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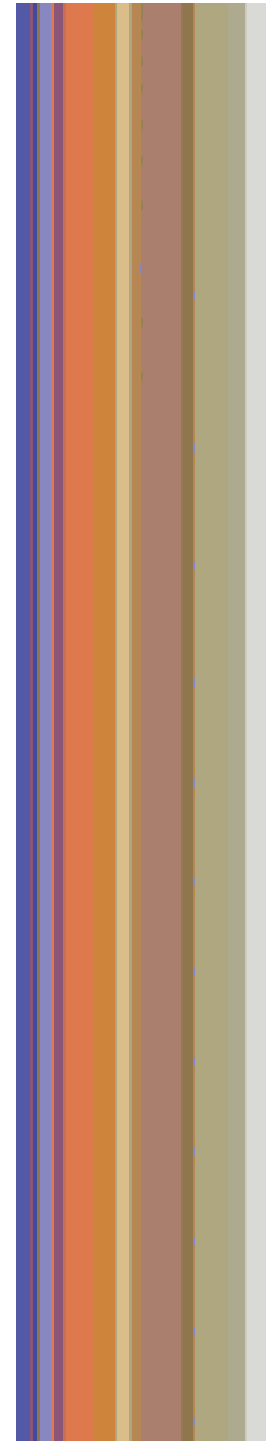
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Economic analysis of measures addressing GHG emissions. A literature survey

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Literature survey: type of analysis

- The papers have been analysed in three separate aspects of the agro-forestry sector:
 1. - relationship between farming and GHG emissions
 2. - biomass for energy production (as substitute of fossil fuel)
 3. - mitigation options by forestry

- Some papers have investigated the overall land use change with possible shift of land between agriculture and forestry

Comparing alternative economic tools

- A linear programming model for the European agricultural sector allows to derive **marginal abatement cost curves** in response to different levels of emission tax or quota permits
- The model shows that a 20 €/tCO₂eq tax can induce a 4% GHG emission reduction respect to 2001 levels in the whole EU agriculture. Also it is highlighted that **CH₄ emissions reduction costs are lower due to the “cheap” option to substitute animal feeding respect to N₂O reductions** which take place only when high tax levels are imposed (above 50 €/tCO₂eq)
- Another study, using an hybrid model for the world agricultural sector, reports **much lower estimates of mitigation potential** in the EU. They conclude that a 20 \$/tCO₂eq tax allows for a 0.2% reduction of non-CO₂ gases in 2010
- A uniform quota system seems **less efficient** than emission tax

Comparing alternative economic tools (2)

- Two studies from USA demonstrate that a **single per hectare subsidy** paying all adopters to undertake conservation tillage can be **much more expensive** than a **discriminatory subsidy** paying only new adopters based on their effective ability to sequester carbon
- Indeed about 1 MMT of carbon can be acquired for \$ 270 from a single subsidy and \$ 190 from a discriminatory subsidy, nevertheless it is recognised that this second scheme may not be viable **either politically** or due to prohibitively **high administrative or enforcement costs**
- Using an integrated assessment modelling framework, it has been demonstrated that **per-tonne contracts could be more efficient of per-hectare contracts** if the spatial heterogeneity of agricultural production systems and the **cost of implementing contracts** are taken into account

The impact of CAP reform

- Some papers show that CAP reform should have a **positive effect** on GHG emissions
- A spatial economic agricultural model for the EU15 estimates that the shrinking effect on agricultural production driven by the reform can induce *per-se* a **1.8% GHG emission reduction** in 2009 respect to the 2001 level
- Crops activities are more affected by the reduction, so N₂O emissions decline more (-3.5%) than CH₄ emissions (-0.3%).
- Other two studies show the effect of Fischler reform in Irish agriculture. 1) A **partial equilibrium** agricultural sector model estimates a relevant reduction of GHG emissions (-13%). 2) In a **general equilibrium** model the reduction seems smaller and it concerns different sectors.

The impact of CAP reform (2)

- In Denmark the decrease in production volume caused by the Agenda 2000 reform is accompanied by **a slight emission reduction**. CH₄ and N₂O emissions are indeed reduced only by 1% of CO₂eq, as changes in the crop mix, in fertilisation intensity and in livestock production counterbalance each other in environmental terms
- **Integrated models** is important to simulate the whole economy, the agricultural activities within it, their specific spatial distributions and the linkages with environment. On the other hand the intrinsic **uncertainties** and the problems of **approximations** and **assumptions** limit the potentials of integrated model to determine relative effects
- Always using an integrated model, **potential economic synergies** were found in policies for the abatement of methane and nitrous oxide with ammonia reductions as a side effects, whereas **negative side effects** were found between ammonia abatement and nitrous oxide emissions

Biomasses for energy production

- The main conclusion of the literature survey is that existing fiscal incentives and management policies supporting energy biomass **are not totally justified** on the basis of its supposed environmental superiority over fossil-fuel based energy.
- The net energy balance for the substitution of gasoline by bio-ethanol based on **wheat** seems negative while it appears positive only for **sugar beet** (Germany)
- A meta-analysis over 15 studies to assess the optimality of tax exemption for bio-fuels in Germany shows that, **without subsidies, bio-ethanol would not be competitive** respect to gasoline
- The positive GHG reduction potential of bio-fuel production has **very high abatement costs** (under the most promising perspective will cost 300 €/t CO₂eq)

Biomasses for energy production (2)

- An alternative more cost-effective option to reduce GHG emissions using agricultural land would be the cropping of **fast-growing woods** to produce electricity which entails an abatement cost lower than 50 €/tCO₂
- Bio-fuel in France are 2 to almost 4 times more expensive than fossil fuels and the needed subsidies are not comparable with the externality reduction (study conducted in 1997)
- Inefficiency in the public support to liquid bio-fuels in France is highlighted by other authors. Micro-economic analysis suggest that there is **margin for more efficient policies**
- Even in presence of price uncertainty, **tax exemptions in France could be reduced the 10%-20%** with no risk for the viability of existing chain

Biomasses for energy production (3)

- The comparison between different bio-fuels highlights that **wood biofuels are less area efficient than biofuels coming from agricultural biomass**, because of lower yields per unit area and they are therefore less effective whether land area is a limiting factor
- On the other hand **wood biofuels give better GHG balances as a function of the produced amount of energy** (CO₂ sequestered / produced GJ), thus would be more effective whether area constraints are absent.
- Considering the **USA context** and given current technologies, biofuels could play an important role in a market for emission reductions provided **the carbon equivalent price was above \$30 per metric ton**. Only the ability to collect considerable additional benefits from carbon savings makes the biofuels more competitive.

Forestry and land use change as mitigation options

- Carbon sequestration strategies (afforestation, sequestration in soils) seems to become attractive at **lower incentives levels** in comparison to biomass strategies for energy
- On the other hand **bioenergy is reported as a preferred option instead of afforestation in the long term**, because of the most permanent impact on mitigation efforts
- The short rotation energy forest or energy crops are **more area efficient** than multifunctional forests as far as emission reduction capacity is concerned (but the **environmental side effects** of these two land uses are quite different)
- **Increasing the stock** in the wood products might be a way to reduce costs of forestry strategies. The estimates suggest that costs might be lowered by perhaps 75% but the stock in wood products don't qualify for the Kyoto Protocol as deforestation reduction

Forestry and land use change as mitigation options (2)

- Wood products may play a role **as substitutes of other materials** in the mitigation of GHG emissions, avoiding emissions. As regards them the waste handling is important for the impact result but further analysis should be developed on their cost competitiveness
- Considering the **US context**, the size of incentives necessary to generate GHG mitigation in the agriculture and forest sectors **range from \$5 to \$80 per tonne of CO₂**:
 - agricultural soil carbon sequestration and forest management are fairly low-cost options, (\$5/tonne);
 - afforestation and biofuels become the dominant mitigation options at GHG prices above \$15–30/tonne;
 - mitigation of CH₄ and N₂O from agriculture has a fairly small but steady scope for mitigation.

Concluding remarks

- The literature concerned with the cost-effectiveness of policy measures for the mitigation of GHG emissions in agriculture and forestry is wide. All this makes it **difficult to compare results** of different studies, nevertheless some results seem confirmed
- Many studies highlight **a potential for the agricultural and forestry sector** to provide GHG abatement at a competitive costs. Policy measures targeted to those sectors can thus be justified in term of effectiveness and efficiency.
- The CAP reforms can contribute to GHG reduction. This contribution seems quite small for the Agenda 2000 reform, but **can be higher for the new reform process** established with the Mid-term Review. This can be due partly to a shrinking in agricultural sectors induced by the increased competition in agricultural markets, but also to improved environmental friendly activities

Concluding remarks (2)

- A crucial aspect for the future of research in the field lays in the role to be played by the IPCC Guidance. There is a substantial dichotomy between the evidences of the recent scientific literature and the approach proposed by the IPCC.
- The former analysing heterogeneity of phenomena, uncertainty, spatial variability and raising doubts, the latter proposing fixed coefficients that can be adopted in various generic contexts of globe.