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SOIL ECOLOGICAL AND ECONOMIC EVALUATION OF GENETICALLY MODIFIED CROPS – ECOGEN

The Maximum Incremental Social Tolerable Irreversible Costs (MISTICs) and other benefits and costs of introducing transgenic maize in the EU-15

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Summary

The decision to release a new transgenic crop variety for planting in the European Union (EU) is a decision under irreversibility and uncertainty. We use a real option model to assess the *ex-ante* incremental benefits and costs of the decision to release *Bt* maize and HT maize in the EU-15 member states. The analysis uses Eurostat data for modelling the benefits and costs of non-transgenic maize using partial equilibrium models. The farm-level benefits and costs of *Bt* maize and HT maize are derived from field trials conducted within the EU-funded ECOGEN project in combination with secondary data sources. Adoption curves, hurdle rates and Maximum Incremental Social Tolerable Irreversible Costs (MISTICs) are calculated at country level for selected EU-15 member states. In general, the results show that the MISTICs on a per capita level are very small confirming previous results calculated in values for the year 1995. The MISTICs per farm are much larger. This indicates a problem for decision makers.

Introduction

Despite several concerns, transgenic crops have been introduced and rapidly adopted in the United States and other countries (James, 2004). Several studies confirm that on average the gross margin per area from transgenic crops is at least as high as, and sometimes higher than, that of non-transgenic crops. However, there seems to be a regional difference in the distribution of benefits, which are correlated with regional factors like pest infestation levels and climatic conditions. Empirical studies also indicate that the amount of pesticides may decrease, but only in specific regions and in specific years. (Carpenter and Gianessi, 1999; Fulton and Keyowski, 1999;

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Fernandez-Cornejo et al., 2000; Scatasta et al., 2006a). Wesseler (2005) provides a detailed background on the environmental effects of transgenic crops.

Rapid adoption of transgenic crops by farmers has been explained by the greater benefits farmers gain from planting transgenic crops. Variable production costs are reduced, due to reduced pest management and labour. Gross revenues increase due to an increase in yield from improved plant spacing. Additional benefits arise from improved risk management and insurance against pests and a reduction in equipment costs in no-tillage production systems (Kalaitzandonakes, 1999). All these are reversible benefits at the farm level (i.e. the effects would stop as soon as the transgenic crop is no longer planted and do not carry over into subsequent years). Decision makers are particularly concerned about the irreversible costs of planting transgenic crops (i.e. effects that would still be evident even after the crop is no longer planted). Gene flow and non-target effects can be considered as irreversible costs as they have to be paid for in addition to the costs that can be recovered if the planting of the transgenic crop stops (Krimsky and Wrubel, 1996; Kendall et al., 1997; Kuiper et al., 2000; Nillesen et al., 2006a; Peterson et al., 2006). The decrease in pesticide use by planting transgenic crops and *Bt* crops (i.e. crops expressing an insecticidal protein from *Bacillus thuringiensis*) in particular not only reduces farmers' expenses but also provides additional benefits, since the application of pesticides may have negative impacts on the environment and human health (Antle and Pingali, 1994; Fleischer, 1998; Waibel and Fleischer, 1998). Most of these external costs of pesticide application are irreversible.

One could perhaps think of reversing some of the irreversible effects such as on biodiversity or pest resistance; however, even if that were possible it would not be costless and Demont et al. (2005) show an irreversibility effect could still exist.

The possibility of irreversible costs with the introduction of transgenic crops into the European Union (EU) was one of the major arguments for some of the EU member states to block new approvals of genetically modified organisms (GMOs) until the European Commission proposed additional legislation governing their introduction (Commission of the European Communities, 1999). The decision became to be known as the *quasi moratorium* on GMOs.

The irreversible effects of transgenic crops, and the uncertainty about their future costs and benefits, will impact when and if they will be released. Both irreversible costs and uncertainty and their impact on optimal investment have been widely analysed (e.g. McDonald and Siegel, 1986; Dixit and Pindyck, 1994; Trigeorgis, 1996). Recently, the approach has been applied, among other things, to the adoption of soil conservation measures (Winter-Nelson and Amegbeto, 1998), marketing (Richards and Green, 2003), wilderness preservation (Conrad, 2000), agricultural labour migration (Richards and Patterson, 1998), the introduction of herbicide-tolerant (HT) sugar beets in the EU (Demont et al., 2004) and the analysis of government reforms (Leitzel and Weisman, 1999). In the case of transgenic crops, there are the additional irreversible government policy costs of the implementation of biosafety regulations and changes in patent laws. As they may be of importance, we will concentrate in this paper on the crop-related irreversibilities.

The objective of this paper is to present economic benefits and costs for pest-resistant (*Bt*) maize and HT maize and to identify, *ex-ante*, potential social welfare impacts of adoption of *Bt* maize and HT maize for grain maize production in the 15 member states of the EU (EU-15). A model will be presented that shows how those concerns can be considered explicitly by using the concept of *Maximum Incremental Social Tolerable Irreversible Costs* (MISTICs).

Materials and methods

Methodological approach to assess the benefits and costs of transgenic crops

Consider a decision maker or a decision-making body similar to an EU agency, such as the European Food Safety Authority or the United States Environmental Protection Agency that has the authority to decide whether or not a particular transgenic crop, e.g., a toxin-producing crop like *Bt* maize, should be released for commercial planting. The agency can approve an application for release or postpone the decision and wait to up-date the information about possible benefits and costs of the technology. The objective of the agency is to maximize the welfare of producers and consumers in the economy while ignoring positive and negative transboundary effects.

Within this setting, the welfare effect of releasing a specific transgenic crop can be described as the discounted sum from T till infinity of the social incremental reversible net benefits (SIRBs), W, minus the difference between incremental irreversible costs, I, and incremental irreversible benefits, R, of the technology.