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Replacing fallow by cover crops: economic sustainability

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Friday, April 12th 2013 NH1.11: Hazard Risk Managment in Agriculture and Agroecosystems



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Outline

- What is a cover crop? Why are them interesting?
- Objectives
- Field experimental setup
- Uncertainty observed
- Economic analysis of possible scenarios
- Economic versus Environmental benefits
- Conclusions







Cover cropping was chosen for this study because, despite the evident environmental services provided and the range of agronomic benefits documented in the literature, farmers' adoption of the technique is still very limited because it could lead to extra costs for the farm.

Objetives

- To evaluate the economic impact of replacing the usual winter fallow with cover crops in irrigated systems using stochastic Monte-Carlo simulations of key farms' financial performance indicators.
 - To relate economic and environmental criteria under different scenarios
 based on measured data.



or basin

Zone: Tajo river basin Field Station "La Chimenea" Climatic conditions:

- Mediterranean semiarid
- •Monoxeric with 4 dry months (June to September)
 - •Average annual temperatures:
 - •20.5 °C maximum
 - •14 ºC mean
 - •6.5 °C minimum
 - Average annual rainfall: 350 mm

•ETo 753 mm



Typic calcixerept (Soil Survey Staff, 2003) **Haplic calcisol** (FAO-UNESCO, 1988)

Silty clay loam texture pH≈8 OM≈2%
 Polygenic origin soil appropriate for irrigation
 Friable structure and porous along the profile
 Without erosion, compactation, inundation, and with low stone content throughout the profile





Cover crop biomass production (B[~]_{cc})



Gabriel, J.L., Quemada, M., 2011. Replacing bare fallow with cover crops in a maize cropping system: Yield, N uptake and fertiliser fate. Eur. J. Agron. 34, 133–143

Cover crop N uptake (N[~]_{cc})



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Effect of each treatment on maize yield variation (Ŷ)









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Prices variation (P[~]_b, P[~]_m and P[~]_f)









MAAMA. Statistical yearbook. Agriculture, Alimentation and Environment Ministry. Madrid, Spain.

Cost increment when cover crops were introduced (C_L and C_S)

 (\mathbf{i})

BY

CC

	Seed	Sown	Tillage	Herbicide	Lift	Cost without lift (C _L)	Cost with lift (C _s)
	€ ha ⁻¹						
Vetch	7.65	1.00	5.00	3.00+55.00	18.00	71.65	31.65
Barley	3.91	1.00	5.00	3.00+55.00	18.00	67.91	27.91
Rapeseed	8.70	1.00	5.00	3.00+55.00	18.00	72.70	32.70

Monte-Carlo simulation for three scenarios:

1. Cover crop residue left on the soil:

$$\pi \tilde{L}_{N} = \tilde{Y} \times P_{m} - C_{L}$$

2. Cover crop residue sold:

$$\pi_{SN}^{\sim} = \tilde{Y} \times P_{m}^{\sim} + B_{cc}^{\sim} \times P_{b}^{\sim} - C_{S}$$

3. Cover crop residue left but fertilizer reduction consider: $\pi_{LF}^{\sim} = \tilde{Y} \times P_{m}^{\sim} + [(N_{cc}^{\sim} \times N_{f} \times P_{f}^{\sim}) / N_{fc}] - C_{L}$

π[~]: stochastic benefit (€ ha⁻¹)

 \tilde{Y} : stochastic yield variation (Mg ha⁻¹)

P[~]_m: stochastic maize price (€ Mg⁻¹)

 N_{cc}^{\sim} : stochastic N uptake by CC (kg N ha⁻¹)

N_f: fraction of N in the cover crop biomass available for the next maize crop

 P_{f}^{\sim} : stochastic fertilizer price ($\in kg^{-1}$)

 N_{fc} : N concentration of the fertilizer

B[~]_{cc}: stochastic biomass produced by cover crops (Mg ha⁻¹)

P[~]_b: stochastic cover crop biomass price as forage (€ Mg⁻¹)

C: extra cost of cover crops (\in ha⁻¹), calculated as the cost of the activities not required for fallow (C_L was the cost when residues were left and C_s the cost when residues were lifted and sold)





Environmental vs. Economic



Gabriel, J.L., Muñoz-Carpena, R., Quemada, M., 2012. The role of cover crops in irrigated systems: water balance, nitrate leaching and soil mineral nitrogen accumulation. Agric. Ecosyst. Environ. 155, 50–61.



CONCLUSIONS

- •Maize yield: Vetch > Barley > Fallow > Rapeseed
- •Economic benefits: Selling residue > fertilizer saving
- •Economic benefits without selling residue: Vetch > Barley = Fallow > Rapeseed
- •Economic benefits selling residue: Vetch > Barley > Fallow = Rapeseed
- •Environmental benefit: Barley > Vetch > Fallow

Cover crops can be economic and environmentally sustainable. But if agroenvironmental services want to promote to leave residue in the field, it should be necessary further investigation for uncertainties reduction, better definition of the cover crops good agricultural practices and probably farmer subsidies would be required to promote cover cropping.



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THANK YOU FOR YOUR ATTENTION

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