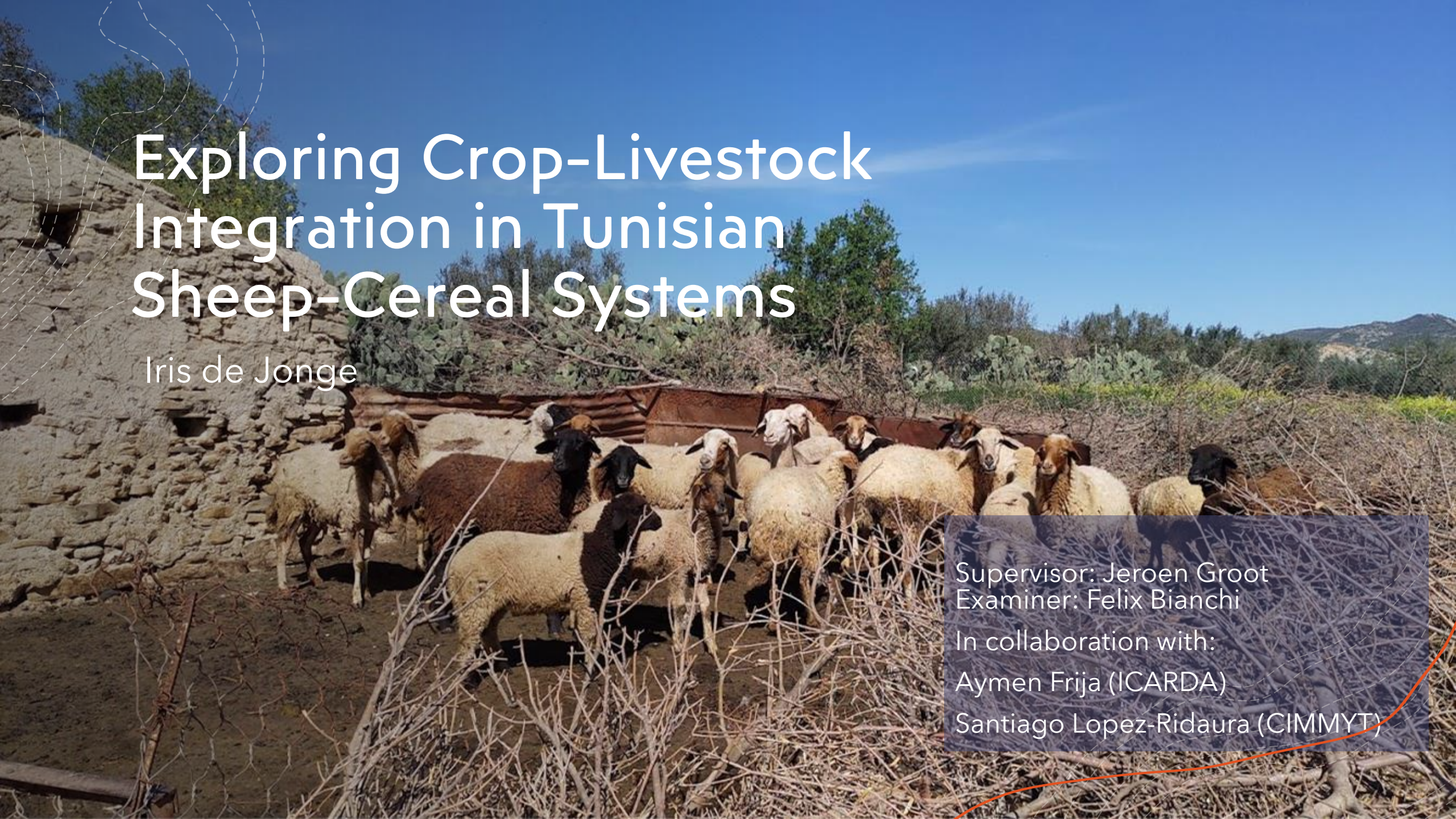
Exploring Crop-Livestock Integration in Tunisian Sheep-Cereal Systems

Iris de Jonge



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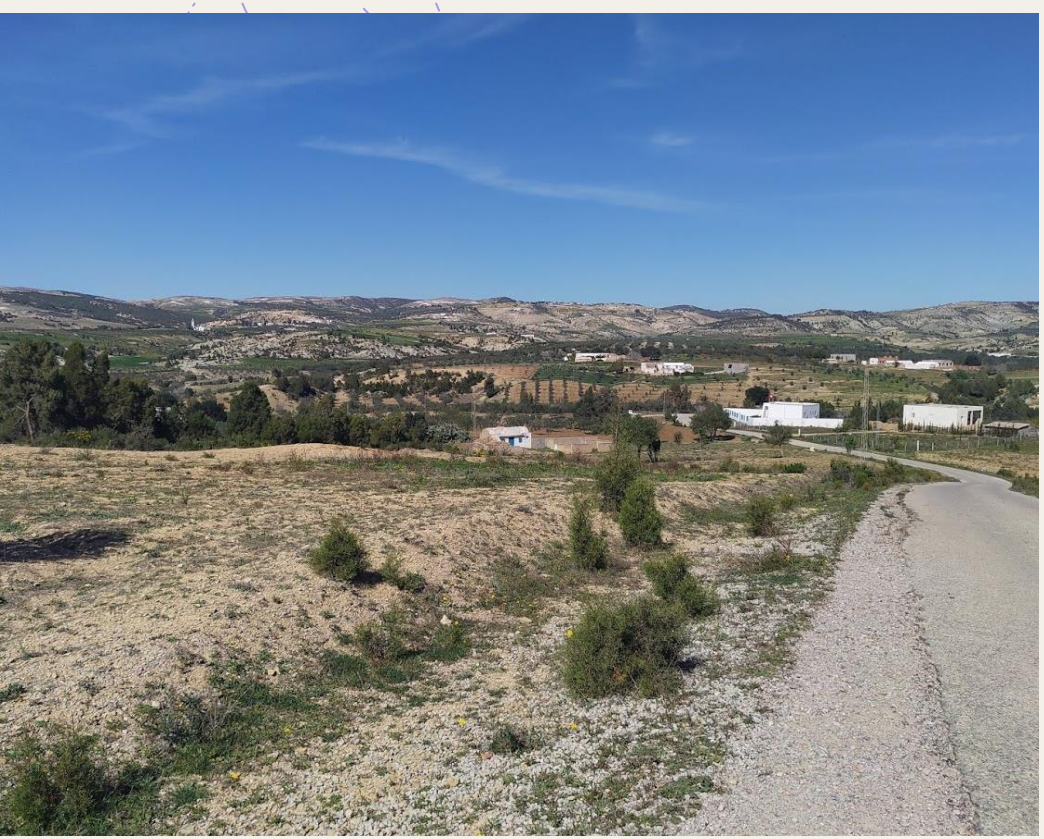
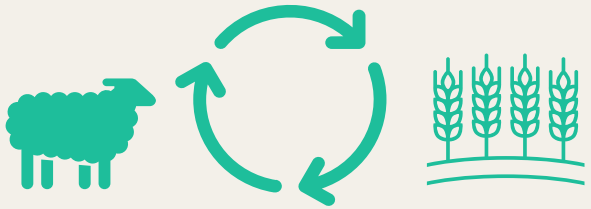
Content



Introduction

- ***Mixed Systems***
- ***Dryland Agriculture***
- ***Drought, Erosion, overgrazing, degradation***
- ***CLCA project; Conservation Agriculture***
  - ***Stubble grazing***
  - ***Fodder mixtures***

Concepts



Crop – Livestock Integration

Farm diversity

Whole farm analysis

Objectives

+ ***Exploring the concept of crop livestock integration in dryland cereal sheep systems in Zaghouan***

+ Analyze the diversity of farm types as a starting point for context-specific improvement of integration
+ Analyze the performance of the current state of different farm types
+ Exploring general trends between objectives and farm assets per farm type
+ Finding optimal management configurations per farm type

Methods

Overview

Five farm types (typology)

+

4 Farm visits and surveys

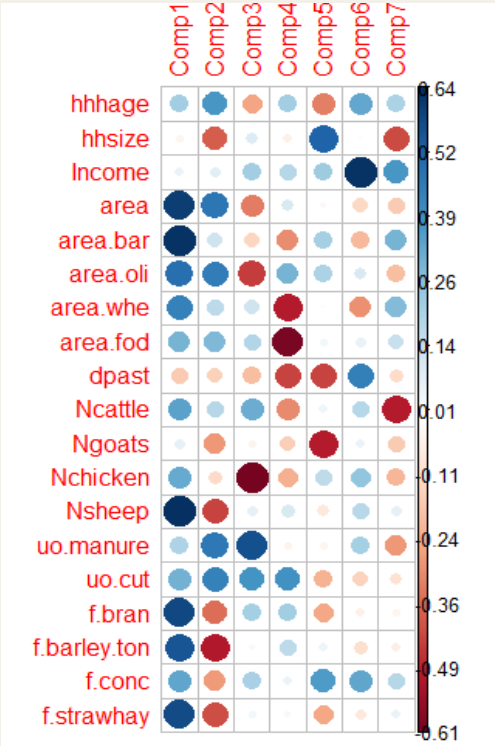
Input

5 types in FarmDESIGN model

Methods

Typology

- Framework by *Alvarez et al. (2014)*
  - Expert knowledge + statistics
  - Database: 214 mixed crop-livestock farmers in Zaghouan
  - Principle Component Analysis (PCA) & Hierarchical Clustering (HC)



Methods

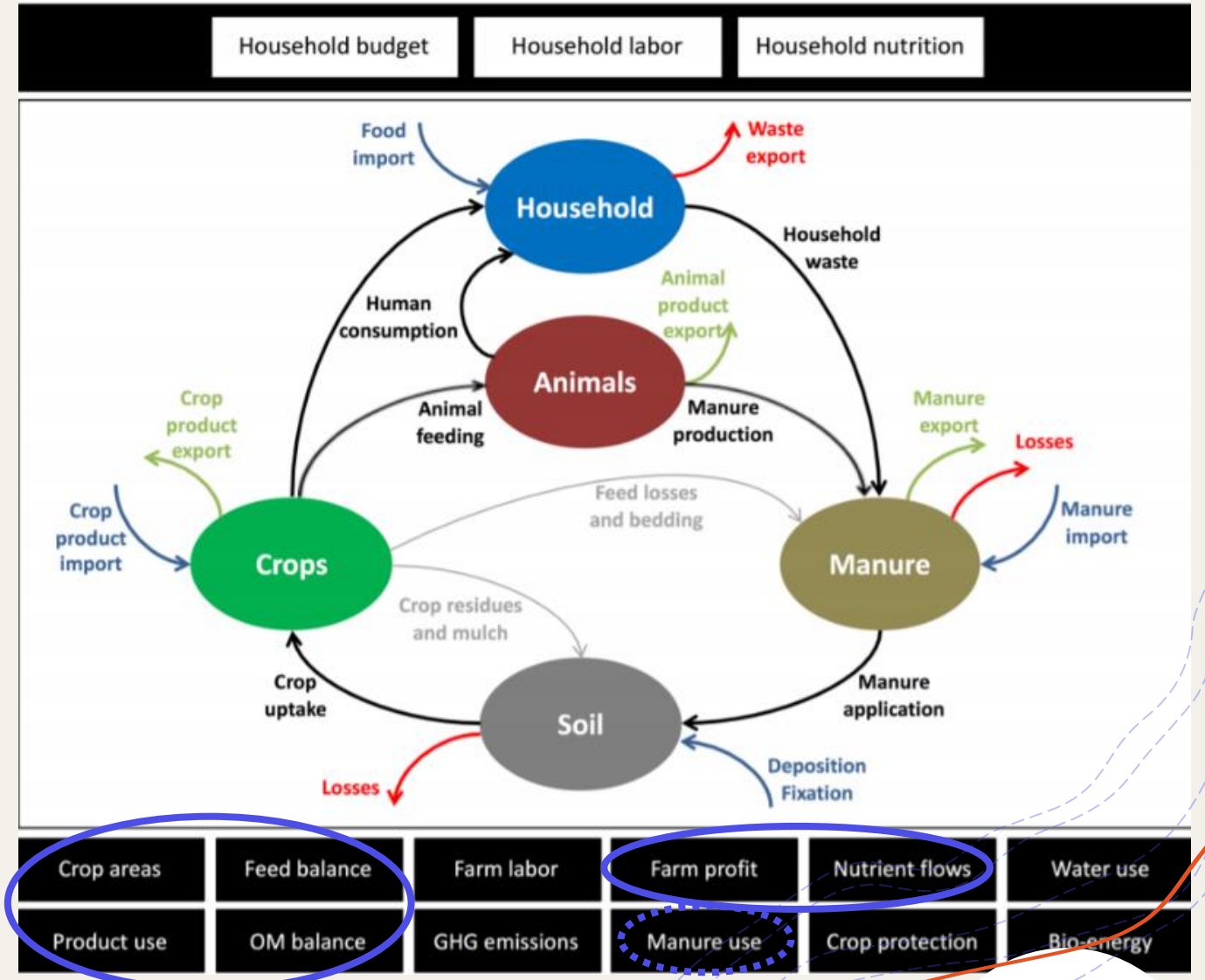
Farm DESIGN

Describe – Explain - Evaluate – Explore – (re) Design

Groot et al. (2012)

Crop Livestock Integration:

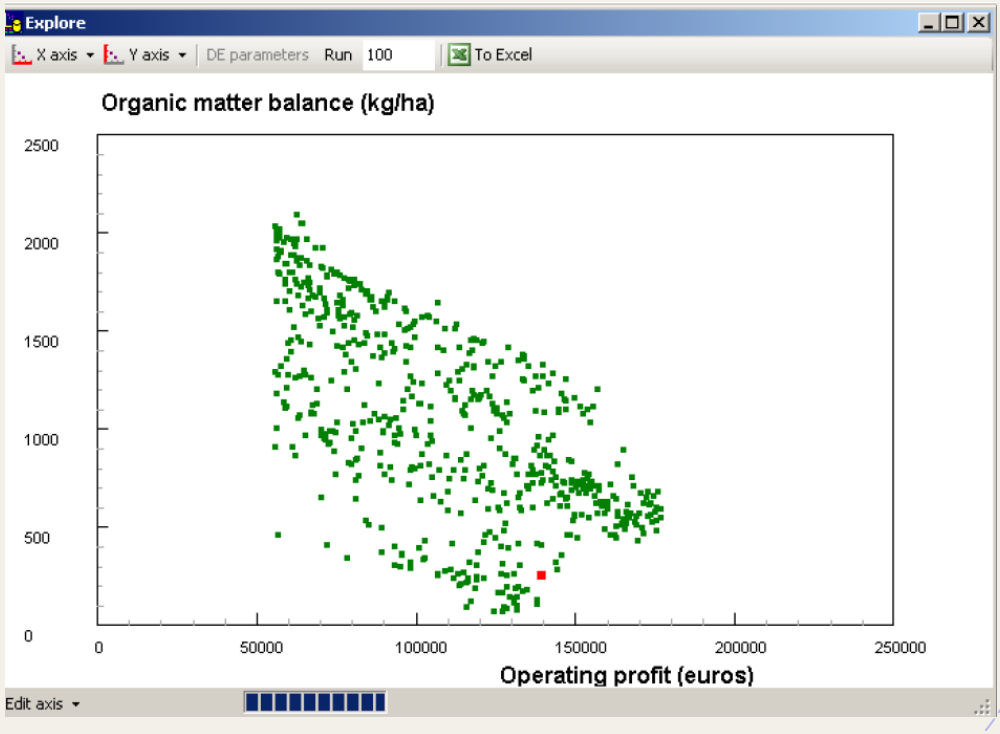
- Finn's Cycling Index
- Feed self sufficiency of energy



Methods

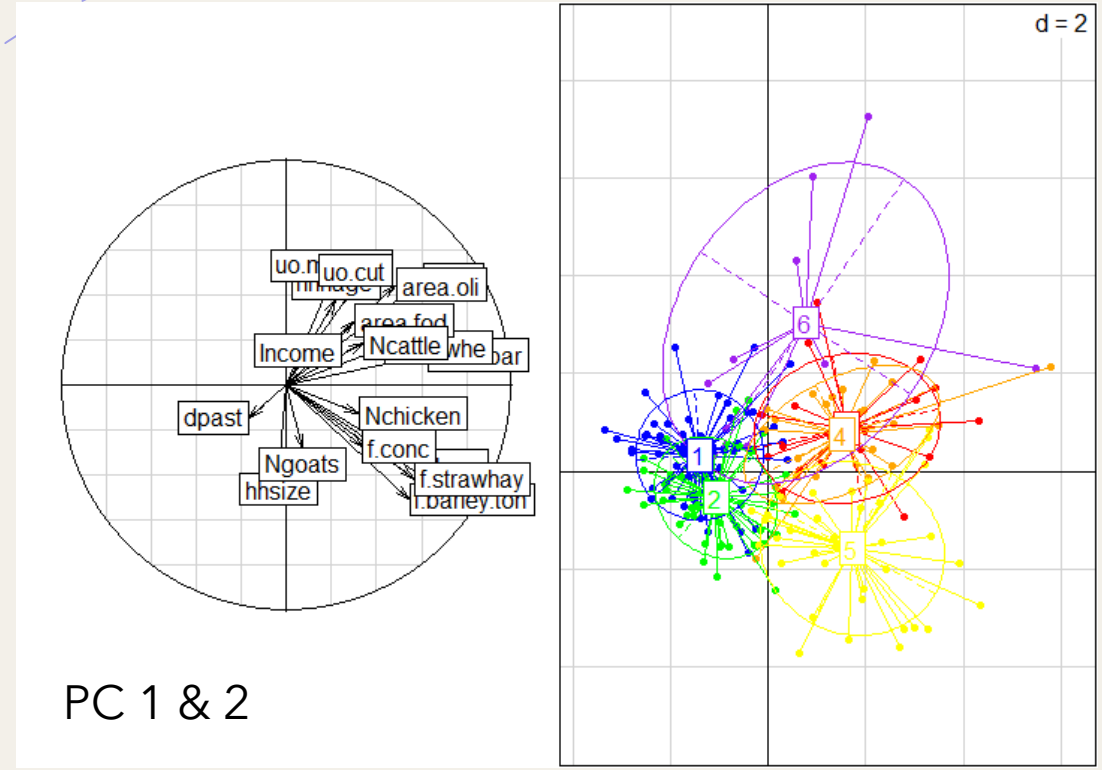
Farm DESIGN: Explore

- Multi-objective optimization
  - Constraints, decision variables and objectives
  - 800 New farms generated
- Objectives
  - Maximizing feed self-sufficiency of energy (Crop – Livestock integration)
  - Maximizing fraction fodder crop area ‘CLCA crops’
  - Maximizing Operating Profit
  - Maximizing Soil N balance
  - Maximizing Soil OM Balance

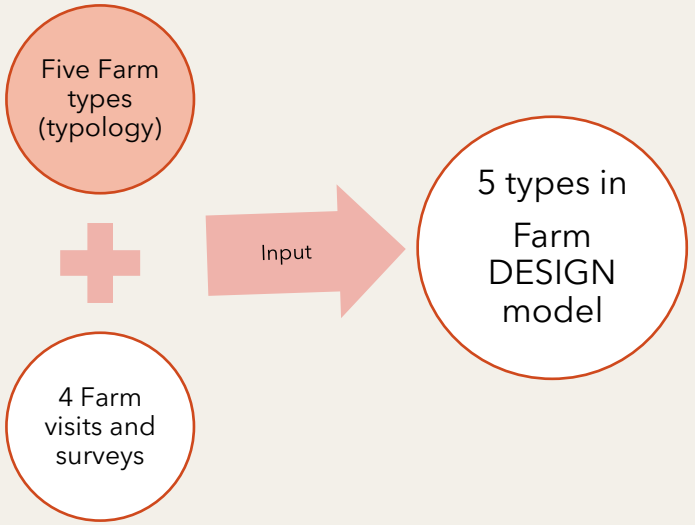


Results

Typology



PC 1 & 2



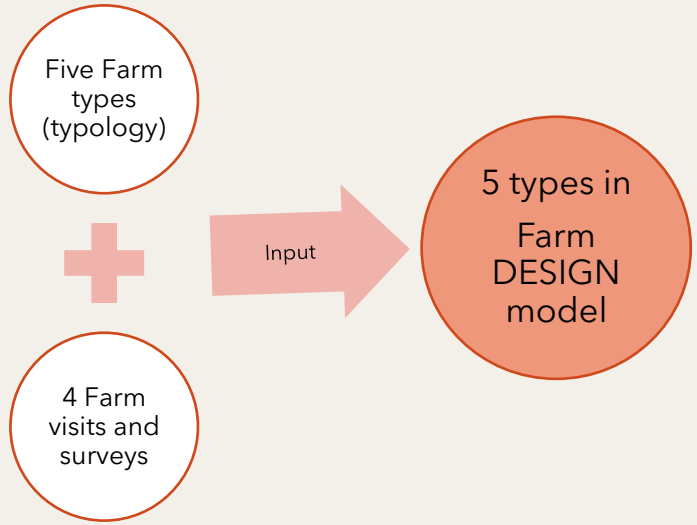
1	**Relatively small average farm size** of 2 ha, having low livestock numbers (10 sheep) and cultivating small plots of barley and olives.
2	**Relatively small average farm size** of 1.5 ha, having intermediate size **herd** (20 sheep) and cultivating small plots of barley and olives.
3	Relatively large farms (8.7 ha), having relatively large plots of **olives** (4.7 ha). Herd consists of 30 sheep and barley is also cultivated.
4	Relatively large farms (5.2 ha), with more **diversification in cropland**. Besides olives and barley, wheat and fodder are also cultivated. On average, 26 sheep are kept. Farmers may have some cows.
5	Intermediate farm size (3.6 ha) with **relatively many livestock** (39 sheep). **Feed imports** are relatively high. Farmers also may have some cows.
6	Small group of relatively large farms (4.9 ha), having relatively few sheep and some cattle. Group is different as **the parameters of integration;** using own residues and manure, show higher quantities.

Results

Current Performances

	Type 1	Type 2	Type 3	Type 4	Type 5
Livestock Units (LU)	3.3	6.6	8.7	9.9	13.8
#Sheep	11	20	29	26	39
Grazing management	 No off-farm grazing	 Off- farm grazing; most perform outside grazing every day	 Most farms have no off-farm grazing	 Farms do not show clear grazing management; general feeding calendar used	 Most farms have no off-farm grazing
Crop land (ha)	Total: 2.1 *Olives: 0.8* *Barley: 1.3*	Total: 1.5 *Olives: 0.6* *Barley: 0.9*	Total: 7.7 *Olives: 4.7* *Barley: 3*	Total: 5.5 *Olives: 0.6* *Barley: 2.4* *Oats: 1* *Wheat: 1.5 (*)*	Total: 3.8 *Olives: 1.4* *Barley: 2.4*

Typology

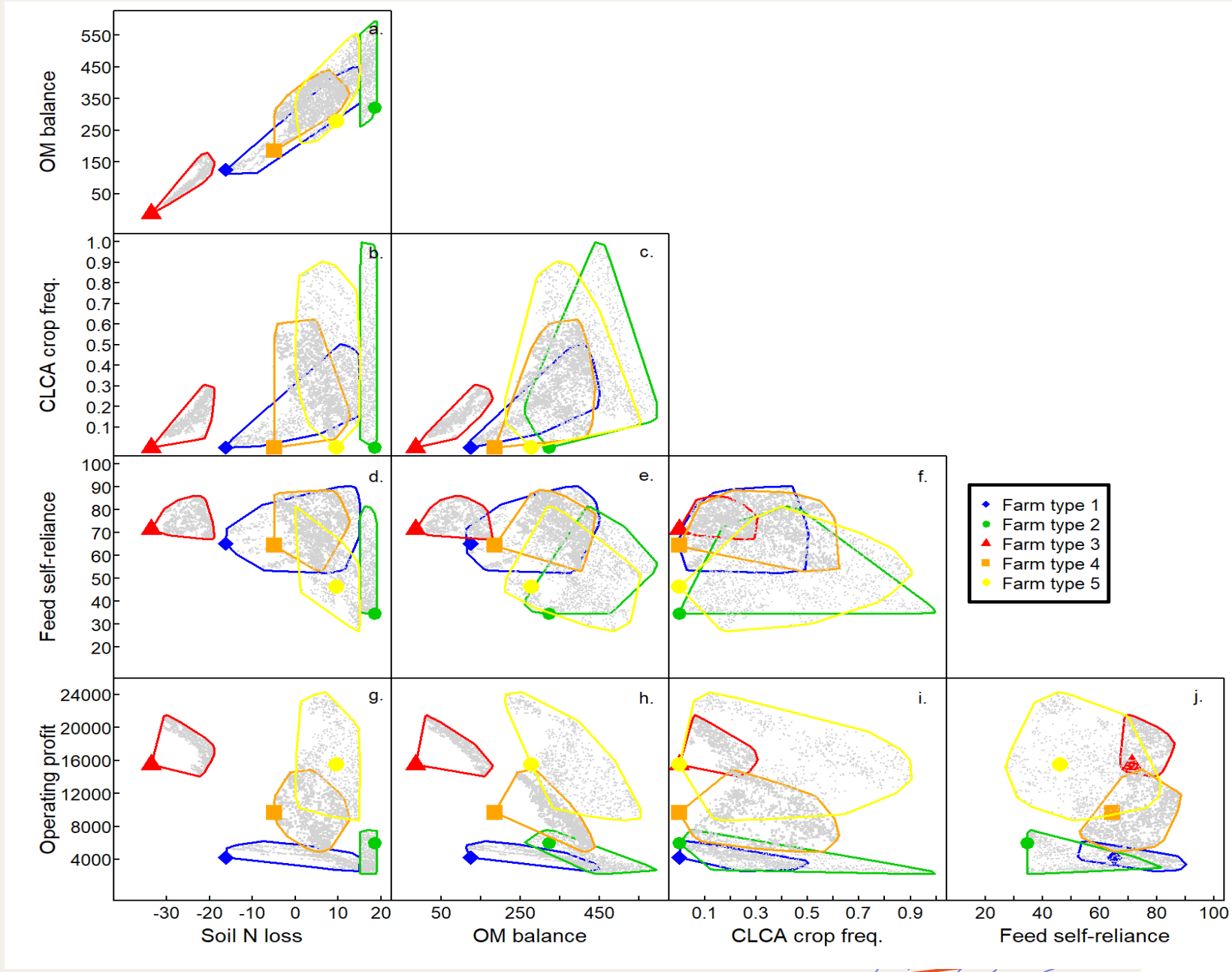


Farm DESIGN

	NUE nitrogen at farm level $\frac{N\ output}{N\ Input} * 100$ (%)	Nitrogen farm balance $N\ output - N\ input$ (kg N/ha)	FCI of N	OM balance	Profit (TND)	Lamb production (kg)	Olive production (kg)
Type 1	122	4	0.23	104	4.193	143	1400
Type 2	31	54	0.14	322	5.955	409	1050
Type 3	135	-7	0.16	-3	15.474	593	8255
Type 4	61	13	0.24	185	9.687	531	1050
Type 5	36	41	0.18	298	15.501	797	2450

Results

Trends



Results

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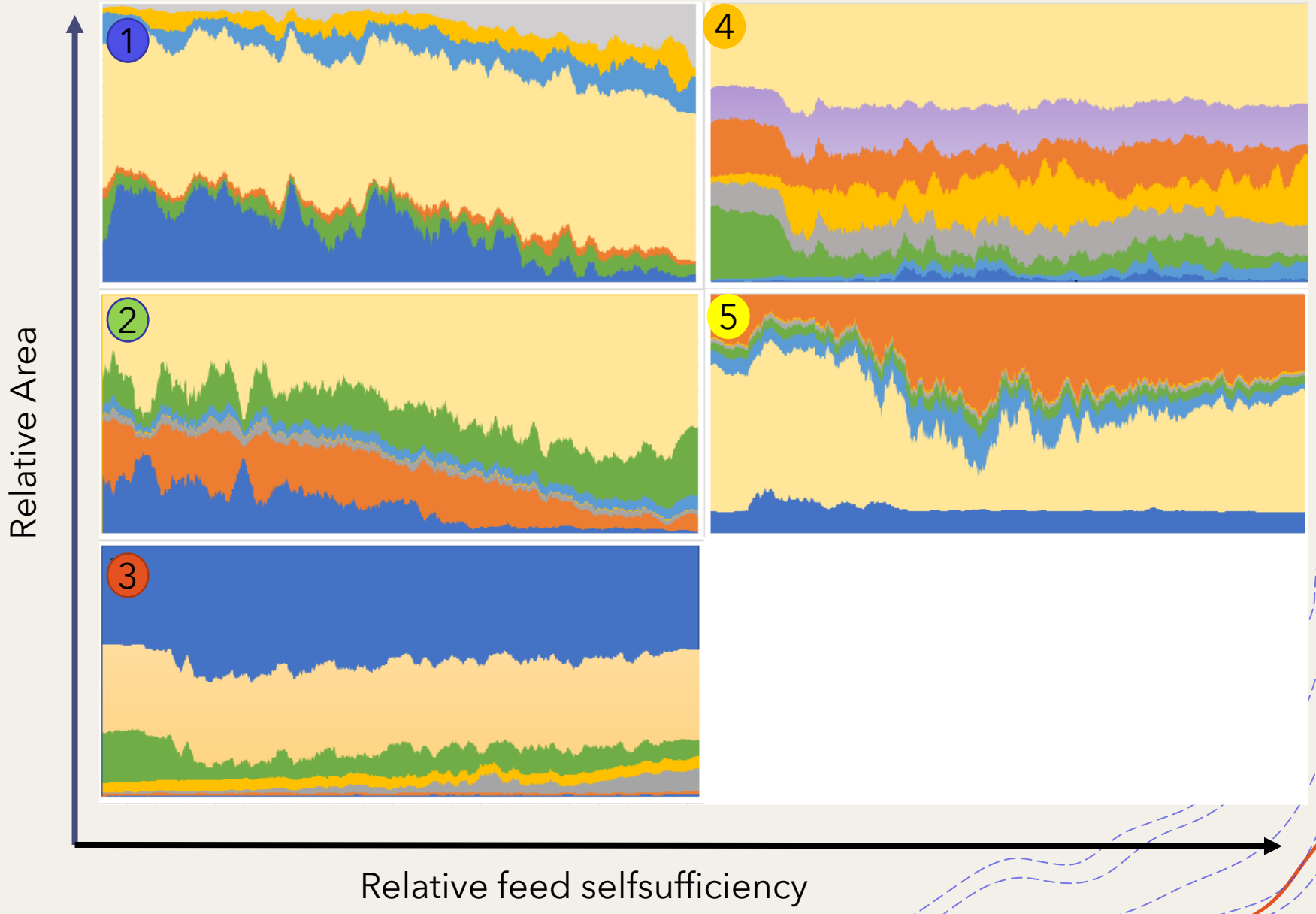
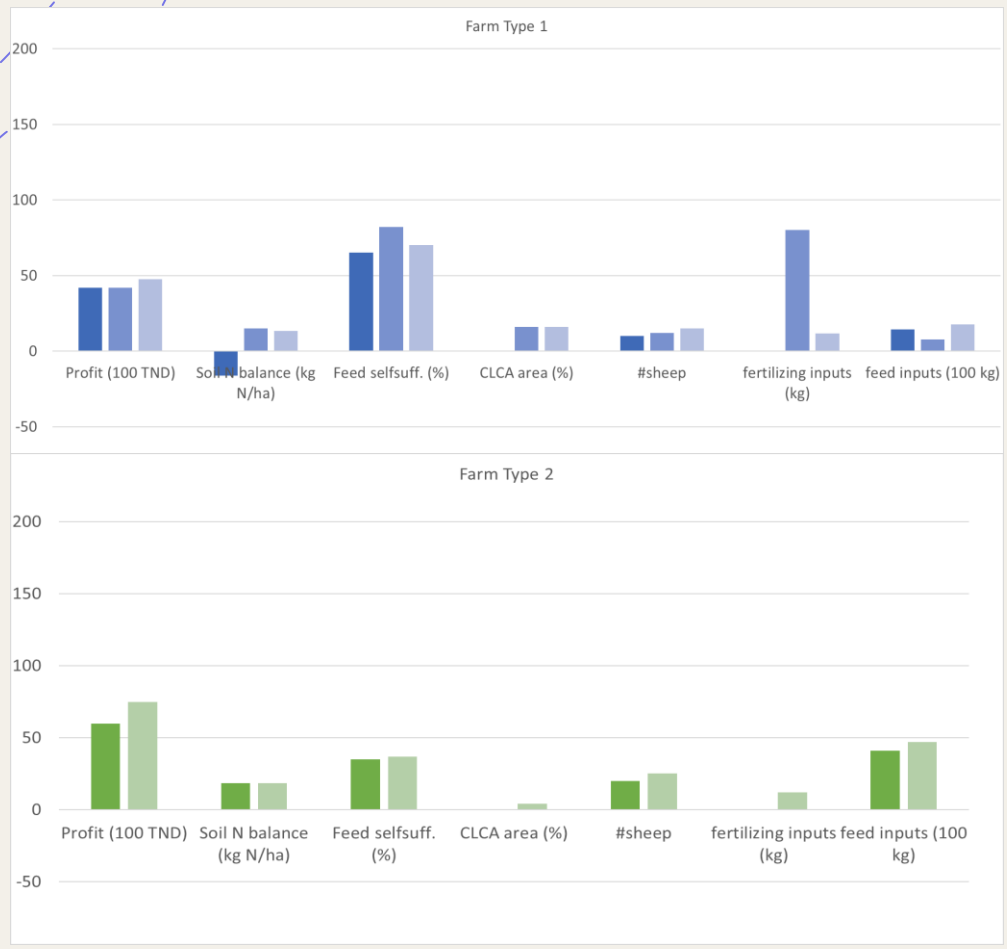
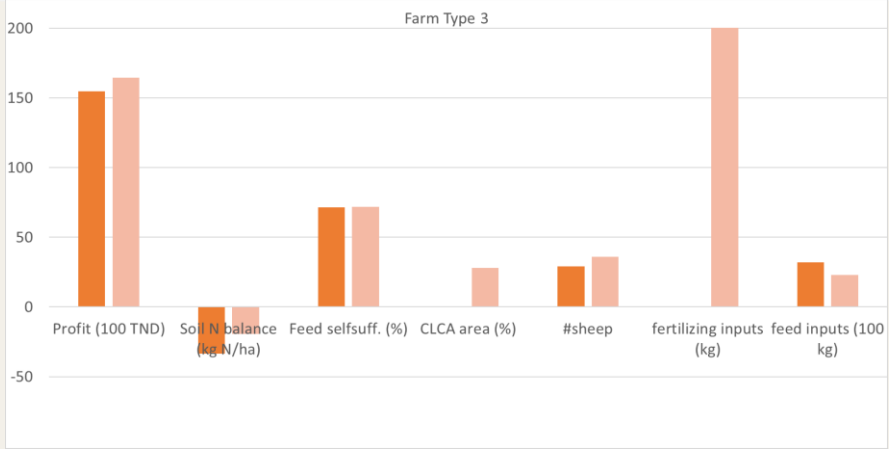
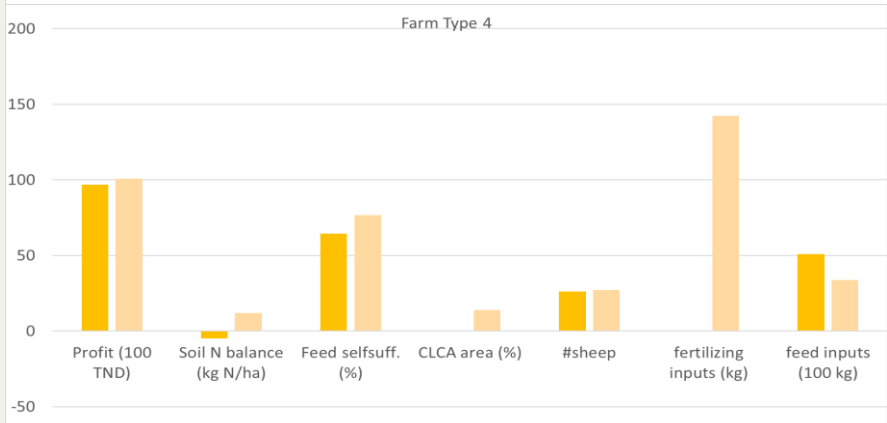


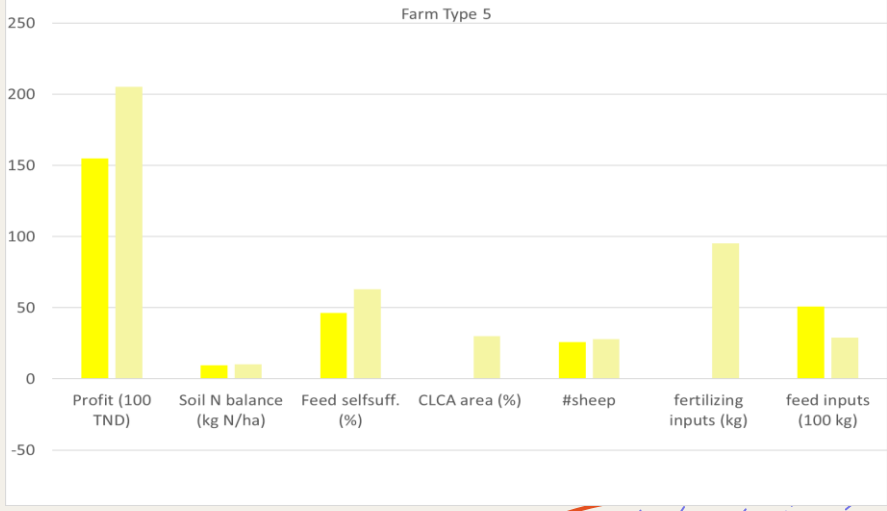
Results

Case-study farms





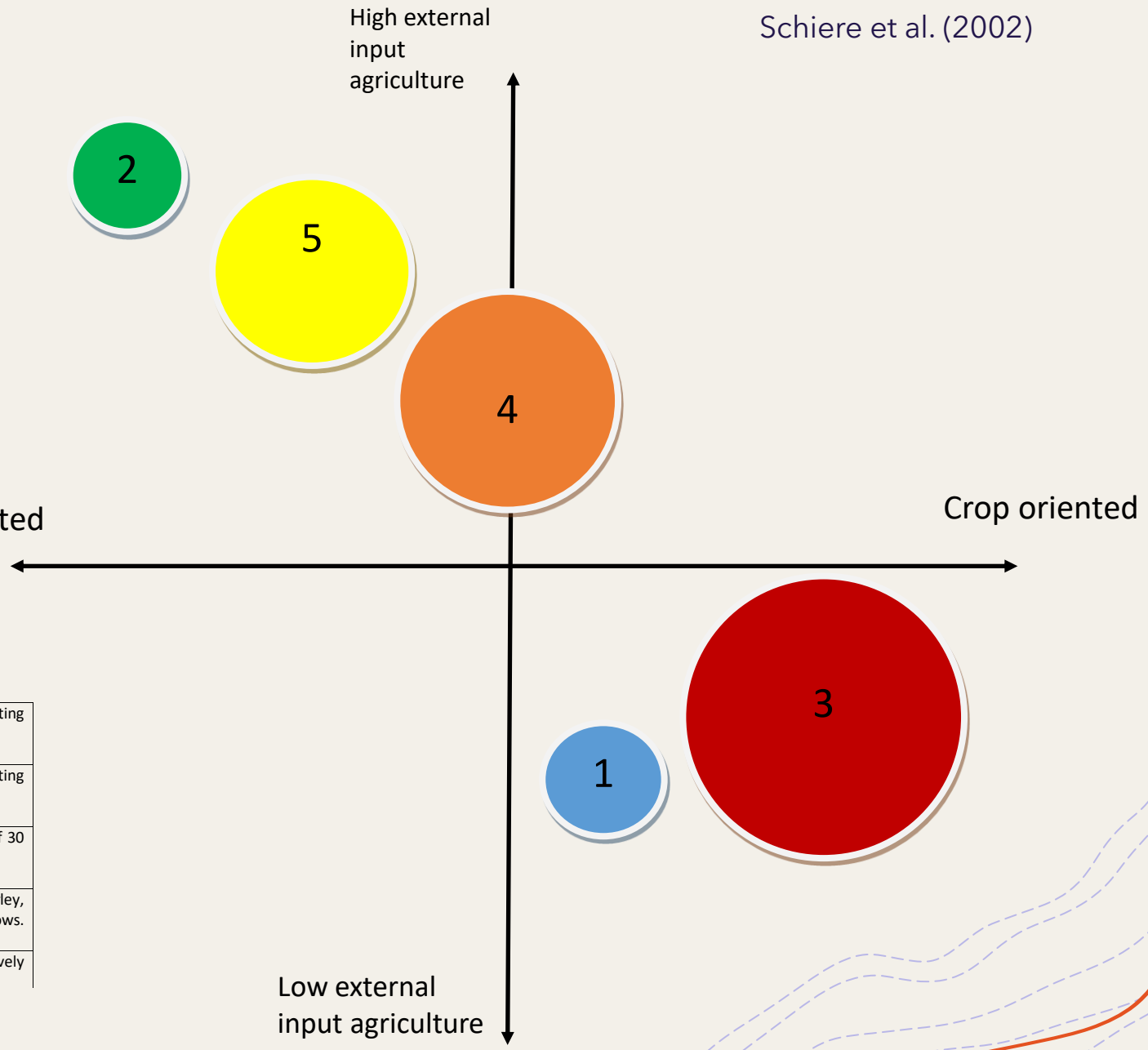




Discussion

Farm Types

Schiere et al. (2002)



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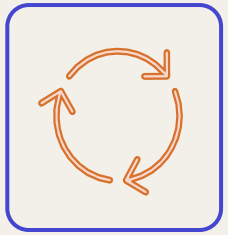
Discussion

Hypothesized Strategies

Fully integrated, with a focus on crop diversity



- Lower livestock numbers, using the herd merely for valorising residues and fodder mixture in rotation
- Low external inputs and optimizing nutrient cycling (manure management, feed production)
- Diversify production, using diverse fodder mixtures

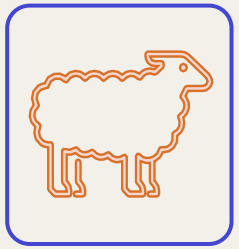
- Ecosystem services, little environmental impact
- Labour intensive and limited profitability on the short term

Intensification of crop production and thereby enhancing livestock production

- Improving yields of crops by increasing inputs, irrigation, manure management and CA
- Adapt fertilizing inputs on the needs of crops and climate, using small amounts.
- Adapt livestock herd on feed which can be provided; livestock numbers should not exceed carrying capacity

- Serves cycling and integration on farm
- Need for enough land in order to be profitable, risk of pollution or wasted nutrients

Intensification of livestock production by higher feed inputs



FT 1, 2

- Increase feed inputs to lower pressure on land
- Feed by-products as much as possible to avoid feed-food competition
- Minimize losses in the system to avoid pollution

- Improving profitability and avoiding soil mining
- Risk of externalization of environmental impact, risk of pollution

Discussion

Limitations & Future Research

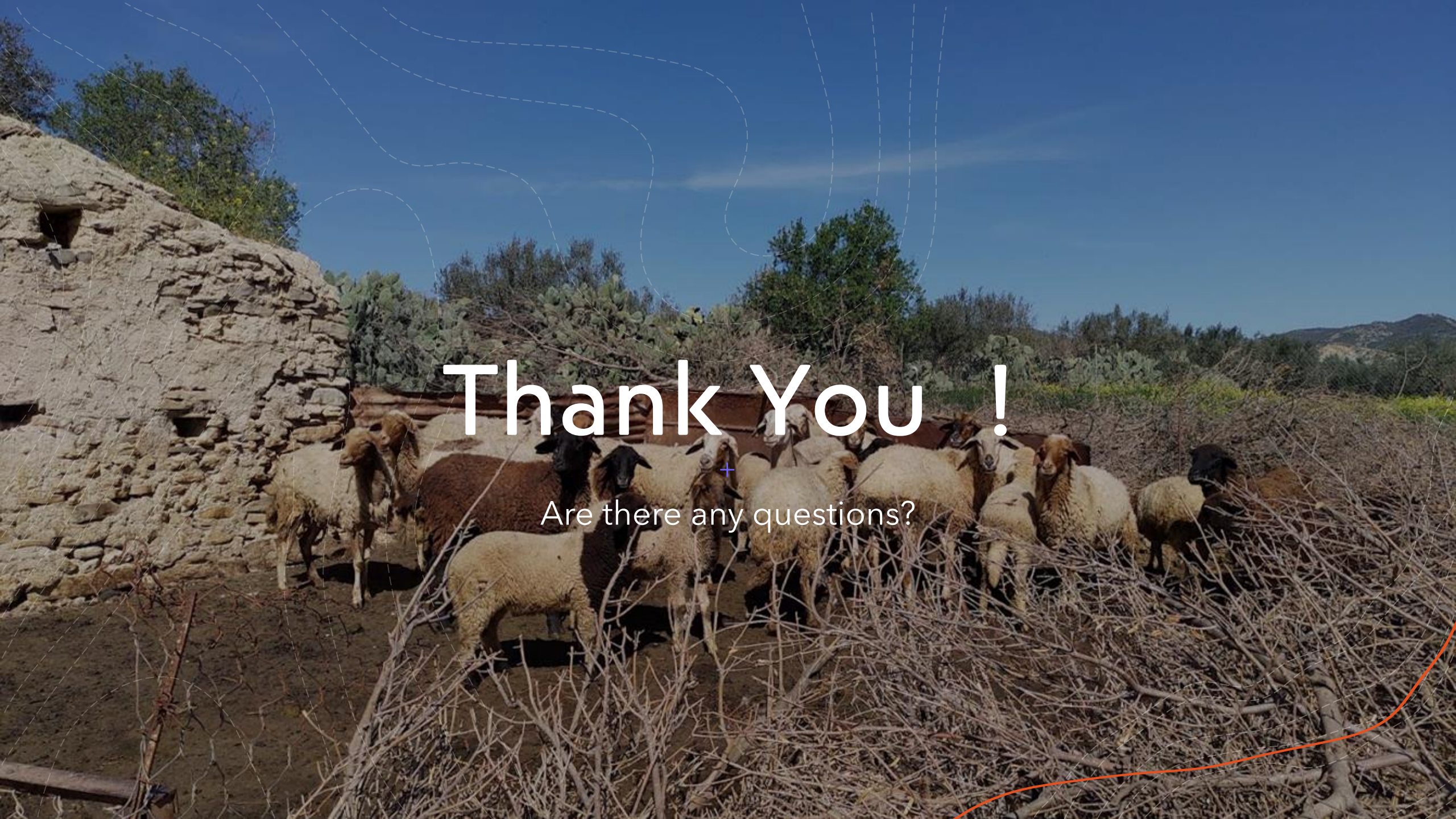
- Model reflects reality?
  - Assumptions made
  - Role of fallow land
  - One year timespan and dryland agriculture
  - N and OM balance calculations

- Potential of manure management
- Translate into easy solutions for farmers

Conclusions

+ Integrating crops and livestock has potential for the improvement of profitability and sustainability of cereal-sheep farming in Zaghouan.

+ Soil N mining
+ Increase in fertilizing inputs may boost productivity and biomass cycling
+ Fodder mixture integration promising


Thank You !
Are there any questions?

References

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+ Groot, J. C. J., Oomen, G. J. M., & Rossing, W. A. H. (2012). Multi-objective optimization and design of farming systems. *Agricultural Systems*, *110*, 63–77.
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