A multi-criteria tool for jointly assessing the sustainability and resilience of dairy farms

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INRAE, UMR SAS

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Context

- Livestock: a major contributor to environmental impacts
- Agro-ecological transition, for dairy farms:
  - increase the share of grass in animal diet (Wezel et Peters, 2014)
  - dependence to grass growth, and climate (Graux et al., 2019)

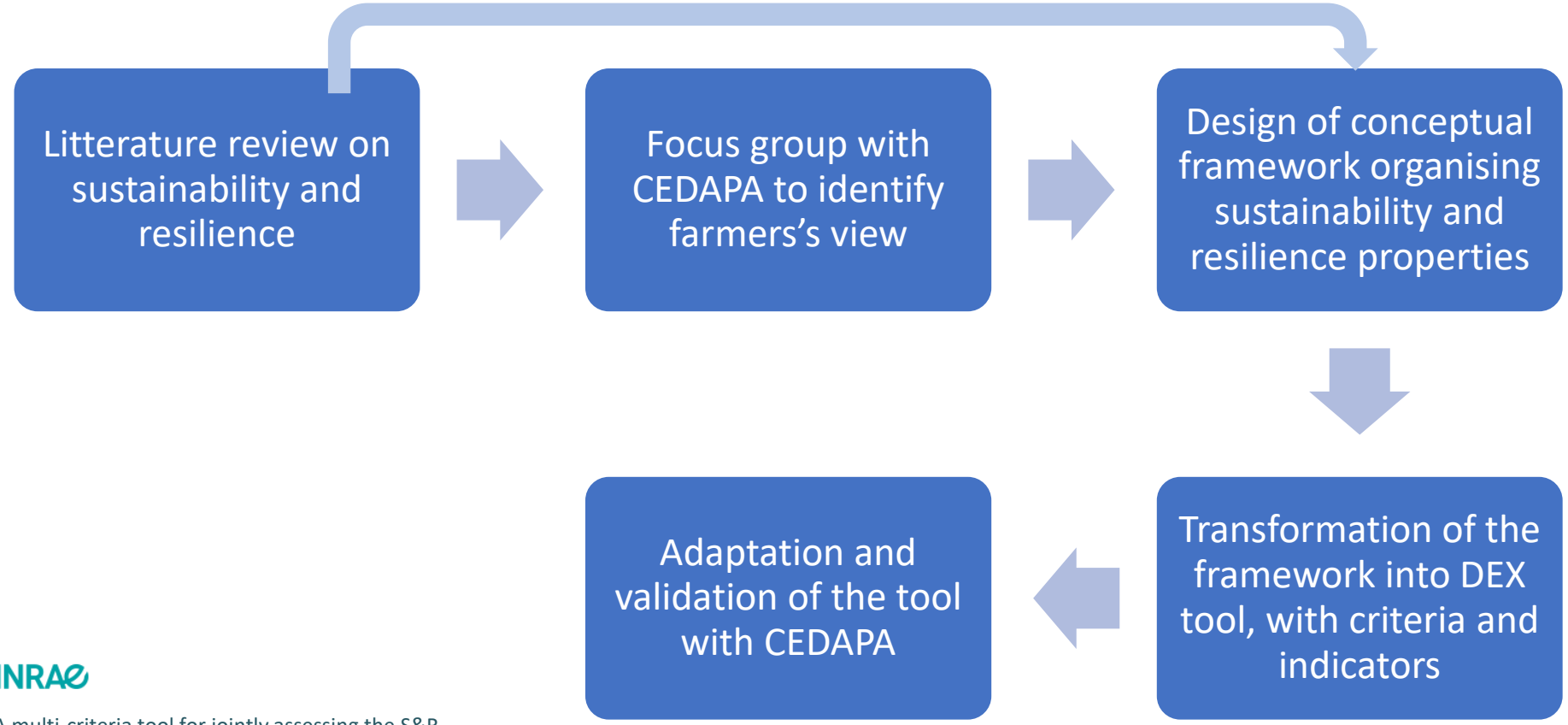
- Grass-based dairy farms have less environmental impact; are they more resilient?
  - To climate change, in particular

- Create and apply a tool for jointly assessing the sustainability and resilience of dairy farms

Creation of the tool

Materials and methods

Collaboration with group of farmers and advisers promoting grass (CEDAPA)



Adapted from Babin, 2022

Assessing a group of dairy farms

Materials and methods

- 23 farms of CEDAPA, assessed with the tool
- Analysis of the determinants of sustainability and resilience (S&R)
  - Principal Component Analysis and Hierarchical Clustering using the tool's indicators as input variables (R software, version 4.2.2).
  - Association with technical and economic descriptors of the farms.

How to assess jointly sustainability and resilience?

Results

- Existing tensions between the concepts:

	Sustainability	Resilience
Assumptions	Stability	Constants changes
Lever	Efficiency (resource use)	Diversity of resources
Properties of systems	Productivity, autonomy, regional involvement, viability…	Buffer, adaptative and transformative capability.

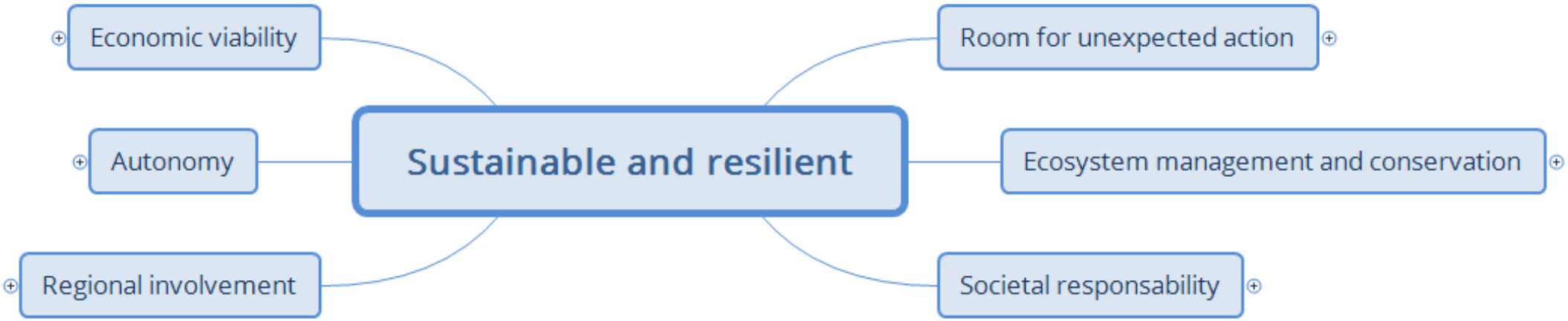
Adapted from Roostaie et al., 2019 and Babin, 2022

- Question:
  - Does the farm achieve the sustainability objectives and to what extent these objectives can be maintained when facing disturbances (resilience)?

Conceptual framework

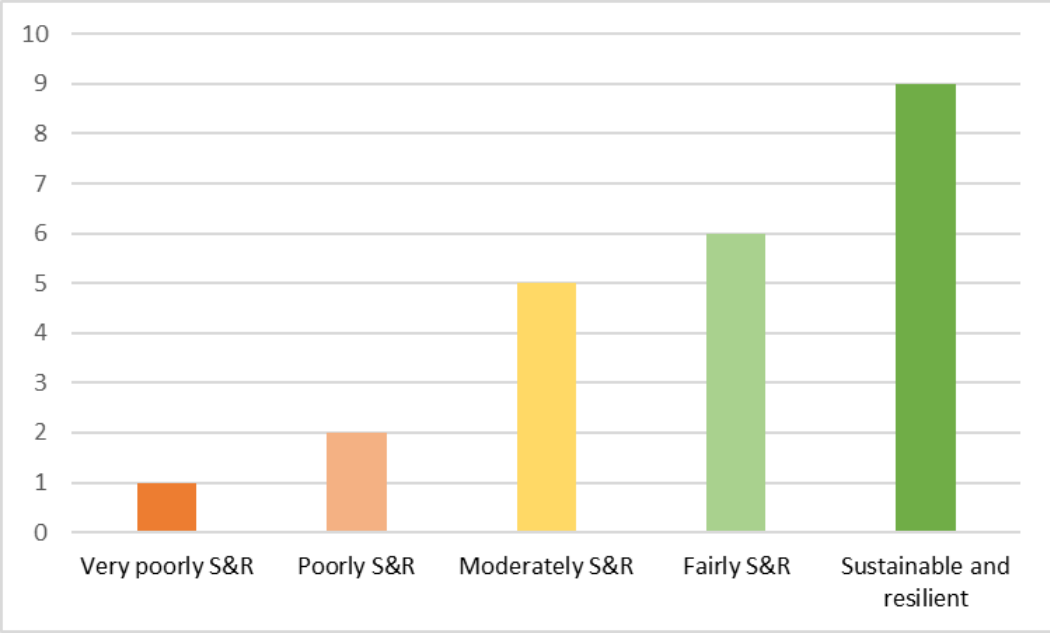
Results

- Based on properties of sustainable and resilient systems, taking into account the overlap between the concepts
- 6 properties, 37 indicators



Sustainability and resilience assessment
Results

- 23 farms assessed, 13 in organic agriculture (OA), 10 in conventional agriculture (CA)



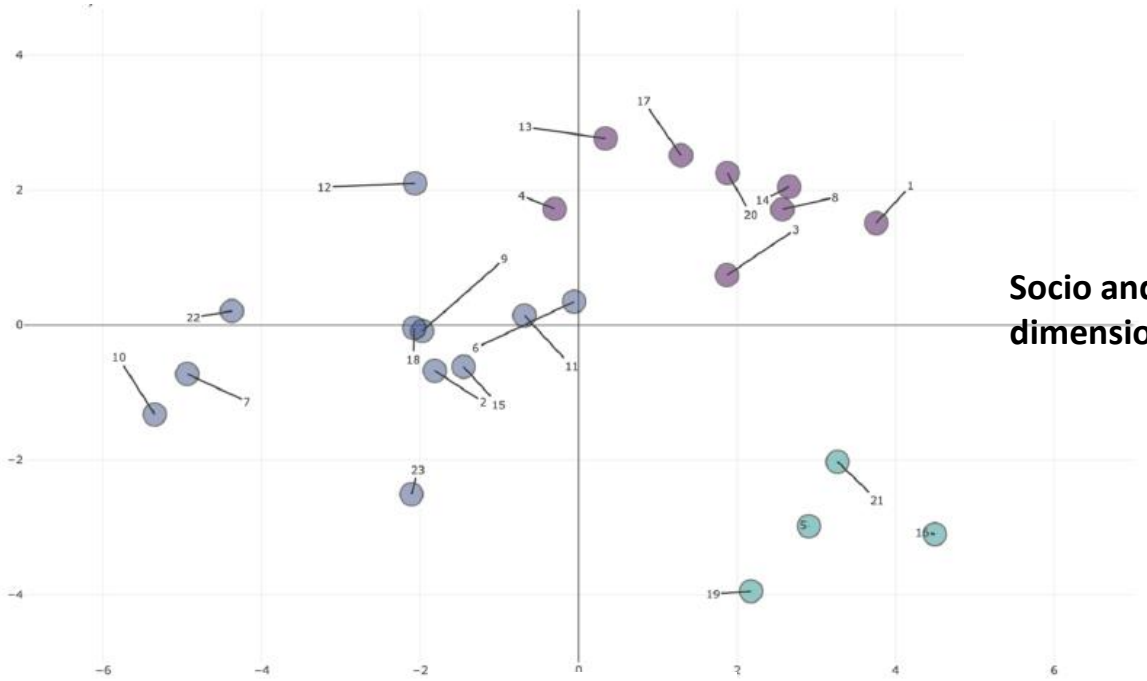
- Fifteen farms in the two most sustainable and resilient classes,
- Five farms in the intermediate class,
- Three farms in the two least sustainable and resilient classes

Farm strategies and S&R performances

Results

Economic dimension

Economic efficiency, high income



Socio and environmental dimension

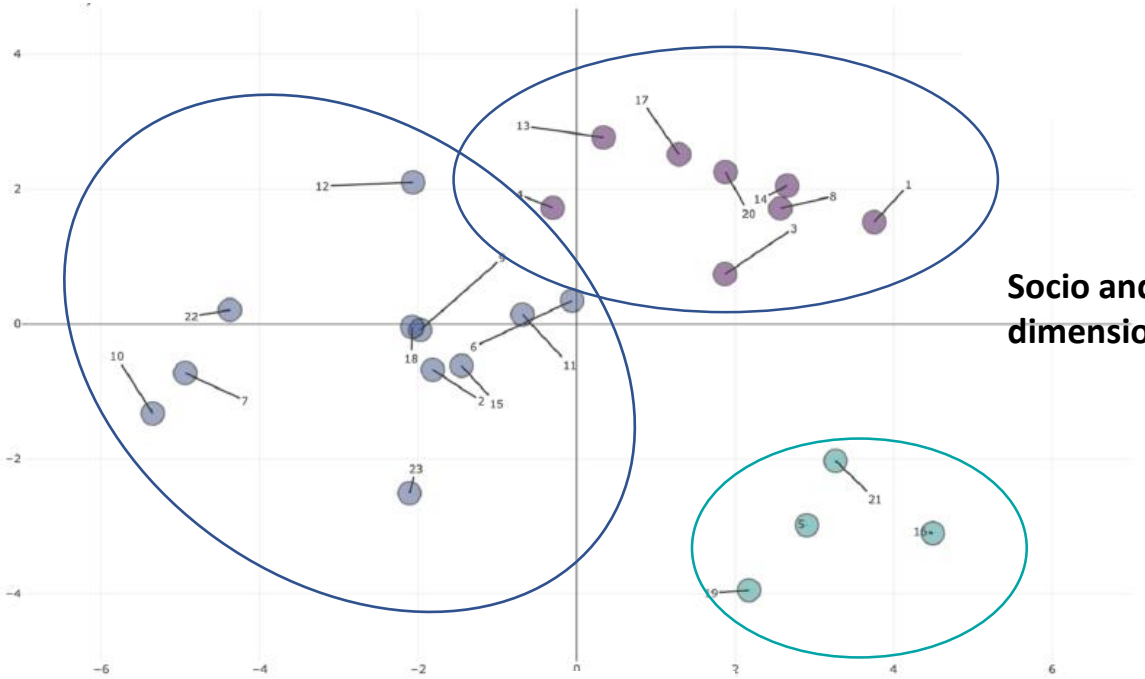
Diversification of productions

Farm strategies and S&R performances

Results

Economic dimension

Economic efficiency, high income



Socio and environmental dimension

Diversification of productions

Farm strategies and S&R performances

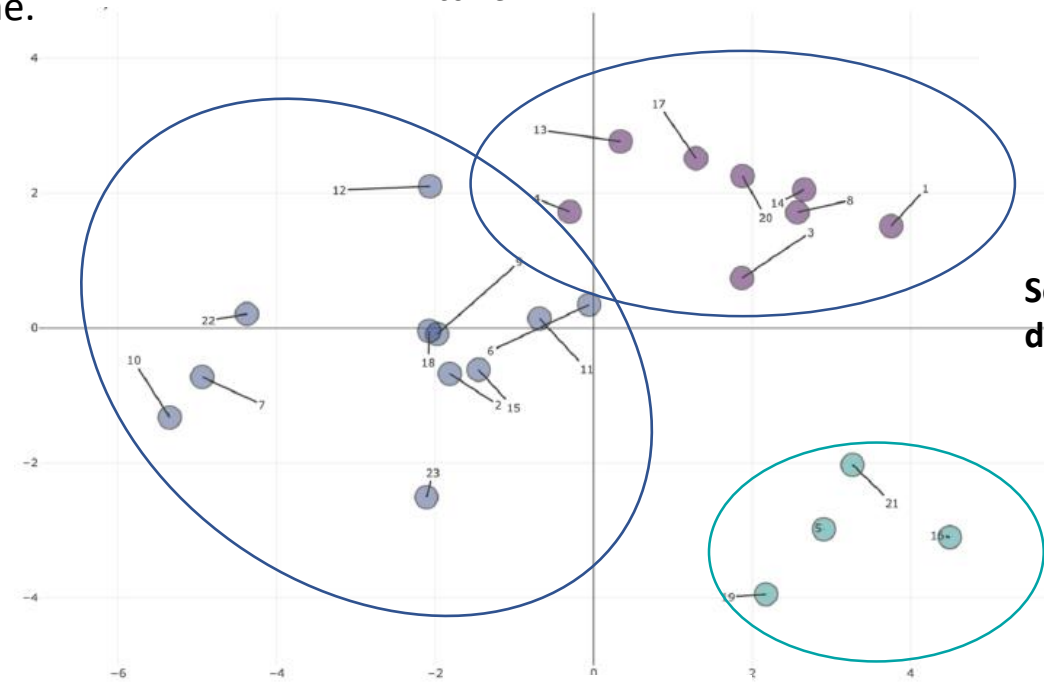
Results

Cluster 2: 11 farms

Dairy production + diversification, with maize and grass forage system
10 farms in CA, high income.

Cluster 1: 8 farms

Specialised in dairy production, with grass-based forage system
Organic farming, high income.



Cluster 3: 4 farms

Dairy production + diversification, with grass-based forage system
Organic farming, medium income.

Farm strategies and S&R performances

Results

Cluster 2: 11 farms

Dairy production + diversification, with maize and grass forage system

10 farms in CA, high income.

S&R performance

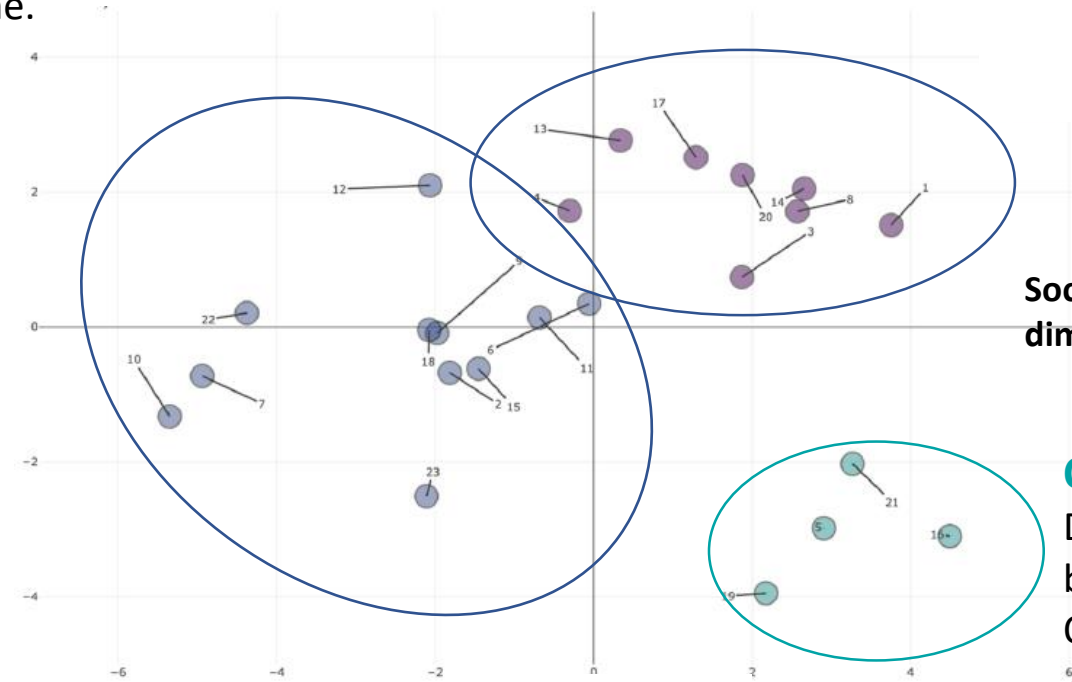
Class 1: 3 Class 3: 3

Class 2: 3 Class 4: 1

Class 5: 1

Economic dimension

Economic efficiency, high income



Diversification of productions

Socio and environmental dimension

Cluster 1: 8 farms

Specialised in dairy production, with grass-based forage system

Organic farming, high income.

S&R performance

Class 1: 4 Class 3: 1

Class 2: 3

Cluster 3: 4 farms

Dairy production + diversification, with grass-based forage system

Organic farming, medium income.

S&R performance

Class 1: 2 Class 3: 1

Class 2: 0 Class 4: 1

Farm strategies and S&R performances

Results

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S&R performance

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Class 2: 3 Class 4: 1
Class 5: 1

Economic dimension

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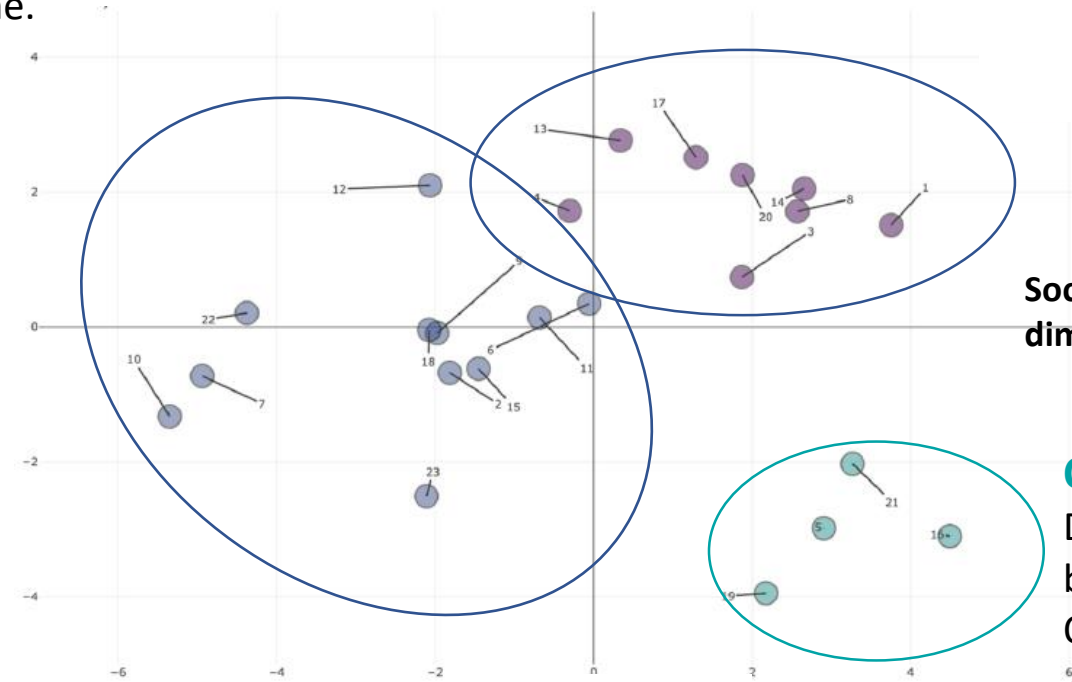

Diversification of productions

Socio and environmental dimension

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S&R performance

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S&R performance

Class 1: 2 Class 3: 1
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The three production strategies can achieve satisfactory levels of S&R

Discussion and conclusion

- Farms assessed achieve good S&R performances.
- Does the tool sort farms too easily into the most favourable classes ?
  - Monte Carlo analysis

Very poorly S&R	Poorly S&R	Moderately S&R	Fairly S&R	Sustainable and resilient
0,579	0,175	0,181	0,055	0,01

- Does the tool favour CEDAPA farming practices ?
- To validate the tool : need to test it on a second set of farms, with other farm practices

Thank you for your attention

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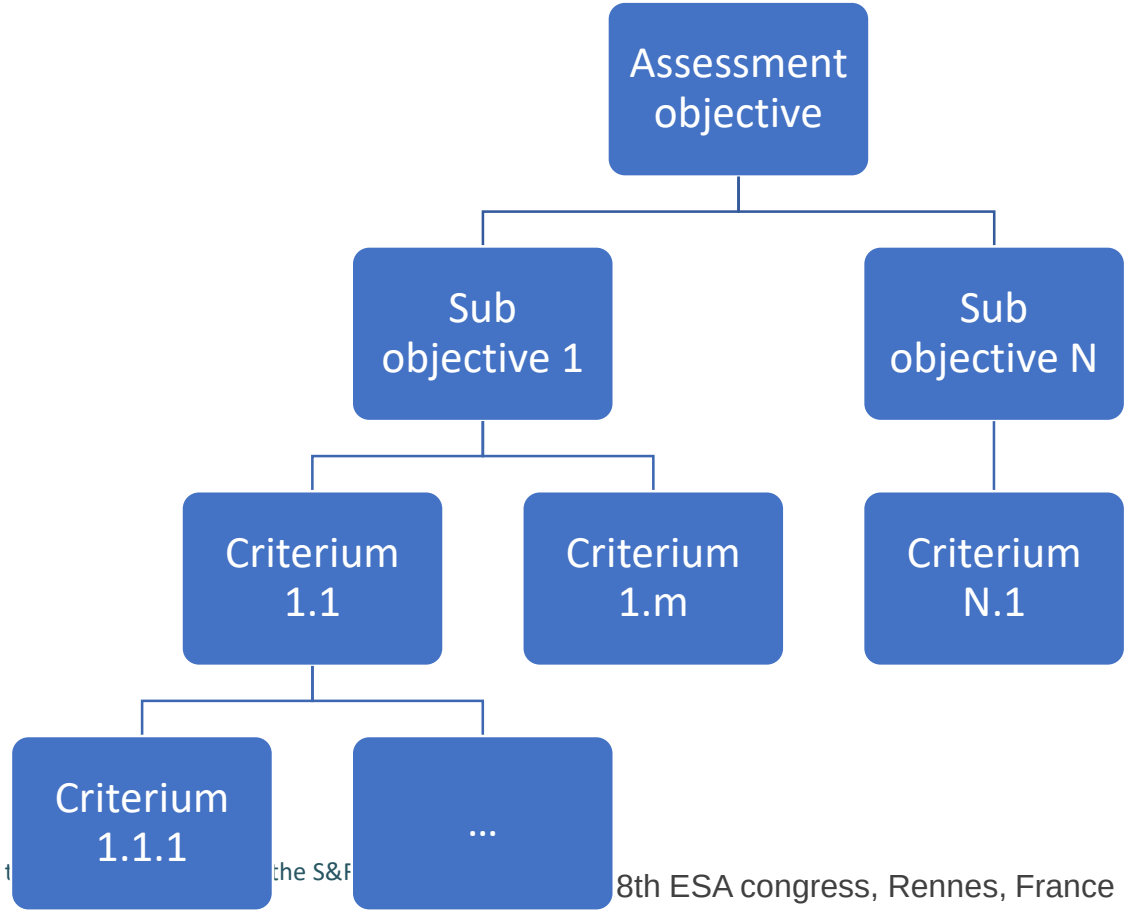
DEXi : multi-criteria assessment method

- DEXi : sorts individuals into classes
- Aggregation at nodes is based on decision rules



DEXi (Bohanec, 2008)

Indicators reflecting the ability to maintain sustainability objectives

- Sensitivity of economic efficience to climate change (% of variation of EE in a difficult year compared with a 5-year average)
  - <5 is good, > 10 is low
- Sensitivity of forage autonomy to climate change (% of variation of forage autonomy in a difficult year compared with a 3-year average)
- Forage storage (safety stock, monthes)
  - 1 is low, 2 is good
- percentage difference between milk selling price and breakeven price
  - < 20 is very low, 20 is very good