DEXiPM
a model for *ex-ante* sustainability assessment of innovative crop protection strategies

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INRA

FOOD QUALITY AND SAFETY

SIXTH FRAMEWORK PROGRAMME

Integrated Pest Management in Europe

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CONTEXT

- Regulation framework aiming at reducing the pesticide use / dependency

- Need to design innovations considering a real *break-away* from current cropping systems

The continuum (Cliff Ohmart, ENDURE Conference 2008)

- Need to assess those innovations **comprehensively and reliably**

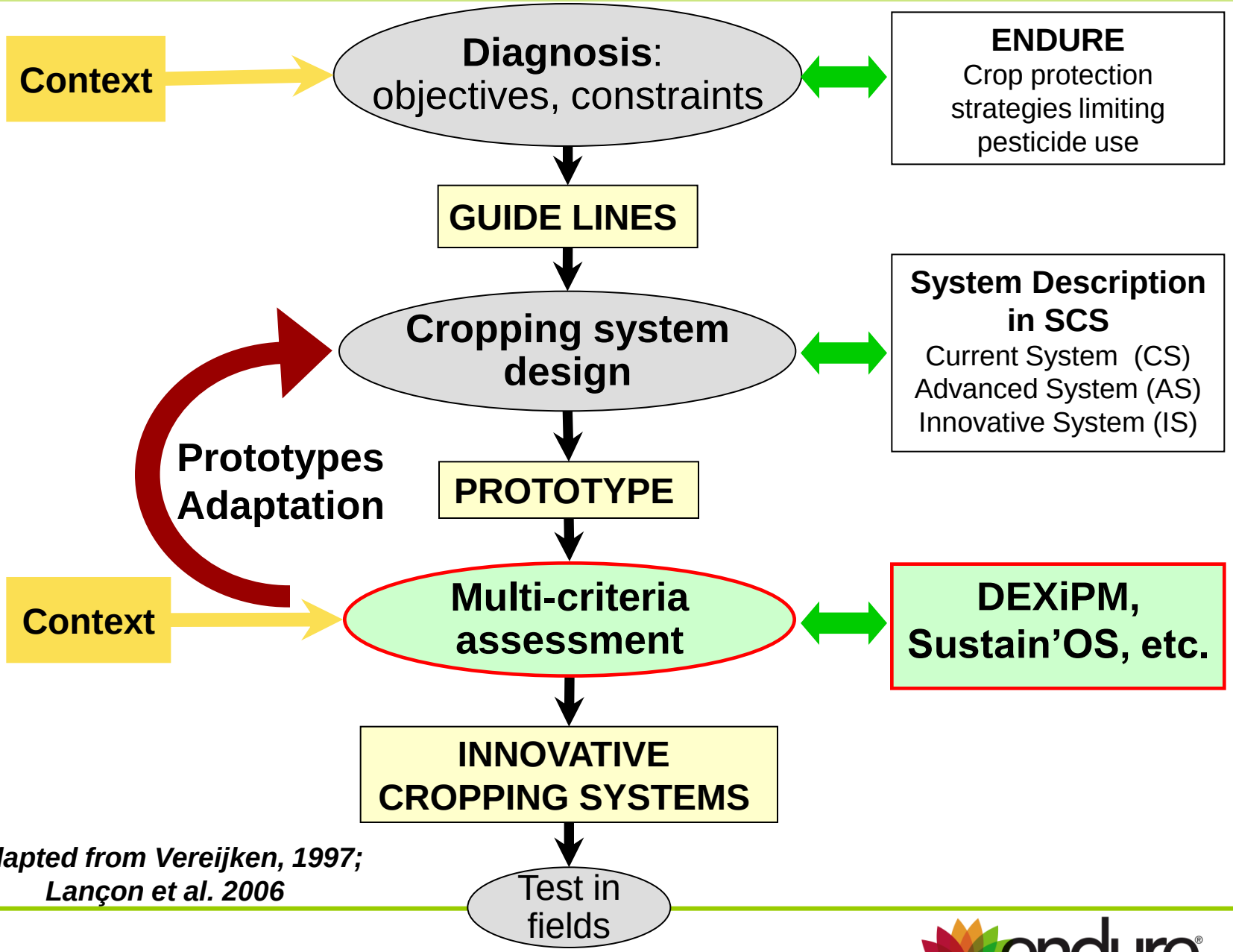
→ NEED FOR SPECIFIC ASSESSMENT TOOLS

ASSESSMENT REQUIREMENTS

- To appraise the performances of the systems (in terms of environmental impact, economic viability and social equity) taking into account a **widened range of criteria**;
- To recognize the existence of **different systems of values** or preferences associated to the cropping systems or practices;
- To analyse cropping systems which are not necessarily economically viable or technically feasible in current context, but which could be **sustainable under different conditions**;
- To assess innovations using **patchy** and sometimes **limited knowledge** coming from expertise.

→ **DEXiPM:** A MULTI-CRITERIA, MULTI-SCALE, MULTI-STAKEHOLDER, DYNAMIC ASSESSMENT TOOL

DESIGN APPROACH



Adapted from Vereijken, 1997; Lançon et al. 2006

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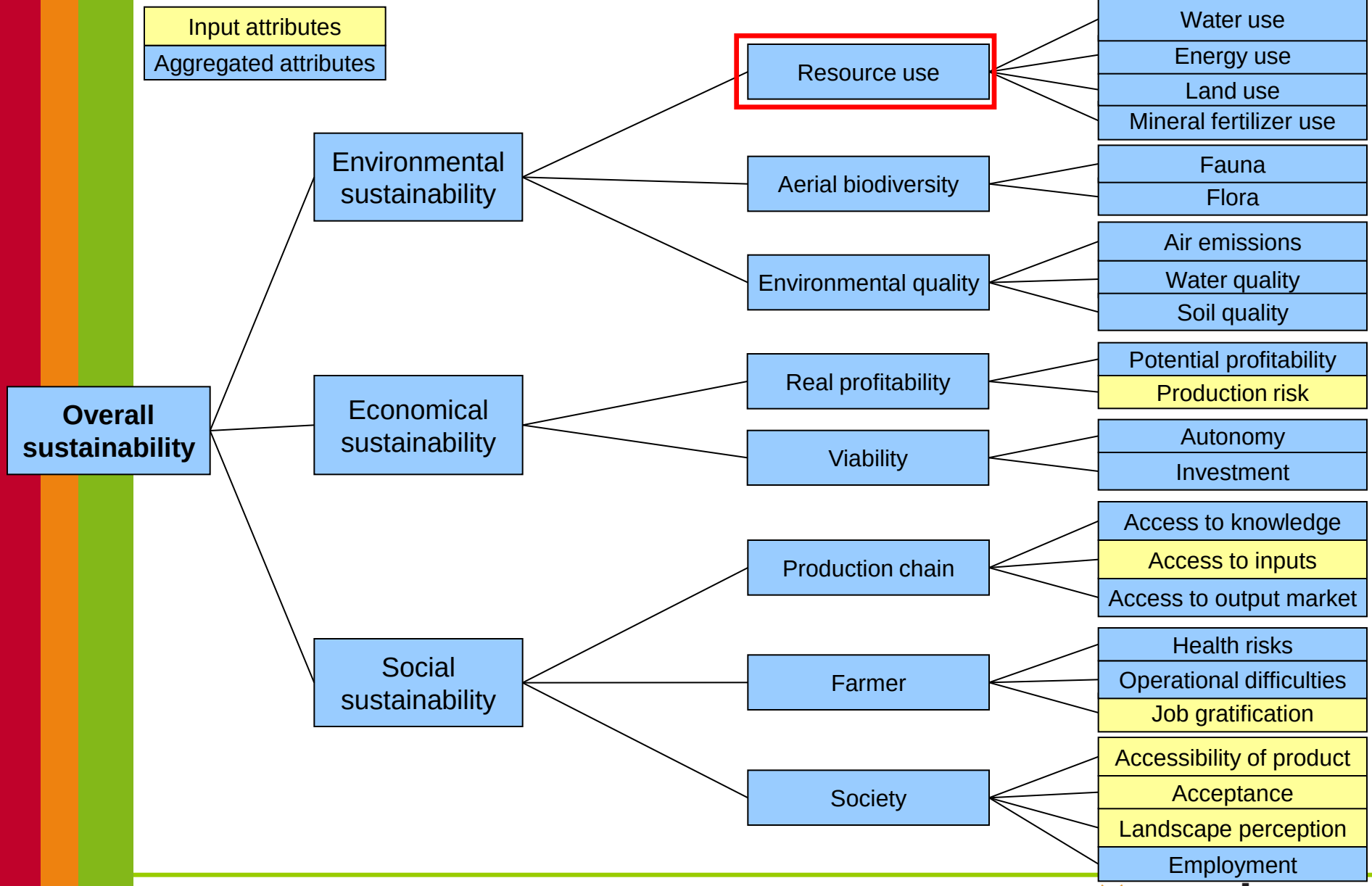
DEXiPM: a hierarchical tree of attributes…



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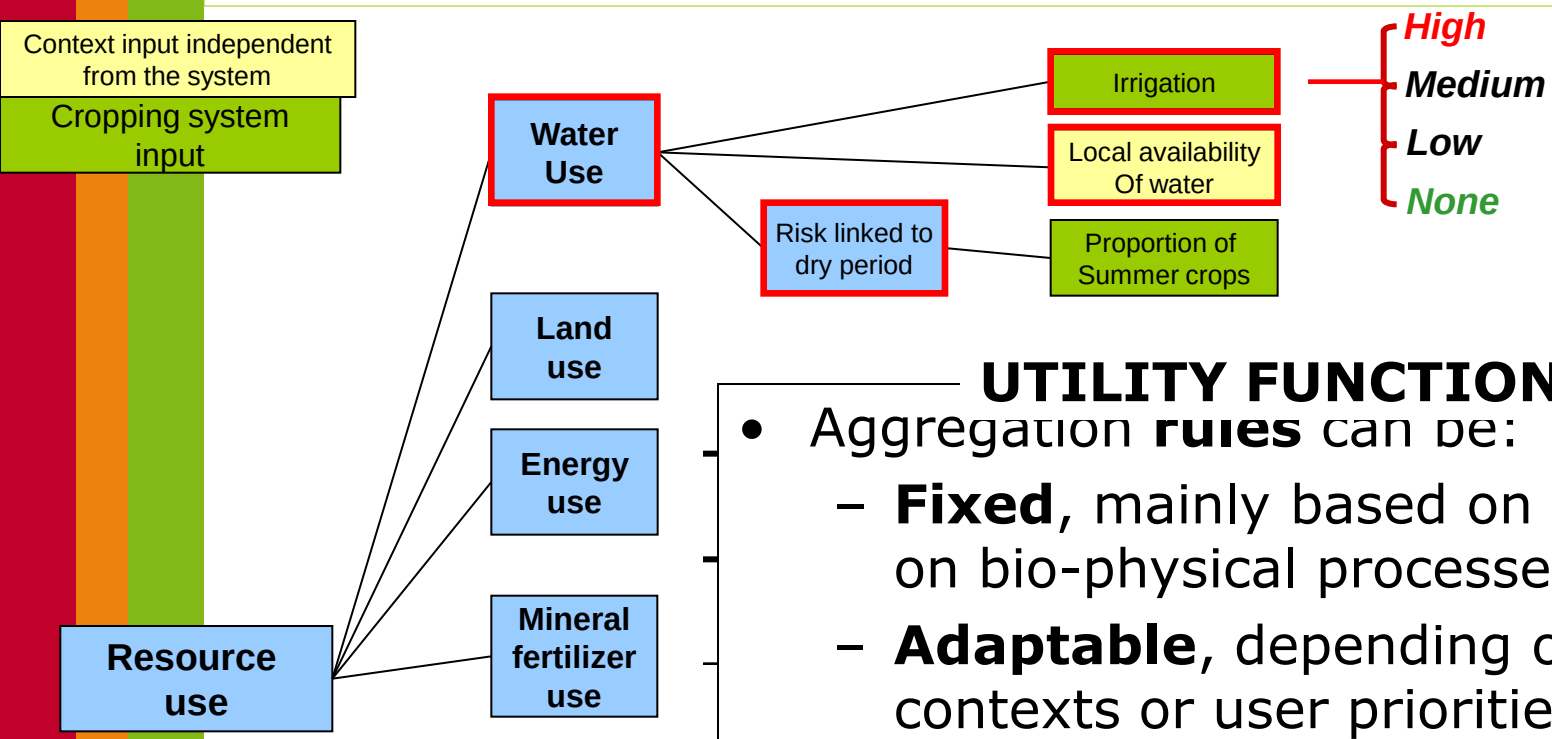
…directly linked with the system and context description



UTILITY FUNCTION

- Aggregation **rules** can be:
  - **Fixed**, mainly based on knowledge on bio-physical processes
  - **Adaptable**, depending on specific contexts or user priorities
- **More details this afternoon during session W1** and in Endure report DR2.22

to low

EXAMPLE OF ASSESSMENT: SYSTEM DESCRIPTION

Option	Current CS	Innovative C
Leaching risk (soil and climate)	very high	very high
Runoff risk due to context	low	low
Field erosion risk due to context	low	low
Hydromorphic soil	no	no
Potential yield	medium to high	medium to high
Regional intensification	not favourable	not favourable
Availability in uncropped land	low to medium	low to medium
Non-productive areas	Low proportion	Low proportion
Average market price	medium to high	medium to high
Labour hourly wage	high to medium	high to medium
Soil cover	medium (41-60	high (61-100%
TFI of insecticides	medium:]1-2]	low:]0-1]
TFI of fungicides	high: >2	none
TFI of herbicides	high: >2	low:]0-1]
Quantity of herbicides' active substance applied	medium: g (a.s.	low: g (a.s.)/ha
Total pesticide TFI	very high: TFI >	low: TFI]0-2]
Pesticide eco-toxicity	medium	low
Pesticides use risk	high : more tha	low : [0-0.5[
Soil cover at pesticide application	medium (21-60	medium (21-60
Mineral N fertilizer applications	high: > 150 kg/	medium: 50-15
Organic N fertilizer application	none	none
Organic amendments	none or liquid m	none or liquid m

- Context inputs independent from the system
- System inputs
- Context inputs dependent on the system

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EXEMPLE OF ASSESSMENT: ANALYSIS

1) To highlight and understand differences between systems (selection of systems to be tested in field)

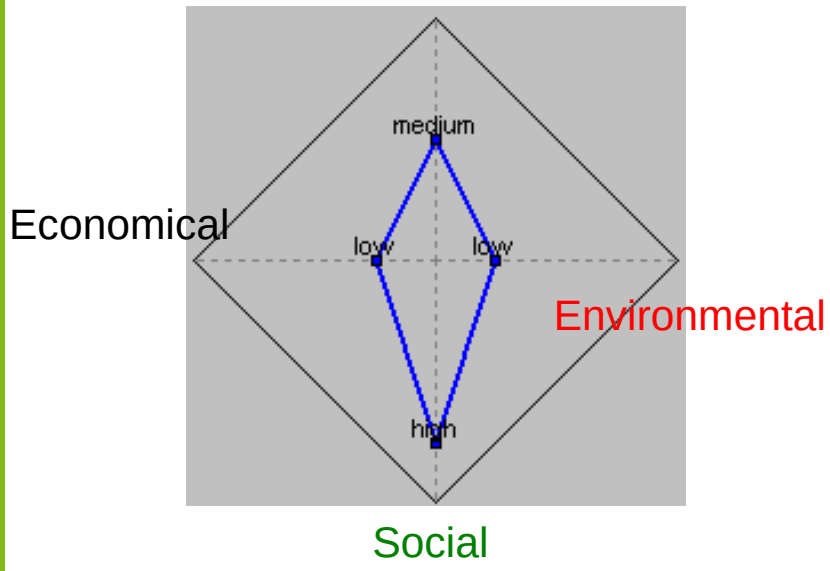
Comparison of options

Attribute	Current CS	Innovative CS
OVERALL SUSTAINABILITY	medium	
ECONOMICAL SUSTAINABILITY	low	very low
Real profitability	low	very low
Production risk	*low*	medium
Potential profitability	very low	
Gross margin	low to medium	very low
Production value	medium to high	very low
Selling price	medium to high	low to medium
Average market price	medium to high	
Valuation or devaluation of price due to the system	neutral	penalty
Valuation or devaluation of price due to crops of the crop sequence	neutral	penalty
Valuation or devaluation of price due to quality and certification requirements	neutral	
Yield	medium	low
Potential yield	medium to high	
Yield reduction	low	medium
Nutrition deficiency	*none*	
Risk of water stress	*none*	
Risk of Nitrogen stress	*none*	
Coverage of crop Nitrogen requirement	*surplus: more than + 25 kg N*	balanced: - 25
Weed state	medium to low	
Weed abundance	low to medium	
Pest state	medium to low	high to mediun
Pest pressure	high	
Pest control	*high*	medium
Yield reduction due to system, other than nutrition and pests or weeds	*no*	medium
Production cost	high to medium	medium to low
Cost of pesticides	high	low
Total pesticide TFI	very high: TFI > 7	low: TFI]0-2]
Cost of fertilizers	high	medium
Mineral N fertilizer applications	high: > 150 kg/ha	medium: 50-15
Mineral P fertilizer applications	low: 0-50 kg/ha P2O5	
Mineral K fertilizer applications	medium: 50-100 kg/ha K2O	
Cost of fuel	medium to low	
Deep tillage	*no*	less than 1/2 y
Total number of treatment operations (fertilizers and pesticides)	7 or more per year	*less than 4 pe*
Superficial tillage	medium	high
Superficial tillage in the crop (mechanical weeding)	*[0;1[per year*	[1;2[per year

EXEMPLE OF ASSESSMENT: EVALUATION RESULTS

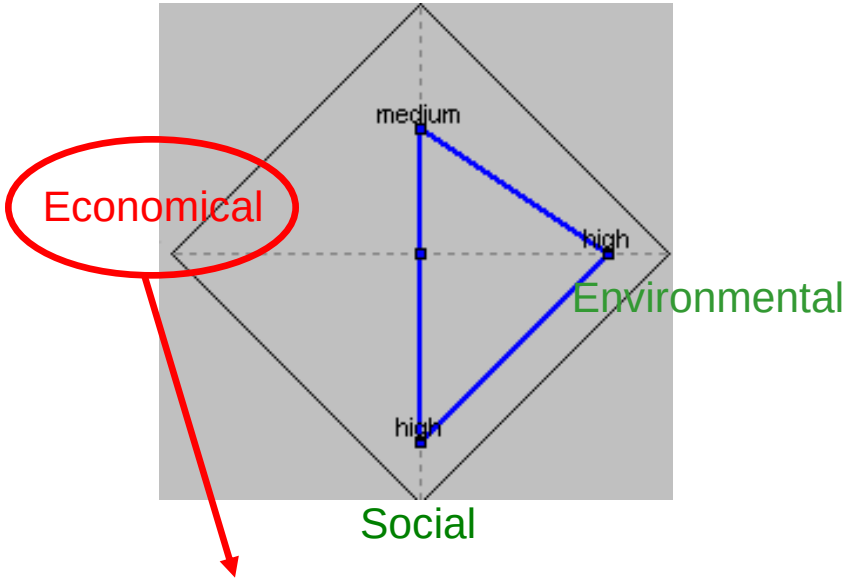
Current cropping system

Overall sustainability

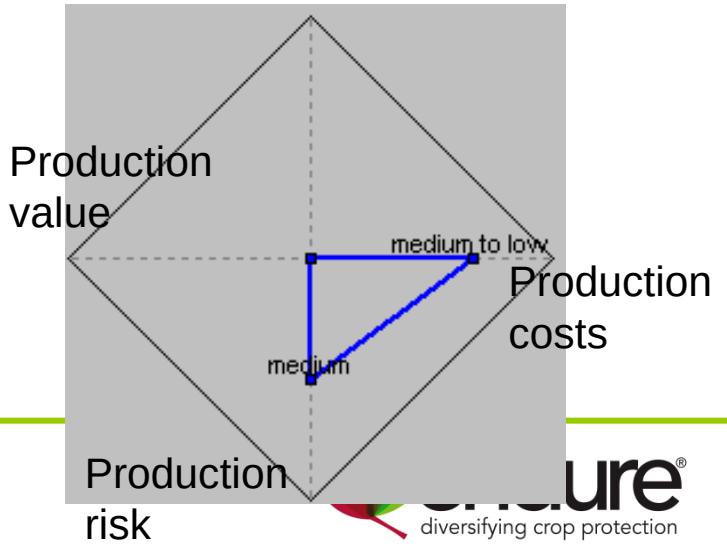


Innovative cropping system

Overall sustainability



Economical sustainability



2) To identify:

- **System elements that should be modified (system adaptation) and**
- **Context parameters that could act as levers (scenario analysis)**

to increase the sustainability of the system

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INTEREST AND LIMITS

- Main difference with other assessment tools (e.g. Sustain'OS, see session D1):

  model inputs → **qualitative information** on cropping practices and context elements (but not calculated indicators).

- Interest: possibility to overcome the lack of data on innovative systems that can be **estimated in a qualitative way by expertise**
- Limits: **complexity** of the tree
- Evolutions:

  – **adapt the DEXiPM tree** depending on the availability of data and tools for calculating aggregated attributes → Simplifying the tree by replacing branches by a calculated indicator (e.g. gross margin or NO_3 leaching)

  –Extend DEXiPM to other production chains

CONCLUSIONS

- DEXiPM, **a design support tool:**
  - To compare systems taking into account a specific context and different elements of the production system (farm, territory, society);
  - To assess the possible modifications of the context that could increase the sustainability of the system.

- DEXiPM, **a discussion tool:**
  - Criteria and aggregation rules are transparent and adaptable depending on stakeholders vision of sustainability.

THANK YOU FOR YOUR ATTENTION

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