Sorting cropping systems on the basis of their impact on groundwater quality

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CONTEXT

SUSTAINABLE DEVELOPMENT

INTEGRATED FARMING SYSTEMS

Economy
Agriculture
Industry

Profitability
Nature preservation
Quality
Social acceptability

Environmental assessment
INRA’S SCIENTIFIC APPROACH

- Amount
- N balance
- Application date
- Splitting up
- Improving techniques

EVALUATION MODULE ‘Nitrogen’

- Amount
- Half-life
- Mobility
- Toxicity
- Location
- Application date

EVALUATION MODULE ‘Pesticides’

- Hydric balance
- Amount

EVALUATION MODULE ‘Irrigation’

--- groundwater ---

THE ACTORS

“How to differentiate cropping systems according to their impacts on groundwater?”

“How to aggregate three different sets of information (nitrogen, pesticides, irrigation)?”

Water Agency → INRA → LAMSADE

client ← analyst

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THE FOUR CATEGORIES OF CROPPING SYSTEMS

C_1
CS with a very high environmental risk level
- Error of practice
- CS that must be rejected

C_2
CS resulting in environmental problems
- Conventional CS
- Common agricultural practices
- CS that have to be improved

C_3
CS aimed at preserving the environment
- Reference methods
- Use of improved methods
- CS that should be implemented

C_4
CS respecting the environment
- Important involvement of the farmer for protecting the environment
- Ideal CS

MULTI-CRITERIA ANALYSIS

.actions:
cropping systems (CS)

criteria:
have to give information on
- nitrogen management
- pesticide management
- water management

non compensatory data
aggregation based on outranking in a partial order

.problem formulation:
assignment of CS to some predefined categories

ELECTRE-Tri method
CONSTRUCTION OF CRITERIA

NITROGEN management
- N balance
- splitting up
- amount
- date
- improving techniques

PESTICIDE management
- amount
- mobility
- toxicity
- location
- date
- amount

WATER management
- hydric balance

EVALUATION MODULE ‘Nitrogen’
EVALUATION MODULE ‘Pesticides’
EVALUATION MODULE ‘Irrigation’

1st criterion family:
3 ‘criteria - evaluation modules’

SORTING THE 33 CS INTO 4 CATEGORIES

<table>
<thead>
<tr>
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<th>C1</th>
<th>C2</th>
<th>C3</th>
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- 6 CS with a very high environmental risk
- 15 CS resulting in environmental problems
- 11 CS aimed at preserving the environment
- 1 CS respecting the environment

number of CS

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CONSTRUCTION OF CRITERIA

NITROGEN management
PESTICIDE management
WATER management

<table>
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<tr>
<th>N balance</th>
<th>splitting up</th>
<th>amount</th>
<th>mobility</th>
<th>location</th>
<th>half-life</th>
<th>toxicity</th>
<th>date</th>
<th>amount</th>
</tr>
</thead>
</table>

2nd criterion - family: 13 criteria - basic data

EVALUATION MODULE ‘Nitrogen’
EVALUATION MODULE ‘Pesticides’
EVALUATION MODULE ‘Irrigation’

DIFFERENT LEVELS OF INFORMATION

Information pesticide 
Information nitrogen
Information irrigation

cropping system

agricultural technique

Information

active ingredient ‘X’

Information

active ingredient ‘Y’

Information

active ingredient ‘Z’

??

amount (X) half-life (X) mobility (X) toxicity (X) location (X) date (X)

amount (Y) half-life (Y) mobility (Y) toxicity (Y) location (Y) date (Y)

amount (Z) half-life (Z) mobility (Z) toxicity (Z) location (Z) date (Z)

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CONSTRUCTION OF CRITERIA

NITROGEN management
  amount N balance date splitting up improving techniques

PESTICIDE management
  amount mobility location half-life toxicity date

WATER management
  amount hydric balance

3rd criterion family: "eight criteria"

EVALUATION MODULE "Nitrogen"
EVALUATION MODULE "Pesticides"
EVALUATION MODULE "Irrigation"

COMMENTS ABOUT MULTI-CRITERIA METHODOLOGY

Criteria:

• simple and transparent

• but:
  - what about a too high number of criteria ?
  - what about the availability level of information ?

Weighting method:

effective but surprising
CLIENTS’ COMMENTS

WATER AGENCY (end user)
- Identification of recommendable cropping systems
- Influence of the decision-maker’s strategies
  - Appropriation of the weighting method
  - Feasibility with a new spatial scale?

INRA (methodology user)
- Exploitation of the evaluation modules
- Feasibility of the multi-criteria methodology
- Questions of end-users
  - Presentation of the multi-criteria approach to the final client
  - Choice of criteria: basic or aggregated data?

INRA’S NEW RESEARCH ACTIVITIES

Water Agency -> INRA -> LAMSADE

“How to select farming systems according to their impacts on wild fauna?”

Hunting Association -> INRA

“How to sort farming systems according to their impacts on landscape?”

Regional Council -> INRA

“How to aggregate various sets of information?”

INRA -> Multi-criteria analyst

“How to aggregate various sets of information?”