

**Limiting the nitrogen losses by N-tax and bioenergy
support : a quantitative analysis of environmental policy mix
impacts in the north of France**

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Limiting the nitrogen losses by N-tax and bioenergy support : a quantitative analysis of environmental policy mix impacts in the north of France

Summary

This paper is devoted to assessment of policy mix impacts regarding nitrogen pollutants. The analysed policy combines a tax on the nitrogen input and incentives promoting perennial crops assumed to be low input ones. We show that perennial crop subsidy increases significantly the tax efficiency, compatible with the balanced budget of the Regulatory Agency in charge of the environment. Based on a MILP agricultural supply model, quantitative analysis provides assessment of impacts regarding land use, farmers income, and N losses at the North France level.

Keywords: Bio-economic model; mathematical linear programming; environmental policy mix; N-fertilizer tax; bio-energy support;

1 Introduction

Agricultural production is well known for having negative externalities such as nitrate losses and GreenHouse Gases (GHG) emissions. Indeed, the intensification of cropping systems and the increase of livestock density have pushed the rise of nitrate concentration in soils as well as the GHG emissions. To regulate these phenomena, and in particular the nitrate content of watersheds, several European Directives and policies have been implemented. The two main ones are (i) the "Water Directive", dealing with the water quality conservation in major reserves by reducing or eliminating pollutant losses and emissions, and (ii) the "Nitrogen Directive" focusing on the water quality protection by preventing the N-pollution from the agricultural sector (mineral fertilizer and livestock manure) through a set of good agricultural practices (especially about N-input consumption). These tools interfere indirectly with the "Biofuel Directive" which promotes the use of energy crops. Among them, the perennial biomass crops, like the miscanthus, have fewer environmental impacts thanks to their lower fertilizer inputs and their less intensive farming practices.

The N-pollution issue is one of the main agricultural negative externalities. Numerous papers showed the low efficiency of the N-loss regulation such as the N-tax. Indeed, this second best issue remains pretty difficult to solve regarding the real world. This is partly due to the number of agents involved in the environmental process, to the spatial heterogeneity of agents and impacts, and to the intricate system of public policies leading to a wide range of interferences. However, by adding other instruments to the N-tax, like land use policy and biofuel support, we lead to relevant policies. Regarding our paper, we focus on the comparison of the impacts of two kinds of agricultural policy schemes aiming to decrease the nitrogen pollutant losses. First, we examine the implementation of usual policy tools like the N-tax on mineral fertilizers. In the context of encouraging environmental-friendly crop production, we then analyze the impact of an agricultural subsidy scheme assigned to a perennial biomass crop: the miscanthus. The miscanthus was chosen for two reasons: i) the existence of literature information, leading us to retain high biomass yields under European climatic-ecological conditions and ii) the claimed low-input request and the high quality regarding the transformation into energy (Lewandowski and Schmidt, 2005). Our methodology uses the agricultural supply model AROPAj. This mathematical linear programming model was built to cover the European Union by the way of a large set of representative farm groups.

These farm groups are representative at the regional scale. Our study should be first devoted to an area under charge of a Water Agency, like the Seine river basin. In this paper we enlarge the area until 14 Regions of the north of France. In the model, there are 99 farm types grouped into these 14 regions. A large set of activities are covered (field crops, grasslands, set-aside, animal production). Each farm group is related to one mathematical programming model and data are mainly provided by the Farm Accountancy Data Network (FADN). A coupling of AROPAj with the crop growth model STICS is proceeded in order to estimate the nitrogen response functions describing the relation the yield and the N-losses. Concerning the introduction of the perennial activity in the model, some improvements are required, like the 'fix use' of the land which can be easily introduced in our annual modelling. The difficulty comes with the computation of the Net Present Value of the miscanthus. The determination of this value is based on "the Faustmann" principle used in the case of perennial crop with annual harvest. The generic function of natural increase used in this level is calibrated on few data available from the works of Miguez et al. (2008), Clifton-Brown et al. (2007), and Christian et al. (2008) and adjusted to the average yield of traditional annual crop such as wheat.

2 Methodology

2.1 The AROPAj model description

The AROPAj model, developed by INRA, is a one-period mixed integer mathematical programming model able to take into account the technical aspects of the agricultural production. Based on a micro-economic approach (Arfini, 2001), AROPAj describes the annual supply choices of the European farmers in term of surface allocation, animal production and on-farm consumption of grains and forrages. Farmers are grouped into farm types according to: the farm techno-economic orientations within its region, the farm economic size and the farm altitude class. Each farm type, which is statistically representative of the different production systems, is assumed to choose the supply level and the input demand which maximize its total gross margin under several constraints: total farm type land endowment, availability of housing and animal demography, quality of feeds and Common Agricultural Policy (CAP) measures (set-aside requirements, milk and sugar beet quotas). Concerning the model calibration, data are mainly provided by the Farm Accountancy Data Network (FADN). Since the creation of the AROPAj model, it was used in the study of the successive CAP reforms (Jayet and Labonne, 2005) - McSharry, Agenda 2000 and Luxembourg reforms - and in the analyses of the agri-environmental problems, such as the afforestation (Cara and Jayet, 2000), the GHG emissions (Cara and Jayet, 2000) and the nitrogen pollution of groundwater aquifers.

For some years, the AROPAj model has been improved by adding dose-response functions, ones linking the N-input and the crop yield (C. Godard) and others linking the N-input and the N-losses. This approach, developed by (Petsakos and Jayet, 2010), considers a nitrogen balance taking into account the nitrogen related to manure management.

2.2 Introduction of perennial crops

*Miscanthus x Giganteus*¹ is a rhizomatous grass which comes originally from the tropics and subtropics, but is found under different species throughout a wide climatic range in East Asia (?). The remarkable adaptability of miscanthus to different environment (Numata, 1974) makes it suitable for establishment and distribution under European and North American climatic conditions (Lewandowski et al., 2000). Field trials have shown the high biomass yield potential, 15 to 20 tonnes dry matter per hectare, in comparison to other herbeaceous crops (Clifton-Brown and Jones, 1996; Jorgensen, 1997; Lewandowski et al., 2000). Thanks to its characteristics, it can provide good protection against soil erosion risks and, with low input consumption, it can decrease the risk of groundwater pollution by pesticides and nitrates.

¹Miscanthus x Giganteus is a steril hybrid between *M. Sinensis* and *M. Sacchariflorus*.

For the introduction of miscanthus in the AROPAj model, two elements have been calculated for each farm-type: the Average Net Present Value (NPV^*) and the average yield (Y), both corresponding to the optimal rotation (T^*). The determination of NPV^* is based on a dynamic optimisation in time used in the case of perennial crop with annual harvest ; and a deterministic function of natural increased is used to compute Y .

2.2.1 Determination of the generic growth function ($Y(t)$):

Basing on the researches of Miguez et al. (2008), Clifton-Brown et al. (2007) and Christian et al. (2008), we build a growth model for miscanthus. Condering a as the maximum biomass yield, b the inflection point in which biomass yield reaches the half of the maximum biomass yield, c the spreading parameter and d the attenuation coefficient, the model is given by the following equation:

$$Y(t) = [a/(1 + \exp((b - t)/c)) - a/(1 + \exp((b)/c))] \exp(-dt) \quad (1)$$

As shown in Figure ??, three phases are identified: i) the installation phase where the yield increases, ii) the maturity phase where the biomass reaches its maximum and iii) the decline phase showing the decrease of the miscanthus growth.

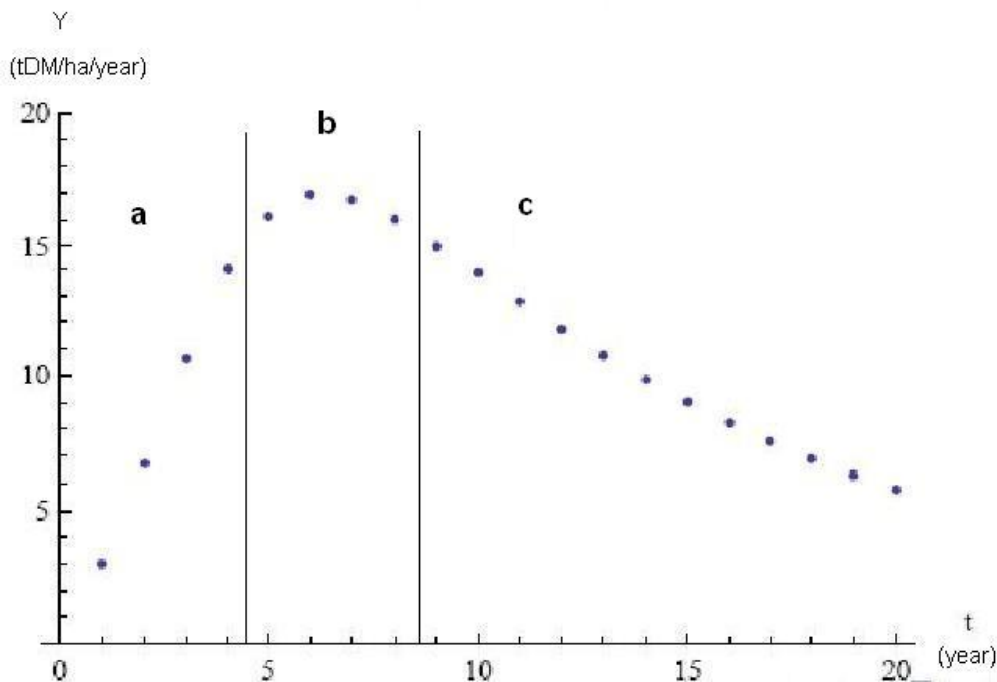


Figure 1: Miscanthus growth curve

2.2.2 From a dynamic approach to a static framework

To introduce miscanthus in AROPAj, we need to compute its yield level for each farm type but, miscanthus yields are not available in the FADN database and, knowing that miscanthus crops have been recently introduced in France, yield informations for the full rotation period (15-20 years) are not available as well. So we suppose that miscanthus yield increases with the quality of the land, following the wheat yield², wheat being a traditional crop presented in the four-fifths of the french farm-type into AROPAj. This assumption is confirmed in Figure ??, which shows the significant correlation between the average regional yield of miscanthus (Regional yield of miscanthus data are provided by the French Biomass Project REGIX) and the average regional yield of wheat. Then,

²Wheat yield data are provided by the FADN database.

we proceed to an adjustment of the average miscanthus yield to the average wheat yield to identify the level of miscanthus yield for each farm-type.

Dependent Variable: RDT_MISC
Method: Least Squares
Date: 11/04/10 Time: 10:44
Sample(adjusted): 1 4
Included observations: 4 after adjusting endpoints

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|--------------------|-------------|------------|-------------|--------|
| RDT_BL | 5.165168 | 0.652004 | 7.921991 | 0.0156 |
| C | -21.48187 | 5.191174 | -4.138152 | 0.0537 |
| R-squared | 0.969116 | | | |
| Adjusted R-squared | 0.953674 | | | |

Figure 2: Correlation between the average yield of miscanthus and the average yield of wheat

2.2.3 The Net Present Value:

We suppose that miscanthus plantations are typically grown as an even-aged monoculture. Prices and costs rise at continuous time about 1.5% per year and the discount rate δ is fixed at 5% for perennial grasses in France. The establishment cost (EC) paid off over T years (rotation) in an infinite sequence, as established by Faustmann's criterion, happens in year zero. First costs, fixed at 3000 €/ha, is composed of: rhizome purchase cost, planting cost, cultivation cost and herbicides cost for a weed control. Then, production costs (PC) happen one year after the establishment and will be appealing to each T year until the infinite. The latters correspond to variable costs and include expenses made for fertilization, weed control and harvest, they are fixed at 400 €/ha/year. To have an annual gross margin (GM) during the rotation, we consider that the crop is harvested annually (several times) during the T years rotation. At year t , its value is obtained by multiplying miscanthus yield, harvested at t ($Y(t)$) in (tDM), with its price (P), fixed by Bical Biomasse France (BBF) at 70 €/tDM. To sum up, we have $GR(t) = P * Y(t)$.

The NPV of miscanthus is obtained by maximizing the discounted profit infinite sequence, at time t_0 . Therefore, the discounted value of the net income is equal to

$$NPV(t) = (-EC + \sum_{t=2}^T (GR(t) \exp(-\alpha) - PC \exp(-\alpha)) \exp(-\delta t) / (1 - \exp(-\delta T))) \quad (2)$$

where α is the inflation rate.

3 Single policy analysis

The aim here is to study the impacts of the introduction of miscanthus on the abatement costs of the three main N-pollutants: N_2O , NH_3 and NO_3 . We first focus on comparing the effects of N-fertilizer tax on abatement costs when the farmers are allowed or not allowed to plant miscanthus. The objective is to assess whether the introduction of miscanthus reduces abatement costs. Secondly, in the case where miscanthus is introduced, we compare the effects of two 2nd best policies (a N-fertilizer tax and a subsidy for miscanthus) on abatement costs and land use.

3.1 Impacts of the introduction of miscanthus on abatements costs in the case of N-fertilizer tax

The benchmark refers to the state in which the perennial crop is not implemented. We focus here on the one-dimension policy when N-fertilizer tax is only implemented. The range of the tax

is [0%,100%] of the N-price³. The main outcome is that the abatement costs of the three given pollutants are reduced when miscanthus is introduced.

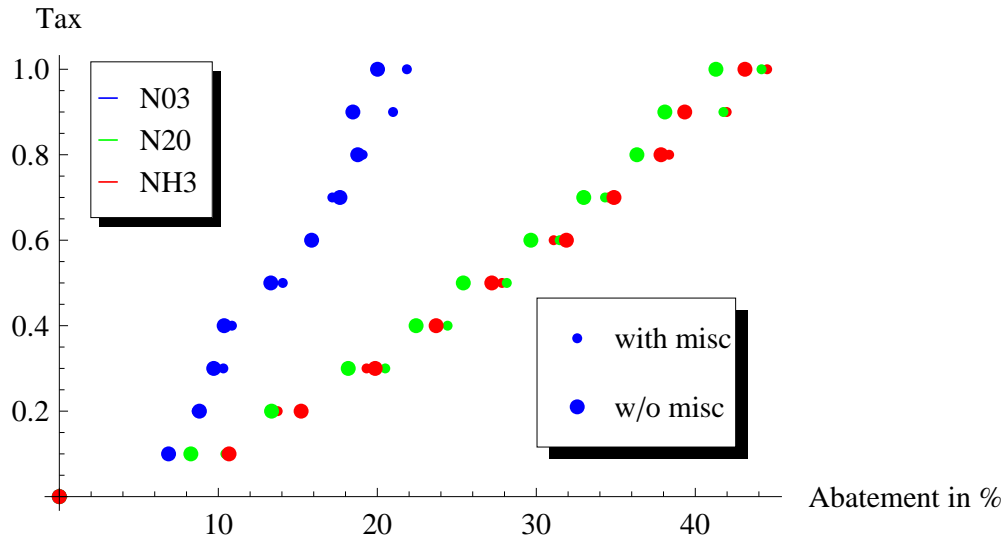


Figure 3: Abatement (%) in function of tax on N-fertilizer

Whether or not miscanthus is introduced, in both cases the tax equals marginal costs and farmers have a tendency to abandon certain plots when the marginal costs of these plots are higher than the tax. In the case where miscanthus is introduced, if the tax is null, the surface of miscanthus is close to zero because the marginal profit of miscanthus production is negative for most of the available plots. However, if the tax increases, the farmers start planting miscanthus on the abandoned plots (from 0 to 2.5 % of Utilized Agricultural Area (UAA)) when the tax increases from 0 to 100 % of the N-price (Cf. Table 1 of the Appendix). Moreover, the share of the abandoned plots covered by miscanthus increases with the tax. This is due to the fact that the last abandoned plots have the highest marginal yields. We can also observe on graphics that the introduction of miscanthus reduces the abatement costs of all three pollutants, in particular when the tax level exceeds 80 % of the N-price as miscanthus increases from 1 to 2.5 % of UAA. In addition, a distinction can be done between lower tax levels, for which only gas pollutions see their abatement costs reduced, and higher tax levels (> 80%), for which all N-pollutant abatement costs are significantly reduce (including N_0_3).

3.2 Comparison of a N-fertilizer tax and a subsidy for miscanthus

Because a relationship seems to exist between an increase of the miscanthus area and the abatement of N-pollutants, it is interesting to compare a N-fertilizer tax, which affects input costs, with a policy in favor of biofuels, particularly with one which provides a miscanthus subsidy (considered as an environmental-friendly crops). Abatement of the three pollutant is evaluated for values of the subsidy varying between 0 to 250€/ha and for values of the tax between 0%, and 100% of the N-price. For those values, the abatement induced by the tax is always higher. However the impact of miscanthus subsidy on abatement is non-negligent, in particular for the N_0_3 pollutant. Indeed, the N_0_3 abatement represents up to 40 percent of the N_0_3 abatement obtained in the case of the N-fertilizer tax (for equal abatement costs).

The miscanthus subsidy only reduces the proportion of land devoted to other croplands production (Cf. Table 2 of the Appendix), without reducing those croplands yields (extensive effect). Taxes on intensity have a double effect on agricultural production. First, taxes reduce the croplands yields (because less inputs are used) and increase the proportion of land devoted to miscanthus crops, fallow land and grassland (Cf. Table 1 of the Appendix). Secondly, taxes reduce intensity and

³The average N-mineral price is close to 1€/kgN.

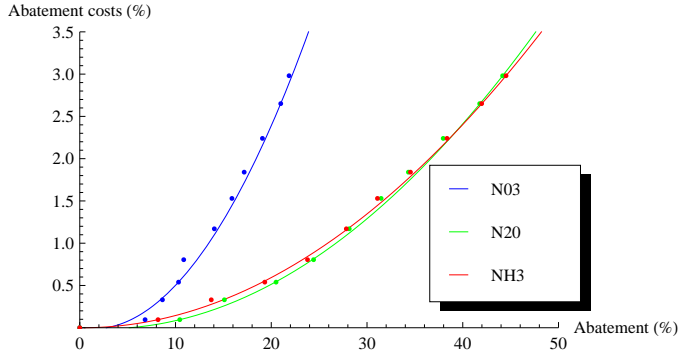


Figure 4: In the case of tax (and no subsidy): Total abatement costs (% of benchmark revenue) in function of N-pollutant abatement (% abatement)

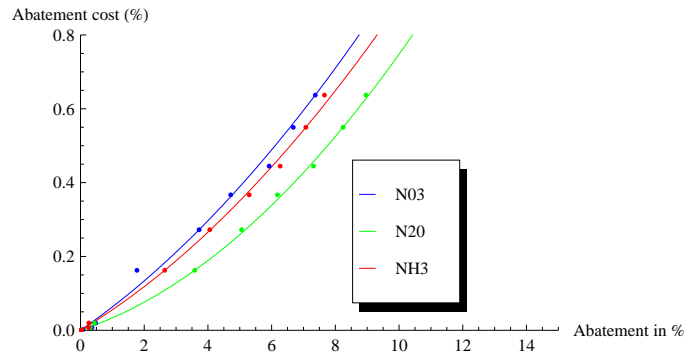


Figure 5: In the case of subsidy (and no tax): Total abatement costs (% of benchmark revenue) in function of N-pollutant abatement (% abatement)

thus the production level for all croplands, including those with high soil quality (intensive effect). An interesting result is that the increase of miscanthus area doesn't imply a significant decrease of grassland and fallow but rather a decrease in cereals (soft wheat, maize and other cereals) and oilseeds. The explanation comes from the Luxembourg CAP reform, where most of the subsidies depend on the area criterion. This reform induces a land reallocation rather than a decrease of grassland. However, even if subsidies contribute to substitute croplands by miscanthus, the impact of the N-fertilizer tax on croplands is more important. Indeed, while miscanthus area reaches 6.7 % of UAA for a subsidy equal to 250€/ha and 2.5% of UAA for a 100% N-tax, croplands (except miscanthus) represent between 66% and 61.7 % of UAA in the first case and between 66 % and 60.7 % of UAA in the second one.

To conclude, N-pollutants can be reduced by: i) decreasing N-fertilizer input use in the case of a N-tax (intensive use) or ii) increasing subsidized environmentally-friendly crops (extensive use). In the next section, we will focus on the combination of those two policy tools in order to achieve a better efficiency.

4 Quantified impacts of the policy mix at the North of France level

In this section, we add a tax on agricultural inputs, and we study how it modifies the results of this previous section.

4.1 Impacts on abatement costs of the policy mix

We can observe that the policy mix instrument reduces the abatement costs for the three given pollutants. As expected, results involving NO_3 abatement costs are better. Indeed, for a 20% abatement target⁴, the abatement costs are reduced 3 fold (3% vs 1% of revenue). For the N_2O and the NH_3 abatements, the abatements costs are higher regardless the target.

The Figures 6 and 7 describe abatement cost curves for each N-pollutant under tax scheme, and the associated horizontal curves correspond to the additional abatement under subsidies, for each tax level. As shown on Figure 6, adding a miscanthus subsidy decreases the abatement cost of NO_3 (in comparison with the tax alone), especially when the input tax is high, whereas the abatement costs of gas pollutants (N_2O and NH_3) increase (Cf. Figures 6 and 7).

This result is mainly due to emissions processes (interpolated as linear function of N-input), NO_3 -losses having a weaker sensitivity to N-input (β) and greater natural emissions compared to N_2O and NH_3 . These latter pollutions are thus mainly sensitive to N-input contrary to NO_3 leaching mainly responding to crops area shares This is noteworthy because NO_3 is the pollutant for which the abatement cost are the highest. This means that it is the pollutant with the weakest elasticity

⁴Goal of the Water Directive for the French Seine Bassin

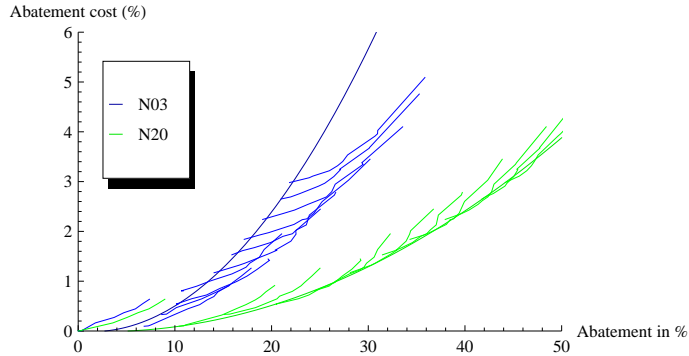


Figure 6: Abatement costs (% of revenue) in function of NO_3 and N_2O abatements in policy mix

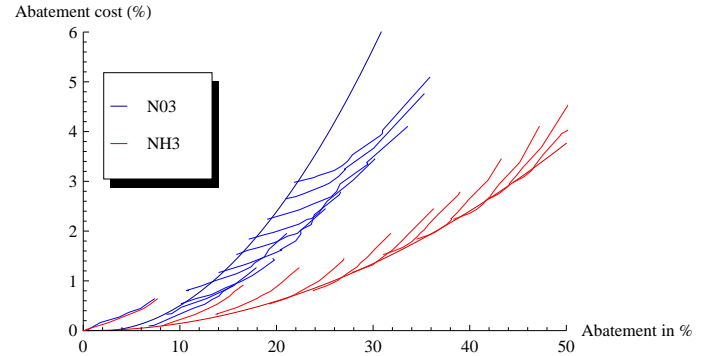


Figure 7: Abatement costs (% of revenue) in function of NO_3 and NH_3 abatements in policy mix

to decrease in N-fertilizer. So, the efficient of policy mix for the NO_3 pollutant is the combination of two extensive margin effects: i) A land reallocation in favor of miscanthus (for which we assumed an α weak) and ii) The elasticity of land reallocation in favor of miscanthus due to subsidy increases with the tax on N-fertilizer (Cf. Table 3 in Appendix). In other words, the higher tax level is, the greater miscanthus maximum area and introduction rate with subsidy level are.

On the contrary, since two other pollutants natural losses (α) are already weak for main crops (especially soft wheat), the land reallocation in favor of miscanthus leads to fewer additional abatement in comparison to N-fertilizer tax alone.

Adding an incentive policy of perennial biomass crops with a price instrument thus increases gas pollution abatement costs, but is of real interest for NO_3 pollution regulation purposes. Therefore, a trade-off exists for the regulatory body between NO_3 and gas pollution control.

4.2 Budget opportunities thanks to the policy mix

In this section we focus on the NO_3 pollutant, which is under the charge of local or Regional Water Agencies directly responsible of their budget. This Public Body is interested in the consequences of the policies regarding the different economic partners possibly affected by their implementation.

Fertilizer producers should first see the policy impact on the fertilizer demand (see Figure 8), and, given a fertilizer abatement target, they undoubtedly prefer the miscanthus support policy more than the tax policy. But isoquants respectively related to the fertilizer abatement and the NO_3 abatement quite differ.

The Public Body should focus on substitutability between N-tax and perennial crop support, which significantly changes with levels of tax and subsidy (see Figure 9). Let us focus on a 25% abatement target regarding the NO_3 loss. The polar policies are the set “50% tax, 250€/ha subsidy” and “100% tax, 75€/ha subsidy”. In the first of these two cases, the fertilizer demand decreasing is 35%. In the second case, the fertilizer demand decreases until more than 45%.

Farmers obviously prefer the perennial crop support than the N-tax. Figure ?? shows the iso-income curves related to the agricultural income including the total refund of the tax (as a lumpsum transfer). In the first of the two previous polar cases, this income slightly decreases (-0.5%), much less than in the second polar case (-0.5%).

Finally under consideration of budget balance on one hand and under consideration of industrial and agricultural producers on the other hand, the best policy tends to adopt the policy mix {50% tax, 250€/ha subsidy}. In this case, the refund of the tax to farmers should not exceed 250M€(see Figure ??). In this case, before refund of the tax, the perennial crop support is close to 380 M€and the N-tax receipt is close to 580 €.

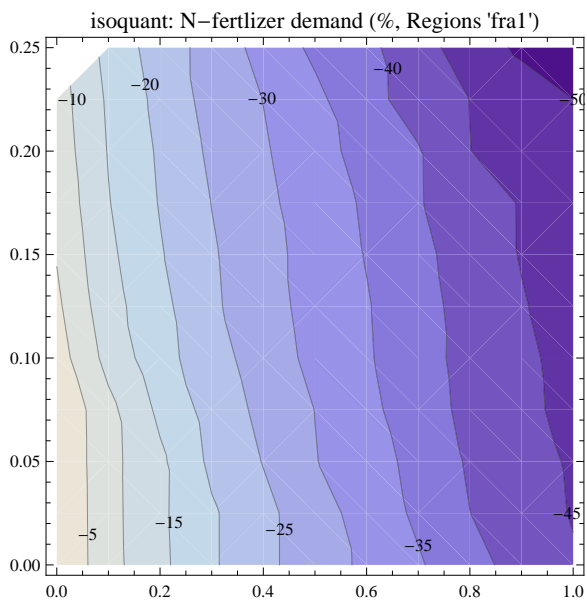


Figure 8: Iso-level curves of fertilizer demand abatement (% of the benchmark) - 14 Regions in the north of France)

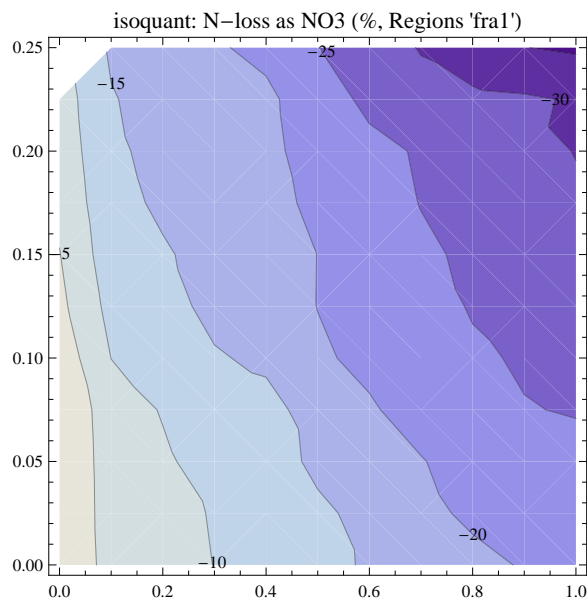


Figure 9: Iso-level curves of soil-root NO_3 abatement (% of the benchmark) - 14 Regions in the north of France)

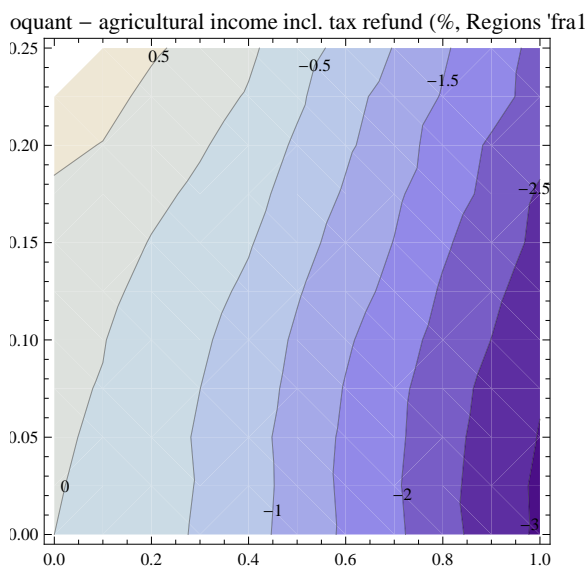


Figure 10: Iso-level curves related to farmers profit including the tax refund (% of the benchmark) - 14 Regions in the north of France)

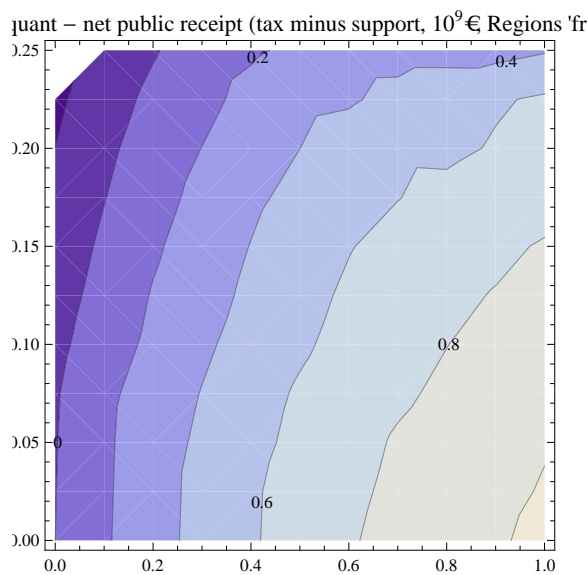


Figure 11: Iso-level curves of net budget receipt (tax minus perennial crop subsidy in 10^9€) - 14 Regions in the north of France)

5 Concluding remarks

We analyse an environmental policy mix combining N-input tax and energy crop subsidies, using a quantitative modelling framework based on the supply-side micro-economic model AROPAj and the crop model STICS. In addition, we used a Faustmann approach allowing us to assess yields and costs of a perennial crop (miscanthus). We show that a policy mix results in higher N-pollutant abatements than implementing each single policy instrument (tax or subsidy), but is cost efficient only for NO_3 . It is well known that single N-input tax leads to low NO_3 abatement with pollution-price elasticity generally less than 20% for reasonable tax levels. But when tax receipt is partly transformed into perennial crop support (250€/ha), a tax close to 50% of N-input price allows a 25% pollution reduction. These results support some water management stakeholders position arguing that substitution of agricultural croplands (targeting protein content) by ligno-cellulosic crops dedicated to dry matter would lower N-pollutions.

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6 Appendix

6.1 Table 1

| Tax | Miscanthus | Soft wheat | Maize | Other cereals | R&T* | Oilseed | Fodder | Fallow | Grassland |
|-------|------------|------------|-------|---------------|-------|---------|--------|--------|-----------|
| 0.000 | 0.905 | 18.920 | 7.350 | 16.354 | 5.836 | 9.738 | 8.437 | 7.879 | 24.579 |
| 0.100 | 0.895 | 18.497 | 7.325 | 16.581 | 5.857 | 9.706 | 8.414 | 7.849 | 24.876 |
| 0.200 | 0.886 | 18.058 | 7.351 | 16.624 | 5.859 | 9.599 | 8.450 | 7.802 | 25.370 |
| 0.300 | 1.051 | 17.300 | 7.267 | 16.910 | 5.875 | 9.519 | 8.415 | 7.665 | 25.998 |
| 0.400 | 1.045 | 16.722 | 7.177 | 16.717 | 5.895 | 9.445 | 8.592 | 8.241 | 26.167 |
| 0.500 | 1.115 | 16.282 | 7.131 | 16.649 | 5.866 | 9.153 | 8.636 | 8.435 | 26.733 |
| 0.600 | 1.031 | 16.179 | 7.100 | 16.495 | 5.882 | 9.119 | 8.541 | 8.541 | 27.111 |
| 0.700 | 1.021 | 15.843 | 6.967 | 16.363 | 5.901 | 9.094 | 8.661 | 8.690 | 27.460 |
| 0.800 | 1.089 | 14.995 | 7.274 | 16.482 | 5.912 | 9.027 | 8.638 | 8.759 | 27.824 |
| 0.900 | 2.472 | 14.367 | 7.225 | 16.172 | 5.898 | 8.824 | 8.561 | 8.385 | 28.095 |
| 1.000 | 2.521 | 14.300 | 7.138 | 16.087 | 5.924 | 8.768 | 8.485 | 8.390 | 28.386 |

Table 1: Area (UAA %) in function of N-fertilizer tax (no subsidy);
= Root and tuber crops

*

6.2 Table 2

| Subsidy | Miscanthus | Soft wheat | Maize | Other cereals | R&T * | Oilseed | Fodder | Fallow | Grassland |
|---------|------------|------------|-------|---------------|-------|---------|--------|--------|-----------|
| 0.000 | 0.905 | 18.920 | 7.350 | 16.354 | 5.836 | 9.738 | 8.437 | 7.879 | 24.579 |
| 0.025 | 1.060 | 18.886 | 7.342 | 16.331 | 5.836 | 9.735 | 8.443 | 7.825 | 24.543 |
| 0.050 | 1.216 | 18.812 | 7.336 | 16.285 | 5.835 | 9.710 | 8.440 | 7.824 | 24.541 |
| 0.075 | 1.440 | 18.803 | 7.320 | 16.280 | 5.835 | 9.709 | 8.409 | 7.663 | 24.540 |
| 0.100 | 3.155 | 18.145 | 7.080 | 16.047 | 5.805 | 9.508 | 8.409 | 7.309 | 24.540 |
| 0.125 | 4.279 | 17.926 | 7.065 | 15.459 | 5.764 | 9.362 | 8.355 | 7.265 | 24.525 |
| 0.150 | 5.074 | 17.607 | 7.000 | 15.371 | 5.717 | 9.268 | 8.186 | 7.232 | 24.545 |
| 0.175 | 5.620 | 17.305 | 6.963 | 15.269 | 5.700 | 9.187 | 8.178 | 7.232 | 24.547 |
| 0.200 | 6.275 | 17.036 | 6.912 | 15.150 | 5.680 | 9.116 | 8.151 | 7.156 | 24.524 |
| 0.225 | 6.744 | 16.803 | 6.903 | 15.136 | 5.668 | 9.058 | 8.143 | 7.155 | 24.391 |

Table 2: Area (UAA %) in function of Subsidy (no N-fertilizer tax)
Root and tuber crops

*=

6.3 Table 3

| Taxe | 0.1 | | | | | | 0.2 | | | | | |
|------|---------|------------|------------|------------|--------|-----------|------------|------------|------------|--------|-----------|--|
| | Subsidy | Miscanthus | Soft wheat | Other Croc | Fallow | Grassland | Miscanthus | Soft wheat | Other Croc | Fallow | Grassland | |
| | 0 | 0.9 | 18.5 | 47.9 | 7.8 | 24.9 | 0.9 | 18.1 | 47.9 | 7.8 | 25.4 | |
| | 0.025 | 1.2 | 18.4 | 47.8 | 7.8 | 24.9 | 1.1 | 18.0 | 47.8 | 7.8 | 25.3 | |
| | 0.05 | 1.2 | 18.4 | 47.8 | 7.8 | 24.9 | 1.2 | 17.9 | 47.8 | 7.7 | 25.4 | |
| | 0.075 | 1.5 | 18.4 | 47.6 | 7.6 | 24.9 | 2.9 | 17.2 | 47.1 | 7.4 | 25.4 | |
| | 0.1 | 3.8 | 17.6 | 46.4 | 7.2 | 24.9 | 4.7 | 16.8 | 46.0 | 7.1 | 25.3 | |
| | 0.125 | 5.0 | 17.2 | 45.8 | 7.2 | 24.9 | 5.1 | 16.7 | 45.7 | 7.1 | 25.4 | |
| | 0.15 | 5.6 | 16.9 | 45.5 | 7.2 | 24.9 | 5.8 | 16.3 | 45.4 | 7.1 | 25.4 | |
| | 0.175 | 6.2 | 16.6 | 45.3 | 7.1 | 24.9 | 6.5 | 16.0 | 45.2 | 7.0 | 25.3 | |
| | 0.2 | 6.5 | 16.4 | 45.1 | 7.1 | 24.8 | 6.8 | 15.9 | 45.0 | 7.0 | 25.3 | |
| | 0.225 | 7.0 | 16.3 | 45.0 | 7.1 | 24.7 | 7.4 | 15.7 | 44.7 | 7.0 | 25.2 | |
| | 0.25 | 7.6 | 16.1 | 44.6 | 7.1 | 24.7 | 8.1 | 15.3 | 44.4 | 7.0 | 25.1 | |
| Taxe | | 0.3 | | | | | 0.4 | | | | | |
| | 0 | 1.1 | 17.3 | 48.0 | 7.7 | 26.0 | 1.0 | 16.7 | 47.8 | 8.2 | 26.2 | |
| | 0.025 | 1.1 | 17.3 | 48.0 | 7.7 | 25.9 | 1.1 | 16.7 | 47.8 | 8.2 | 26.1 | |
| | 0.05 | 2.5 | 16.9 | 47.1 | 7.5 | 25.9 | 2.6 | 16.3 | 47.1 | 7.9 | 26.1 | |
| | 0.075 | 3.5 | 16.8 | 46.5 | 7.2 | 26.0 | 3.8 | 16.2 | 46.4 | 7.5 | 26.1 | |
| | 0.1 | 4.8 | 16.4 | 45.7 | 7.0 | 26.0 | 5.3 | 15.8 | 45.6 | 7.2 | 26.2 | |
| | 0.125 | 5.7 | 16.0 | 45.3 | 7.0 | 25.9 | 5.9 | 15.5 | 45.3 | 7.1 | 26.1 | |
| | 0.15 | 5.9 | 15.9 | 45.2 | 7.0 | 25.9 | 6.2 | 15.3 | 45.3 | 7.1 | 26.1 | |
| | 0.175 | 6.5 | 15.6 | 45.0 | 6.9 | 25.9 | 6.7 | 15.1 | 45.0 | 7.1 | 26.1 | |
| | 0.2 | 7.2 | 15.4 | 44.6 | 6.9 | 25.9 | 7.3 | 14.9 | 44.7 | 7.1 | 26.1 | |
| | 0.225 | 8.0 | 15.0 | 44.3 | 6.9 | 25.8 | 8.0 | 14.8 | 44.2 | 7.1 | 26.0 | |
| | 0.25 | 8.1 | 15.0 | 44.3 | 6.9 | 25.7 | 9.1 | 14.5 | 43.5 | 7.1 | 25.8 | |
| Taxe | | 0.5 | | | | | 0.6 | | | | | |
| | 0 | 1.0 | 16.3 | 47.5 | 8.4 | 26.7 | 1.0 | 16.2 | 47.1 | 8.5 | 27.1 | |
| | 0.025 | 1.1 | 16.3 | 47.4 | 8.4 | 26.7 | 2.5 | 15.8 | 46.5 | 8.2 | 27.1 | |
| | 0.05 | 3.2 | 15.8 | 46.1 | 8.1 | 26.7 | 3.3 | 15.7 | 45.8 | 8.2 | 27.0 | |
| | 0.075 | 3.9 | 15.8 | 46.0 | 7.7 | 26.7 | 4.4 | 15.4 | 45.4 | 7.8 | 27.0 | |
| | 0.1 | 5.7 | 15.2 | 45.2 | 7.3 | 26.6 | 5.6 | 15.1 | 44.8 | 7.4 | 27.0 | |
| | 0.125 | 6.2 | 14.9 | 45.0 | 7.2 | 26.6 | 6.2 | 14.8 | 44.7 | 7.3 | 27.0 | |
| | 0.15 | 6.2 | 14.9 | 45.0 | 7.2 | 26.6 | 6.5 | 14.6 | 44.5 | 7.3 | 27.0 | |
| | 0.175 | 7.1 | 14.6 | 44.6 | 7.2 | 26.6 | 7.1 | 14.5 | 44.2 | 7.2 | 27.0 | |
| | 0.2 | 7.8 | 14.4 | 44.1 | 7.2 | 26.6 | 8.0 | 14.3 | 43.7 | 7.2 | 26.9 | |
| | 0.225 | 8.0 | 14.4 | 44.0 | 7.2 | 26.5 | 9.5 | 13.7 | 42.7 | 7.2 | 26.9 | |
| | 0.25 | 9.7 | 13.8 | 43.1 | 7.2 | 26.3 | 9.7 | 13.6 | 42.7 | 7.2 | 26.8 | |
| Taxe | | 0.7 | | | | | 0.8 | | | | | |
| | 0 | 1.0 | 15.8 | 47.0 | 8.7 | 27.5 | 1.1 | 15.0 | 47.3 | 8.8 | 27.8 | |
| | 0.025 | 2.7 | 15.4 | 46.2 | 8.4 | 27.4 | 3.2 | 14.6 | 46.1 | 8.4 | 27.8 | |
| | 0.05 | 3.3 | 15.4 | 45.6 | 8.4 | 27.4 | 3.8 | 14.2 | 45.8 | 8.4 | 27.7 | |
| | 0.075 | 5.0 | 14.8 | 44.9 | 7.9 | 27.4 | 5.2 | 13.9 | 45.2 | 8.0 | 27.7 | |
| | 0.1 | 5.9 | 14.5 | 44.6 | 7.6 | 27.3 | 5.9 | 13.7 | 45.0 | 7.7 | 27.7 | |
| | 0.125 | 6.2 | 14.5 | 44.6 | 7.5 | 27.3 | 6.4 | 13.5 | 44.8 | 7.7 | 27.6 | |
| | 0.15 | 6.8 | 14.2 | 44.2 | 7.4 | 27.3 | 7.0 | 13.3 | 44.5 | 7.5 | 27.6 | |
| | 0.175 | 7.8 | 14.0 | 43.6 | 7.4 | 27.2 | 7.8 | 13.1 | 44.0 | 7.4 | 27.6 | |
| | 0.2 | 7.9 | 13.9 | 43.5 | 7.4 | 27.2 | 9.4 | 12.6 | 43.0 | 7.4 | 27.6 | |
| | 0.225 | 9.6 | 13.3 | 42.6 | 7.4 | 27.2 | 9.5 | 12.5 | 43.0 | 7.4 | 27.6 | |
| | 0.25 | 11.1 | 12.8 | 41.6 | 7.2 | 27.1 | 12.3 | 11.9 | 41.4 | 7.0 | 27.5 | |
| Taxe | | 0.9 | | | | | 1.0 | | | | | |
| | 0 | 2.5 | 14.4 | 46.7 | 8.4 | 28.1 | 2.5 | 14.3 | 46.4 | 8.4 | 28.4 | |
| | 0.025 | 3.2 | 14.4 | 46.1 | 8.4 | 28.0 | 3.8 | 13.9 | 45.6 | 8.4 | 28.3 | |
| | 0.05 | 3.8 | 14.0 | 45.8 | 8.4 | 28.0 | 4.1 | 13.8 | 45.4 | 8.3 | 28.3 | |
| | 0.075 | 5.4 | 13.5 | 45.2 | 7.9 | 28.0 | 5.3 | 13.4 | 45.0 | 8.0 | 28.3 | |
| | 0.1 | 6.1 | 13.4 | 44.9 | 7.6 | 28.0 | 6.3 | 13.2 | 44.6 | 7.6 | 28.3 | |
| | 0.125 | 7.0 | 13.1 | 44.6 | 7.4 | 27.9 | 6.9 | 13.1 | 44.3 | 7.4 | 28.3 | |
| | 0.15 | 7.7 | 12.9 | 44.1 | 7.4 | 27.9 | 7.6 | 12.9 | 43.9 | 7.4 | 28.2 | |
| | 0.175 | 7.8 | 12.9 | 44.0 | 7.4 | 27.9 | 9.2 | 12.3 | 42.9 | 7.4 | 28.2 | |
| | 0.2 | 9.5 | 12.3 | 43.0 | 7.4 | 27.9 | 9.4 | 12.2 | 42.8 | 7.4 | 28.2 | |
| | 0.225 | 9.5 | 12.3 | 43.0 | 7.4 | 27.9 | 9.7 | 12.2 | 42.6 | 7.4 | 28.2 | |
| | 0.25 | 13.6 | 11.4 | 40.4 | 6.9 | 27.8 | 13.8 | 11.2 | 40.0 | 6.9 | 28.1 | |

Figure 12: Surface Area in the case of policy mix