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**

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

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

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

- **A2**: **pure environmental objective**

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

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

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

- **A3: environmental economic objective**

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

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

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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