EAAP 2019

A multidimensional decision support tool to assess the sustainability of livestock farming systems

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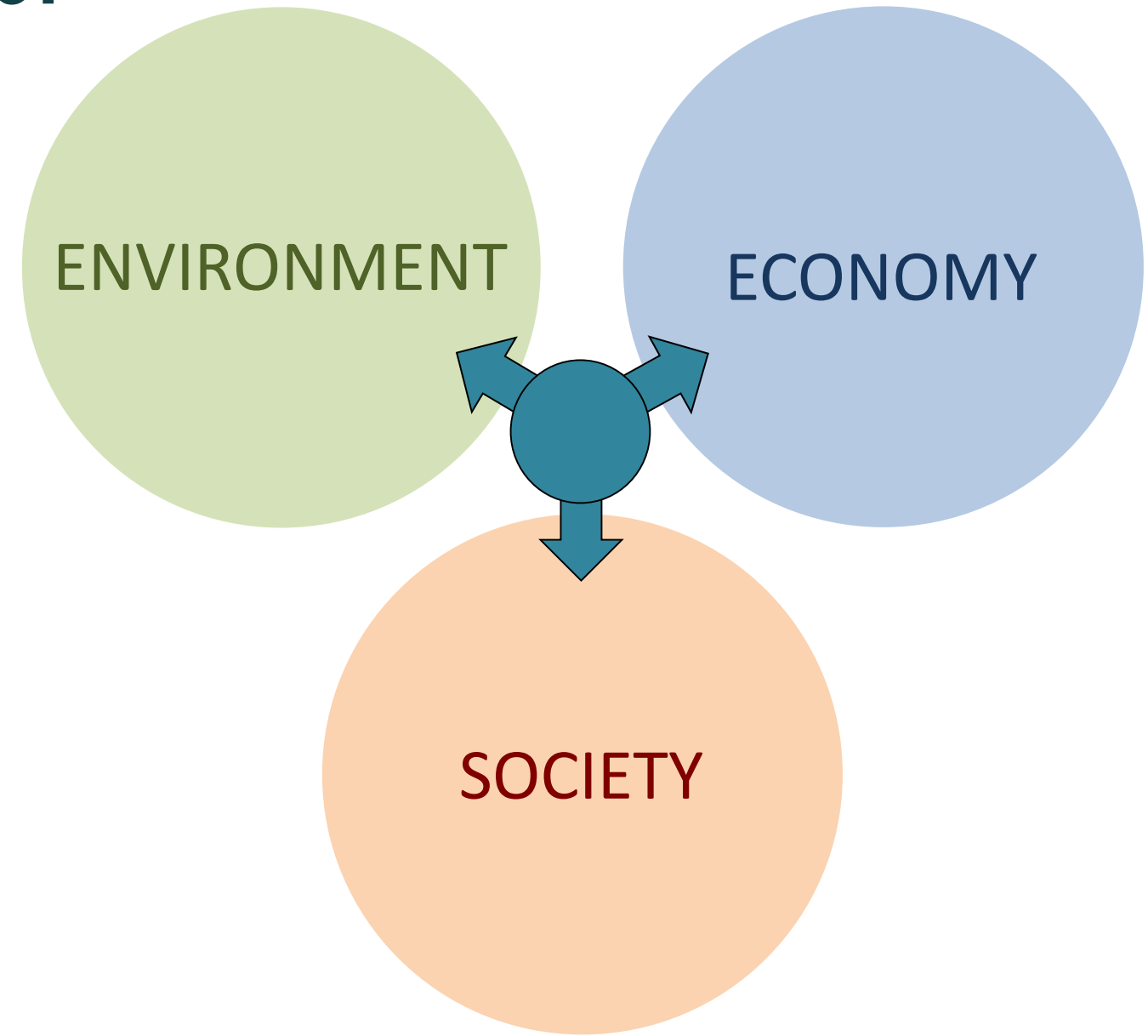
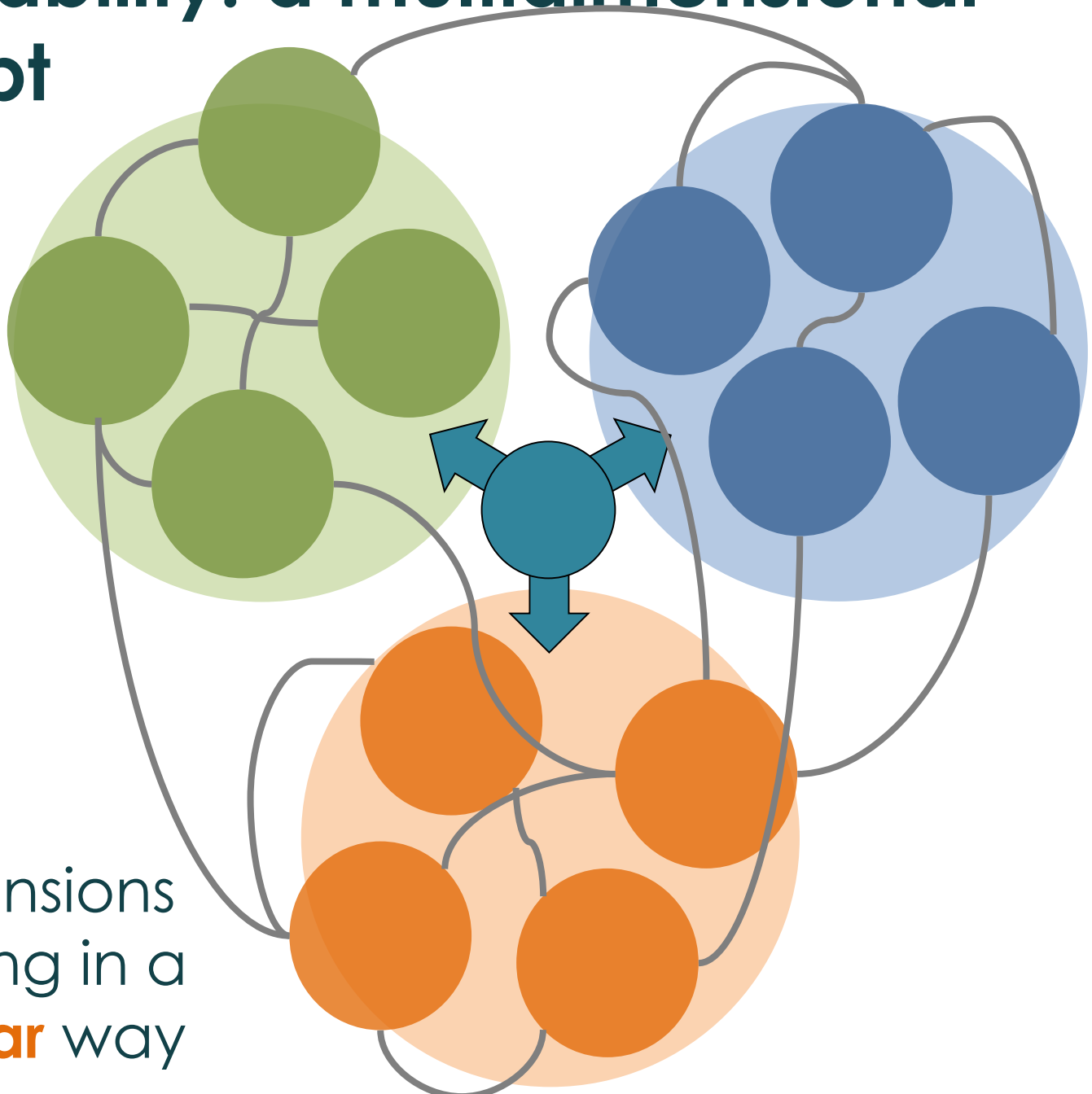
Sustainability: a multidimensional concept



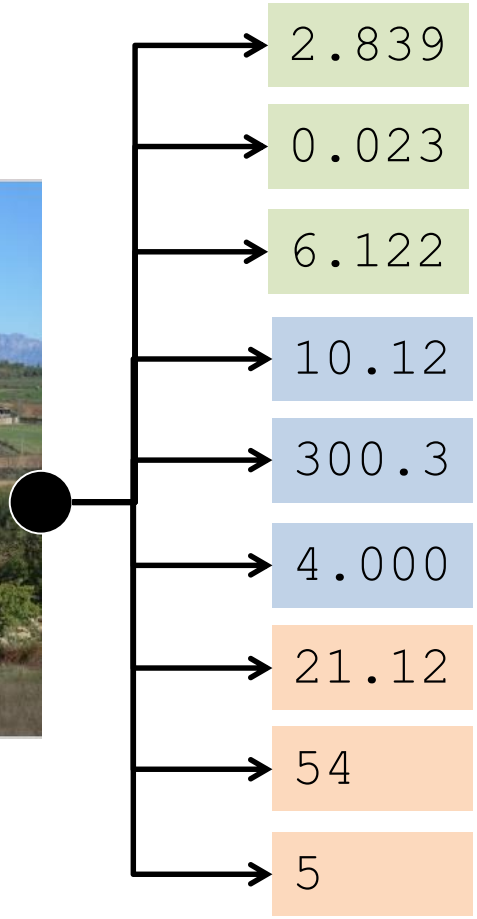
Sustainability: a multidimensional concept



Subdimensions interacting in a **non-linear** way

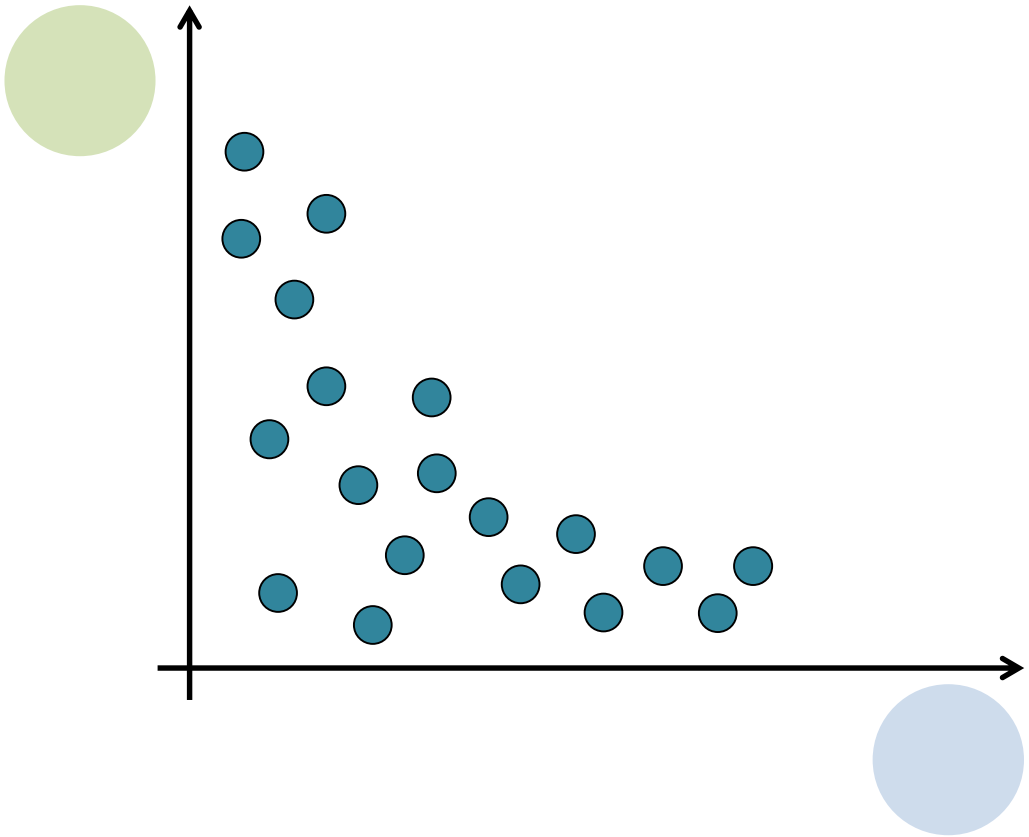
How to assess tradeoffs in sustainability

Translate the different sub-dimensions of sustainability into **measurable indicators** (avoiding aggregation)



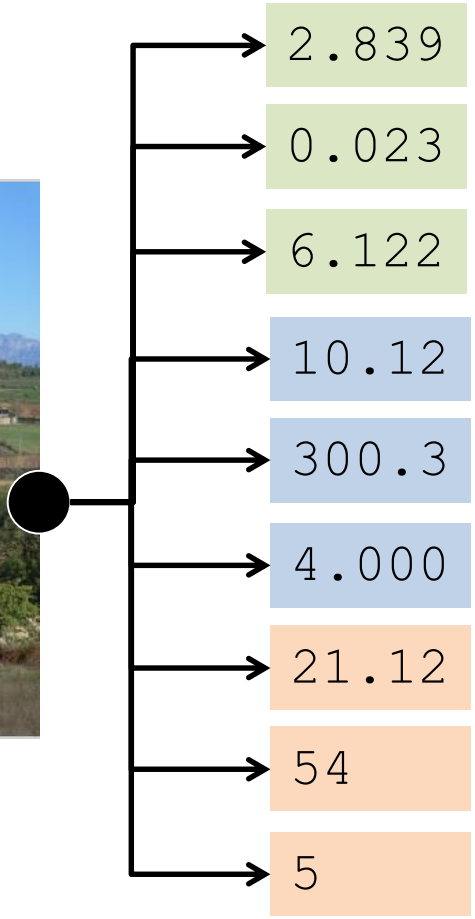
How to assess tradeoffs in sustainability

Explore relationships between indicators collected in different farms/regions



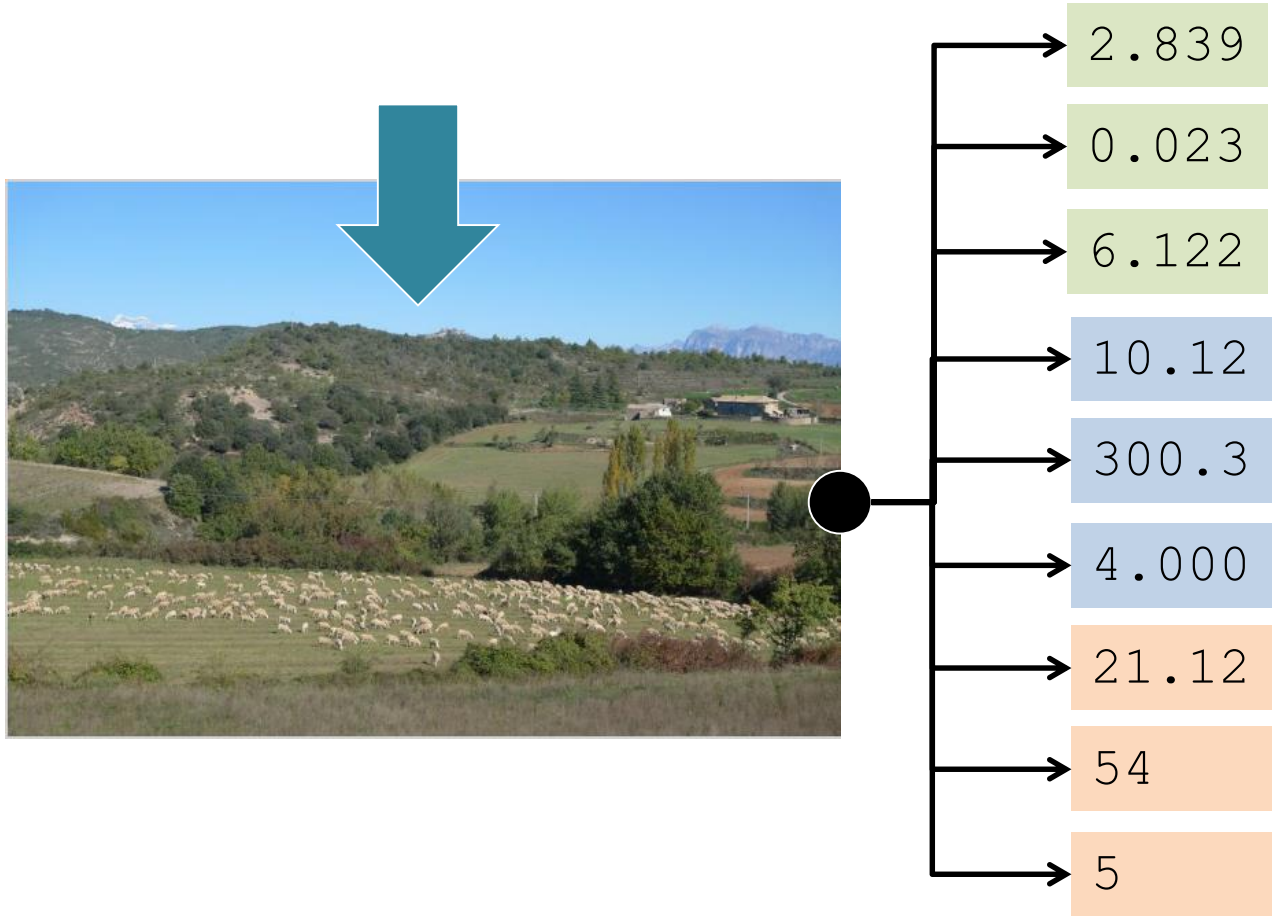
How to assess tradeoffs in sustainability

Predict **how indicators would change** in response to **modifications** to the system



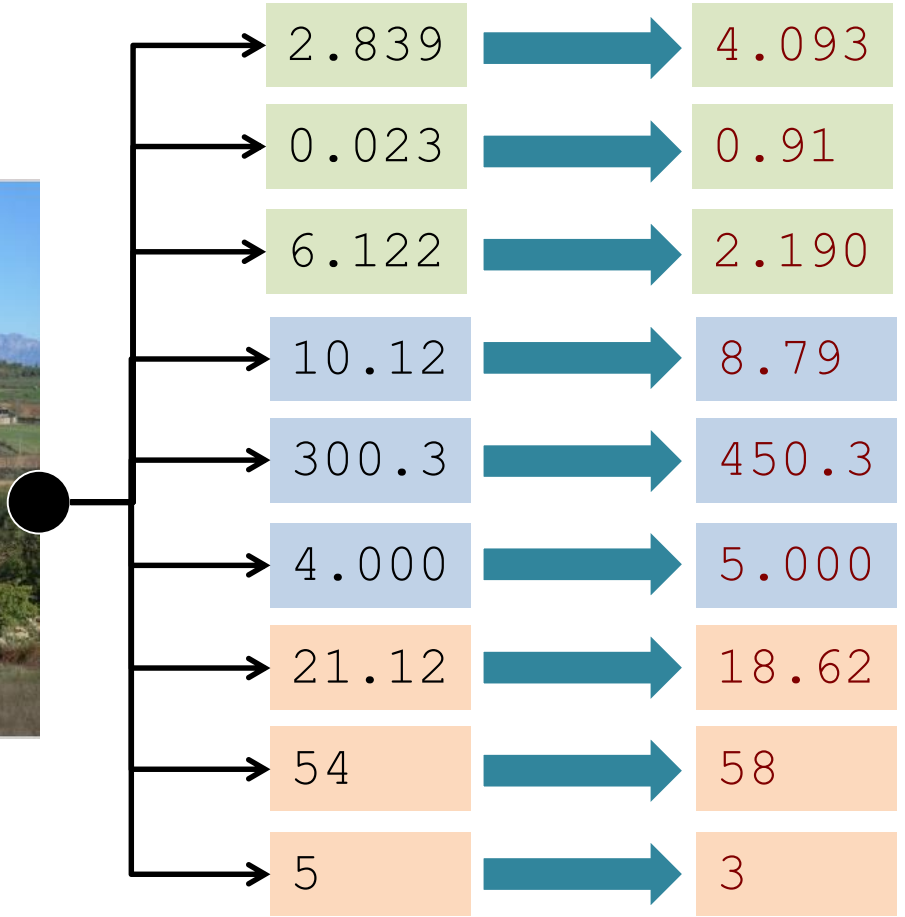
How to assess tradeoffs in sustainability

Predict **how indicators would change** in response to **modifications** to the system



How to assess tradeoffs in sustainability

Predict **how indicators would change** in response to **modifications** to the system



The project Animal Future

ERA-NETSUSAN

- **Decision support system** – set of indicators defined and collected
- **Inventory of innovations** in different European animal production systems
- Analyzing **how indicators are related**
- Predict **impacts of innovations on indicators**

- **MULTISCALE APPROACH**: from farm, to region, to Europe

Case studies

Case studies

Portugal
Alentejo region

Beef cattle on permanent pastures (some with sheep)

Case studies

Germany
Oberbayern region

Dual purpose cattle
grassland + arable

Case studies

France
Pas de Calais region

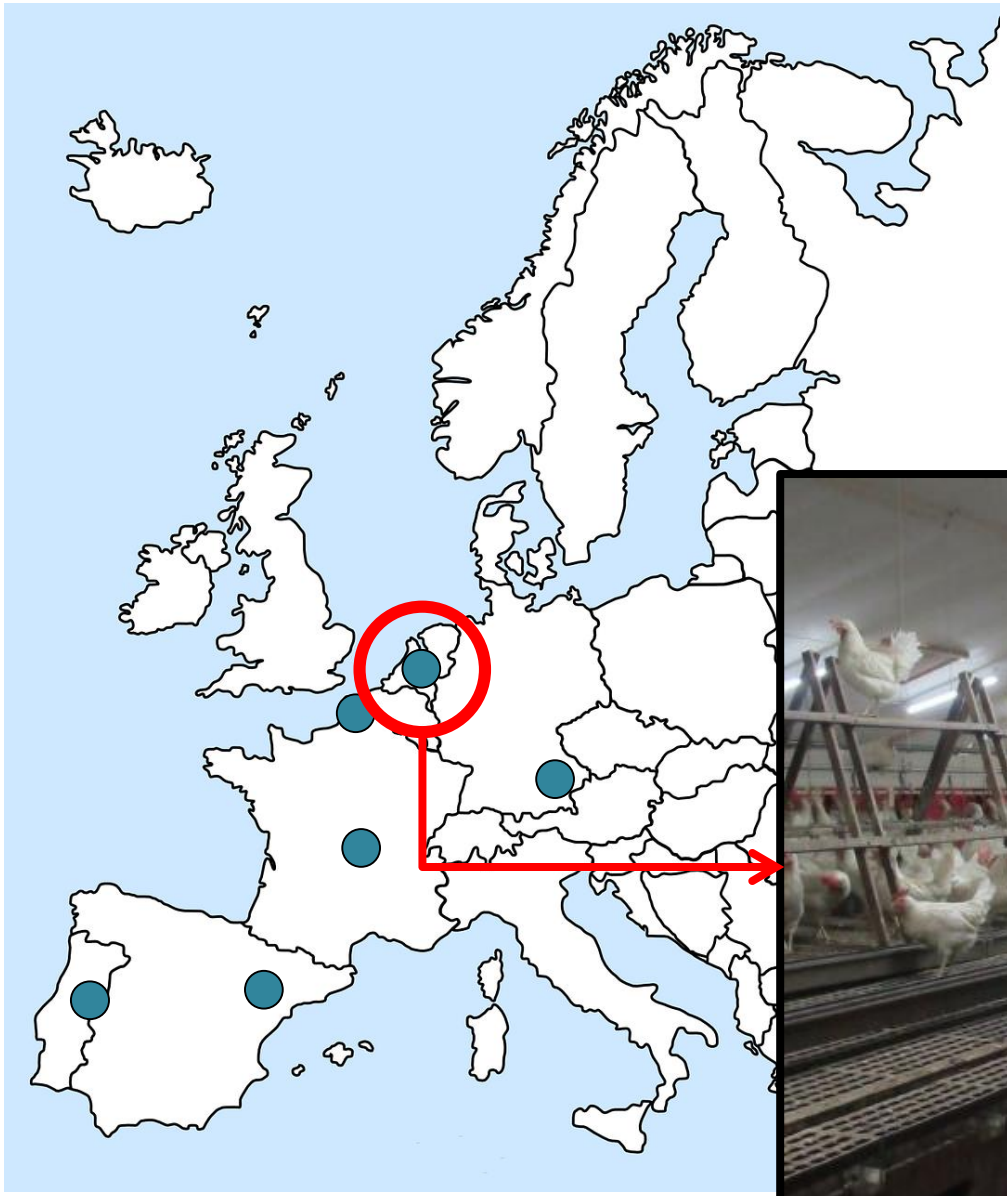
Extensive dairy cattle

Case studies

France
Bourbonnais region

Extensive beef cattle

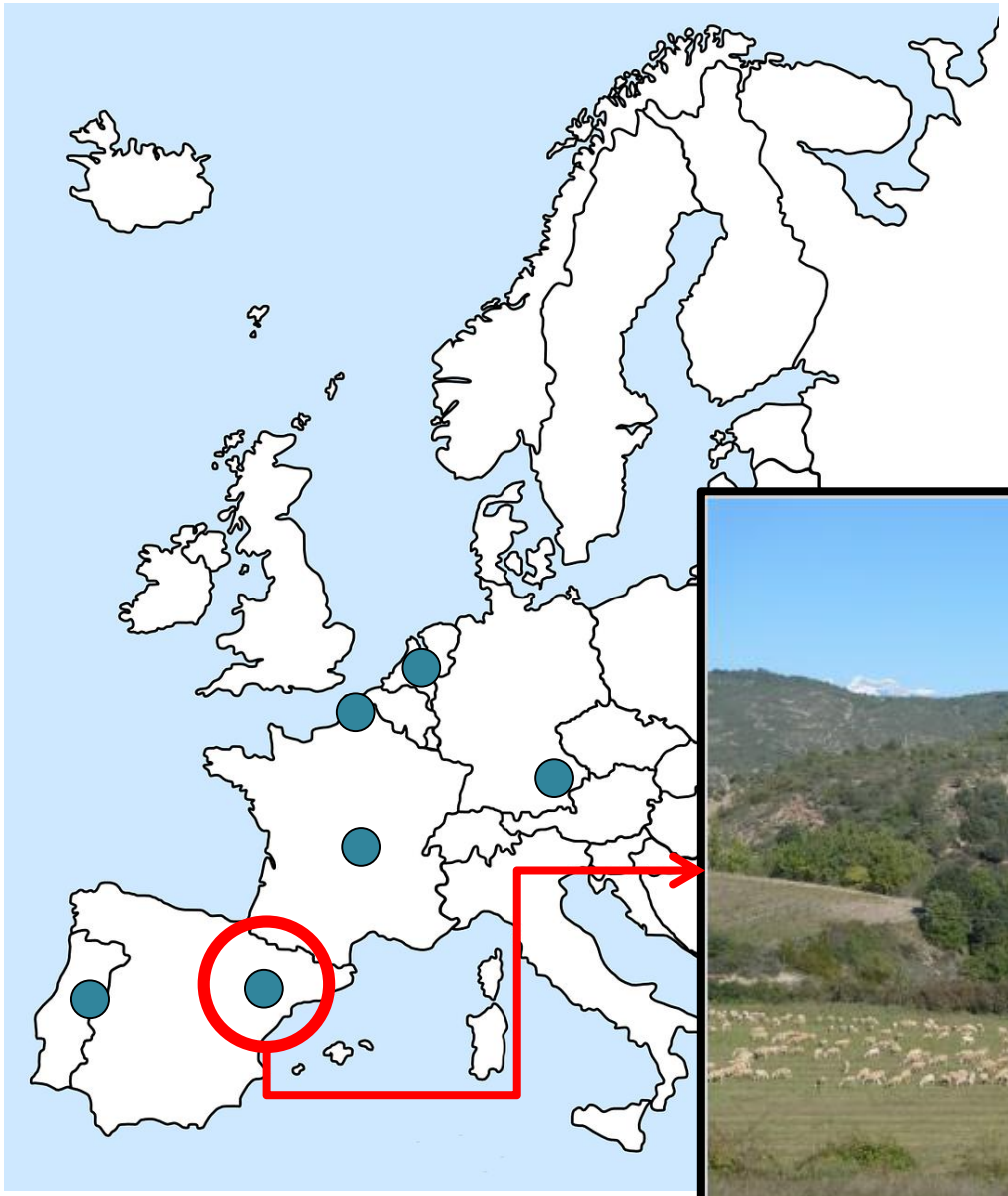
Case studies



The Netherlands
Gelderland region

Laying hens

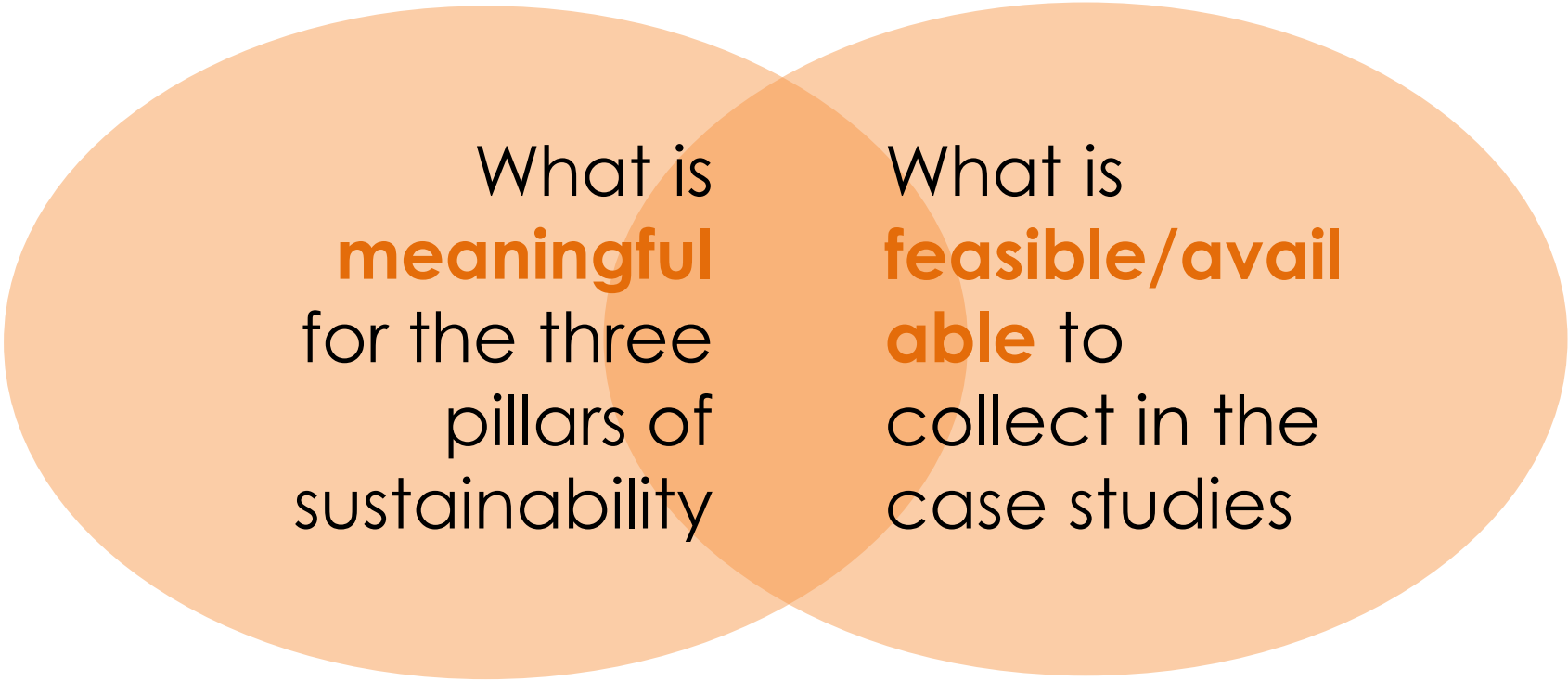
Case studies



Spain
Aragòn region

Extensive sheep

Which indicators?



- List of indicators is **open** and **non-exhaustive**
- A priori **difficult to select** the **most meaningful indicators**

Building the database

ENVIRONMENT	ECONOMY	SOCIETY
36 INDICATORS	**10** INDICATORS	**28** INDICATORS

Building the database

ENVIRONMENT	ECONOMY	SOCIETY
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Examples:

- Nitrogen input per surface unit
- Feed nitrogen self sufficiency
- Methane emission from enteric fermentation per nitrogen output
- Diesel consumption per surface unit
- Fraction of area in the Natura 2000 network
- Length of hedges

Building the database

ENVIRONMENT	ECONOMY	SOCIETY
36 INDICATORS	**10** INDICATORS	**28** INDICATORS

Examples:

- Gross farm income per work unit
- Fraction of subsidies in gross farm income

Building the database

ENVIRONMENT	ECONOMY	SOCIETY
36 INDICATORS	**10** INDICATORS	**28** INDICATORS

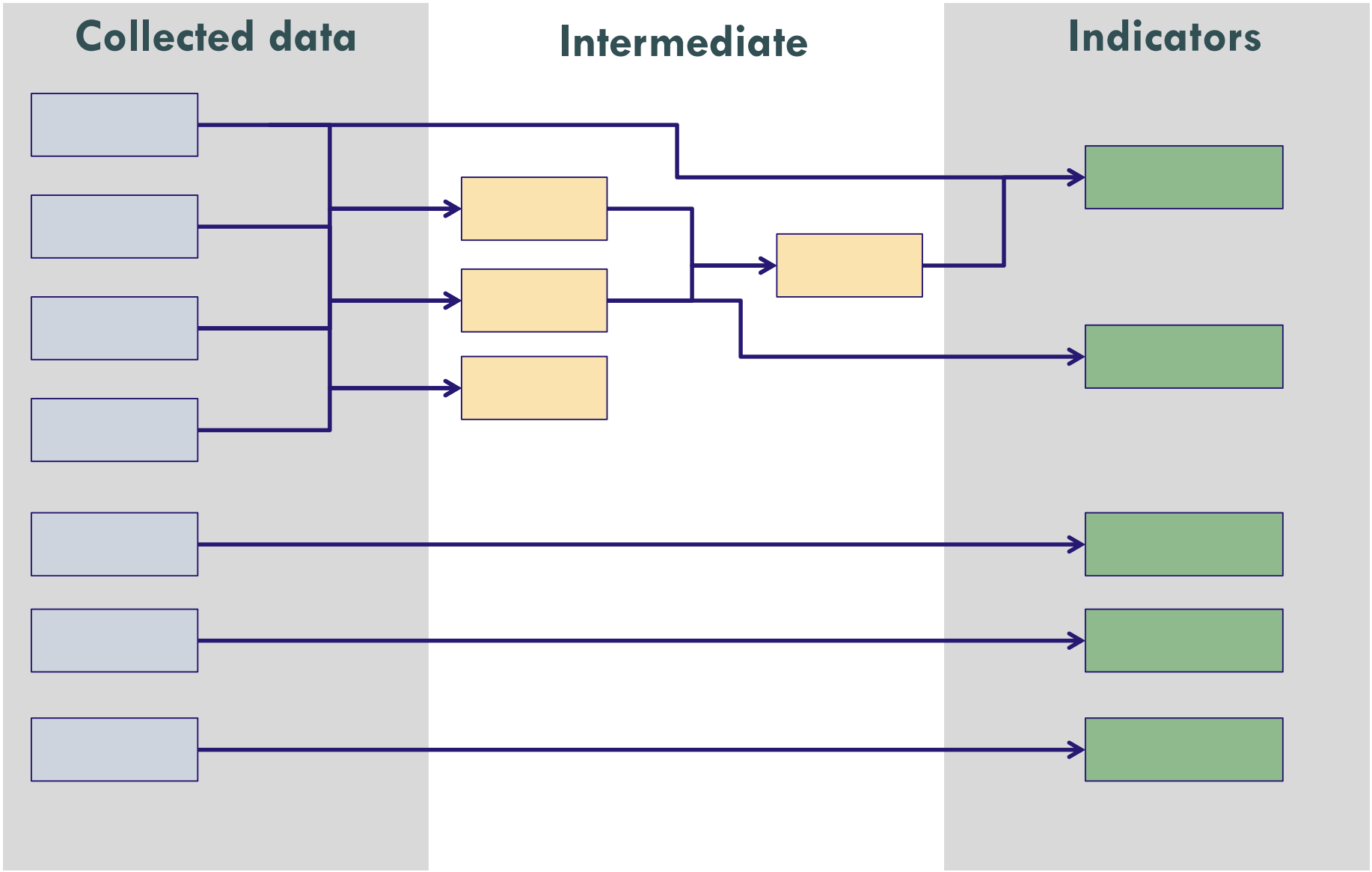
Examples:

- Days of holiday for the farmer
- Overwork and stress as perceived by the farmer
- Work-life balance
- Training days for family workers
- Days of antibiotics use for animals

Building the database: a work in progress

		ENV	ECO	SOC
GER	2Pcattle	22	22	22
FRA	DairyCattle	44	44	3
FRA	BeefCattle	48	48	3
NED	LayngHens	17	0	17
ESP	ExtSheep	10	10	10
POR	BeefCattle	34	31	19

Decision Support System: the structure



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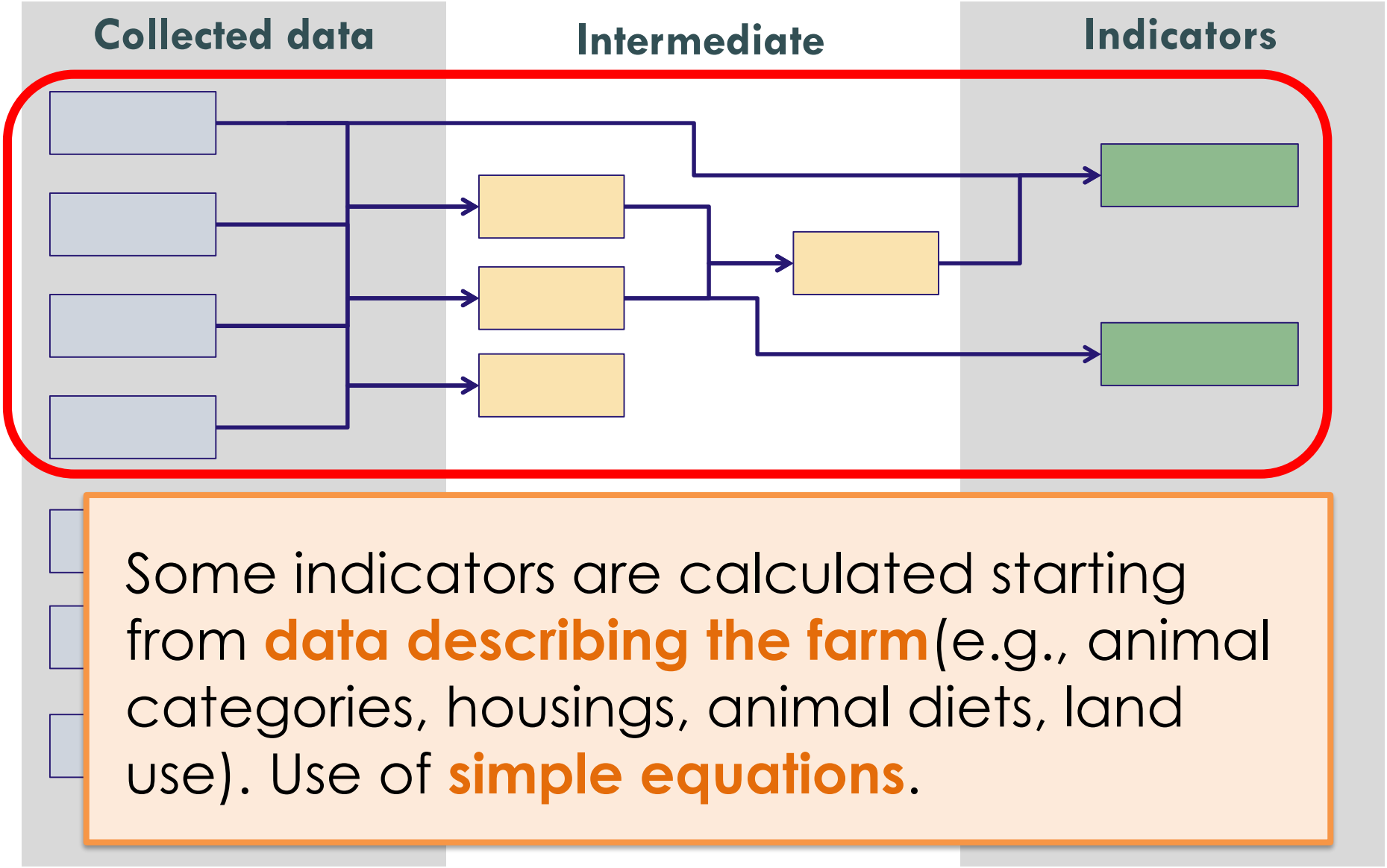
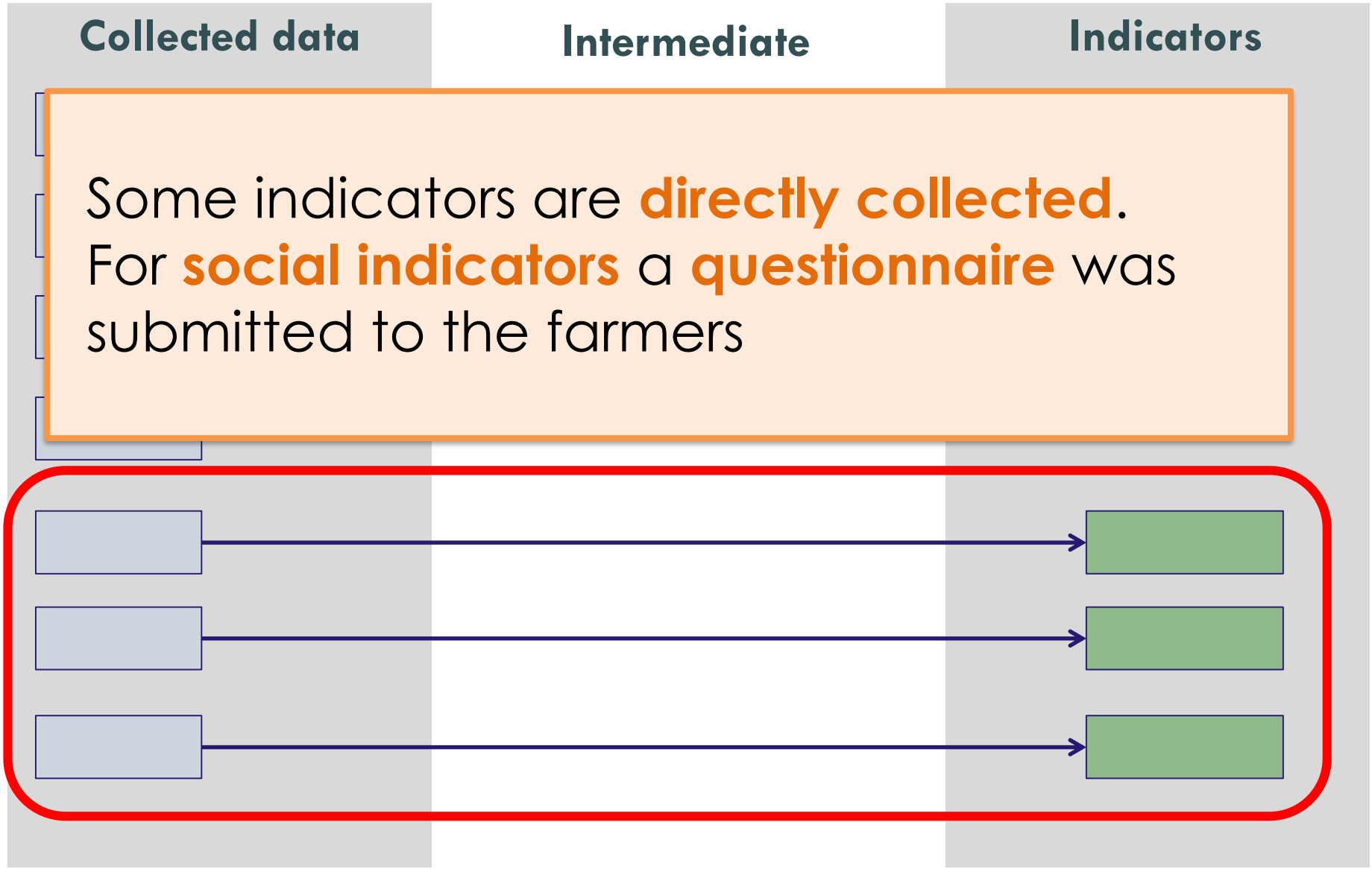


Some indicators are calculated starting from **data describing the farm**(e.g., animal categories, housings, animal diets, land use). Use of **simple equations**.

Decision Support System: the structure



Decision Support System: the structure

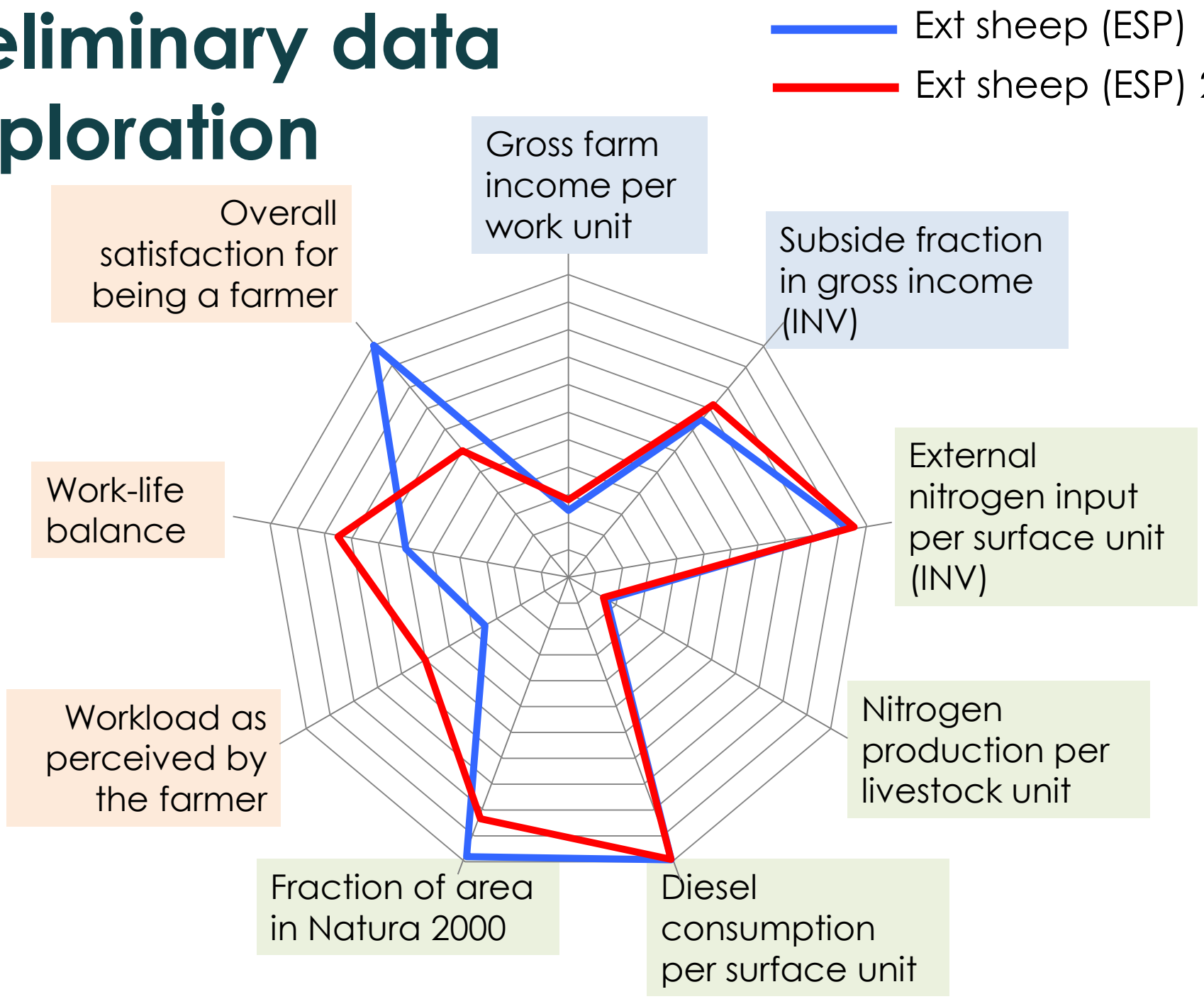
- AnimalCategories_FRA.xlsx
- AnimalCategoriesHousings_FRA.xlsx
- Areas_FRA_old.xlsx
- Areas_FRA.xlsx
- DietaryPeriods_FRA.xlsx
- DietsComposition_FRA.xlsx
- EconomicPillar_FRA_RevisedFA
- EconomicPillar_FRA.xlsx
- FarmsGeneral_FRA.xlsx
- FertilizersInArea_FRA.xlsx
- Housings_FRA.xlsx
- LandProducts_FRA.xlsx
- Resources_FRA.xlsx

A	B	C	D	E	F	G	H
FARM_ID	ANIMAL_CATEGORY_ID	LivestockType	Breed	AverageNumber	TimeFractionOnFarm	LivestockUnitCoefficient	Mortality
6	DairyCows	Cattle	11: Fleckvieh	76.31	1	Default	0.05
6	F06	Cattle	11: Fleckvieh	15.94	1	Default	0.00
6	F12	Cattle	11: Fleckvieh	23.8	1	Default	0.00
6	F2	Cattle	11: Fleckvieh	4.1	1	Default	0.00
6	F61	Cattle	11: Fleckvieh	13.26	1	Default	0.00
6	female calves (born)	Cattle	11: Fleckvieh	1.47	1	Default	0.05
6	M06	Cattle	11: Fleckvieh	3.69	1	Default	0.03
6	male calves (born)	Cattle	11: Fleckvieh	1.86	1	Default	0.00
7	DairyCows	Cattle	11: Fleckvieh	46.28	1	Default	0.02
7	F06	Cattle	11: Fleckvieh	6.03	1	Default	0.08
7	F12	Cattle	11: Fleckvieh	10.72	1	Default	0.00
7	F2	Cattle	11: Fleckvieh	5.02	1	Default	0.00
7	F61	Cattle	11: Fleckvieh	5.31	1	Default	0.00
7	female calves (born)	Cattle	11: Fleckvieh	0.91	1	Default	0.04
7	M06	Cattle	11: Fleckvieh	0.99	1	Default	0.00
7	male calves (born)	Cattle	11: Fleckvieh	0.88	1	Default	0.04
8	DairyCows	Cattle	11: Fleckvieh	68.5	1	Default	0.01
8	F06	Cattle	11: Fleckvieh	29.46	1	Default	0.05
8	F12	Cattle	11: Fleckvieh	39.5	1	Default	0.00
8	F2	Cattle	11: Fleckvieh	17	1	Default	0.04
8	F61	Cattle	11: Fleckvieh	26.5	1	Default	0.00
8	fattening bulls 1-2 years	Cattle	11: Fleckvieh	1	1	Default	0.00
8	female calves (born)	Cattle	11: Fleckvieh	2.19	1	Default	0.00
8	M06	Cattle	11: Fleckvieh	6.44	1	Default	0.00
8	male calves (born)	Cattle	11: Fleckvieh	2.07	1	Default	0.07

```
def CalculateNitrogenInProducedAnimals( self ):
    self.NitrogenInProducedAnimals = self.NumberOfProducedAnimals * self.LiveWeightAtSla

def CalculateNitrogenInSoldAnimals( self ):
    self.NitrogenInSoldAnimals =  self.NumberOfSoldAnimals * self.LiveWeightAtSale * sel

def CalculateNitrogenInMilk( self ):
    if ( self.AnnualMilkProduction == 'Not Applicable' ) or ( self.AnnualMilkProduction
        self.NitrogenInMilk = 0
    else:
        self.NitrogenInMilk = self.AverageNumber * self.AnnualMilkProduction * self.Prot

def CalculateNitrogenInEggs( self ):
    if ( self.EggsPerHen == 'Not Applicable' ) or ( self.LayingFraction == 'Not Applicab
        self.NitrogenInEggs = 0
    else:
        self.NitrogenInEggs = self.AverageNumber * self.LayingFraction * self.EggsPerHen

def CalculateNitrogenInWool( self ):
    if self.WoolProduction == 'Not Applicable':
        self.NitrogenInWool = 0
    else:
        self.NitrogenInWool = self.AverageNumber * self.WoolProduction * self.WoolProtei

def CalculateNitrogenOutput( self ):
    self.CalculateNitrogenInProducedAnimals()
    self.CalculateNitrogenInSoldAnimals()
    self.CalculateNitrogenInMilk()
    self.CalculateNitrogenInEggs()
    self.CalculateNitrogenInWool()
    self.TotalNitrogenOutput = self.NitrogenInProducedAnimals + self.NitrogenInSoldAnima


def CalculateFeedIntakeIndicators( self, DIETS ):
    self.TotalDryMatterIntake = 0
```

- A set of excel tables organized as a **relational database**
- A python **object-oriented code** for computing indicators
- Ambition: to be put **on line**

Preliminary data exploration



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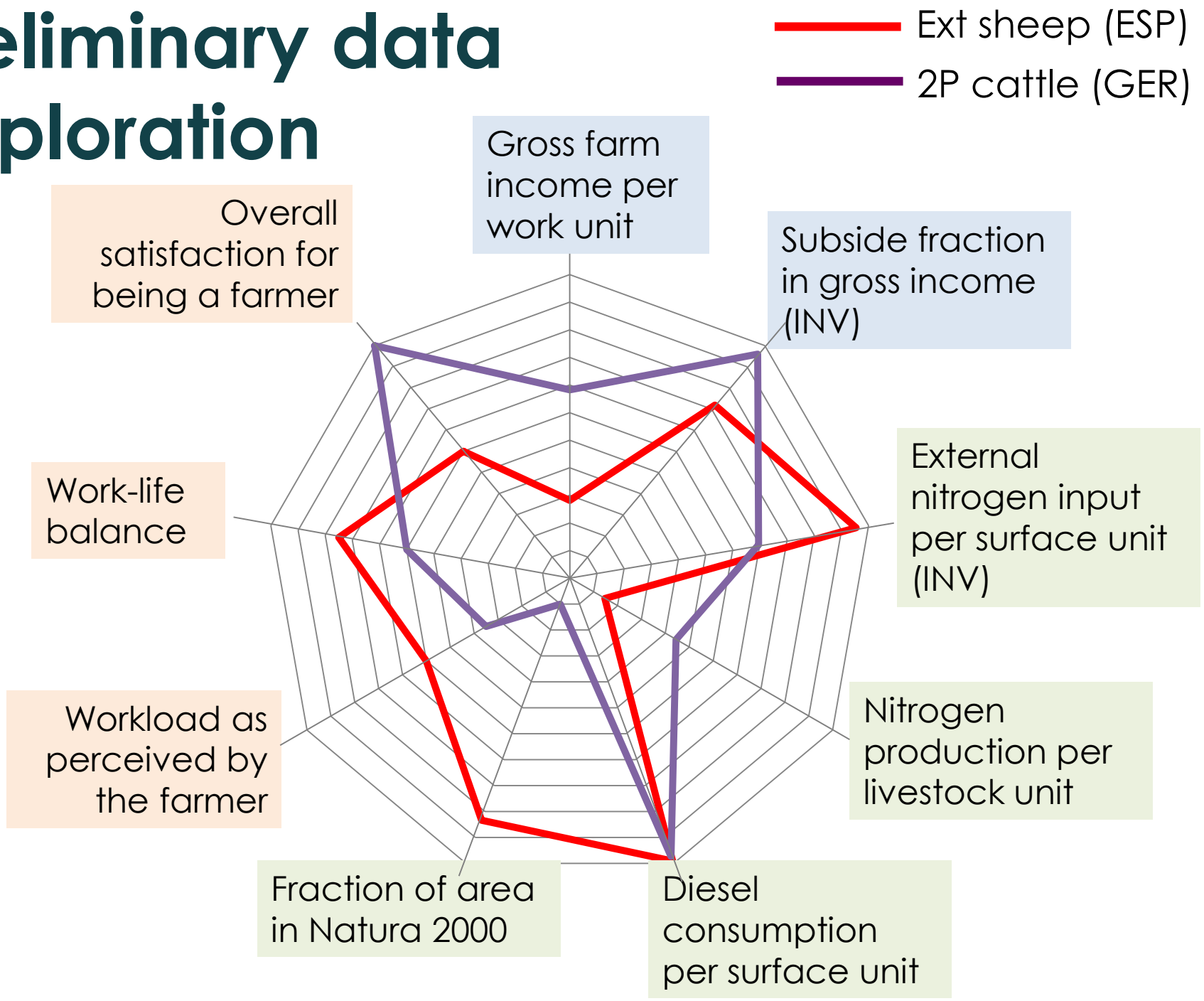

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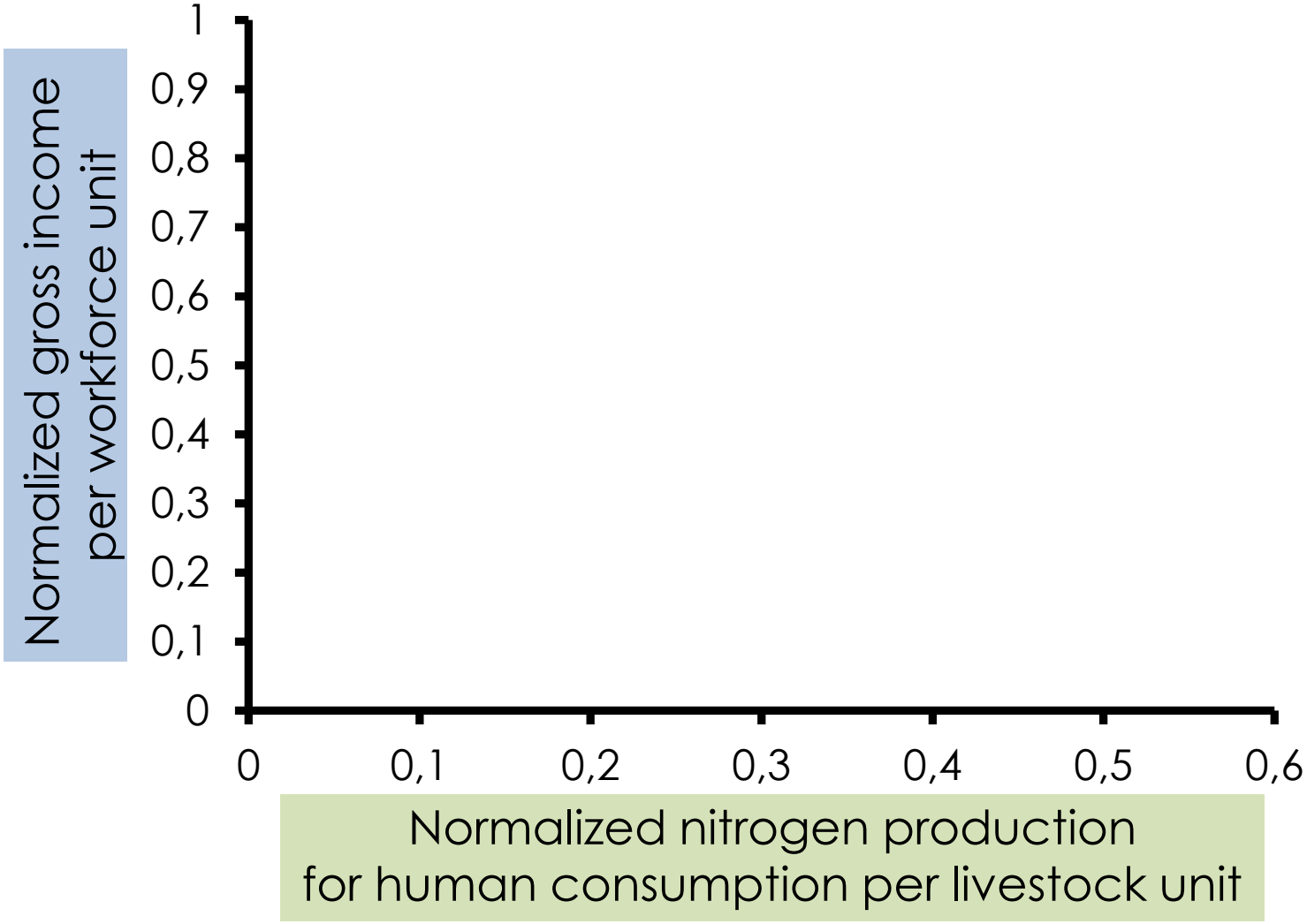

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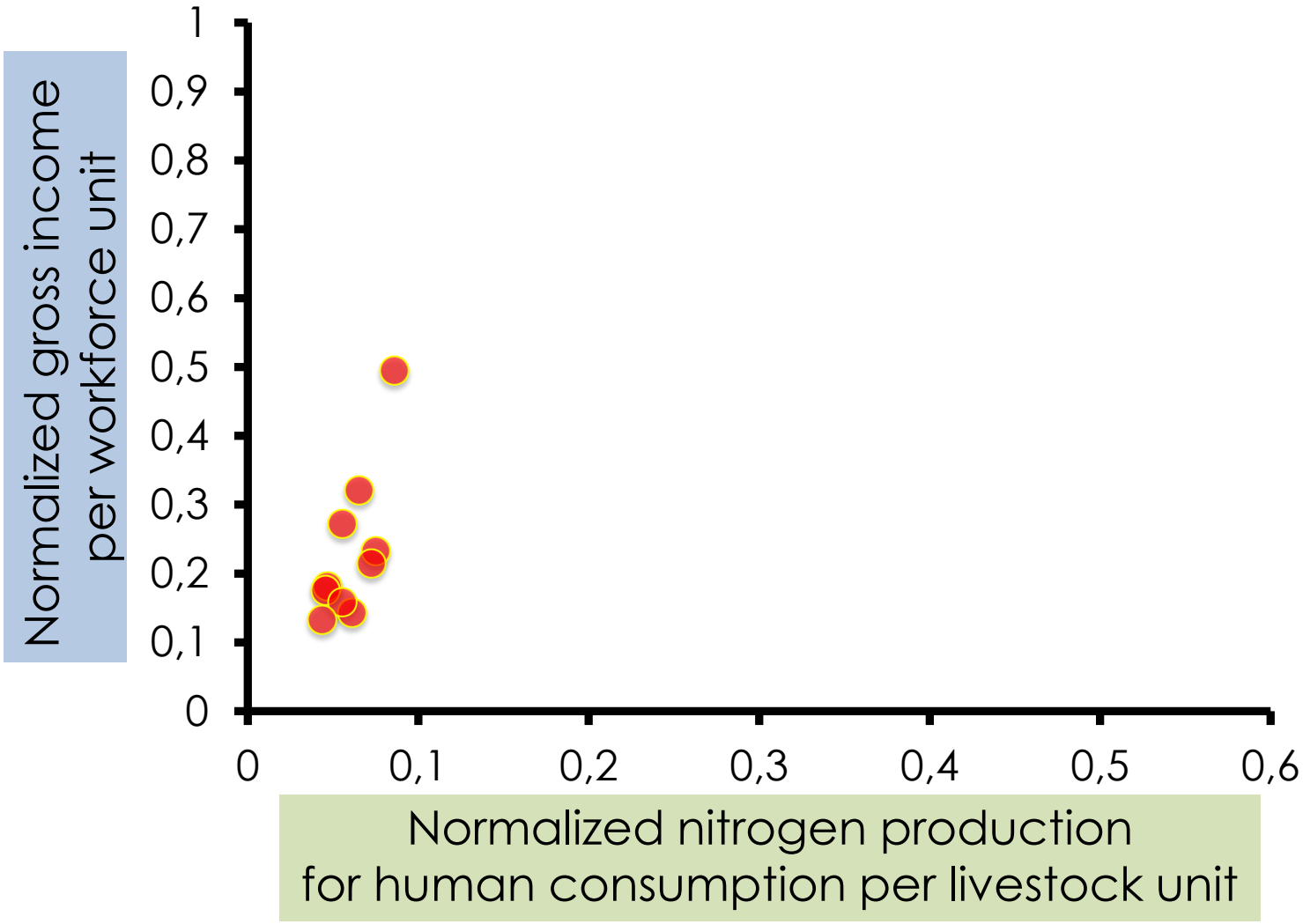

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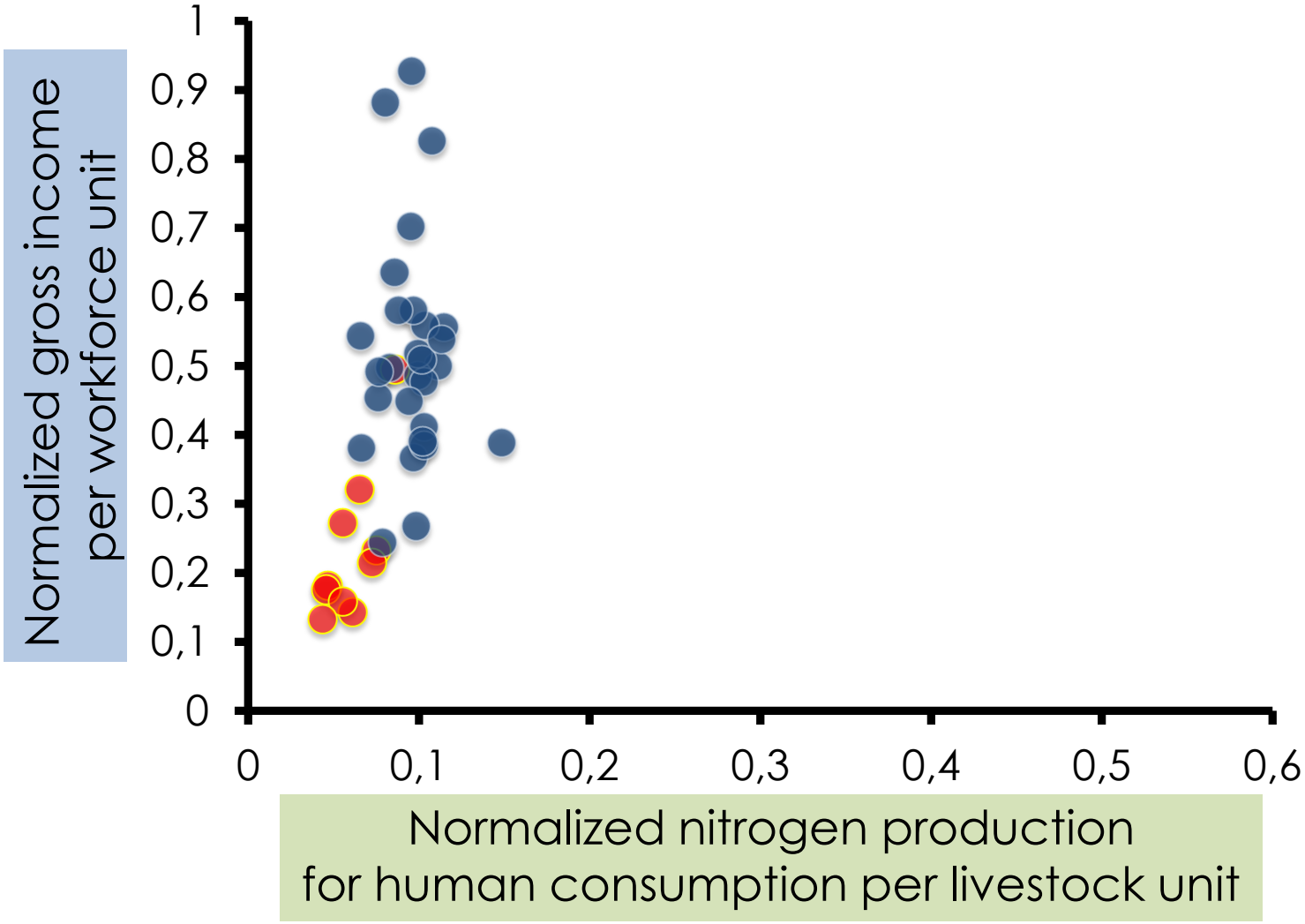

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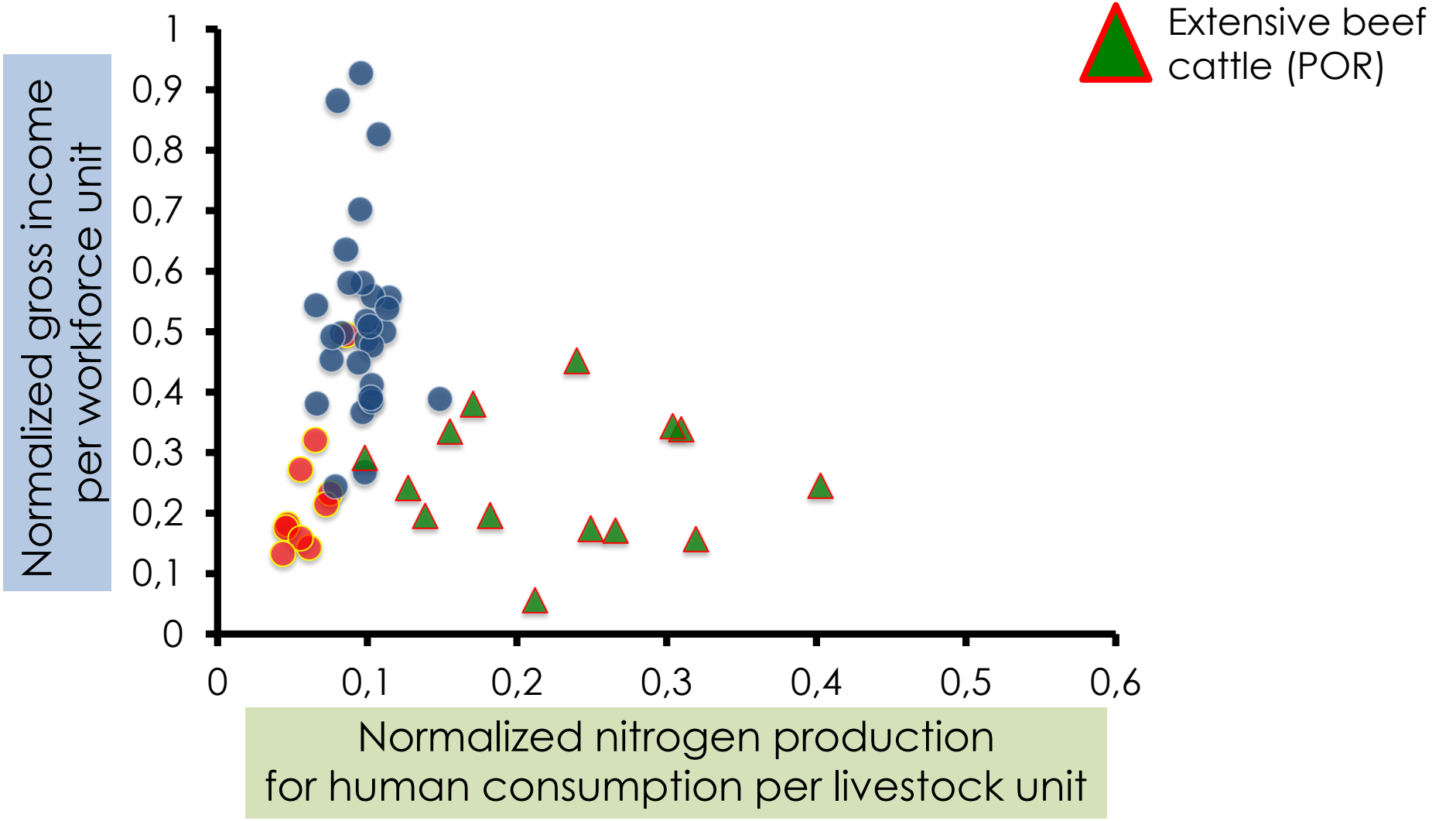

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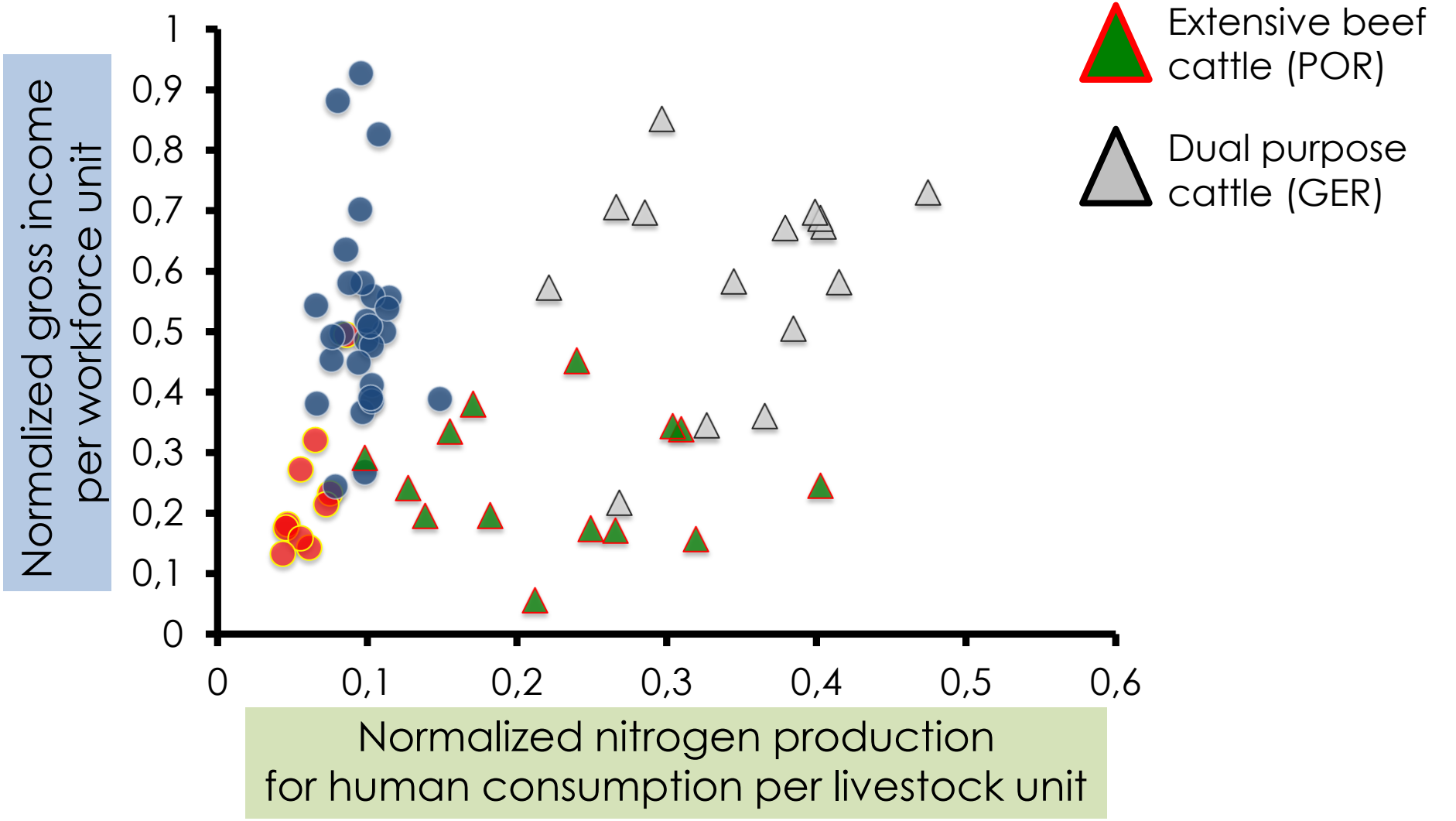

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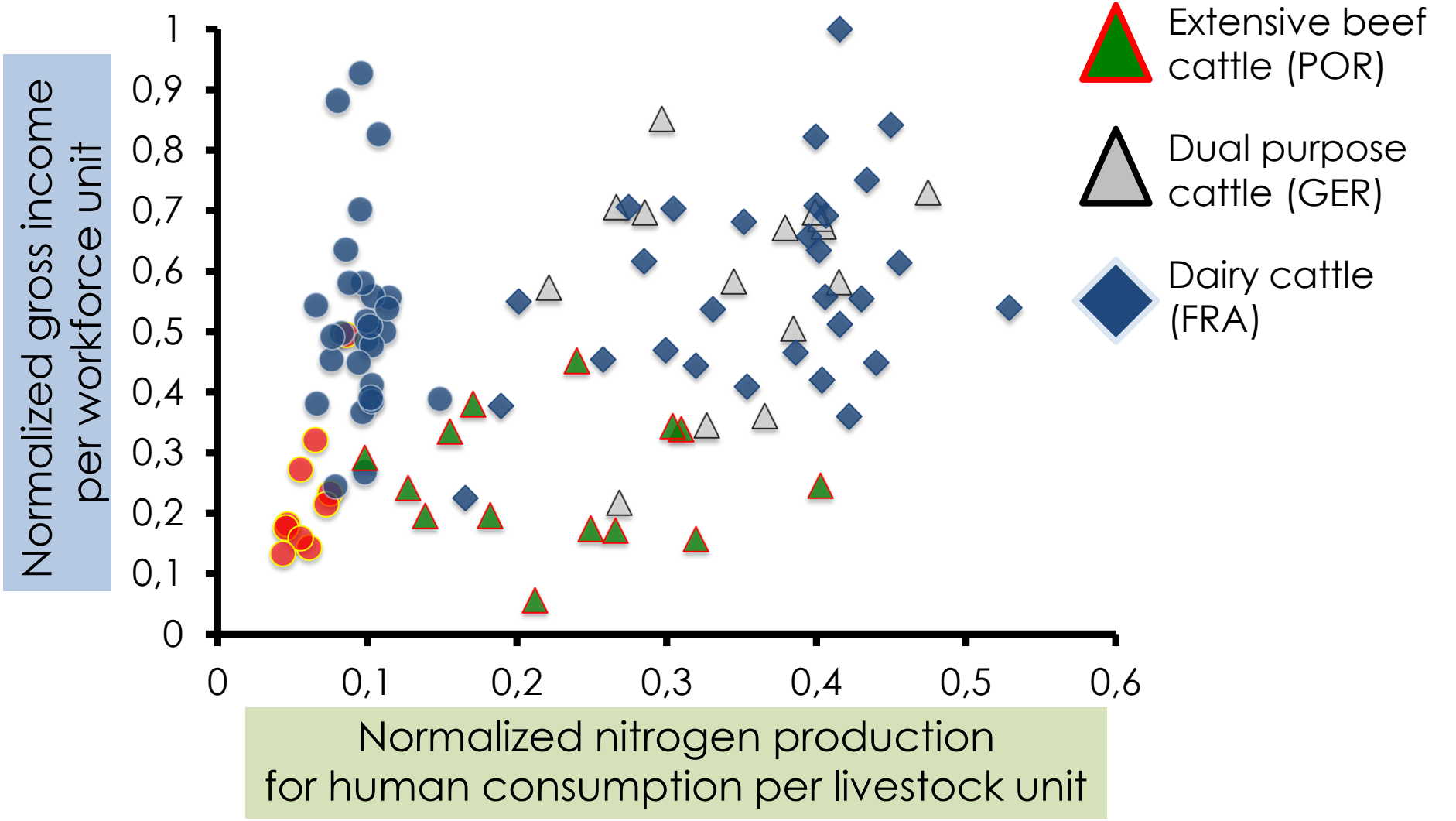

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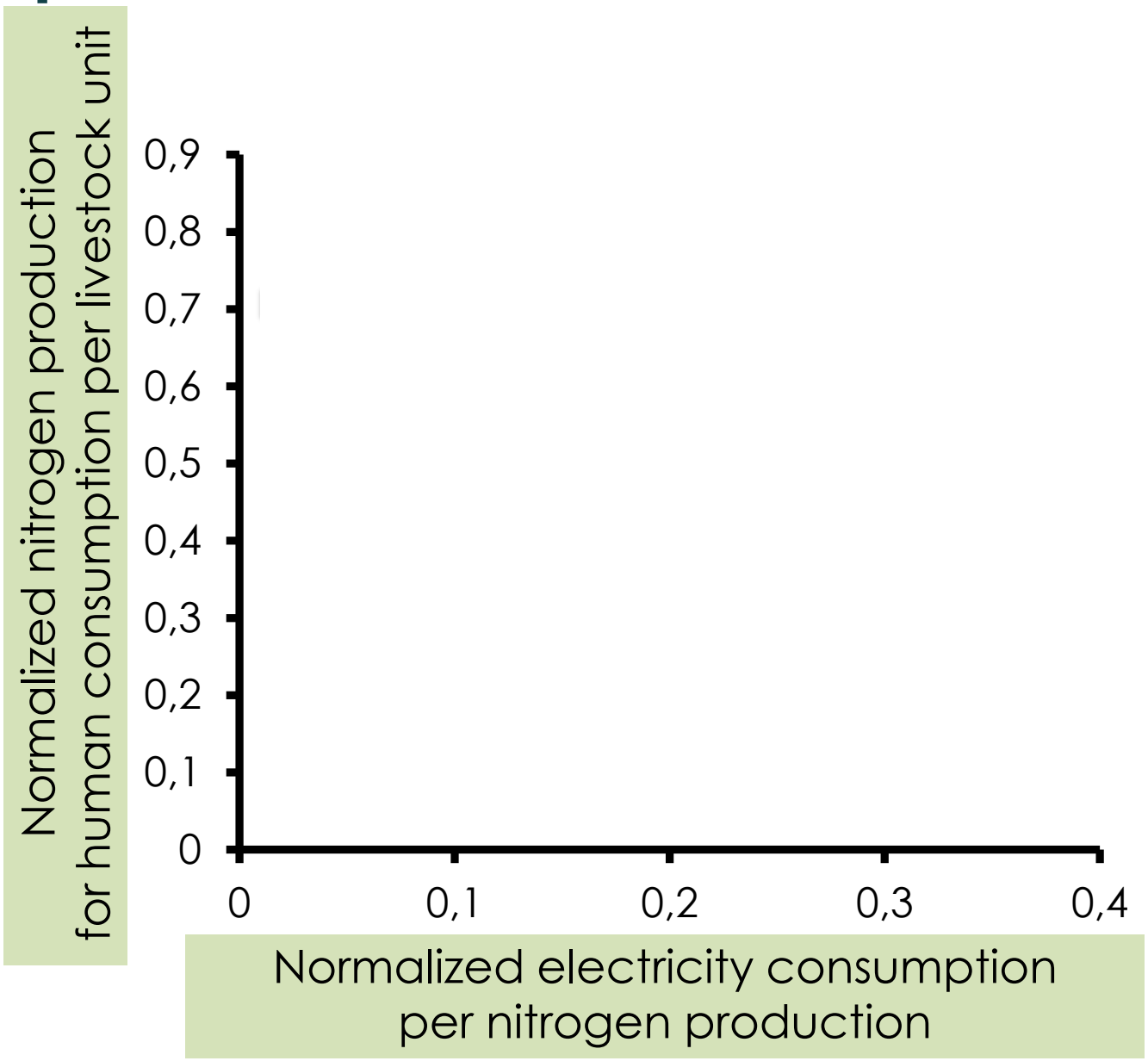

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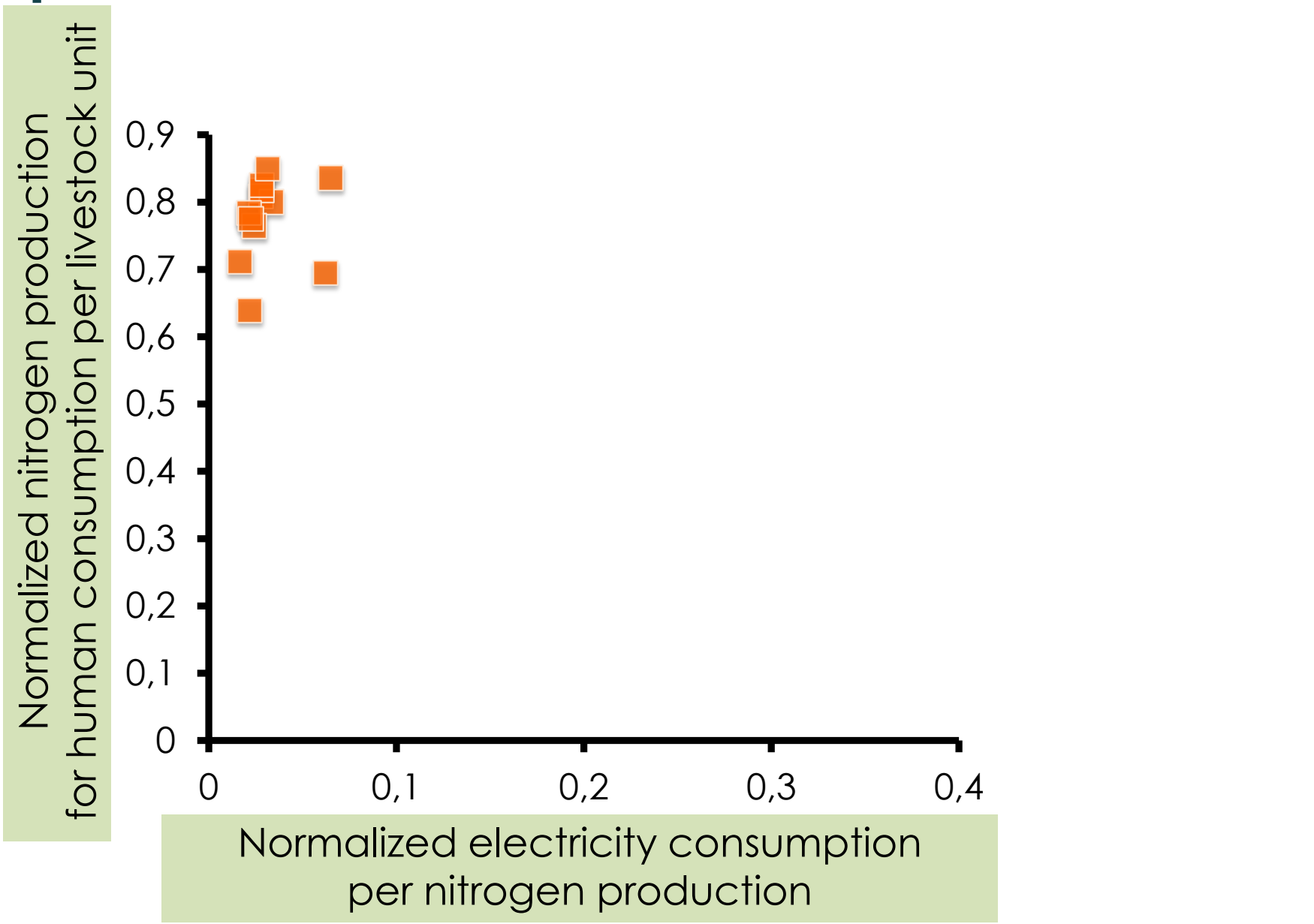

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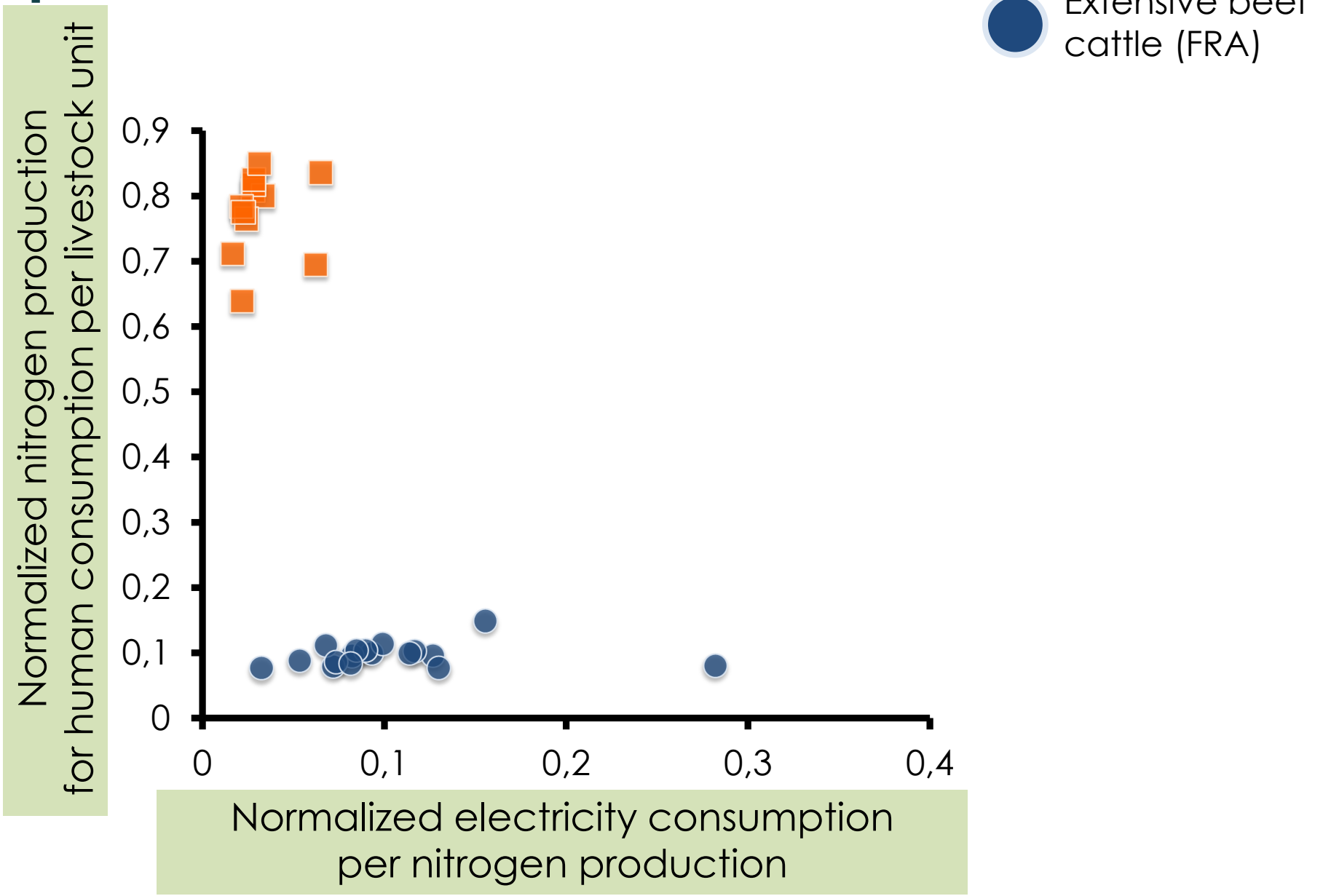

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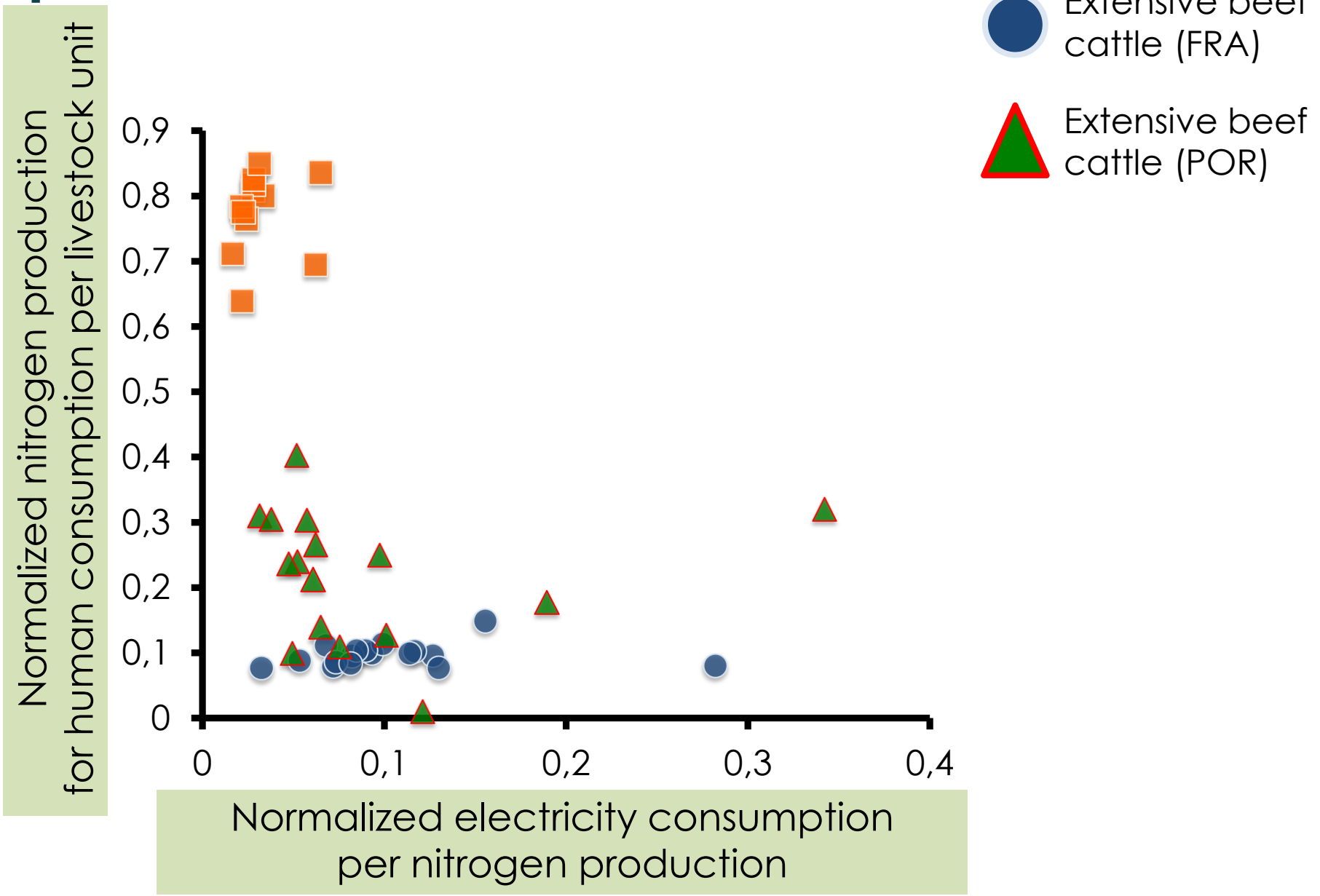

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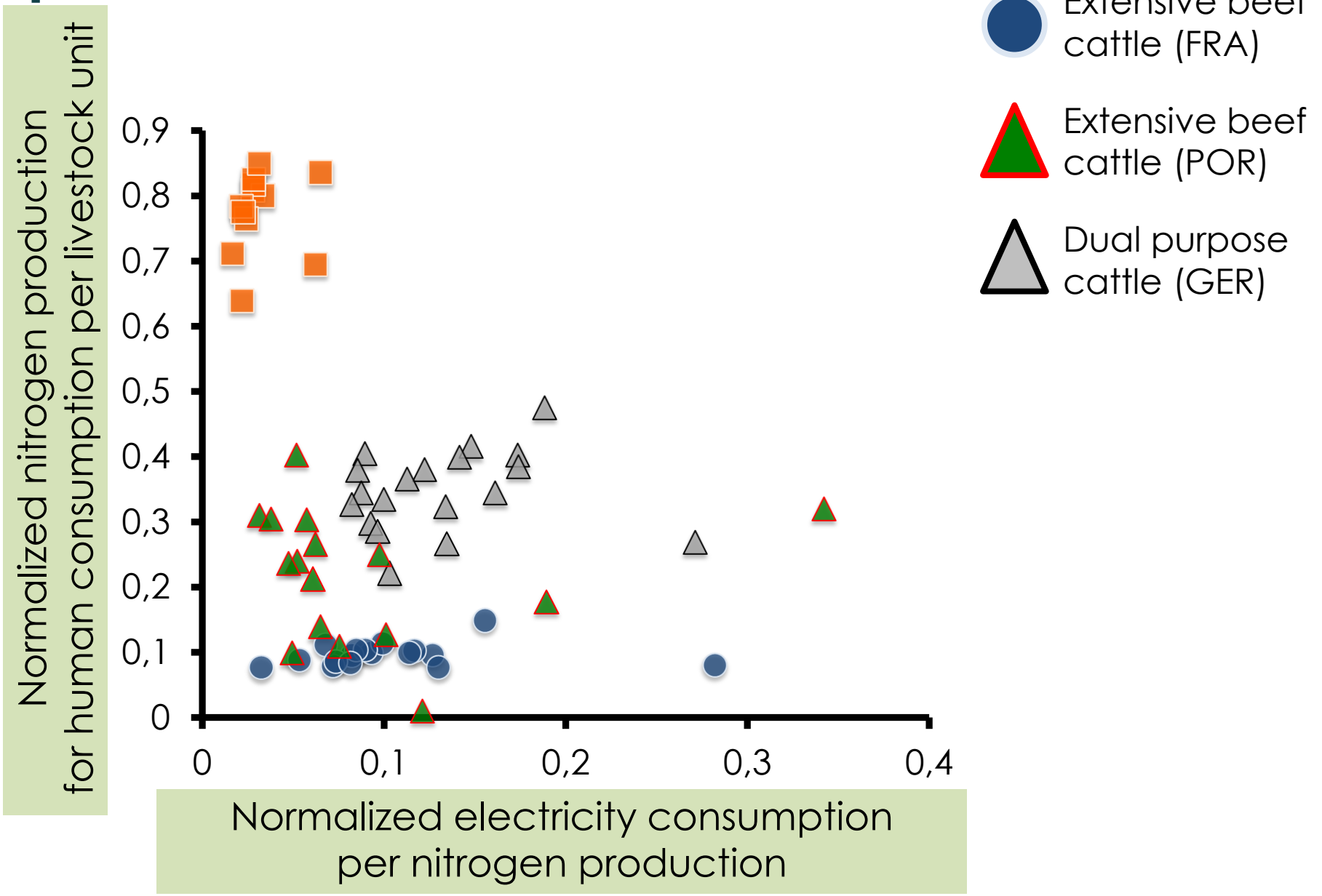

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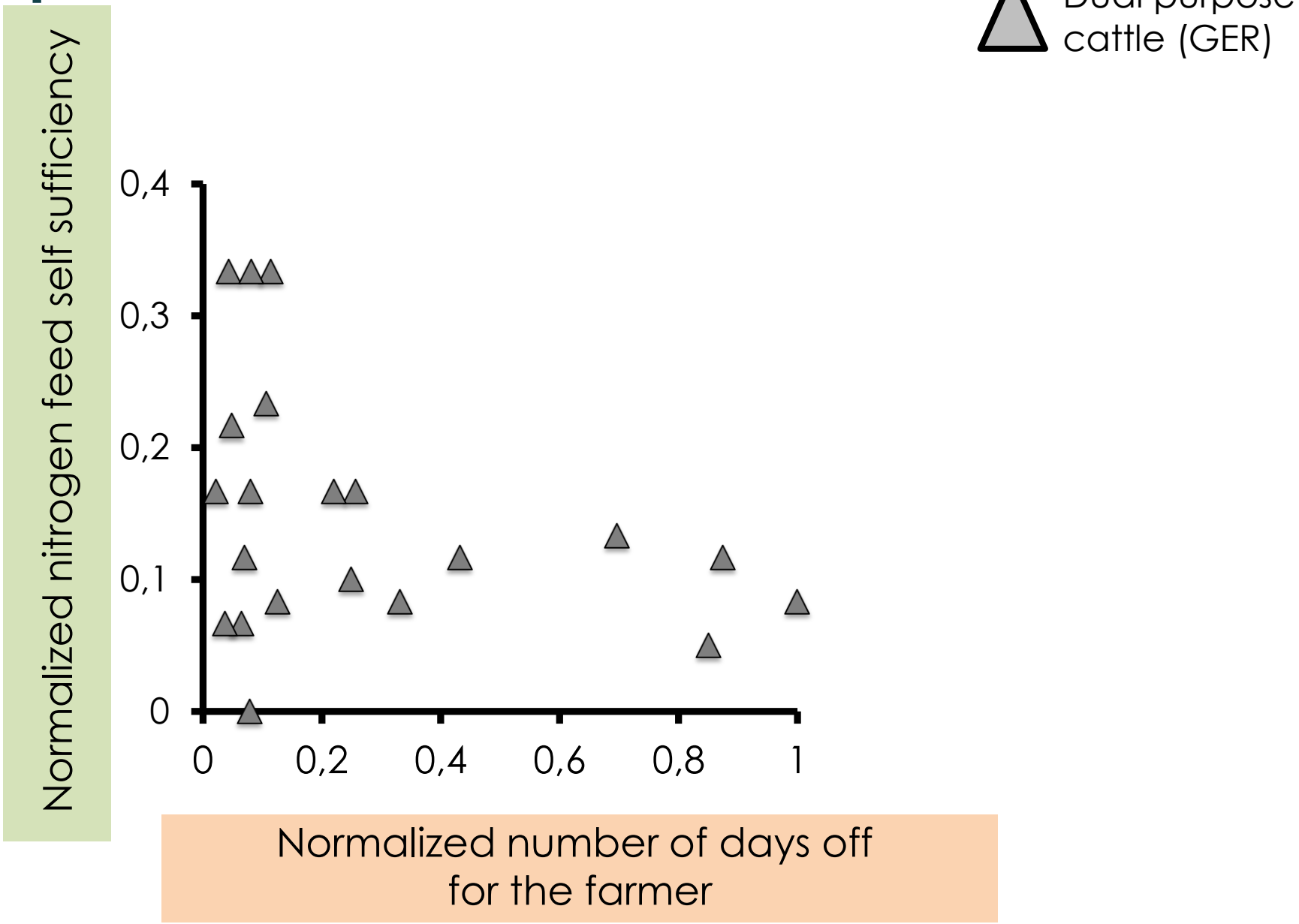
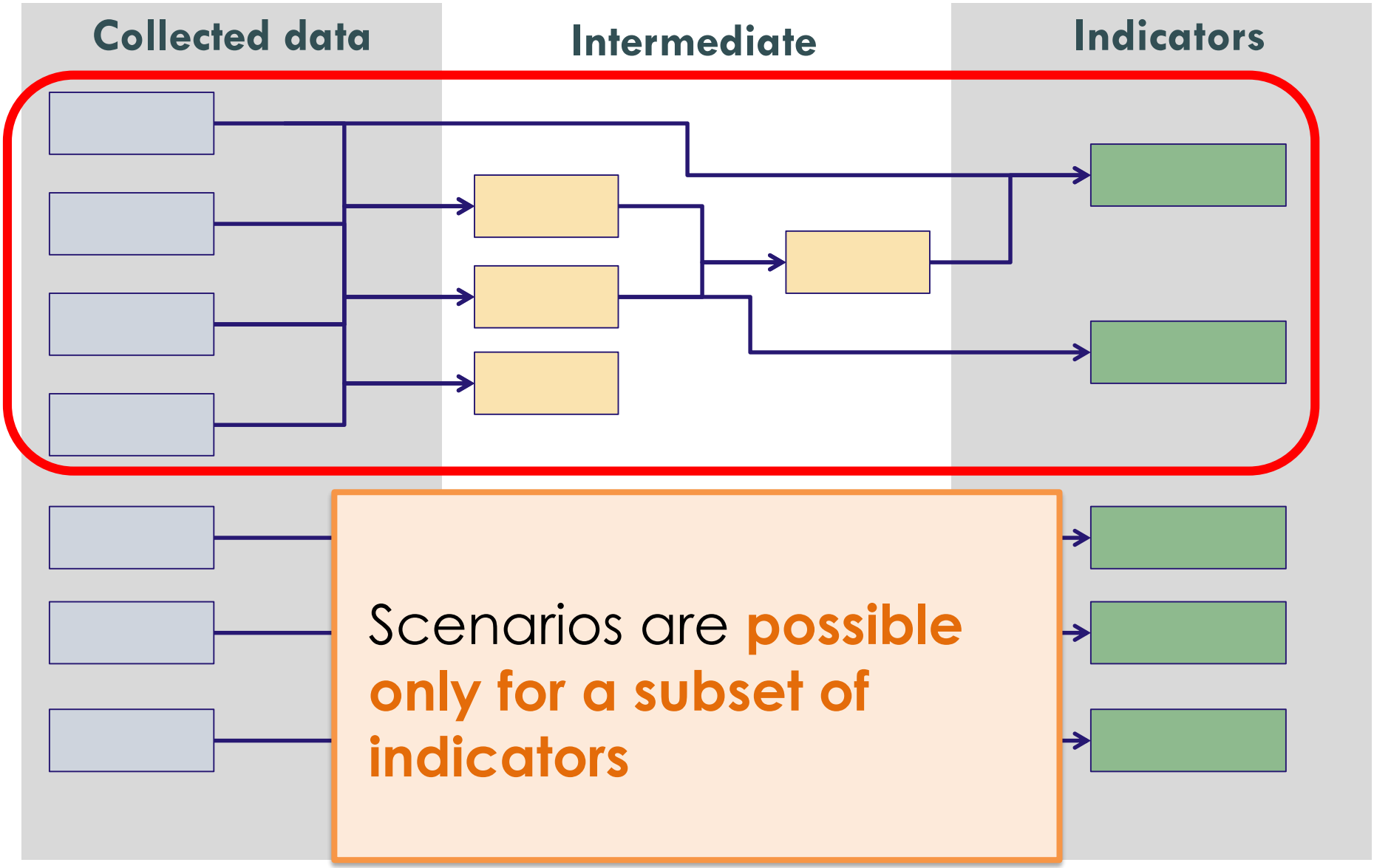


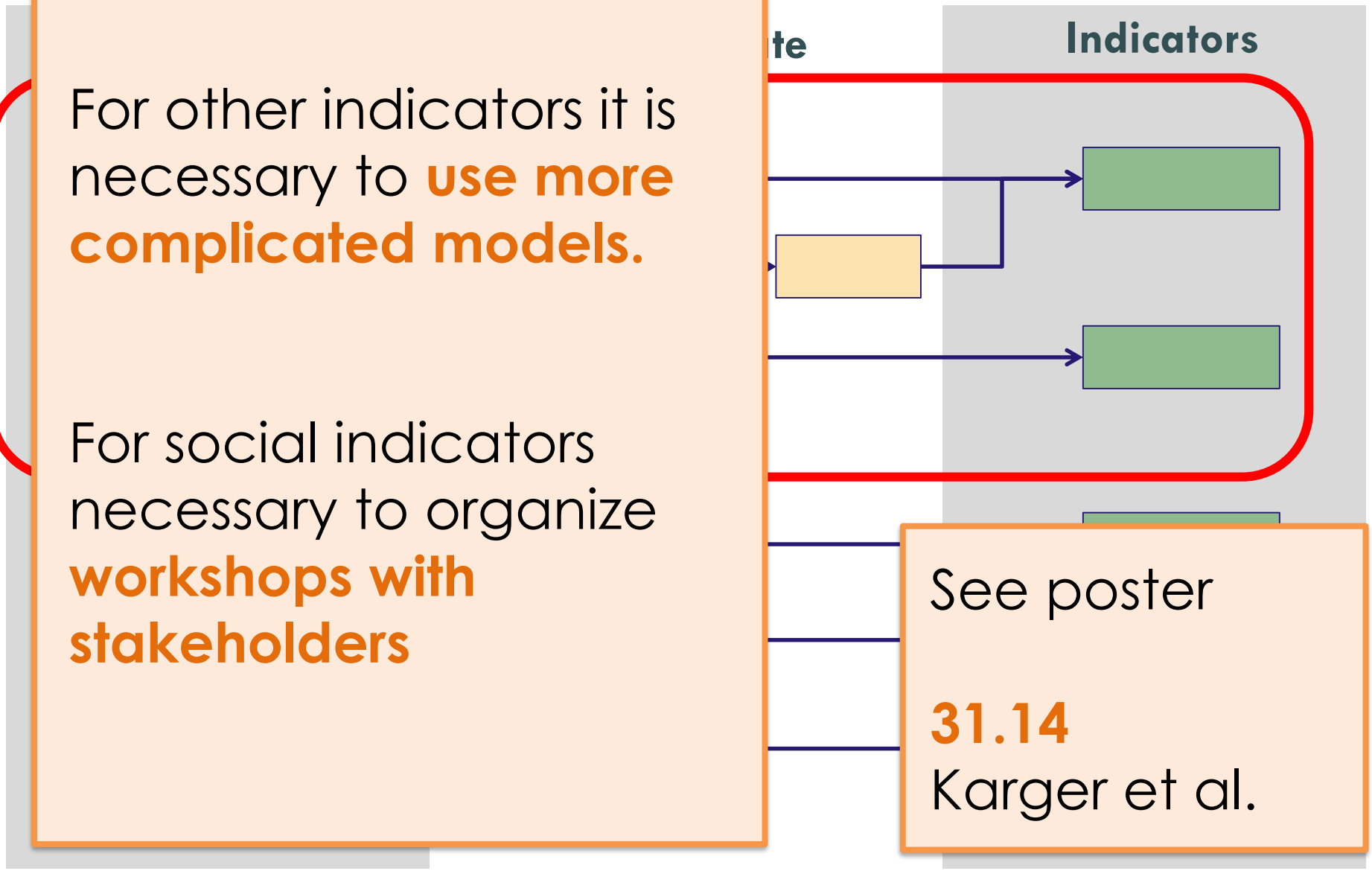
Scenarios


Collected data
Intermediate
Indicators
Scenarios are possible only for a subset of indicators

Scenarios

For other indicators it is necessary to **use more complicated models.**

For social indicators necessary to organize **workshops with stakeholders**



See poster

31.14
Karger et al.

Perspectives

- Completing the data collection
- **Systematic exploration of relationships** between indicators

Thank you!

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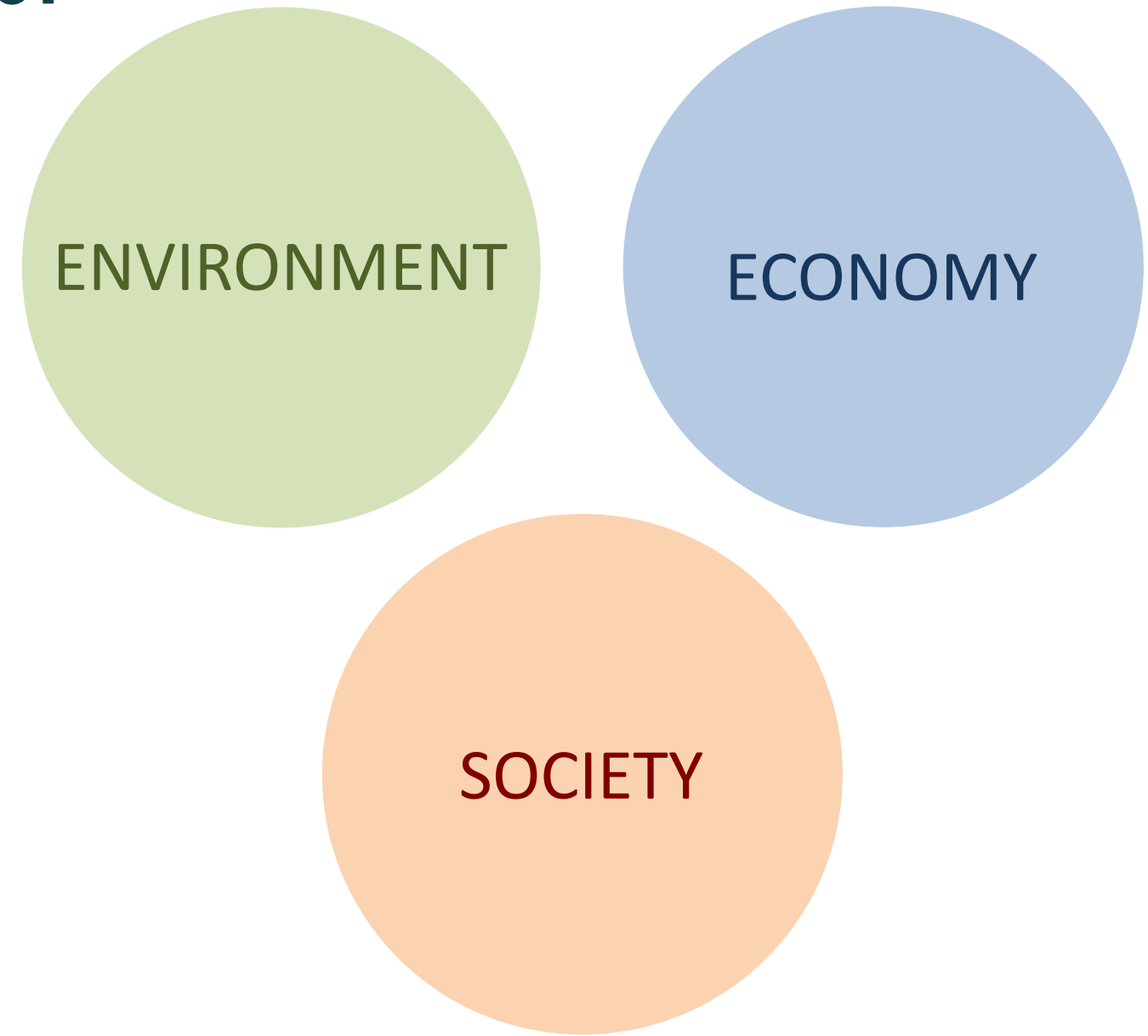
Sustainability: a multidimensional concept



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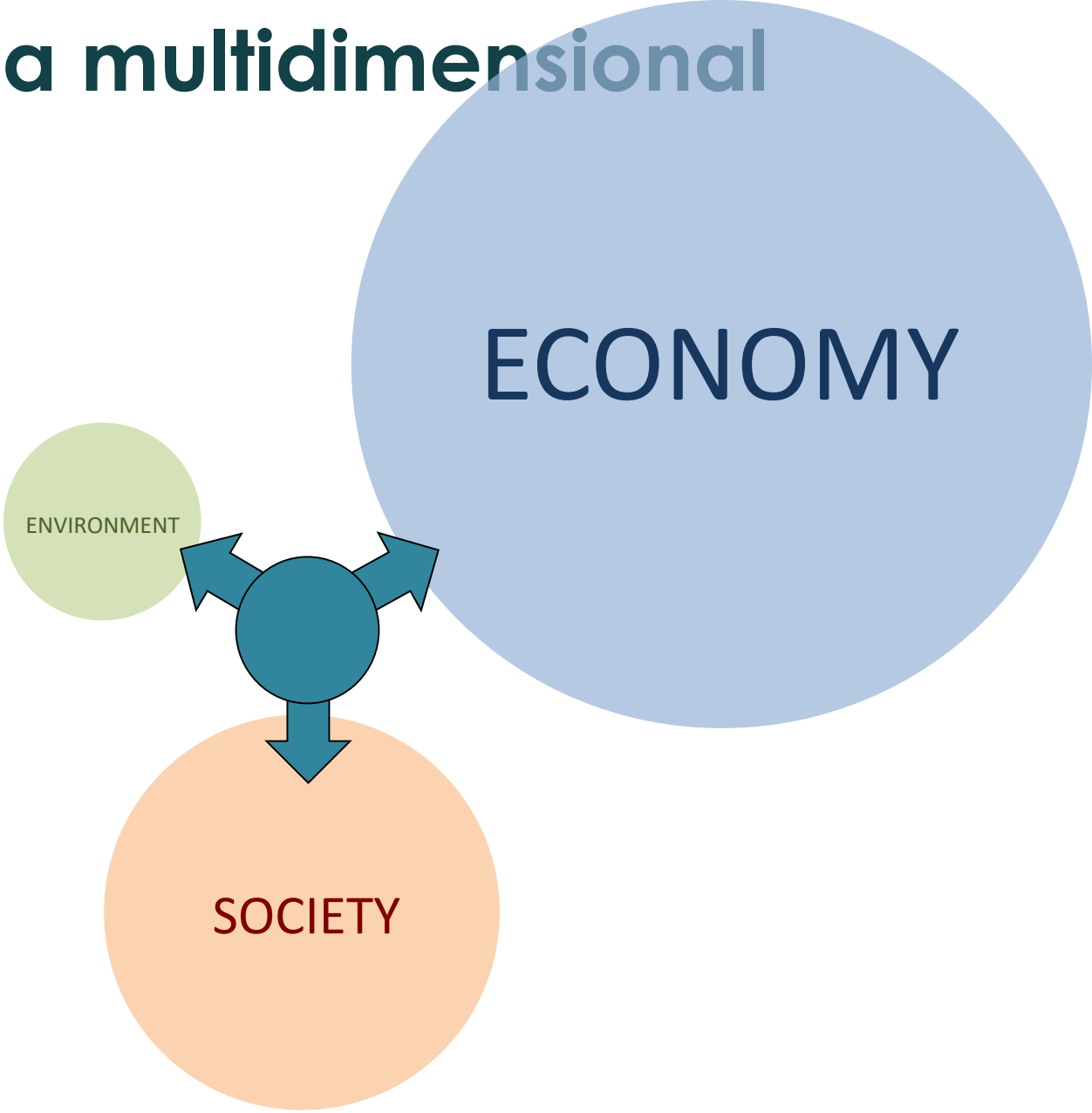

Assessing tradeoffs and synergies

- Exploring **relationship between indicators** in different animal production systems

- **Scenarios** (what-if) and **optimization**