Optimal policy mix to address nutrient runoff and GHG emissions in agriculture

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The purpose of this paper is to analyse the characteristics of policy instrument mix for addressing simultaneously nutrient runoff and greenhouse gas (GHG) emissions from agriculture. The analysis is based on the heterogeneous land quality model with the following aspects: (i) nutrient runoff depends on fertilizer application and chosen tillage method (conventional tillage and no-till), (ii) sources of GHG emissions are fertilizer application, autonomous soil emissions and life cycle analysis (LCA) emissions associated with alternative tillage methods, (iii) emissions and yields vary over three soil textural classes (clay, silt and organic soils) and over land qualities, (iv) green set-aside can be adopted as a mean to sequester soil carbon and, (v) the entry and exit of land between agriculture and forestry (afforestation of arable land) is allowed as a land use option that decreases nutrient runoff and sequesters soil carbon relative to crop production.

Our theoretical framework suggests that to establish the socially optimal fertilizer intensity, choice of cultivation technology and land allocation, the climate policy design requires policy mix consisting of emission taxes levied on both fertilizer use and autonomous soil emissions and soil carbon sequestration payments to promote long-term green set-aside and afforestation. This policy mix provides full incentives for farmers to adjust production intensity, tillage choice and land allocation to the socially optimal level.

Our empirical results show that nitrogen and particulate phosphorus runoff are considerably higher from conventional tillage than from no-till. However, no-till increases dissolved phosphorus runoff relative to conventional tillage. Optimal policy requires a combination of a tax on fertiliser application and a tax on fertiliser independent soil emissions both of which are differentiated in terms of soil type, soil quality and tillage method. No-till is socially preferable tillage method to lower production costs and total nutrient runoff. On high quality soils crop production with no-till is adopted while on low quality soils afforestation gives the highest returns.

The optimal fertiliser tax rates increase when more emissions types are accounted for. If only CO_2 emissions are accounted for, the tax rate is small, only 3% but it increases to 19% with all CO_2-equivalent emissions. When also nutrient runoff is included the tax rate increases to 60 %. Finally, the tax rates for no-till are lower than for conventional tillage, because no-till causes so much lower nutrient runoff damage.