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# Land sharing versus land sparing to protect water from pesticide pollution?

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## INTRODUCTION

Increasing pesticide use  
→ pollution of water bodies

Hascic and Wu, 06:  
land use affects the  
level of water  
pollution.

2 main strategies can be implemented to achieve  
water quality goals:

- **Land sharing strategy:** implementing economic instruments to guide farmers towards integrated pest management strategies.
- **Land sparing strategy:** purchasing and excluding from agricultural production the lands with the highest risk of pesticide contamination.

## OBJECTIVES

- What is the best strategy to implement?
- Should land sharing and land sparing strategies be considered separately or in a combined way?
- Do the answers depend on the land-planner's objectives?
- Three possible assumptions on land-planner's objectives:
  - A1: pure economic objective.
  - A2: pure environmental objective.
  - A3: environmental economic objective.
- How to answer those questions *ex ante*, before the implementation of the strategies?

Method based on Babcock et al., 96  
who value a land sharing strategy ex post

## METHODS

- **A1: pure economic objective**

$$\max_{x_{h,i}, x_{p,i}} \sum_{i=1}^I x_{h,i} + \sum_{i=1}^I x_{p,i}$$

$$\text{s.t.} \begin{cases} \sum_{i=1}^I x_{h,i} \cdot c_{h,i} + \sum_{i=1}^I x_{p,i} \cdot c_{p,i} \leq B \\ x_{h,i} + x_{p,i} \leq s_i \end{cases}$$

Ranking of lands according to the minimum cost  
between both strategies.

- **A2: pure environmental objective**

$$\max_{x_{h,i}, x_{p,i}} \sum_{i=1}^I x_{h,i} \cdot b_{h,i} + \sum_{i=1}^I x_{p,i} \cdot b_{p,i}$$

$$\text{s.t.} \begin{cases} \sum_{i=1}^I x_{h,i} + \sum_{i=1}^I x_{p,i} \leq A \\ x_{h,i} + x_{p,i} \leq s_i \end{cases}$$

Ranking of lands according to the maximum  
environmental benefit between both strategies.

- **A3: environmental economic objective**

$$\max_{x_{h,i}, x_{p,i}} \sum_{i=1}^I x_{h,i} \cdot b_{h,i} + \sum_{i=1}^I x_{p,i} \cdot b_{p,i}$$

$$\text{s.t.} \begin{cases} \sum_{i=1}^I x_{h,i} \cdot c_{h,i} + \sum_{i=1}^I x_{p,i} \cdot c_{p,i} \leq B \\ x_{h,i} + x_{p,i} \leq s_i \end{cases}$$

Ranking of lands according to the maximum  
benefit to cost ratio between both strategies. To be  
selected, each land must satisfy:

$$\max \left( \frac{b_{h,i}}{c_{h,i}}, \frac{b_{p,i}}{c_{p,i}} \right) < \max \left( \frac{b_{s2,j} - b_{s1,j}}{c_{s2,j} - c_{s1,j}} \right)_{j < i}$$

Otherwise, j switches from s1 to s2.

*Ex ante* computation of costs and benefits:

- $c_h$  computed from field survey and experts knowledge about semi-net margins;
- $c_p$  computed from econometric estimation of purchase cost (hedonic price method);
- $b_h$  and  $b_p$  computed from a predictive indicator that assesses the risk of pesticide contamination of water

Table 1: Descriptive statistics of land costs and benefits.

	Mean	Standard Deviation	Minimum	Maximum
$c_h$	1,809	2,750	0.95	38,896
$c_p$	11,410	14,570	115	112,359
$b_h$	2.89	0.62	0.065	3.83
$b_p$	8.98	0.79	4.98	9.99
$b_p/c_p$	0.005	0.008	0.00007	0.083
$b_h/c_h$	0.029	0.103	0.00003	1.773

## RESULTS AND DISCUSSION

Table 2: Total cost and environmental benefit for separated strategies.

	Cost (€)	Env. Gain		
	Sparing	Sharing	Sparing	Sharing
A1	200,000	200,000	138	631
A2 (A1)	651,346	569,917	6,481	4,020
A3	200,000	200,000	3,198	3,012

Table 3: Surface and mean size of parcels selected for separated strategies.

	Surface (ha)	Mean size		
	Sparing	Sharing	Sparing	Sharing
A1	157	1,140	10.47	3.23
A2 (A1)	157	1,140	0.22	0.84
A3	43.5	472	0.12	0.45

Table 4: Total cost and environmental benefit for combined strategies.

	Cost (€)	Env. Gain		
	Sparing	Sharing	Sparing	Sharing
A1	-	200,000	-	640
A2 (A1)	3,644,718	-	12,398	-
A3	126,444	73,556	2,319	1,508

The combination of strategies increases environmental gain (3,827) with respect to a pure land sharing strategy, without altering the cost of land planning (200,000€).

## CONCLUSION

- Importance of considering the possibility to implement a mix of strategies when comparing targeting options for the preservation of water
- Ranking procedure for each land planning program, useful to implement.

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