Development and piloting a comprehensive framework for assessment of sustainability of smallholders farming systems

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ICRISAT
INTERNATIONAL CROPS RESEARCH
INSTITUTE FOR THE SEMI-ARID TROPICS

CGIAR
RESEARCH
PROGRAM ON
Grain Legumes and
Dryland Cereals

Context

Sustainable intensification is at the forefront of food security discussions as a means to meet the growing demand for agricultural production while conserving land and other resources.

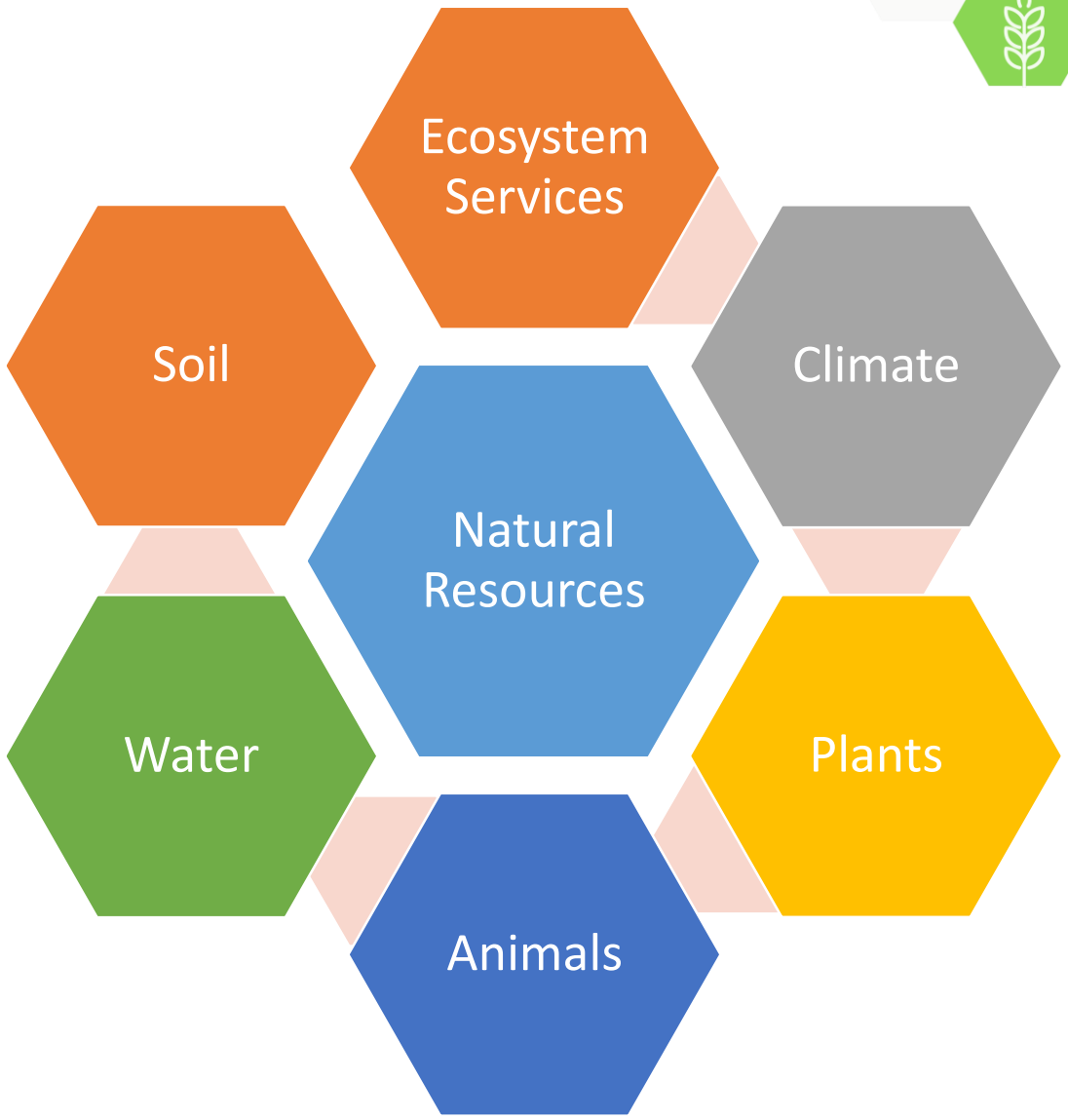
Next steps require identification of indicators and associated metrics for farming systems sustainability assessment, to track progress, assess tradeoffs and identify synergies.

Triple Bottom Line of Sustainability

Sustainable Agriculture Development

Natural Resources

- Natural resources, are fundamental for the structure and function of agricultural systems and for social and environmental sustainability, in support of life on earth.
- Historically, global agricultural development has been narrowly focused on increased productivity rather than on a more holistic integration of NRM [Natural Resource Management] with food and nutritional security.
- A holistic, or systems-oriented approach, can address the difficult issues associated with the complexity of food and other production systems in different ecologies, locations and cultures.
- Resolution of natural resource challenges will demand new and creative approaches by stakeholders with diverse backgrounds, skills and priorities. Capabilities for working together at multiple scales and across different social and physical environments must be developed.



Measuring sustainability of farming systems in SAT

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Empirical evaluation of sustainability of divergent farms in the dryland farming systems of India

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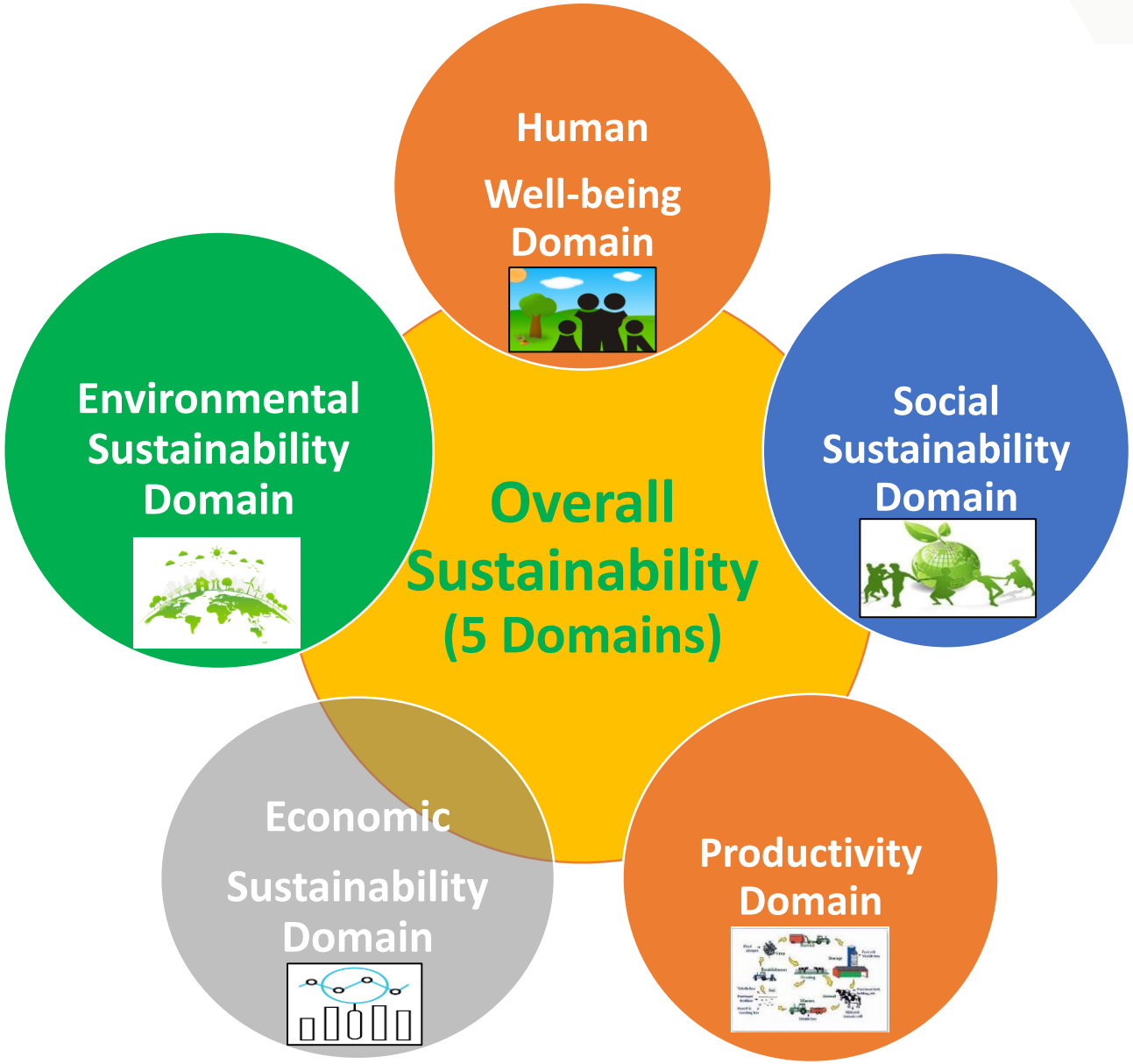
ABSTRACT

The present study argues that there are heterogeneous farm systems within the drylands and each farm system is unique in terms of its livelihood asset and agricultural practice, and therefore in sustainability. Our method is based on household survey data collected from 500 farmers in Anantapur and Kurnool Districts, in Andhra Pradesh State of India, in 2013. We carried out principal component analysis (PCA) with subsequent hierarchical clustering methods to build farm typologies. To evaluate sustainability across these farm typologies, we adopted a framework consisting of economic, social and environmental sustainability pillars and associated indicators. We normalized values of target indicators and employed normative approach to assign different weights to these indicators. Composite sustainability indices (CSI) were then estimated by means of weighted sum of indicators, aggregated and integrated into farm typologies. The results suggested that there were five distinct farm typologies representing farming systems



Key questions

- What sustainability goals are targeted ?
- How are they ranked, aggregated or compared in terms of trade-offs ?

- What are the missing indicators ?

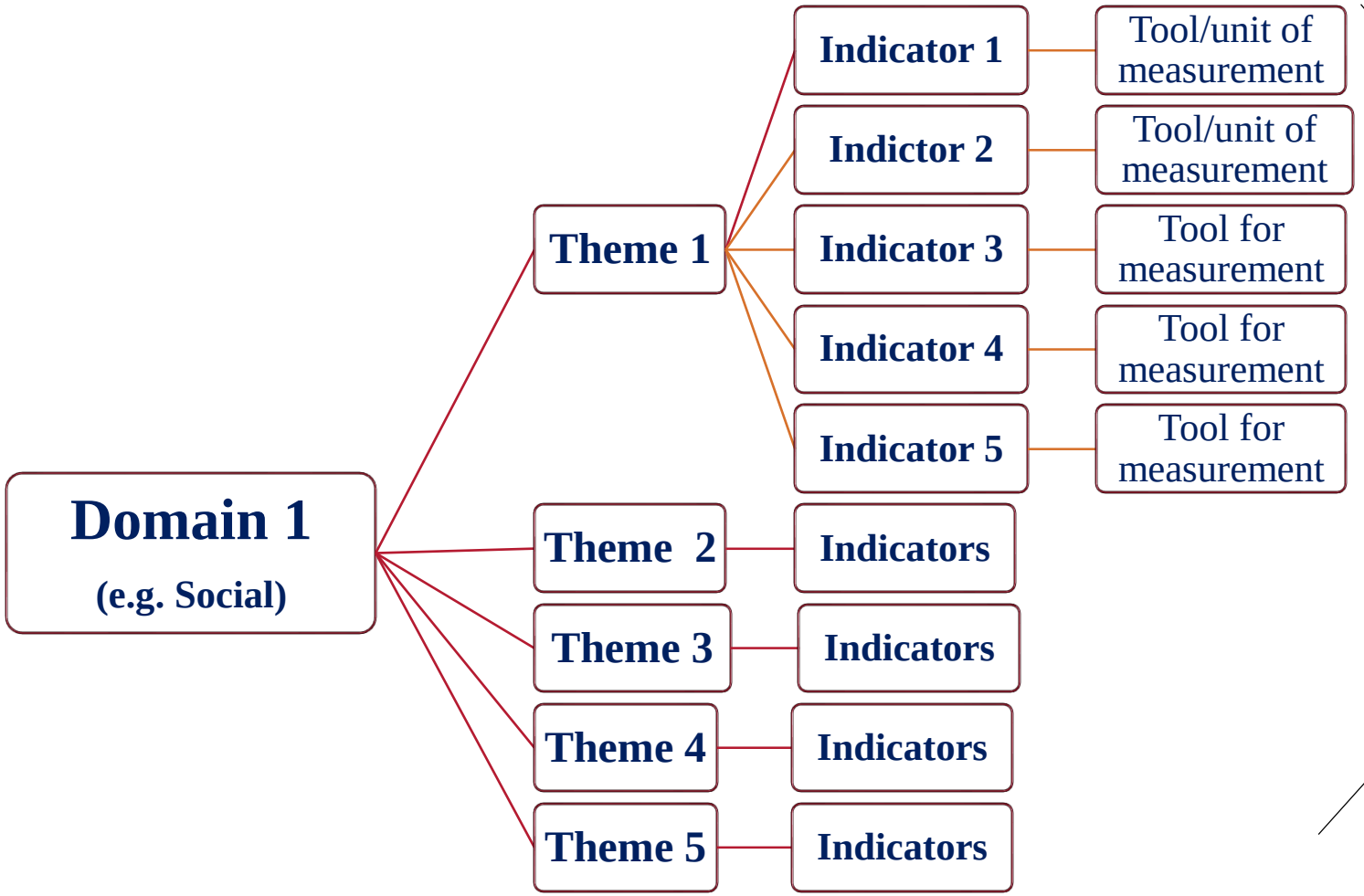
- What are the boundaries of the system assessed between the farming system and the household ?

Type of data required

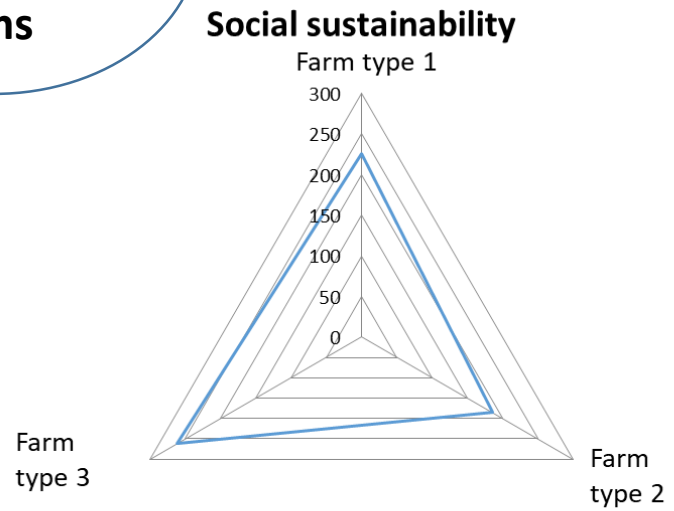
1. **Primary household/ farming system level data**

2. **Secondary data**
   - Capturing the trends which could be considered as permissible.
   - The level of use of modern inputs should not be seen in relative term only. Need to define an absolute/ threshold value for chemical use etc.
   - Need to consider the indirect positive impact of certain commodities in dry regions for example small ruminants to replace that otherwise
   - Need to visualize that if we consider a practice less sustainable: do we have an economically viable alternative or visualize that it could be possible that if the existing practice is discouraged, the farmers might adopt far more unsustainable practice.

Measuring sustainability of farming systems



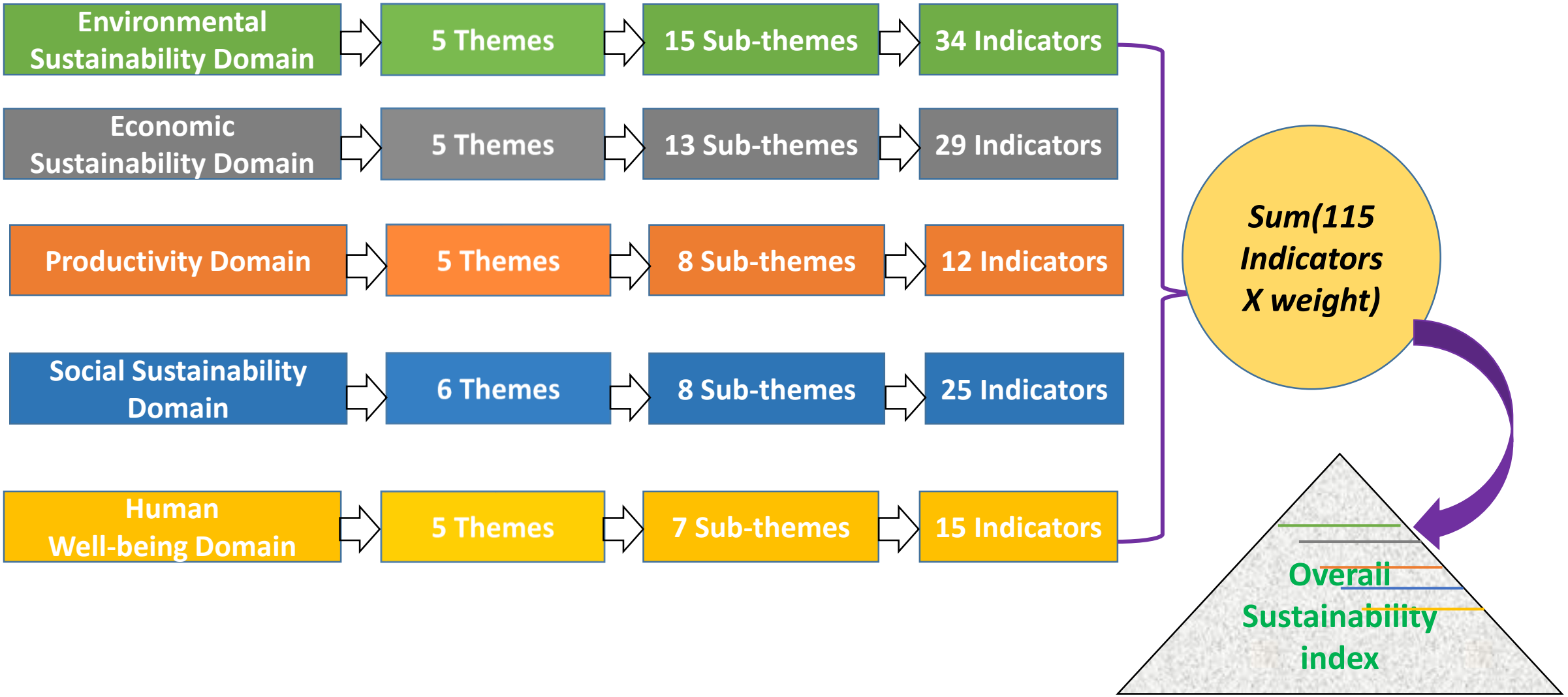
Sustainability index for a farming systems



An example in SAT, India

Measuring sustainability of farming systems:

Quantification framework



Criteria and indicators- An example of environmental sustainability

Environmental sustainability																																			
Land								Water								Biodiversity		Climate , Air and Energy Utilization						Soil and waste management											
Land use pattern			Cropping intensity	Conservation		Soil quality	Water sources	Water Quality	Water use efficiency			Pollution/ overexploitation		Species availability		Climate Change		Greenhouse gas emissions			Energy utilization		Fertilizer application and frequency		Erosion				Waste segregation and disposal					
Crop diversity Index	Share of area under perennial horticulture and agro-forestry	Extent of livestock integration: high, medium, low	Number of crops raised from the same field during one agricultural year	In-situ moisture conservation- ridge and furrow, conservation furrow, broad bed & furrow, etc	Maintaining permanent soil cover through mulching or cover crop- Full, partial, no cover	Normal, alkaline/saline, acidic soils	Sources of Irrigation (RainfedPipelines/bore-wells$ponds etc)	Ph level (Salty/acidic soil – 1 Moderate soil- 2 Normal or good soil – 3)	Crop choice in relation to water availability: Low water requiring (LWR) crops; medium WR, high WR crops	Irrigation technique used -Flooded/sprinkler/drip Alternate dry and wet method/ skip row	Storage availability- Water stored through farm ponds for irrigation, etc	Rate of groundwater depletion/year	Any untreated domestic/processed water discharged in the nearby natural waterbody	No of livestock species maintained	Farm's annual and perennial crop diversity	Change in amount and pattern of precipitation. Climate variability: Frequency of drought/flood conditions in past 5 years(1.33)	Sufficiency of Rainfall (normal rainfall)	Amount of CO2 emissions – fossil fuel consumption and energy needed for input production	Recycling of resources	Amount of CH4 and N2O emissions (method of fertilizer use& paddy cultivation and livestock management practices)	Share of fossil fuel/ animal driven machinery	Usage of renewable and non-renewable energy	Use of inorganic fertilizers like NPK, Urea etc	Management and method of fertilizer application	Crop rotation if practiced or not	Level of soil erosion on farm as influenced by topography and practices	Frequency and amount of pesticides, Insecticides used per crop cycle	Protection used while applying fertilizers and pesticides	Biodegradable and non-biodegradable waste segregated or not , method of waste disposal used	Surplus residue and dung converted into manure or not(1.33)	Method of waste disposal (dumped anywhere or burnt)	Disposal of the chemical containers

Assessing Farming System Sustainability- A case study in West Africa

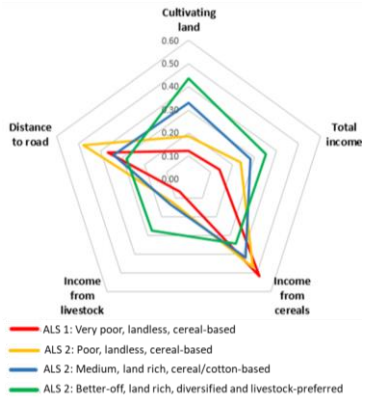
- **Newly holistic set of criteria and indicators combined complementary approaches:**
  - ✓ ***Thematic domains of sustainable intensification***: productivity, economic, human well-being, environmental and social sustainability
  - ✓ ***Solution-oriented mechanisms***: subsidiary linkages, self-organizing capacities for system resilience
  - ✓ ***Resources criticality***: criticality of FS resources, level of supply risks, critical farm design options
  - ✓ ***Farmers perceptions and prioritizations***

- **Participatory Multi Criteria Assessment of FS sustainability** *versus* interventions and farm types
  - ✓ ***Considered Interventions***: improved seeds, legume-cereal associations (individual and combined)
  - ✓ ***Farm types***: main typologies empirically identified and tested

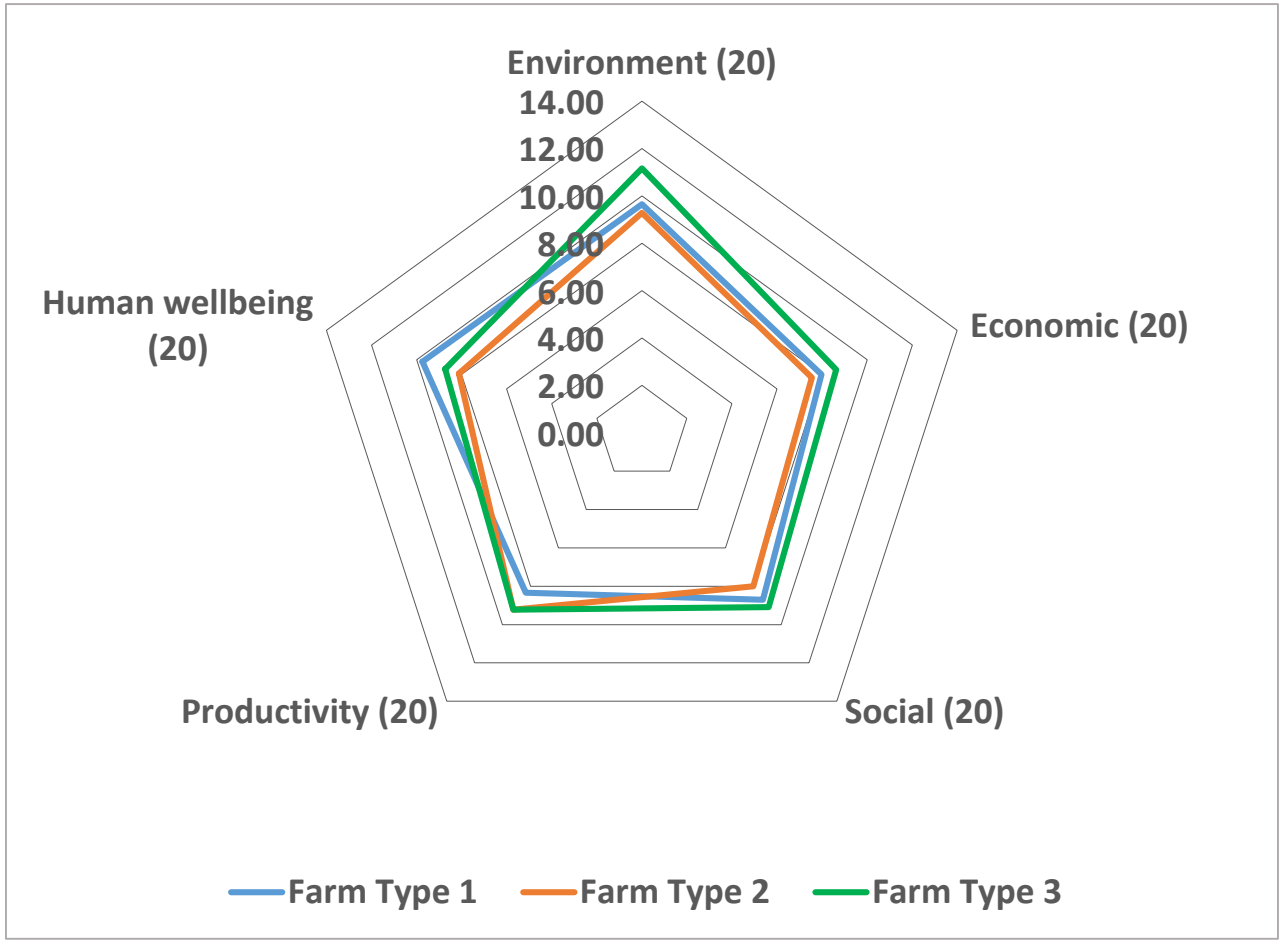
Science-aid multi-stakeholder plenary meeting

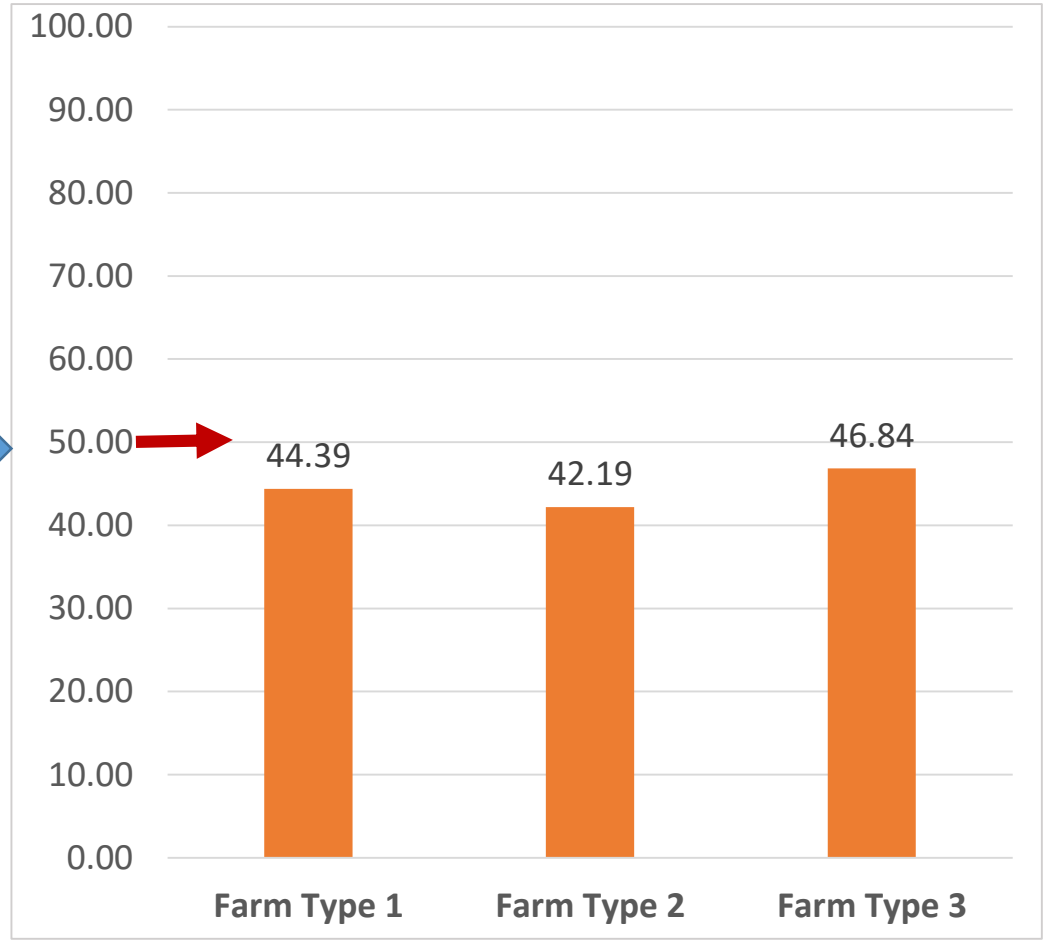
Farmers' perception and ranking of indicators' importance/ criticality

Applied for participatory sustainability assessment for FS typologies



Measuring sustainability of farming systems: A case study in Nalgonda district, Telangana, India



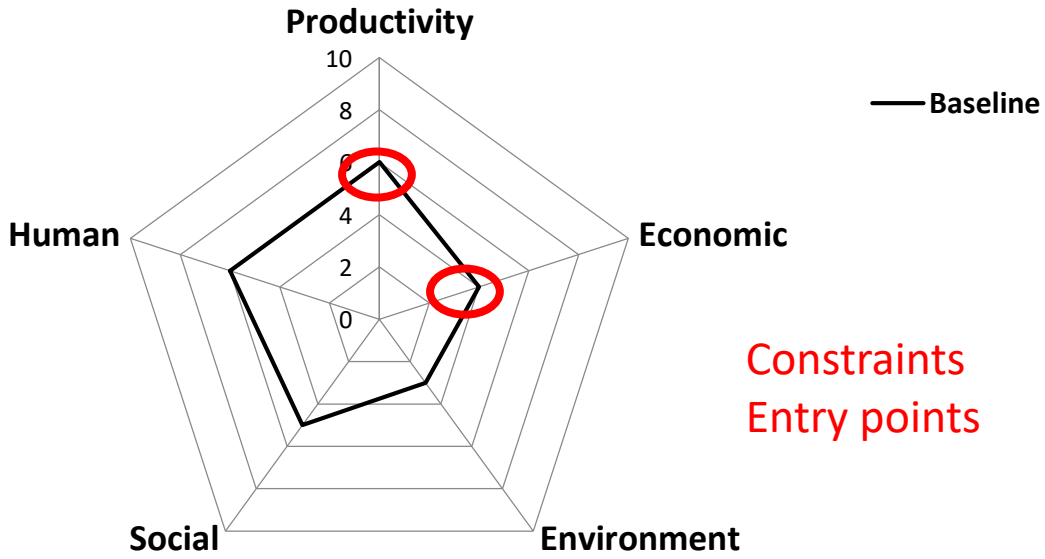


Performance of different farm types across **sustainability domains**

Overall sustainability index score of different farm types (maximum score=100)

Impact assessment

Engage Stakeholders



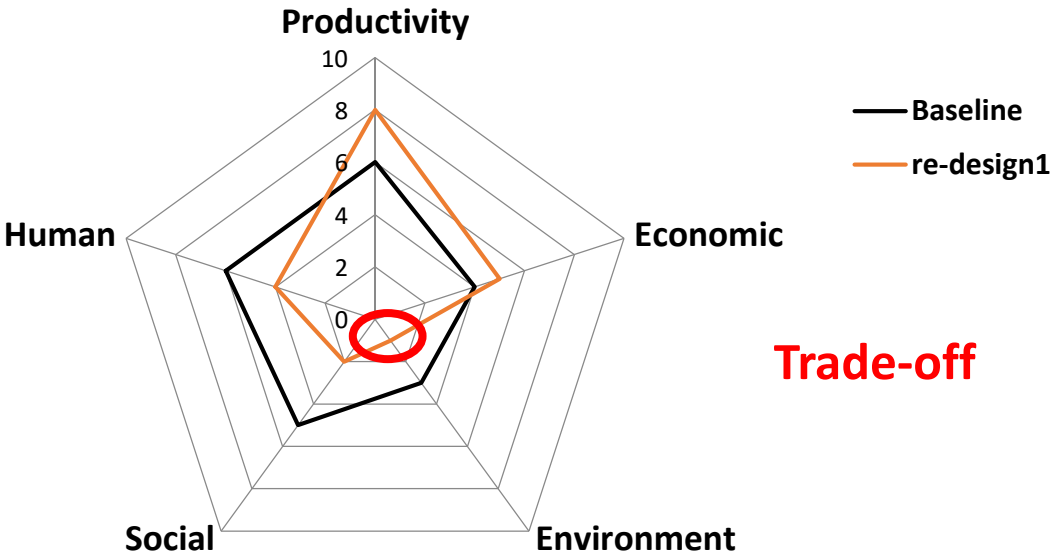
Constraints
Entry points

Co-Design

Systems modelling
Trade-off analysis

Assess impact across scales and dimensions in relation to farm HHs

Impact assessment



Trade-off

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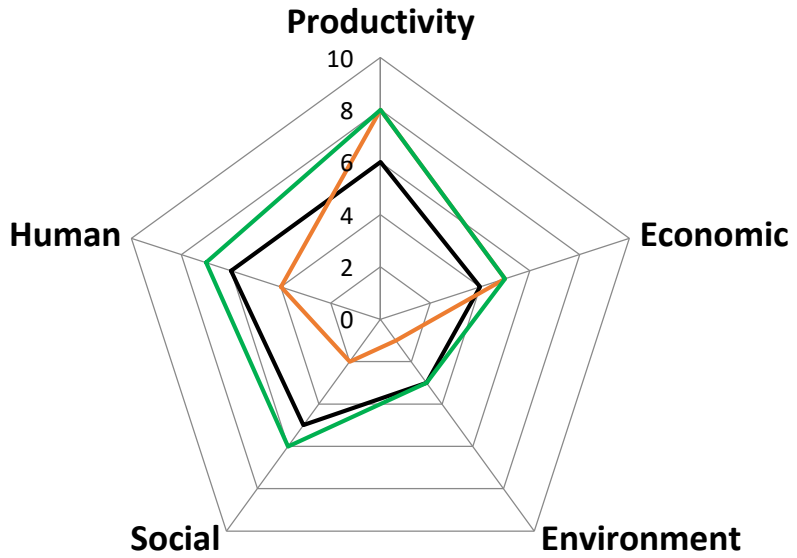
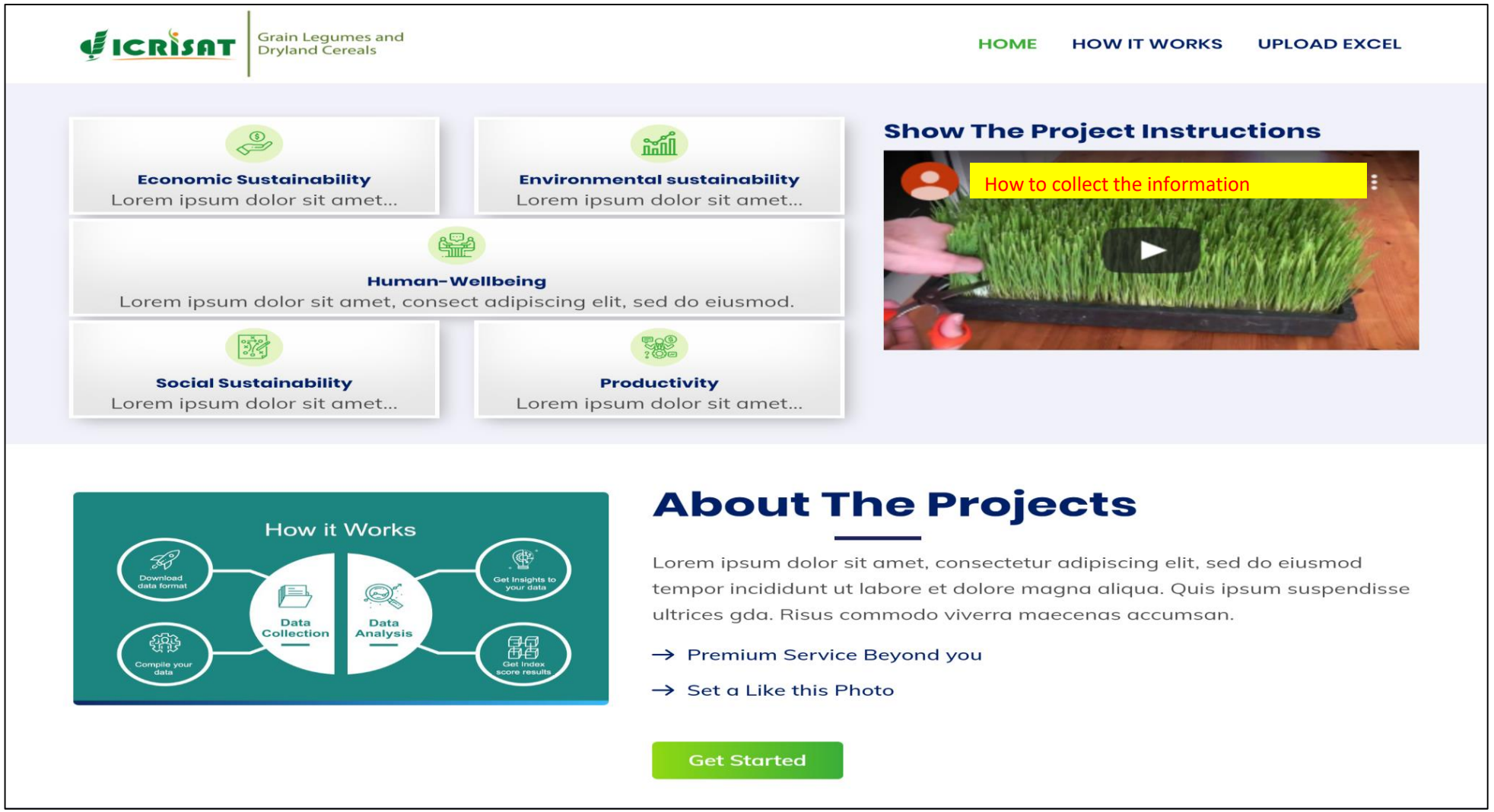


Co-Design

Systems modelling
Trade-off analysis

Measuring sustainability Index: Online automated dashboard



Thank You
for your attention

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