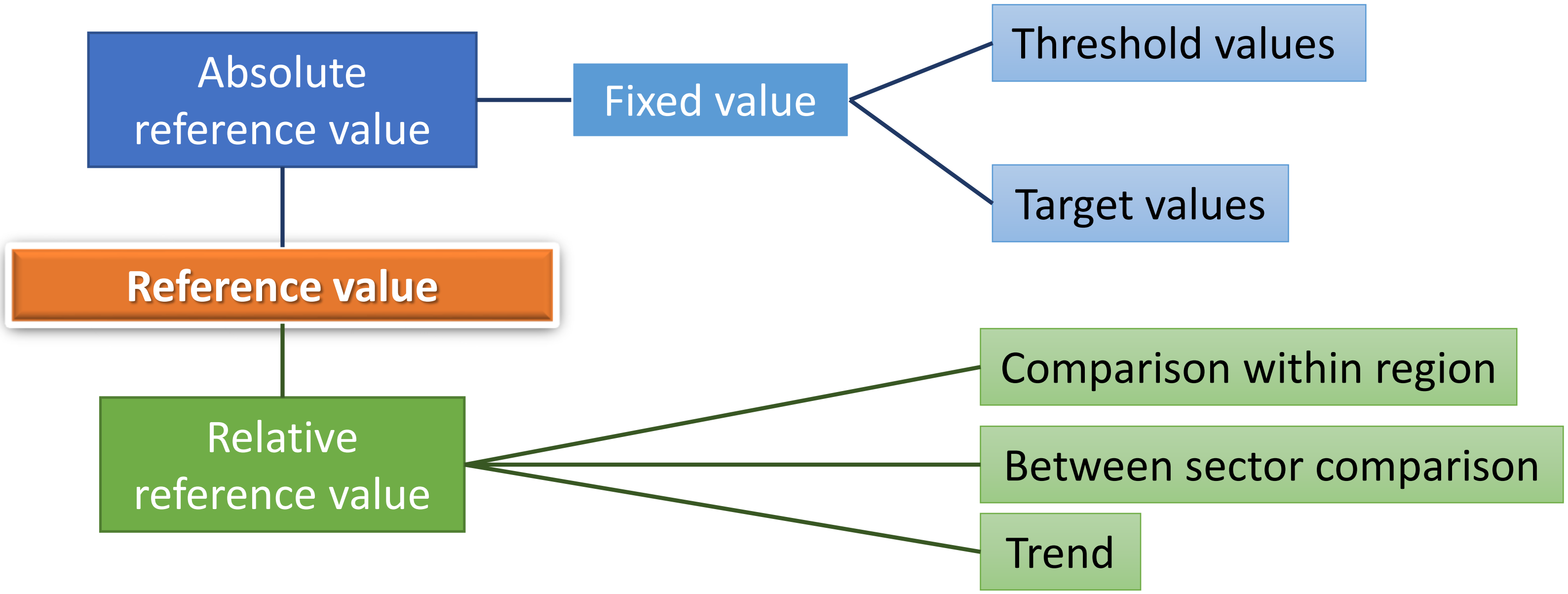
Data management

- **Easy** to measure, document and interpret
- **Cost** effective
- Data **available**
- **Comparable** across locations and time
- **Representative** and transparent
- Geographically **relevant**
- **Relevant** to users
- User **friendly**
- Widely **accepted**

2.2 Formulation of sustainability indicators:
4. Reference values

They describe the **desired level** of sustainability **for each indicator**

They give **users guidance** in the process of continuous improvement towards sustainability



Application of sustainability indicators to legume based – TRUE approach

3. APPLICATION

3. Assessment of Sustainability

- For any study on sustainable (agriculture), the **question** arises as **to how (agricultural) sustainability can be assessed**?

- **System theory** was proofed for sustainability assessment:
  - Definition of the **boundaries** of the system under consideration
  - **Hierarchical** aggregation of sustainability dimensions
  - Description of **hierarchical levels with sustainability criteria and indicators**
  - Description of **interactions** between different levels:

Sustainability level	Sustainability dimensions		
	Ecological	**Economic**	**Social**
International	Secondary	Secondary	Secondary
National	Secondary	Secondary	Primary
Community	Secondary	Primary	Primary
Farm	Primary	Primary	Primary
Field	Primary	Secondary	Secondary

3.1 Steps of sustainability assessment

1. **Selection** of systems under investigation

2. Setting of sustainability **goals**:
   a) optimal **social** development: **social well-being**
   b) optimal **economic** development: **economic well-being**
   c) optimal **environmental** development: **environmental health**

3.1 Steps of sustainability assessment

3. **Selection** of assessment strategies:

   a) **Absolute** evaluation procedures:
      i. Indicators derived from **one** single system.
      ii. Assessment is based on a **comparison** with previously defined margins of **tolerance** or **distinct threshold** values for each selected indicator

   b) **Relative** evaluation procedures:
      i. A **comparison of different systems** among themselves or with selected reference systems.
      ii. Comparative assessment **does`t distinct margins** of tolerance or threshold values.
      iii. The **results** of a relative evaluation are presented as **normative point** scores.

3.1 Steps of sustainability assessment

4. **Determination** of indicators:
   a) based on **ideal goals** and selected **assessment strategies** ideal or desired social, environmental, and economic indicators are determined
   b) verification if ideal set of indicators is present **in practice**

5. **Validation** of indicators:
   a) self-validation (done by the developers themselves),
   b) scientific validation(independent experts' judgment)
   c) social validation (public participation).

3.1 of sustainability assessment

6. **Final selection of a minimum** set of indicators:
    a) **too few** indicators: important development **processes are not elaborated a**nd particular area of the system are **not be properly assessed**
    b) **too many** indicators: data collection and data processing is **difficult and expensive**, **redundancies** might appear and the message expressed by the indicator set becomes **difficult to understand**

7. **Selection of assessment methodology:**
    a) Multi-criteria decision analysis (MCDA)
    b) Multiattribute Value Theory (MAVT)
    c) Hierarchical PREference Analysis (Web-HIPRE)
    d) Decision expert system (DEX)

3.2 Example of sustainability indicators

esa

ECOSPHERE

Assessing multimetric aspects of sustainability: Application to a bioenergy crop production system in East Tennessee

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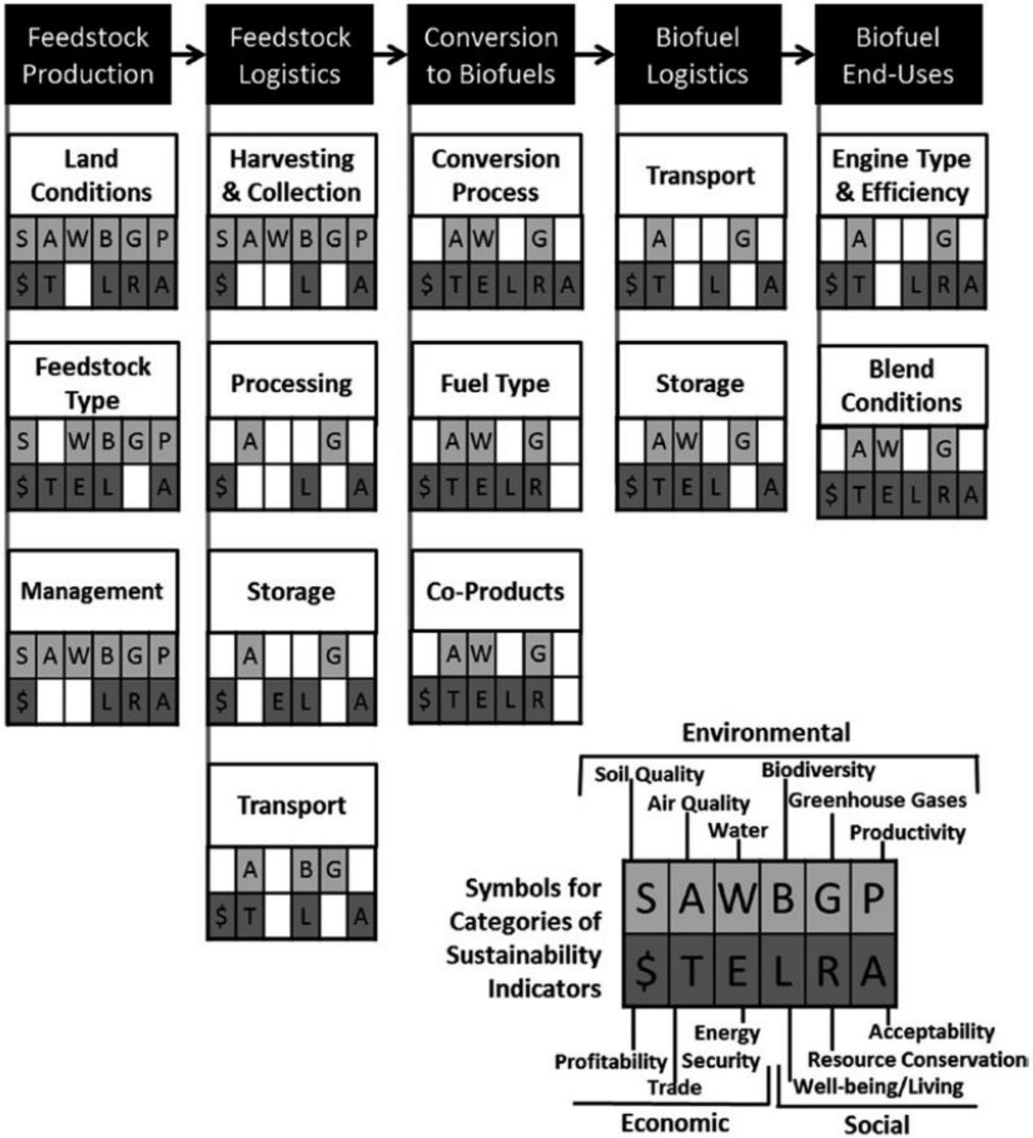
3.2 Example of sustainability indicators

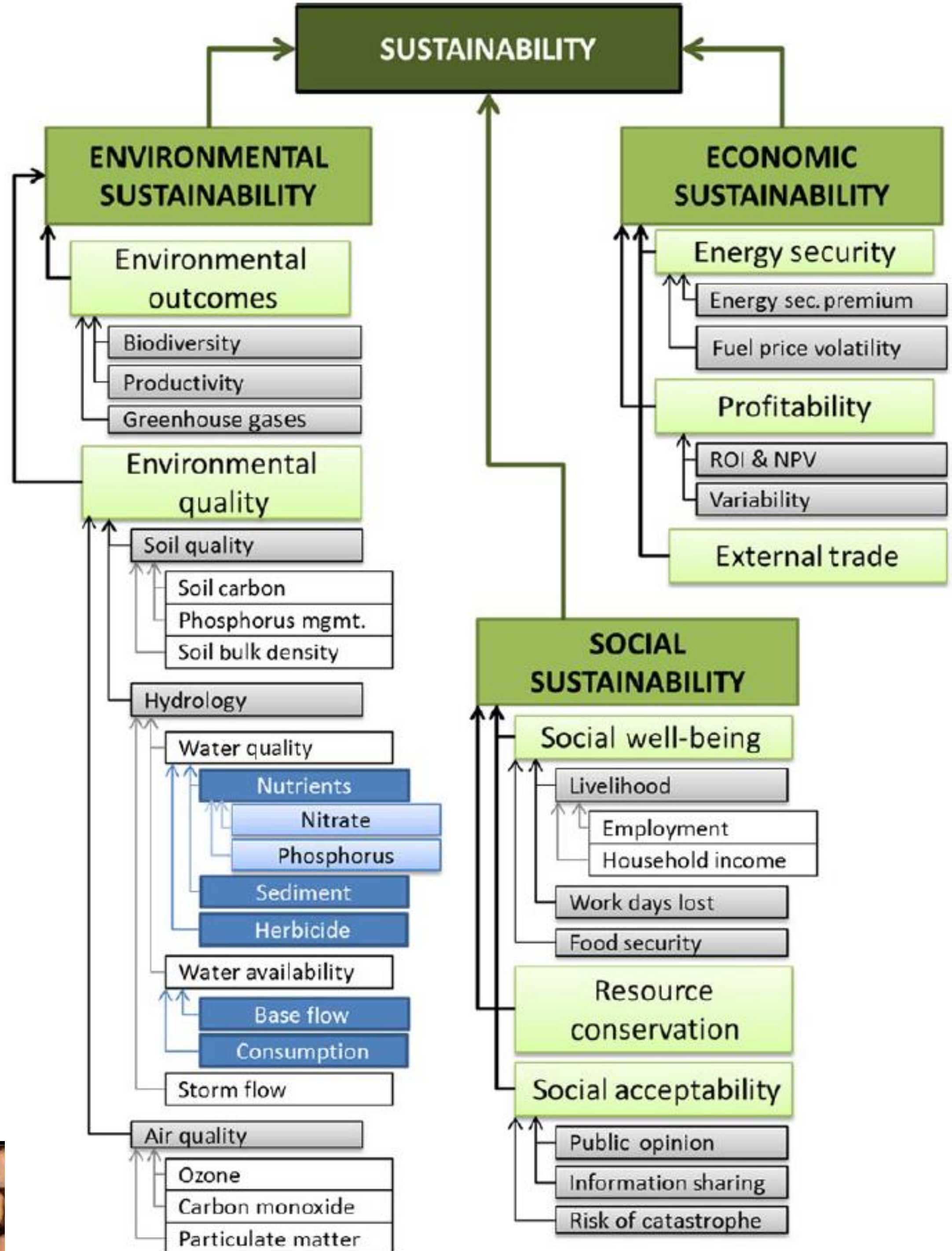


3.2 Example of sustainability indicators

Table 2. Environmental sustainability indicator ratings assigned to the feedstock and logistics portions of an East Tennessee switchgrass-to-ethanol demonstration-scale production system.

Sustainability indicator category	Sustainability indicator	Case study information	Sustainability ratings		
			Low	Intermediate	High
Soil quality	Total organic carbon (TOC) in Mg/ha	38 Mg/ha at depth of 15–20 cm (6–8 in.) after 3 yr of production ($n = 120$) with increasing trend	Decreasing soil TOC over years	No change in soil TOC	**Increasing soil TOC over years**
	Total nitrogen (N) in Mg/ha	…	…	…	…
	Extractable phosphorus (P) in Mg/ha	0–0.06 Mg/ha at depth of 15–20 cm (6–8 in.) averaged over 3 yr ($n = 120$)	Additions of P exceed removal rate	**P applied at removal rate**	No P applied to soil
	Bulk density in g/cm^3	1.2 g/cm^3 at depth of 15–30 cm (6–12 in.) prior to 2008 plantings ($n = 120$)	Low bulk density OR high bulk density	**Nonrestrictive bulk density†**	N/A
Water quality and quantity	Nitrate concentration in streams in mg/L and as export in kg·ha^{-1}·yr^{-1}	Export of 0.36 kg·ha^{-1}·yr^{-1} measured at Thompson farm; 0.15 mg/L modeled in Lenoir City catchment	Increasing nitrate concentration/export over years	No change in nitrate concentration	**Decreasing nitrate concentrations/export over years**
	Total phosphorus (P) concentration in streams as mg/L and as export in kg·ha^{-1}·yr^{-1}	Export of 0.13 kg·ha^{-1}·yr^{-1} measured at Thompson farm; 0.11 mg/L modeled in Lenoir City catchment	Increasing P concentration/export	No change in P concentration/export	**Decreasing P concentration/export**

3.2 Example of sustainability indicators

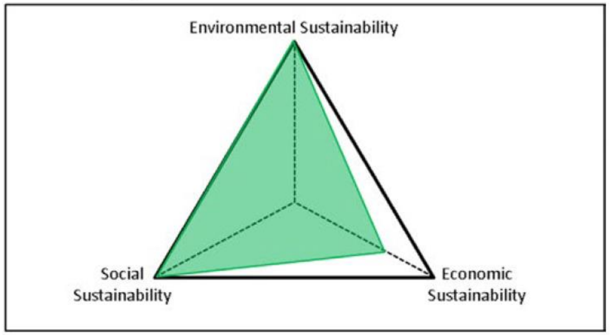


3.2 Example of sustainability indicators

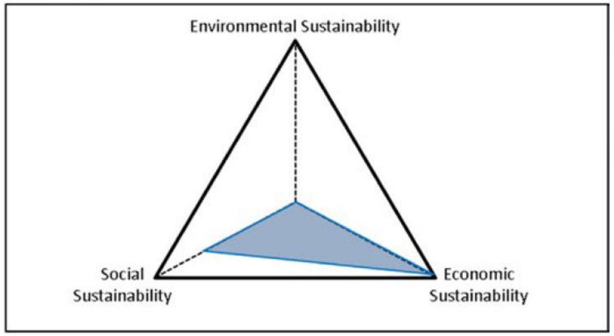
Table 7. Summary of the overall sustainability and sustainability pillar ratings for the East Tennessee switchgrass-to-ethanol experiment compared to two alternative agricultural scenarios.

Type of sustainability	No-till switchgrass	Unmanaged pasture	Tilled corn
Overall sustainability	High	Intermediate	Intermediate
Environmental sustainability	High	High	Low
Economic sustainability	Intermediate	Low	High
Social sustainability	High	Intermediate	Intermediate

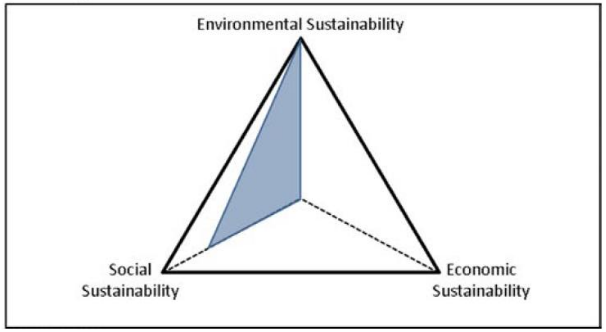
No-Till Switchgrass



Tilled Corn



Unmanaged Pasture




food
security,
nutrition &
innovation


market
access &
stability

Thank you!


creating
awareness


productivity &
environmental
sustainability

TRansition paths to sUstainable legume-based systems in Europe

Planning the Continental Legume Innovation and Networking Workshop

21st-22nd of November 2017 at University of Hohenheim, Stuttgart, Germany

What are the best indicators of sustainable legume based systems?

(16:30-16:50)

Marko Debeljak

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What are the best indicators of sustainable legume based systems?

We don`t know yet …

BUT

We know the way!!!

1. TRUE Conceptual diagram

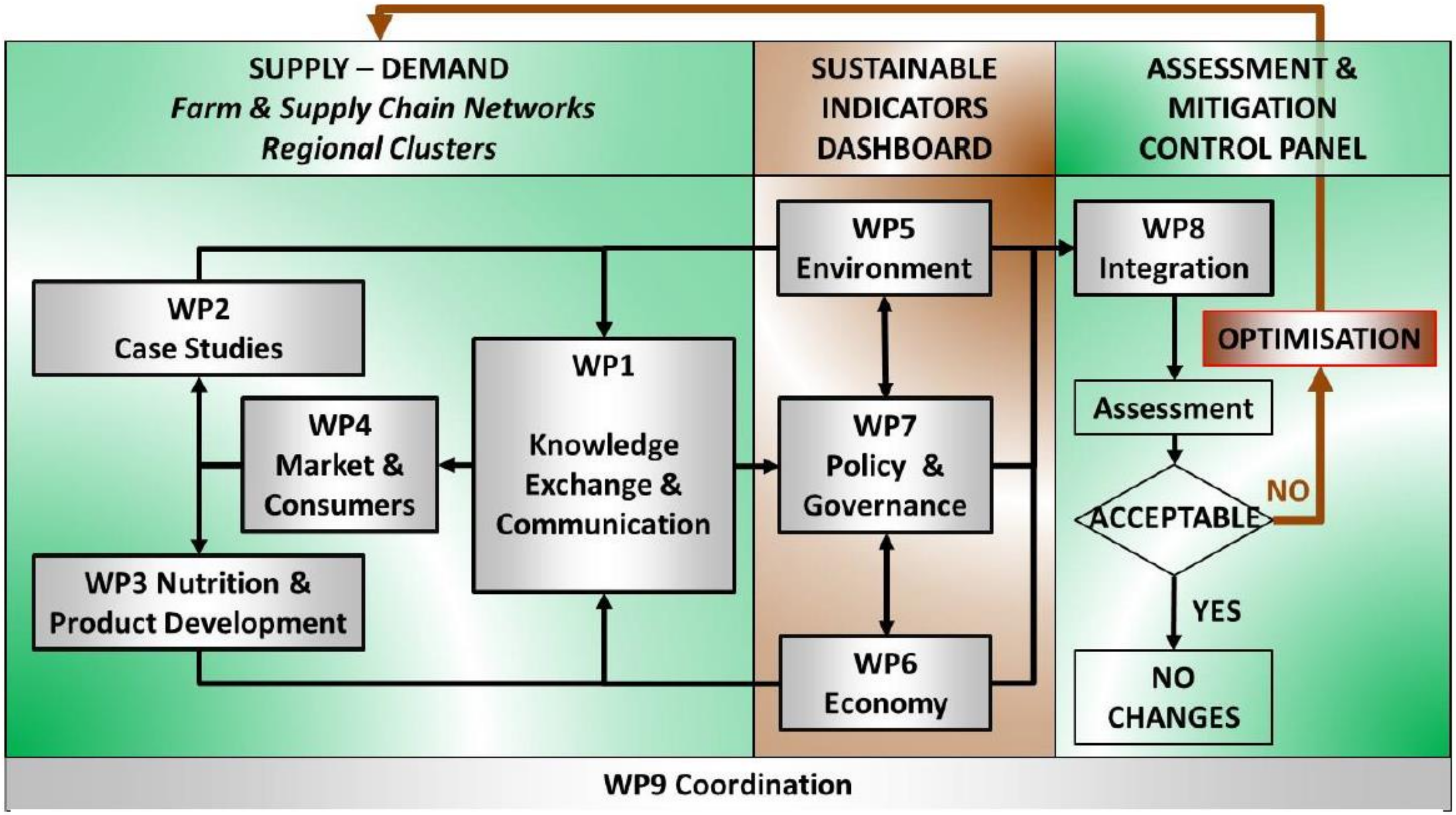
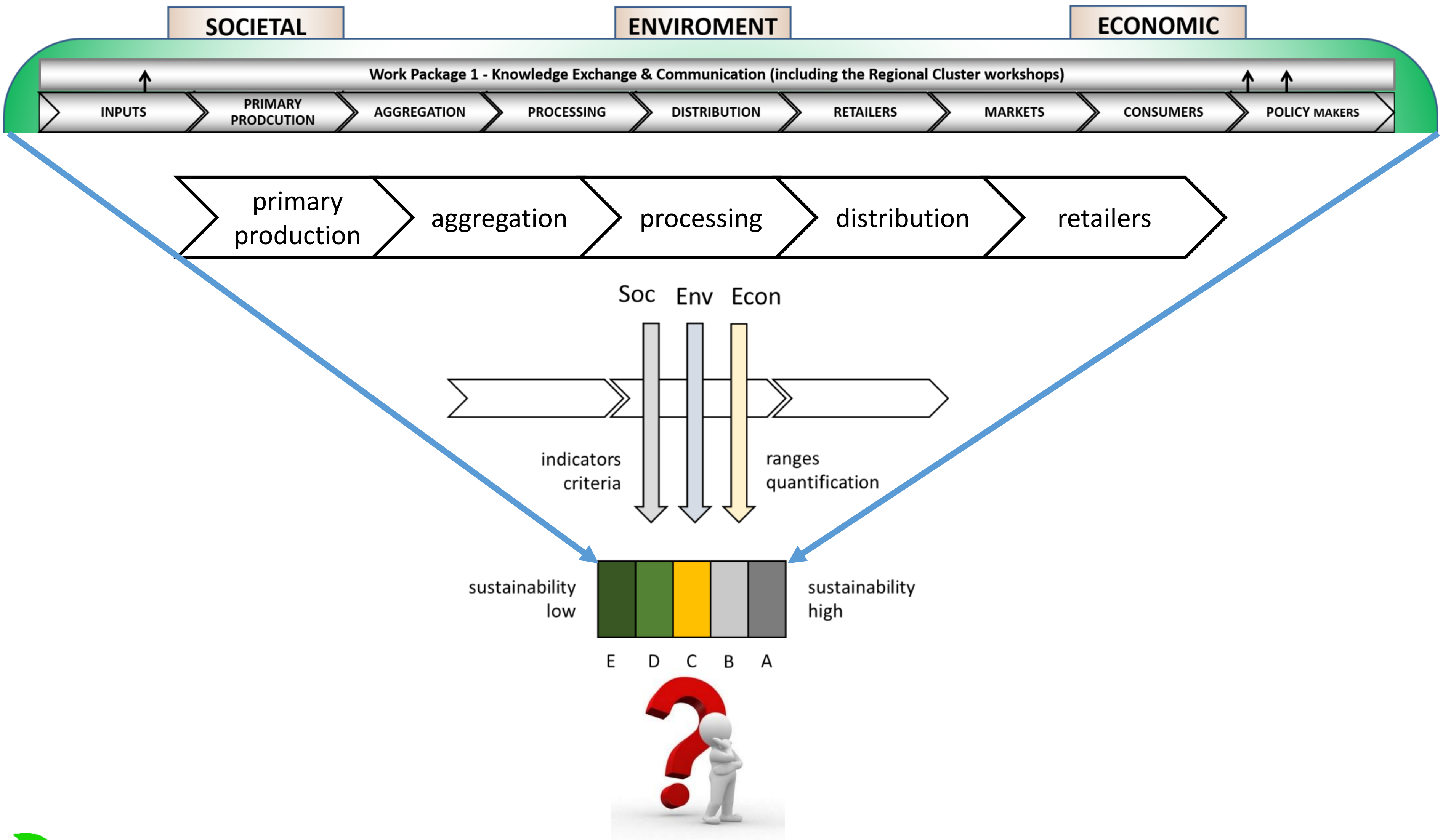


Figure 1.3: Flow of information and knowledge in TRUE, from definition of the 24 case studies (left), quantification of sustainability (centre) and synthesis and decision support (right).

2. Sustainability assessment of TRUE quality chain



3. Formulation of TRUE sustainability indicators

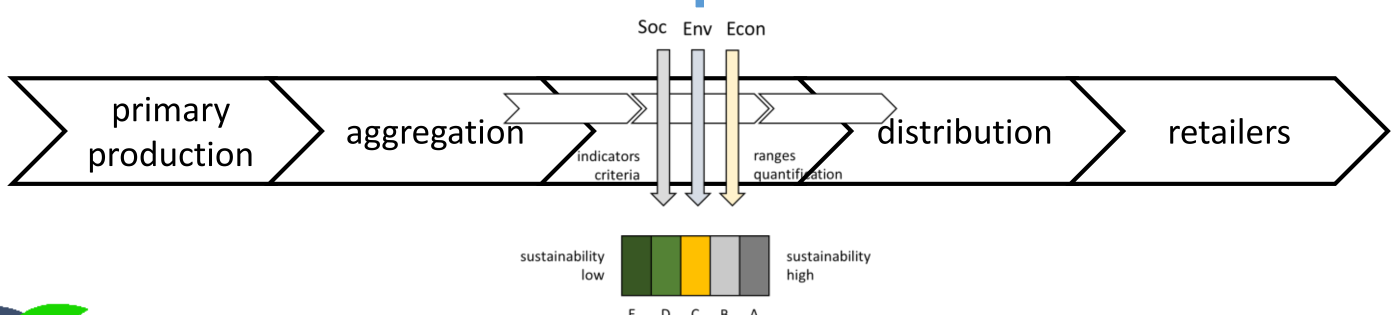
Step 1: System under investigation — **What is my production system?**

Step 2: Setting of sustainability goals — **What is the sustainability level of my system?**

Step 3: Selection of evaluation strategy — **What is the reference system or what is a relative sustainability level of my system?**

Step 4: Determination of sustainability indicators — **What is the minimum number of sustainable indicators?**

Step 5: Assessment methodology — **Which methodology should be selected?**



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3. Formulation of TRUE sustainability indicators

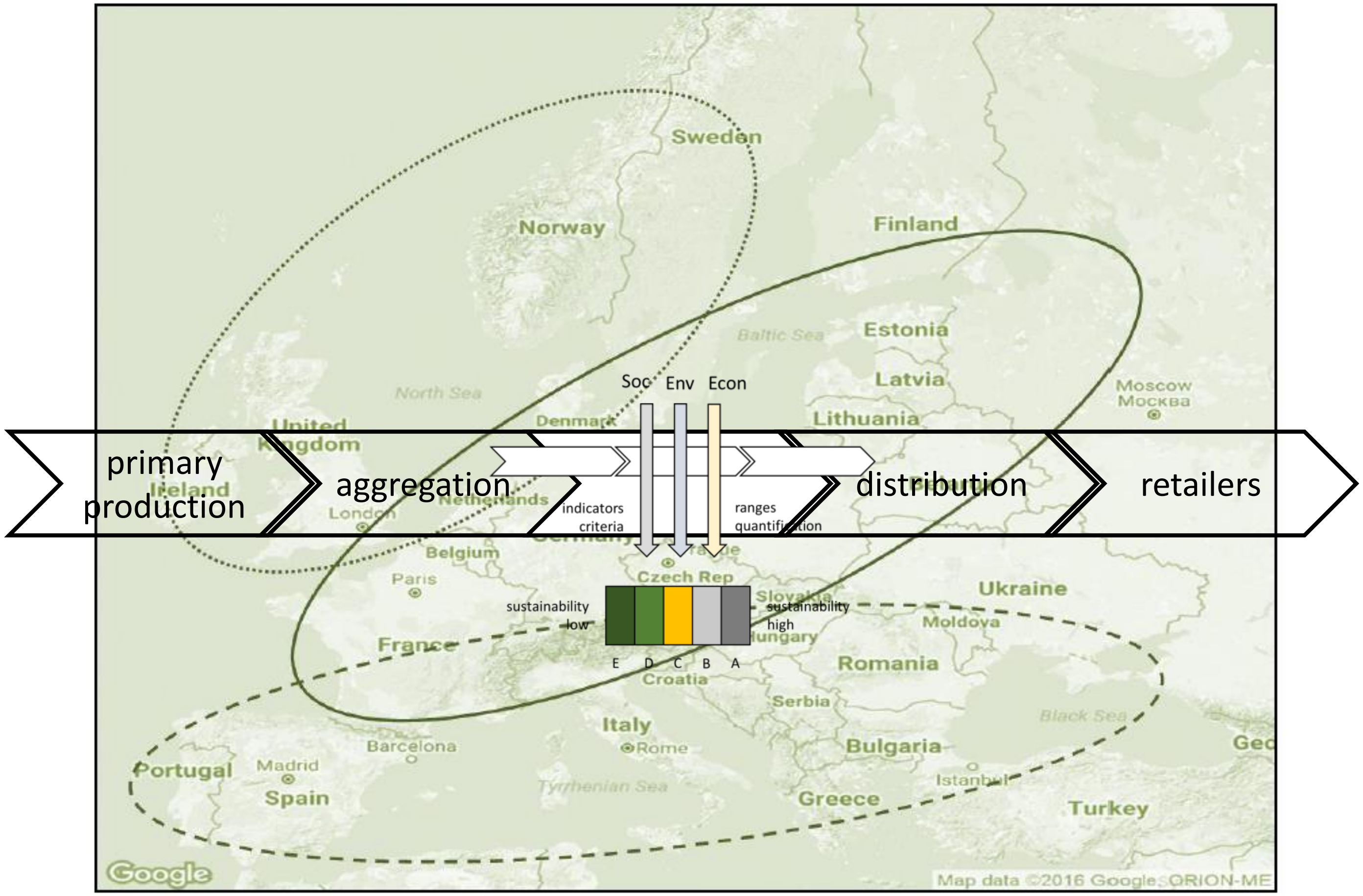

Figure 1.4: (Top) *TRUE Regional Clusters through which the Knowledge Exchange and Communication (WP1), events and workshops will be carried out with stakeholders. The three Regional Clusters are denoted with full, dashed and dotted lines for Continental, Mediterranean and Atlantic pedo-climatic areas of the Europe, respectively.* ***(Bottom)***

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3. Formulation of TRUE sustainability indicators

Table 1.6: *Regional Clusters characterised with respect to full-partners (and 3rd party sub-contractors where relevant), for their respective and main Case Studies activities, products and focus within the various components of the supply- and quality- chains for the main legume crops studied.*

Cluster	Country	Case Study No	Work package(s)	Actor [Sub-contractor]	Activity (TRL)	Main Products	Input/Suppliers	Producers	Processors	Markets	Consumers	Legume Crops
Atlantic	IE	1	2	Teagasc (RTO)	Expanding legume based pasture uptake **(8)**	Milk & Dairy						Clover
		2			Clover-sward reliant organic production **(8-9)**							
	GB	3		Arbikie (SME)	Intercrops for food & feed **(4-6)**	Beer, spirit, salmon, meat						Faba bean
												Pea
		4		SRUC (ACAD)	Self-sufficiency - novel rotation **(6)**	Dairy products						Clover
						Ruminant feed						Faba bean
		5		JHI (RTO)	Legume intercrops for forage or biomass **(8-9)**	Feed, AD feedstock						Forages
		6		STC (SME)	Precision Agriculture Technologies: living mulches for cereal production **(5-6)**	PAT, grains						Clover
				[Manterra]								Lucerne
		7		CU (ACAD)	Heritage varieties – nutritional qualities **(8-9)**	Grain						Faba bean
												Pea
												Common bean
		8			Living mulches for horticulture **(4-6)**	Tomatoes, pepper cucumber						Forages (misc)
					Fertiliser fish-bone and -blood replacement **(4-6)**							Bean meal
												Pea meal
	DK	9	4	IFAU (SME)	Retailer-producers quality chain length **(6-7)**	Producer-labelled products						Lentil
												Pea
												Faba bean
												French bean
		10			Market model development for organic pork **(5-6)**	Pork, pork products						Lupin
												Faba bean
		11			Characterise vegetarian foods quality chain **(5)**	Vegetarian products						Soybean
												Lupin

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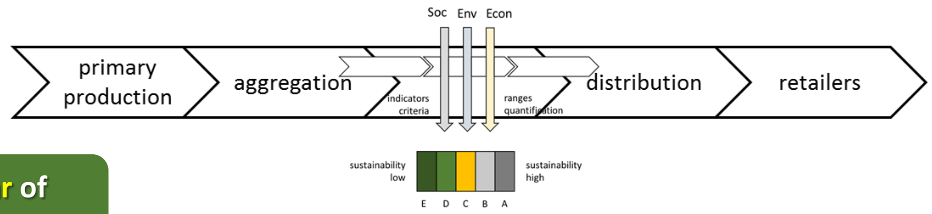
Cluster	Country	Case Study No	Work package(s)	Actor [Sub-contractor]	Activity (TRL)	Main Products	Input/Suppliers	Producers	Processors	Markets	Consumers	Legume Crops
												Lentil
												Pea
		12			Vegetarian food formulation **(4-6)**	Vegetarian foods						Pea
Continental	DE	13	2	**UHOH (ACAD)**	Assess structure/profit short supply chains **(3-6)**	Grain products						Lentil
		14				Tofu, feed						Soybean
		15		**AWI (RTO)**	Organic lupins for aquaculture feeds **(6)**	Bass,salmon,shrimp						Lupin
	HR	16	2	**REDEA (GOV)**	Policy for sustainable development **(8-9)**	Sustainability policy						Misc.
	HU	17	2	**Agri Kulti (SME)**	Sustainable short supply chains delivering novel legume products to reconnect producers and urban consumers **(8-9)**	Pulse based foods						Beans (misc)
												Pea
												Lentils
Mediterranean	PT	18	3	**Freixo do Meio (SME)**	Ancient & heritage variety screening for higher nutritive value **(4)**	Greenpods, grain, grain products						Common bean
												Lupin
												Lentil
												Chickpea
		19		**Eurest (IND)**	Consumers - legume dishes **(4-6)**	Menu design & recipe books						Common bean
												Faba bean
												Soybean
												Lentil
		20		**UCP (ACAD)** [Palmeiro Foods, IND]	Processors - snack and convenience foods **(4-6)**	Inc. purees & symbiotic yogurts						Common bean
												Lentil
												Chickpea
												Pea
	GR	21	2	**AUA (ACAD)**	Novel grafted types - high yield **(5-6)**	Food), germplasm						Common bean
		22			Elite inoculum – inc. yield & profit **(7-8)**	Grain - food & feed						Chickpea
	ES	23		**Solintagro (SME)**	Breeding for high production and NUE Mediterranean agroecological pedoclimatic stresses **(3-5)**	Grain, elite germplasm						Pea
												Lentil
												Faba bean
	KE	24		**KEFRI (RTO)**	Silvo-arable production & quality chain characterisation **(8-9)**	Grain, grain products						Common bean
												Cowpea

4. Use of indicators in TRUE Transition Pathfinder

Modelling **the environ. pillar** of sustainability of legume systems

Modelling **the economic pillar** of sustainability of legume systems

Modelling **the social pillar** of sustainability of legume systems



Sust. indicators

Current management

Production system
Climate
Soil
Crop
Costs
Subventions
Jobs

Sustainability assessment

Integration of all sustainability **pillars** and their interactions in a DSS system

Evaluation

Assessed EQUAL Demanded

Yes → Continue with the current management

No → Sustainability management

Modification options

Crop
Product
Market
Education

List of modification measures

What - if

Building a **web-based Transition path-finder**

Marko Debeljak
Jozef Stefan Institute
Slovenia


food
security,
nutrition &
innovation


market
access &
stability

Thank you!


creating
awareness


productivity &
environmental
sustainability

TRUE Consortium of 24 project partners from 11 countries:

agri Kulti
ARBIKIE Highland Estate
AWI
Prifysgol Bangor University
Centre for Agroecology, Water & Resilience
Coventry University
essrg (environment social science research group)
Eurest
herdade do Freixo do Meio – Agricultura Biológica
Universität Hohenheim 1818
The Institute for Food Studies & Agroindustrial Development - IFAU
IGV
The James Hutton Institute – Science connecting land and people
Institut "Jožef Stefan" Ljubljana, Slovenija
Kenya Forestry Research Institute – KEFRI
Universitas Catholica Lusitana – Veritati
PGRO
REDEA
Slow Food® Deutschland e.V.
Solintagro S.A.S – Soluciones Integrales para el Agro.
SRUC
Stockbridge Technology Centre
Teagasc – Agriculture and Food Development Authority
Trinity College Dublin – Coláiste na Tríonóide, Baile Átha Cliath – The University of Dublin

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