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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**

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

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

- **A2: pure environmental objective**

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

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

- **A3: environmental economic objective**

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

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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