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COUPLING A BIOPHYSICAL AND AN ECONOMIC MODEL TO ANALYSE AGRIENVIRONMENTAL POLICIES: A CASE STUDY IN SOUTH-WEST FRANCE

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Introduction

With the reform of the Common Agricultural Policy (CAP), the principle of eco-conditionality will be set forth. This will require agricultural production techniques, crops and rotations that should respect criteria for environmental quality assurance. The complex relations between the levels of inputs, levels of production, and levels of pollution may render conventional methods prescribed by customary environmental policies (taxes on the emissions, inputs, and products, establishment of a market of pollution quotas) inappropriate for many situations.

Objective

· To develop a mathematical economical model that simulates the trade-off between nitrate pollution levels and farm income

· Use the modelling system in a case study in South-West France

Methods

The bio-economical model. The coupling of a biophysical cropping systems model with an economic model based on linear programming optimization.

The biophysical model used was CropSyst. CropSyst is a daily-time step model which contains modules for the simulation of crop growth, water and nitrogen balance, residues fate, erosion by water, and pesticide fate. The model allowed evaluating different management options in terms of input (nitrogen fertilization) - output (yield, nitrate leaching) relationship.

The economic model developed included the possibility of imposing environmental, technical, economical etc. constraints.

Steps to the modelling

1 / Cropping System Simulation

· Build of rotations and management typical of the basin Auradé Gers-France (84.6 ha, four soil types)

· Model calibration using simulated (S) and measured (M) yields of sunflower (sf) and wheat (w). Example of calibration:

year	S (t ha^{-1})	M (t ha^{-1})	(M-S)/M (%)
1990	sf:1.6	sf:1.8	+11.1
1991	w:6.6	w:6.3	-4.8
1992	sf:2.8	sf:2.5	-12.0
1993	w:6.1	w:6.0	-1.7
1994	sf:1.6	sf:1.8	+11.1
1995	w:5.6	w:6.0	+6.7

· N fertilization (kg N ha^{-1} $year^{-1}$)

T1 (actual): sf:70-90 w:140-150

T2: -20% on both sf and w

T3: -50% on sf

T4: -70% on sf

2 / Economic Simulation

· Introduction in the model of an environmental constraint represented by a tolerance limit with respect to nitrate leaching

· Analysis at four price levels:

- Before the first CAP reform (1990)

- After the reform (1995 and 1998)

- Agenda 2000

· Search for a compromise solution to maintain the farmer's income while not trespassing the tolerance limit for nitrate leaching

Results

1 / Cropping System Simulation

· Cropping system simulations did not estimate massive leaching, also because of runoff

· Leaching was more sensitive to the rainfall amount of the year than to the soil type

· Leaching in sunflower was greater than in wheat, but the decrease of yield corresponding to N fertilization reduction was negligible

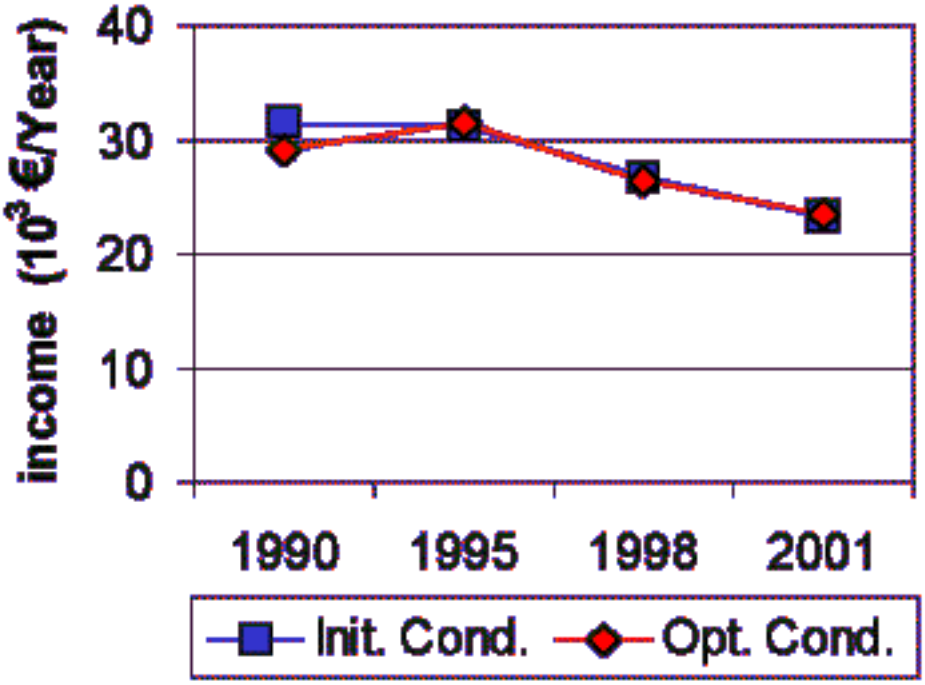
· The decrease of wheat yield due to N fertilization was, on the average:

	T2	**T3**	**T4**
Decrease:	-1%	-12%	-22%

2 / Economic Simulation

· Best management practices resulted **T2** for wheat, and **T4** for sunflower:

Crop	**yield**	**N leaching**
Wheat	-1.4%	-16.8%
Sunflower	-1.5%	-18.0%



Conclusions

The methodology used improved the understanding of the relationship between agricultural management and risk of pollution.

The bio-economical model allowed quantifying the trade-off between environmental efficiency and economical impact of management.

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