FIRST WORKSHOP ON MITIGATION OF GHG EMISSIONS

FROM THE SPANISH AGROFORESTRY SECTOR

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Evaluation of climate change mitigation policies in agriculture

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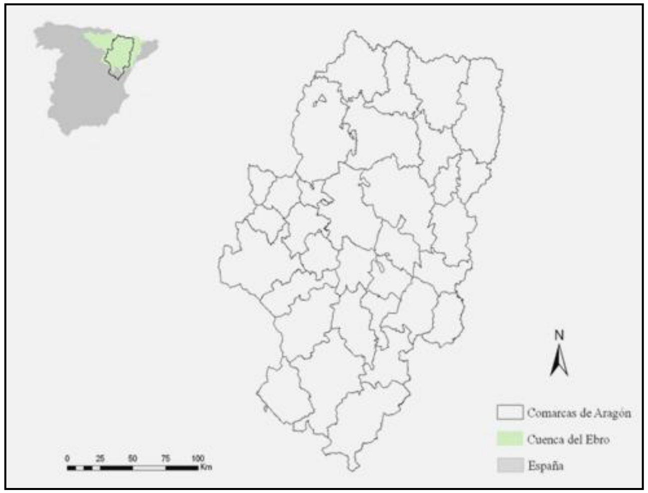
I. Introduction

- Climate change is an important challenge to human society, with environmental, social and economic dimensions.
- In the South of Europe and the Mediterranean basin, there will be large negative effects from climate variability, with considerable damages in food production (FAO 2011).
- Appropriate climate conditions for cultivation are expected to move northwards, resulting in more frequent and severe droughts in the Mediterranean area (IPCC 2011).
- A large body of scientific evidence continues to accumulate, indicating that climatic change is driven by the increasing atmospheric greenhouse gas (GHG) concentrations (IPCC 2007).

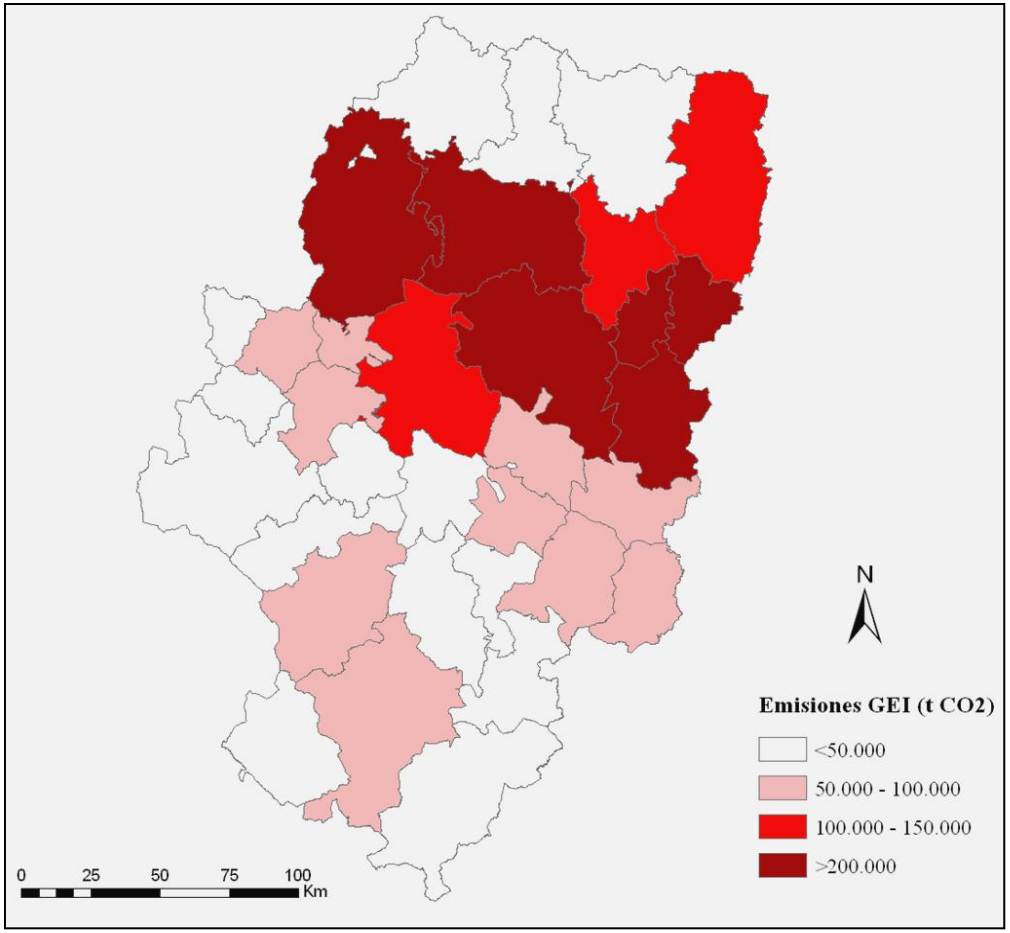
- Agriculture is a source of GHG emissions such as methane (CH_4) and nitrous oxide (N_2O), coming from nitrogen fertilization in cultivated soils, large animal production facilities, and nitrogen pollution loads in rivers and water streams.
- In Spain, GHG emissions from agriculture are close to 39 million t CO_2eq (11% of emissions) (MARM 2011).
- 45% of all agricultural GHG emissions are from soil fertilizer management, making it the largest agricultural source.
- 32% of emissions are methane from enteric fermentation from livestock.
- 21% are nitrous oxide and methane from manure handling and storage.
- LULUCF activities contribute to the improvement of the Spanish GHG emission budget. Carbon sequestration amounts to 29 million t CO_2eq, or 8 percent of total emissions.

- Agriculture in Aragon releases almost 3.6 million t CO_2eq of GHG (EACCEL 2011).
- GHG agricultural emissions in Aragon represent 20 percent of the total emissions of the region, which is above the national percentage (11%).



- Cultivation activities release 1.7 million t CO_2eq (46%).
- Manure management release 1.2 million t CO_2eq (35%).
- Enteric fermentation from livestock release 0.7 million t CO_2eq (19%).
- Forests in Aragon are an important carbon sink, removing 3.4 million t CO_2eq/year from the atmosphere.

The larger agricultural GHG emissions in Aragon are located in the Bajo Cinca, Cinca Medio, Cinco Villas, La Litera and Monegros counties, because of the large acreage of intensive irrigated crops (corn, rice, peach), and the large swine and cattle herd in these areas.



II. Objectives

- Analyze the GHG emission sources linked to agricultural production activities in an intensive agricultural area in Aragon.
- Evaluate the cost-efficiency of several GHG mitigation measures.
- Analyze European agricultural policies at local scale, in order to evaluate their contribution to climate change mitigation.

III. Methodology

- The study analyzes cultivation and livestock activities in four counties of the Huesca province: Barbastro, Cinca Medio, Hoya de Huesca and Monegros. This area includes 138,000 ha of crops acreage and more than 2 million heads of swine.

- The assessment of agricultural GHG emissions follows the approach of the Intergovernmental Panel on Climate Change (IPCC 1996).

- A linear programming model has been developed to assess the cost-efficiency of several climate change mitigation measures.

IV. Results

1. Assessment of GHG emissions

GHG emissions and quasi-rent from agricultural production activities

	Barbastro	**Cinca Medio**	**Hoya de Huesca**	**Monegros**	**Total study area**
N_2O direct emission (10^3 t CO_2eq)	16	12	20	45	93
N_2O indirect emission (10^3 t CO_2eq)	10	7	12	27	56
N_2O manure management (10^3 t CO_2eq)	3	8	5	9	25
CH_4 manure management (10^3 t CO_2eq)	63	88	45	246	442
CH_4 enteric fermentation (10^3 t CO_2eq)	15	32	17	47	111
Total emissions (10^3 t CO_2eq)	**107**	**147**	**99**	**374**	**727**
Crop quasi-rent (10^6 €)	9	8	5	17	39
Livestock quasi-rent (10^6 €)	4	6	5	13	28
Total quasi-rent (10^6 €)	**13**	**14**	**10**	**30**	**67**
Emission intensity (€/t CO_2eq)	**122**	**95**	**100**	**80**	**91**

2. Policy scenario

Social welfare and quasi-rent under each scenario

Scenarios	Welfare (10^6 €)	Quasi-rent (10^6 €)	Environmental damage (10^6 €)	Crop acreage (10^3 ha)	Swine herd (10^3 heads)
Baseline	49	67	18	134	2,050
Emission tax (t_e=25 €/t CO_2eq)	67	49	18	136	1,940
Emission limit (10%)	49	65	16	130	1,769
Water quality control	48	65	17	100	2,050
Fertilization standards	55	71	16	134	2,050
Nitrogen tax (t_n=0.5 €/kg N)	48	58	17	114	2,050
Nitrogen tax (t_n=1 €/kg N)	48	51	17	111	2,050
Improved feed	46	64	18	134	2,050
Swine herd reduction (15%)	48	64	16	134	1,746
Water tax (t_w=0.02 €/m^3)	48	57	18	119	2,050
Water tax (t_w=0.05 €/m^3)	47	43	18	117	2,050
Reduction of irrigation water (25%)	43	61	18	118	2,050

Water and nitrogen use and pollution loads under each scenario

Scenarios	Water use (Mm^3)	Nitrogen Fertilization (t N)	Manure surplus (t N)	Nitrogen leaching (t N)	GHG emissions (10^3 t CO_2eq)
Baseline	567	19,720	7,500	5,900	727
Emission tax (t_e=25 €/t CO_2eq)	569	19,900	7,100	6,000	700
Emission limit (10%)	549	19,080	6,700	5,700	655
Water quality control	503	13,140	8,800	3,950	677
Fertilization standards	567	10,751	2,200	2,700	653
Nitrogen tax (t_n=0.5 €/kg N)	505	16,890	9,400	4,700	694
Nitrogen tax (t_n=1 €/kg N)	497	16,300	9,600	4,500	690
Improved feed	567	19,720	4,650	5,900	726
Swine herd reduction (15%)	558	19,720	6,300	5,900	655
Water tax (t_w=0.02 €/m^3)	506	17,470	7,800	5,200	711
Water tax (t_w=0.05 €/m^3)	492	16,800	8,100	5,050	706
Reduction of irrigation water (25%)	437	18,240	7,600	5,200	709

3. Abatement costs

GHG abatement potential and cost of measures

Scenarios	GHG abatement potential (t CO_2eq)	GHG abatement cost (€/t CO_2eq)	Cumulative GHG abatement (t CO_2eq)
Fertilization standards	74,000	-54	74,000
Emission limits (10%)	72,000	28	146,000
Water quality control	50,000	40	196,000
Swine herd reduction (15%)	72,000	42	268,000
Nitrogen tax (t_n=0.5 €/kg N)	33,000	273	301,000
Reduction of irrigation water (25%)	18,000	333	319,000
Nitrogen tax (t_n=1 €/kg N)	37,000	432	356,000
Water tax (t_w=0.02 €/m^3)	16,000	625	372,000
Emission tax (t_e=25 €/t CO_2eq)	27,000	667	399,000
Water tax (t_w=0.05 €/m^3)	21,000	1,143	420,000
Improved feed	1,000	3,000	421,000

V. Conclusions

- Agriculture is an important sector for the implementation of climate change policies.

- Agriculture is a significant source of GHG emissions and the main source of non-CO_2 emissions.

- The design of adequate mitigation policies for the agricultural sector is needed and requires the cooperation of farmers through the right institutional setting.

- The emission intensity in the study area is 91 €/t CO_2eq, well above the average emission intensity of agriculture in Aragon (339 €/t CO_2eq).

- This type of information is important because the spatial dimension of emissions contributes to the design and implementation of climate change mitigation policies adjusted to local conditions.

- The analysis of the climate change mitigation measures in agriculture indicates that there is not a unique preferred measure.

- No single instrument can work to mitigate climate change. A combination of adequate regulatory instruments is highly recommended to achieve climate stabilization requirements in a cost-efficient way.

- Local characteristics and social acceptability have to be considered in the design of measures, because enforcement requires the support of stakeholders to be legitimate.

- One important result is the need of considering the entire nitrogen cycle and sources when implementing measures to reduce GHG emissions. Inappropriate measures could indirectly increase the loss of nitrogen to water resources through increased leaching and runoff from crop cultivation and manure surplus.

- A comprehensive nutrient management planning is needed to reduce emission pollution loads.
- In the case of Aragon, more attention has to be paid to manure management in order to find solutions for a better use of this waste.
- Manure management is an important aspect for the implementation of the current environmental regulation. This regulation needs some revision and adaptation to local conditions.
- Results indicate that the use of economic instruments following the “polluter pays” principle is quite inefficient in the abatement of agricultural nonpoint pollution.

Thank you for your attention