The indirect trade and virtual land effects of a greener EU agriculture[1]

Paper submitted to
$7^{\text{ièmes}}$ *Journées de Recherche en Sciences Sociales*
December 12-13, 2013, Angers

PRELIMINARY DRAFT; DO NOT QUOTE

Cecilia Bellora[2*,†] and Jean-Christophe Bureau[3‡,†]

[*]Université de Cergy Pontoise, France
[†]INRA, UMR 210 Economie Publique, F-78850 Thiverval-Grignon, France
[‡]AgroParisTech, UMR 210 Economie Publique, F-78850 Thiverval-Grignon, France

August, 2013

---

[1] The research leading to these results has received funding from the European Union's Seventh Framework Programme FP7/2007-2011 under Grant Agreement n.290693 FOODSECURE. This paper is work in progress; comments are welcome. The authors only are responsible for any omissions or deficiencies. Neither the FOODSECURE project and any of its partner organizations, nor any organization of the European Union or European Commission are accountable for the content of this paper.

[2] cecilia.bellora@grignon.inra.fr

[3] jc.bureau@agroparistech.fr

Abstract

The global food system faces a major challenge: agriculture must feed a growing population while simultaneously reducing its impact on environment and releasing scarce resources for use by other sectors. Thus, the promotion of ”environmental friendly techniques” in agriculture is on the European agenda. Nevertheless, if these techniques require intensification or deforestation somewhere in the world because the EU would import more agricultural goods, their global consequences could be ambigous. Because the impact of the very fuzzy set of ”environmentally friendly techniques” in agriculture is difficult to assess, we focused on a well-defined way to make EU agriculture greener, i.e. a target on organic production. Our aim is to measure the variation in EU agricultural trade, but also the displacement of crop production between regions, substitution between crops, accounting for important substitution and revenue effects. Therefore, we build on Mirage-BioF, a dynamic global computable general equilibrium model with an improved representation of land use. We added to this model a specific representation of the European organic production technologies, based on micro-founded data, as well as a simplified representation of organic demand. We find that if 20 rapessed, sunflower and wheat in Europe is converted to organic practices by 2020, as planned by some Member States, sizeable demand and production displacements will take place, since the gap between organic and conventional yields is considerable. The decrease in European production (-7 million tons for wheat, -1.6 for maize) is partially compensated by an increase of 0.4 Mha in the global cropland area leading to the emission of 62 million tons of CO_2eq. These preliminary results have to be balanced with the local benefits of organic farming but could help to optimize global environmental impacts of future agricultural policies.

Keywords: indirect land use change, organic farming, computable general equilibrium, EU agricultural policies
JEL classification: F11, F18, Q15, Q18, Q56

1 Introduction

While making it possible to feed the EU population, European agriculture has generated several negative externalities over the last decades, affecting soil, water and biodiversity [EEA, 2010]. In particular, agriculture is responsible for a large share of the pollution of European surface water, aquifers and coastal seas by nutrients and pesticide residues [EEA, 2012]. The combination of modern production techniques, the use of chemical inputs, the draining of wetlands and the uprooting of hedges has led to dramatic erosion in farmland biodiversity, as testified by the sharp decline observed in farm bird populations [EBCC, 2012][1]. All these externalities generate economic costs. For example, recent estimates show that the cost of nitrogen pollution could exceed the actual economic contribution of fertilizers to agricultural output [Sutton et al., 2011b,a]. Estimates also suggests that the threats on population of pollinating insects and the threats on those species that control for pests (i.e. ladybugs, bats, birds) could cause economic losses of billion euros [Gallai et al., 2009, Allsopp et al., 2008, Boyles et al., 2011, Sumner and Boriss, 2006]. The long term sustainability of modern agriculture is questioned, given the risk that soil erosion and compaction and the decline in pollinators become limiting production factors [Jones et al., 2012, Klein et al., 2007, Bauer and Wing, 2010].

1.1 The disappointing attempts to ”green” EU agriculture

Such concerns and the related economic costs have led to a series of policy measures. Since 1992, Agri-Environmental Schemes (AES) have been introduced in the Common Agricultural Policy (CAP). They are designed to compensate farmers for voluntary actions protecting the environment that go beyond standard practice. However, designing precise terms of reference, inspecting and controlling compliance generate high transaction costs. One cause is the asymmetric information on the level and cost of environmental effort, which generates informational rents and, in some cases, moral hazard. While they have helped reducing some externalities, the cost-effectiveness of agri-environmental schemes has been found to be limited [ECA, 2011]. In parallel to the development of AES, those CAP subsidies that provided direct incentives to produce intensively have progressively been replaced by a more production neutral Single Farm Payment (SFP). The latter has been made conditional to good environmental practices. However, in practice, the conditions attached to the single farm payment have been lenient. And the impact of these reforms has recently been dampened by the higher prices for agricultural products, driven by a growing demand, caused by population growth, change in diets and the increasing use of feedstocks for biofuels. High prices provide incentive to produce more intensively and to abandon voluntary conservation programs. As a result, the use of both pesticide and nitrogen, which were on decreasing trend in the 1990s and 2000s have recently bounced back. Under the combined effect of the ending of the land set-aside requirements in 2008 and the increase in pesticide use, the decline in biodiversity has also resumed at an alarming pace over the most recent years [Jiguet et al., 2012].

The EU Commission has recently attempted to impose environmental conditions to the ”Pillar 1” payments, i.e. mostly the Single Farm Payment, expecting a lever effect higher than with the more targeted Agri-Environmental Schemes whose budget is much more limited. That is,

---

[1] From 1980 common farmland bird populations fell by 50 % [EEA, 2010]. While the population has levelled off between the mid 1990s and mid 2000s, the decline seems to have resumed since 2008 [Jiguet et al., 2012]. The population of some rather ”common” species in grain growing areas has decreased by 30 to 70 percent in the last 20 years in a country like France (linett, common quail, skylark, etc.). Grassland butterfly populations have decreased by 60% since 1990 and the decline is continuing [EEA, 2010].

under its proposals for a reformed CAP, the Commission suggested to condition 30% of the €44 billion direct payments to the respect of some ecological focus areas, which would consist in maintaining semi natural agricultural habitats on 7% of agricultural land [EC, 2011a]. While this reform is still being debated, amendments from the Council and the European Parliaments have already watered down this proposal [Bureau, 2013]. Extra environmental conditions proposed for the green payment (maintaining permanent grassland, obligation of crop rotation) are unlikely to have any significant impact due to both their lack of initial ambition and also to the watering down by the Council and Parliament. When counting for the planned reduction of the rural development budget (which funds the Agri-Environmental Schemes) and the fact that this budget will be asked to fund new large ambitious program, with the risk of diverting resources away from agri-environmental measures, there is little hope that an effective ”greening” of the SFP takes place [Matthews, 2013, Allen and Hart, 2013].

1.2 A more ambitious development of organic production?

Taking stock of the failure to make the CAP greener, there are calls for promoting a more radical reorientation of EU agriculture towards more environmentally friendly practices. Encouraging organic farming is increasingly seen as a way to cope with the poor record of the ”greening” of the single farm payment and the limitations of the agri-environmental scheme. Even if the 2004 EU action plan for organic farming has not led to setting a EU-wide figure, many Member States have set national targets: France set a target of 20% of arable land grown organic in 2020[2]; Ireland set a target of 5% in 2012 in a 2008-2012 Action plan; the 2007-2013 Austrian action plan maintains a target of 20% of organic land; the Plan of Long Term Development of organic farming of Slovenia sets a target of 20% of organic land by 2015[3]. These national policies translate into an acceleration in the growth of organic agriculture in the EU. In the recent years, the EU-27 area under organic farming (including fully converted and under conversion areas) increased by 7.4% between 2009 and 2010, by 42% between 2009 and 2006)[4], even if the total surface still accounted only for 5.1% of the EU Total Utilised Agricultural Area in 2010.

More focus on organic production would have several benefits. There is a large consensus that the requirements for organic production certification correspond to environment-friendly farming practices [EC, 2004, EEA and UNEP, 2007]. Organic production was found to result in higher soil organic matter content, less nitrogen and phosphor losses, less N_2O emissions, less energy use, lower eutrophication potential, and a positive impact on biodiversity even though some studies find that some particular non organic biodiversity friendly schemes had even better results [Tuomisto et al., 2012, Mondelaers et al., 2009]. Importantly, organic farming is governed by clear, verifiable rules that leave little place for moral hazard, compared to the complex definition of terms of reference for agri-environmental scheme that often lead to windfall gains and information rents. Certification procedures have been successfully tested over several decades[5]. In addition, the terms of reference for organic certification include provisions that match the demand for a bundle of attributes, from pesticide free food, to nitrogen runoffs

---

[2] Note that not all of these targets are actually realistic. In the case of France, the 2010 target of 6% of land grown as organic was not met (the actual figure was 2.6%) casting doubts on the ability to reach the 20% target in 2020.

[3] Results of the European Commission funded research project ORGAP (Development of criteria and procedures for the evaluation of the European Action Plan for Organic Agriculture), http://www.orgap.org/

[4] Eurostat *food_in_porg1* database, updated on May 14, 2013.

[5] Organic production is covered by EU Regulations EC/834/2007 and EC/967/2008 that lay out rules on organic farming practices.

controlled production and animal welfare requirements. This bunching of attributes makes it attractive to a large set of consumers who have a variety of environmental, health and ethical concerns.

However, at a large scale, organic production might have some undesirable effects which have so far been poorly documented. In particular, there is a risk of indirect, international effects. They can be paralleled with the well-known carbon leakage, i.e. the risk that, by making domestic production more costly or less competitive, an environmental measure leads to a displacement of production resulting in a less positive global environmental balance than expected. Such spatial displacement of environmental costs to other territories is part of the explanation of the ”environmental Kuznets” curve in developed countries, but the environmental record at the global level is questionable [Lambin and Meyfroidt, 2011, Roca, 2003]. Should the development of organic production in Europe result in some direct Land Use Change (dLUC) and even more in Indirect Land Use Changes (ILUC) indirect environmental impacts might offset direct benefits [Roca, 2003]. Since the pioneering work of Searchinger et al. [2008] it has often been argued that such indirect effects should be taken into account when assessing the Greenhouse Gases (GHG) emission consequences of substituting biofuels for fossil fuels. Because the price effects resulting from a more extensive agricultural production show some similarities with the channelling of feedstocks to the energy market, it is possible that rather similar ILUC effects take place. Should the greening of EU agriculture result in land use changes at the international level, it is legitimate to question the induced ILUC impact and the indirect environmental consequences that follow.

In this paper, we focus on a target on organic production. Even though there might be some other ways to make EU agriculture more environmentally friendly (making the findings of the paper actually more general), organic targets provides a benchmark for assessing other possible policies. Focusing on a shift to organic production also makes it possible to avoid uncertainties inherent to the rather fuzzy set of ”environmentally friendly techniques” proposed in the agro-environmental literature. For the sake of simplicity, we estimate the indirect consequences of a shift of 20 percent of EU agricultural land into organic production. While the direct environmental effects are rather unambiguously positive, the objective is to assess how the global environmental impact is affected when we include indirect effects in the analysis.

2 The mechanisms at stake

2.1 dLUC and ILUC effects

The European Commission’s sustainable impact assessment of agricultural reforms tend to focus on the direct, i.e. intra-EU, effects [EC, 2011b]. However, making the CAP ”greener” involves indirect mechanisms that spill across markets and countries. Assessments of these indirect effects have so far been limited [Cantore, 2012]. Recently, Britz et al. [2013] show that ecological set-aside, if implemented in the EU, would have some (limited) indirect consequences on the greenhouse gases (GHG) emissions in distant countries such as Canada through land use changes. A much broader literature on the indirect effects of EU agricultural policies has been developed on the impact of biofuel policy [Laborde, 2011, Havlìk et al., 2011, Mosnier et al., 2012, Laborde, 2013]. Even though results vary considerably across studies, large ILUC effects have been measured when EU land is channelled into the production of energy crops [De Cara et al., 2012]. One well-publicized effect of devoting land to production of rapeseed oil for biodiesel is that changes in relative prices lead the EU food industry to import more palm, soybean and canola oil, whose production has negative environmental consequences, through deforestation and the draining of peatlands (palm oil in Indonesia) or the ploughing of natural pastures and forest land (soybean in South America, canola in Canada).

In a way that shows similarity with setting land aside or diverting it for non-food use, the mechanisms at stake in case of a large shift of EU agriculture towards organic production can lead to cross-market and cross-countries displacement effects. If the productivity of organic farming is significantly lower than the conventional one, European food supply may decrease. New relative prices may change the EU agricultural trade balance, hence some macroeconomic impacts. This may also change net exports in the rest of the world. Depending on demand, the changes in prices may lead to put land in production, or to intensify current agricultural production outside the EU. If the consequence is to bring some previously uncultivated land into production, the shift to more organic production in the EU could lead to more environmental damage at the world level, in particular in the area of biodiversity and GHG emission. In theory, it is even possible that the decline in EU production is such that it requires importing food from countries that expand their agricultural production by deforesting or turning into industrial plantations some biodiversity rich habitats.

Such harmful consequences are not warranted, though. If, for example, the price effects are such that they trigger significant fall in demand, for example through shifts to a more vegetarian diets, indirect negative environmental effects would be minimal. Changes in the price of feedstuffs may also lead to some rebound effects that offset some of the dLUC and ILUC effects. The environmental effect of land displacement could be limited if expansion of production took place on unused degraded land rather than high natural value areas. The overall consequences are therefore ambiguous and there is a need for quantification of the various mechanisms at stake.

2.2 Some key factors for production and environmental effects

With a shift to organic production, a key variable is the change in yields that would take place in the EU. If yields decrease significantly following a conversion to organic agriculture, the Net Displacement Factor (NDF) is large. The NDF is the ratio of hectares of (a) land brought into crop production anywhere in the world to replace land used for organic crops to (b) hectares dedicated to additional organic crops [Plevin et al., 2010]. A large NDF would result in a variety of negative impacts on the environment (GHG emission, biodiversity erosion, water pollution and depletion, etc.). There is evidence that organic production can reach high yields in experimental conditions or even in commercial agriculture. However, this often requires a large amount of labour that substitutes for chemical inputs. Given the relatively high cost of labour that prevails in most EU Member states, in practice, a shift to organic production often results in lower yields. [Seufert et al., 2012] found in their meta-analysis an average organic-to-conventional yield ratio of 0.75 (0.89 for oilseed, 0.74 for cereals, 0.63 for vegetables). The meta-analysis conducted by Tuomisto et al. [2012] find a similar aggregate figure, with a standard deviation of 17%. The largest yield gap with conventional production was for winter wheat (yield ratio of 0.62), but the gap is lower for some productions (e.g. vegetables). Ponti et al. [2012] find that organic yields are on average 80% of conventional yields, with possible substantial variations (standard deviation of 21%). Niggli et al. [2008] find large gaps for yields in wheat in countries where production is more fertilizer intensive (organic yield for wheat reaches on average only 50% of the conventional yield in France but 88% in Italy). They also find large gaps for potatoes in Austria and Germany. But, they find lower yields gaps for barley, oilseeds and pulses across Europe.

The allocation of organic production across land plots is another important determinant of the direct Land Use Change (dLUC) effect within the EU. In the case of ecological set-aside, it has been shown that most of the land enrolled in conservation was the one yielding lowest production levels [Rygnestad and Fraser, 1996]. When mandatory set-aside was introduced in the early 1990s in the EU, it has been observed that production became more capital and chemical input intensive in the land that was not left idle. The price increase of commodities as a consequence of US conservation programs has also provided some incentive for farmers to raise yields on land that is not enrolled in conservation [Wu et al., 2001]. All these factors explain why the impact on production of land retirement based conservation programs tends to be limited [Boyd et al., 1992, OECD, 1997]. In the case of organic production, the land allocation effect depends on the policy instrument: in the case of a mandatory conversion or national targets on the share of land under organic production, it is likely that farmers would chose to allocate these lands where the yield gap and the economic costs of conversion are lower. For example, it is possible that most of the shifts to organic land take place on already extensive grazing areas, or on traditional orchards, vineyards or olive trees. The production impact would therefore be limited and so would be both the dLUC and ILUC effects. However, it is also likely that the shift to organic production would be larger in those sectors where the price gap between organic and standard product is wider. This might mean that more land be devoted to fruits and less to rapeseed and hemp, for example. The changes in the EU trade balance and the ILUC effects depend on how these effects will combine. Another key factor is the ability to expand agricultural land. Wu et al. [2001] show that one of the consequences of price changes induced by the US conservation reserve program is to put in production additional amounts on land that heretofore was idle (Wu [2000] estimates that about 20 acres were brought into crop production for every 100 put out of production under the program). Whether this form of slippage could also offset some of the production as well as environmental impact of a shift to organic production is uncertain. Land in the EU is more limited than in the US, but marginal agricultural land abandoned over the recent decades could be put back in production, should the new price vector make it profitable.

Slippage may also take the form of intensification of production on those fields that are left to non-organic production. When mandatory set-aside was introduced in the early 1990s in the EU, production became more capital and chemical input intensive in the land that was not left idle, so that the overall output reduction of the set aside was lower than initially expected. The same effect was observed in the US for conservation programs with a raise in yields on land that is not enrolled in conservation [Wu et al., 2001]. A consequence might be more pollution in the non-organic areas, but a lower ILUC effect, suggesting a trade-off between local and foreign environmental damage.

3 Methodology

The impact of a shift to organic production on the demand for intermediate consumption and capital also has some general equilibrium effects, through changes that disseminate in the entire price system. A lower use of fertilizers and pesticides, a change in the demand for capital would modify the structure of the input industry. The induced changes in relative prices, production and trade in farm and non farm sectors depend on the substitution and complementarity between chemicals, capital and petroleum products (organic agriculture could require less treatments but more mechanical intervention e.g. for weeding, for example). In order to assess these effects it is important to take into account the new economic equilibria that would take place in what is sometimes called a ”systemic” Life Cycle Analysis (LCA) approach. A way to do so is to construct a General Equilibrium (GE) model in order to assess the impact of EU policies on a given product on third markets in third countries, accounting for a series of domino effects. This approach makes it possible to compare the current situation to a counterfactual one where the EU would have converted part of its agriculture into organic, while taking into account market adjustments, and supply and demand reactions in the different parts of the world.

Simulations rely on the framework developed under MIRAGE, a multi-country, multi sector recursive dynamic model. MIRAGE was originally developed to assess the impact of trade negotiations [Bchir et al., 2002, Decreux and Valin, 2007]. Building on this framework, a specific version that distinguishes land allocation was developed to assess the ILUC impacts of some specific policies, in particular the biofuel policies, by a team of modellers from the International Food Policy Research Institute, the International Institute for Applied System Analysis and the French Institut National de la Recherche Agronomique (see Laborde and Valin [2012]). The representation of land markets relies on a nested structure of constant elasticities of transformation, so as to account for the various possibilities of land substitution and expansion in each country. Land extension is endogenously calculated but also integrates an historical trend to track non-market-driven land-use change. The possibilities of substitution between crops have been refined, distinguishing agro-climatic conditions. The calibration of elasticities has benefited from a particular effort. A highly detailed database has also been built, introducing new sectors and recalibrating production technologies in order to ensure the consistency between values and volumes. This is of particular importance for our simulations, since physical linkages and substitutions play a critical role in the assessment of demand displacements and land use change.

Building on MIRAGE-Biof, we constructed specific demand and supply systems to explicitly represent the organic agricultural sector. A specific organic production technology was introduced, and consumers’ preferences between conventional and organic products were also represented[6]. This required constructing a consistent set of social accounts that makes possible to represent the economic situation of organic products and the linkages with the production and consumption of non organic products, as well as the linkages with the other sectors.

Data availability is one of the main difficulties faced when building the new database. Characterization of the production technology in the organic sector runs into the lack of consensus regarding the yield gap with conventional agriculture. While some studies show that in experimental conditions it is possible for organic farming to reach yields that are similar to conventional production, it often depends on the ability to use more labour, hence some possible violation of the separability assumptions that are implicit in the functional forms used in GE models. And for certain agricultural productions, giving up chemical inputs (often used as a way to reduce production risk) generates more irregular output. Uncertainty also prevails on the ability of improving yields in organic production, since the there has been so far little research on organic farming or on agroecology compared to conventional agriculture. High rates of technical change in the organic sector are plausible in the future.

---

[6] Note that the use of a specific representation of the organic production technology, instead of a shock on factor productivity, is a key specification here. Indeed, it has been shown that the organic and conventional production technologies are not homogeneous [Mayen et al., 2010]. Organic technology was introduced for maize, rapeseed, sunflower and wheat in the model.

We calibrated the production technology and the yield changes when shifting from standard to organic production on microeconomic data. We used data from the European Farm Accounting Data Network, which includes since 2000 an identifier variable for organic farms. The average organic to conventional ratio we obtained from Farm Accounting Data Network (FADN) for maize, rapeseed, sunflower and wheat is 0.68, which is a little bit lower than the average value of 0.74 found by [Seufert et al., 2012] for cereals but seems nevertheless be in the range of the ratios they observed. To calibrate the area dedicated to organic crops, we used data from Eurostat, which reports areas under organic practices for many different crops. Data reported for recent years are accurate and are available for almost all European countries. MIRAGE-BioF model integrates an endogenous yield response to shock in fertilizers price and to increase in demand. This feature allows for an evolution of crop yields, including organic yields, depending on market evolution. The land supply constant elasticity of transformation tree of MIRAGE-Biof was amended to differentiate between organic and conventional land for each crop, adding an extra substitution level in the three. That is, the calibration reflects the current organic technology, rather than the one obtained if producers reduced the gap with potential yields obtained in experimental conditions, but accounts for the impact of prices on yields.

Calibration of the demand system also runs into limited data availability. Existing studies focus on final goods and not on rough products, mainly used as intermediary consumption, as it is the case for the crops we analyze. In our calibration of the demand system, organic and conventional crop productions are aggregated in a virtual good that is used by other sectors, by final domestic consumers and by foreign demand. Few econometric studies deal with the elasticity of demand for organic products, and they focus on very specific products aimed at final consumption. We used these estimates to choose the elasticity of substitution between organic and conventional production system, but the parameter lacks solid micro- foundations. This is why sensitivity analysis is carried out on the simulations.

To calculate emissions from land use change, we rely on the guidelines for National Greenhouse Gas Inventories of the International Panel on Climate Change [IPCC, 2006], according to Bouet et al. [2010]. We use the Tier 1 methodology, which provides generic estimates of the carbon stocks in different climate zones (these climate zones are matched with the agro-ecological zones used in the Mirage-BioF model following Bouet et al. [2010]). We consider the emissions due to (a) the conversion of forest to other types of land (deforestation), (b) the cultivation of the land that was previously uncultivated. To determine emissions from deforestation, we take into account the stock of carbon both above and below ground for managed and primary forests. We compute emissions induced by the cultivation of new land through the variation of the content of soil in mineral carbon. The IPCC Tier 1 method gives indicative release of carbon for different management practices. In order to simplify the computation, the different practices we consider are non cultivation of land, cultivation with full tillage, rice cultivation under irrigation and land set aside. We consider a medium level of input in each case. Finally, we compare the carbon stocks in forest biomass and in soils (forest + cultivated) in 2020 in our scenarios to the carbon stocks in 2020 in the baseline in order to estimate the carbon emissions due to land use change in our scenarios.

At this stage, we consider only emissions of carbon, although nitrous dioxide releases are recognized to play a significant role. We do not take into account (a) the emissions of N_2O due to the increase of fertilizers on the land where there is an intensification in the production and (b) the decrease in the N_2O emissions on the land cultivated under organic farming. Indeed, Tuomisto et al. [2012] show that median nitrous oxide emissions per unit of field area were 31% lower in organic systems than in conventional systems. This lowering is mainly due to the lower use of nitrogen inputs in organic farming than in conventional farming.

3.1 Simulations

The scenarios we build are implemented on a baseline starting in 2004 and extended through 2020, in which we reproduce the present rate of adoption of organic farming in the European maize, sunflower, rapeseed and wheat sectors[7]. We also include in the baseline the existent programs and announced commitments of biofuel policies (for details in biofuel programs included in the baseline, see Laborde and Valin [2012]) since they represent an important part of agricultural demand of the next years. Precise data on consumers' preferences for each considered organic crop are not available but we used recent results estimating that the average market share for organic products in the EU is around 2% in 2010 [Bio, 2012, Willer, 2012](Eurostat data). After 2010, we consider a slight increase in the consumers' preferences for organic products: our hypothesis is that the market share of organic products will reach 5% by 2020, a value that is compatible with the historical trend[8] in the consumption of organic products.

In the scenario ORG_LAND, the EU requires 20% of area cultivated for maize, rapeseed, sunflower and wheat to be under organic farming practices by 2020. We chose the rate of 20% since this figure is targeted in the organic action plans published by several European Member States (see above). We implemented the mandate progressively, in a linear fashion from 2010 to 2020, on each crop, in each agro-ecological zone of EU, without any explicit tax or subsidy. A share greater than 20% is not allowed. Consumers' preferences are the same as in the baseline.

4 Results

The mandate on the share of organic land has strong effects on organic production. Since the gap in yields between organic and standard production is significant for most of the agricultural productions considered, impacts on trade and EU consumption of virtual land are sizeable. It is nevertheless noteworthy that the fact that the support to organic production takes the form of a mandate on hectares drives the result in a peculiar way compared to other possible policies to support organic production.

A EU-wide mandate on the share of organic land is a strongly effective way to support the development of the organic sector: organic area and produced quantities are multiplied by 15 by 2020 in our ORG_LAND scenario with respect to the baseline. The displacement of a great amount of land to organic production, while consumers' preferences are constant, has strong effects on prices. In the organic sector, output prices go down. The price of land decreases much more, since the mandatory use of land for organic production reduces the profitability of arable crops,

---

[7] In 2011, in the European Union, the share of organic area in the total cultivated area of maize, rapeseed, sunflower and wheat were respectively 0,77%, 0,43%, 1,49% and 1,64% (authors' calculations based on Eurostat data)

[8] In the EU, the value of organic consumption increased by 5% between 2008 and 2009 and by 6.2% between 2009 and 2010. In France, the share of organic consumption has been multiplied by 1.8 between 2007 and 2010. Furthermore, in 2010, the most developed organic market was in Danemark, were organic products accounted for 7% of the total consumption. An organic market share of 5% therefore seems to be a realistic assumption for the growth of the European organic sector.

in particular. At the same time, the demand for conventional crops remains high but the production of non-organic agricultural goods decreases because of the mandate that diverts some land towards organic production. As a consequence, producer prices of conventional crops increase strongly whereas organic prices plunge. Finally, in the EU, prices of (conventional + organic) maize, rapeseed, sunflower and wheat increase respectively by 1.9%, 2.2%, 1.4% and 2.9%.

These effects on prices have some consequences on yields, through the endogenous yield calculation that is embedded in the MIRAGE-BioF model (Table 1). On the one hand, the decrease in the producer prices of organic crops leads to a smaller increase of organic yields in the ORG_LAND scenario than in the baseline. In 2020, the yields of organic maize, rapeseed, sunflower and wheat are respectively 3.6%, 2.6%, 3.2% and 2.1% lower in our scenario than in the baseline. On the other hand, as a consequence of the increase in their prices, conventional crops have slightly increasing yields (+0.2%). This increase is the result of both an increase in the use of factors and fertilisers. The decrease of organic producer prices and consequently of organic yields will accentuate the effects on trade and land use change.

[Table 1 about here.]

Organic yields being lower than conventional ones, the mandate on organic land translates into a negative supply shock in the affected sectors. This shock is significant: the European production of wheat decreases by 7 million tons and the maize production by 1.6 million tons. As a consequence, world prices are affected (+1.6% for maize, +1.4% for rapeseed, +1.2% for sunflower and +2.4% for wheat) and global demand and production are displaced.

Table 2 displays the distribution of the change between supply and demand on each market. The decrease in the European supply is partially compensated by an increase in other regions' production. The increase in the world price due to the supply shock also leads to a demand displacement. In the case of wheat, the greater displacement comes from the livestock sector. Since the relative price increase of wheat is greater than the relative price increase of other crops, the livestock sector displaces its demand from wheat to maize, sunflower and rapeseed. Notwithstanding this displacement, the European demand for crops as feedstock decreases by 0.73%, and is partially replaced by grazing: the EU pasture area slightly increases in the ORG_LAND scenario. In the case of rapeseed, sunflower and maize, the main demand displacement comes from the vegetable oils sectors and in the case of maize, it comes from the final consumption. The demand displacement is allowed by the elastic demand and helps to dampen the effect of the EU mandate on world markets and land use changes.

[Table 2 about here.]

As a consequence of the decrease in the quantities produced, the change in prices and the demand displacement, the EU trade balance deteriorates, as shown in Table 3. The net trade of maize, rapeseed, sunflower and wheat respectively decreases by 24.7%, 19,9%, 29.7% and 15.3%. The production of rapeseed and sunflower oil also decreases and their imports raise. The demand for these oils is partially displaced to palm and soybean oils, which trade balances also decrease. Interestingly, EU trade balance of the cattle sector improves. As said before, livestock grazing develops in Europe and therefore producer prices of cattle augment relatively less in Europe than in other regions. Hence, European imports decline and export increase leading to an improvement of the trade balance. The shock in the European supply does not change the ranking between regions exporting to Europe, even if the increase in exports is not perfectly homogeneous across exporters, as shown in table 4.

[Table 3 about here.]

[Table 4 about here.]

Changes in demand and production lead to a change in land use across regions. Globally, through the changes in prices and production and demand displacements, the European target of 20% of maize, rapeseed, sunflower and wheat surfaces converted to organic production requires around 410 000 ha of land to be converted worldwide to grow new crops, as shown in table 5. The first source of land converted to cropland is pasture and to a lesser extent forest.

[Table 5 about here.]

Assessing the global environmental impacts is difficult. Valuation of the ecosystem services gained and lost is not realistic at the global level, given the heterogeneity of these services and their valuation across regions and local specificities. A metric that is often used is GHG emissions. This approach faces severe criticisms (Tittonell, 2013). Clearly, this should not be the only criterion when assessing environmental impact, but it is a useful proxy for more energy use and more deforestation. Estimates on the case of the ORG_LAND scenario suggest that the related land use changes would emit around 62 million tons of CO_2 equivalent by 2020. We also computed the NDF. We found an NDF of 0.05, meaning that the changes in relative prices induces 0.05 hectare of additional cropland anywhere in the world for each additional hectare of organic maize, rapeseed, sunflower or wheat in Europe. We can compare these estimates to other values found in the literature, for other policies: Laborde and Valin [2012] found a NDF value between 0.19 and 0.2 for the European biofuel policy and Plevin et al. [2010] consider values in the range from 0.25 to 0.8 for US corn ethanol.

5 Conclusion and extension

In the ORG_LAND scenario, the increase in organic area may have some local negative effects that should be balanced with the well known positive impacts. The increase in the conventional crops' prices leads to an intensification of their production technologies. Because of the mandate in the organic area, the drop in the land used by conventional crops is partially compensated by an increase in the use of fertilizers and capital per hectare/ton of conventional crop produced. Anyway, the global EU consumption of fertilizers by the maize, rapeseed, sunflower and wheat sectors decreases. Supporting organic production through a mandate on organic land leads to a decrease in the producer prices of organic inputs and therefore of crops. As a consequence, organic yield grows in the ORG_LAND scenario between 2008 and 2020 but at a slower pace than in the reference scenario. Thus, the increase in the yield gap between conventional and organic production technology enhances the supply shock.

Alternative scenarios to ORG_LAND suggest that the global trade and land use impacts of organic production strongly depend on the way organic production is supported. In the ORG_LAND scenario, we have modelled a support to organic production through a mandate. Some Member States expressed preferences for rather supporting demand of organic products, for example through food subsidies, or other measures that could be adopted to encourage the change in consumers' preferences: mandatory incorporation of organic food in public institutional catering, support for marketing operations or for value added chains of organic products[9]. Therefore,

---

[9] For example, in France, the recent *Grenelle* laws set a target of 20% of organic products in school cafeteria.

we have built an alternative scenario in which the policy that supports organic farming pulls organic demand rather than supply. The increase in organic consumption is modeled with a massive change in consumers' preferences towards organic products, supported by a sizeable subsidy on organic consumption. We exogenously fixed the magnitude of the change in the consumers' preferences and of the subsidy so as to reach in 2020 the same absolute area under organic crops as the one reached in the ORG_LAND scenario. At this stage, our results for this scenario are still preliminary but the way the policy is built affects the distribution of the organic land across crops as shown in Figure 1. It seems that the policy construction also impacts global markets and land use change.

[Figure 1 about here.]

We show that a greening of EU agriculture, which we modeled through a strong increase in the land dedicated to organic farming, has sizeable indirect effects in terms of price changes, demand and production displacement and land use change. A good comprehension of the mechanisms at stake will be necessary to build policies that limit the negative global effects of the promotion of environmental friendly practices in agriculture, while enhancing the local benefits.

One of the next steps will be to improve the regional disaggregation of our model, in order to precisely track demand and production displacements across regions. Our work will be completed with an accurate sensitivity analysis on key parameters of the model. We will also include a more realistic representation of organic international markets. The EU is a net importer of organic products. Before authorizing imports, certification bodies must verify and label organic production methods in the exporter countries, following European regulations, on a case by case (product + country) basis. These procedures are difficult to represent in a CGE model but recently, the EU has signed trade agreements with some countries, recognizing that their organic production methods are equivalent to the European ones. In particular, in February 2012, a free trade agreement for organic products has been signed with the US. The incorporation of organic trade in our model would alleviate the pressure on European organic markets in the case of a policy that supports organic consumption. In the case of a mandate on land, it would modify the effects on global price systems and thus on land use. Another extension of this very preliminary work is to assess the indirect consequences of a reorientation of the current SFP towards supporting to organic production. Only the assessment of both the direct and indirect effects would make it possible to see whether such reforms would make the CAP truly greener.

References

B. Allen and K. Hart. Meeting the eu's environmental challenges trhrough the cap - how do the reforms measure up ? *Aspects of Applied Biology*, 118:9 – 22, 2013.

Mike H. Allsopp, Willem J. de Lange, and Ruan Veldtman. Valuing insect pollination services with cost of replacement. *PLoS ONE*, 3(9):e3128, 09 2008. doi: 10.1371/journal.pone.0003128.

Dana Marie Bauer and I Sue Wing. Economic consequences of pollinator declines: a synthesis. *Agr. Resource Econ. Rev*, 39:368–383, 2010.

M. Bchir, Y. Decreux, J.L. Guérin, and J. Sébastien. Mirage, a computable general equilibrium model for trade policy analysis. Working Paper 17, CEPII, 2002.

Agence Bio, editor. *L'agriculture biologique, chiffres clés – Édition 2012*, chapter Chapitre 3 – L'agriculture biologique dans l'Union européenne, pages 33 – 60. La Documentation française, 2012.

A. Bouet, B. V. Dimaranan, and H. Valin. Modeling the global trade and environmental impacts of biofuel policies. IFPRI discussion papers 1018, International Food Policy Research Institute (IFPRI), 2010.

Roy Boyd, Kazim Konyar, and Noel D. Uri. Measuring aggregate impacts: The case of the conservation reserve program. *Agricultural Systems*, 38(1):35 – 60, 1992. ISSN 0308-521X.

Justin G. Boyles, Paul M. Cryan, Gary F. McCracken, and Thomas H. Kunz. Economic importance of bats in agriculture. *Science*, 332(6025):41–42, 2011. doi: 10.1126/science.1201366.

W. Britz, T. Hertel, and J. Pelikan. Green light for green agricultural policies ? an analysis at regional and global scales. Technical report, Global Trade Analysis Project, 2013.

J.-C. Bureau. The biodiversity consequences of killing ecological focus areas. Technical report, 2013. URL `http://www.capreform.eu/the-biodiversity-consequences-of-the-killing-of-the-ecological-focus-area-measure-by-the-council-and-the-comagri/`.

N. Cantore. The potential impact of a greener cap on developing countries. Technical report, Overseas Development Institute, 2012.

S. De Cara, A. Goussebaïle, R. Grateau, F. Levert, J. Quemener, and B. Vermont. Revue critique des études évaluant l'effet des changemes d'affectation des sols sur les bilans environnementaux des biocarburants. Technical report, ADEME, Mars 2012.

Y. Decreux and H. Valin. Mirage, updated version of the model for trade policy analysis - focus on agriculture and dynamics. Technical Report 15, CEPII, October 2007.

EBCC. Trends of common birds in europe, 2012 update. Technical report, European Bird Census Council, 2012.

EC. European action plan for organic food and farming. Technical Report COM(2004)415 final, European Commission, June 2004.

EC. Impact assessment, common agricultural policy towards 2020, annex 2b : Assessment of selected measures under the cap for their impact on greenhouse gas emissions and removals, on resilience and on environmental status of ecosystems – european commission staff working paper sec(2011) 1153 final/2. Technical report, European Commission, 2011a. URL `http://ec.europa.eu/agriculture/policy-perspectives/impact-assessment/cap-towards-2020/report/annex2b_en.pdf`.

EC. Legal proposals for the cap after 2013. Technical report, European Commission, 2011b. URL `http://ec.europa.eu/agriculture/cap-post-2013/legal-proposals/index_en.htm`.

ECA. Is agri-environment support well designed and managed ? Technical report, European Court of Auditors, 2011.

EEA. 10 messages for 2010 – agricultural ecosystems. Technical report, European Environment Agency, 2010.

EEA. European waters - current status and future challenges - a synthesis. Technical Report 9/2012, European Environment Agency, November 2012.

EEA and UNEP, editors. *Sustainable Consumption and Production in South East Europe and Eastern Europe, Caucasus and Central Asia (EEA and UNEP Joint Report)*. European Comunities, 2007. ISBN 9291679658.

Nicola Gallai, Jean-Michel Salles, Josef Settele, and Bernard E. Vaissière. Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. *Ecological Economics*, 68(3):810 – 821, 2009. ISSN 0921-8009. doi: 10.1016/j.ecolecon.2008.06.014.

P. Havlìk, U. Schneider, E. Schmid, Hannes Böttcher, Steffen Fritz, Rastislav Skalsky, Kentaro Aoki, Stéphane De Cara, Georg Kindermann, Florian Kraxner, Sylvain Leduc, Ian McCallum, Aline Mosnier, Timm Sauer, and Michael Obersteiner. Global land-use implications of first and second generation biofuel targets. *Energy Policy*, 39(10):5690 – 5702, 2011. ISSN 0301-4215. doi: 10.1016/j.enpol.2010.03.030.

IPCC. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Institute for Global Environmental Strategies (IGES), 2006.

Frédéric Jiguet, Vincent Devictor, Romain Julliard, and Denis Couvet. French citizens monitoring ordinary birds provide tools for conservation and ecological sciences. *Acta Oecologica*, 44(0):58 – 66, 2012. ISSN 1146-609X. doi: 10.1016/j.actao.2011.05.003. ¡ce:title¿Sino-French Cooperation on Biodiversity and Natural Resource Management¡/ce:title¿.

Arwyn Jones, Panos Panagos, Sara Barcelo, Faycal Bouraoui, Claudio Bosco, Olivier Dewitte, Ciro Gardi, Javier Hervás, Roland Hiederer, Simon Jeffery, et al. The state of soil in europe-a contribution of the jrc to the european environment agency's environment state and outlook report–soer 2010. Technical report, Joint Research Centre (JRC), European Commission, 2012.

Alexandra-Maria Klein, Bernard E Vaissière, James H Cane, Ingolf Steffan-Dewenter, Saul A Cunningham, Claire Kremen, and Teja Tscharntke. Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society B: Biological Sciences*, 274 (1608):303–313, 2007. doi: 10.1098/rspb.2006.3721.

D. Laborde. Assessing the land use change consequences of european biofuel policies. Technical report, IFPRI, October 2011. Report for DG Trade, second version.

D. Laborde. Land use changes of european biofuel policies – presentation to the envi comitee of the eu parliament bbase on http://www.ifpri.org/sites/default/files/publications/biofuelsreportec2011.pdf. Technical report, International Food Policy Research Institute, 2013. URL `http://prezi.com/va67ayq2pdxp/land-use-changes-of-european-biofuel-policies/`.

D. Laborde and H. Valin. Modeling land-use changes in a global cge : assessing the eu biofuel mandates with the mirage-biof model. *Climate Change Economics*, 3(3), 2012. doi: 10.1142/S2010007812500170.

E. F. Lambin and P. Meyfroidt. Inaugural article: Global land use change, economic globalization, and the looming land scarcity. *Proceedings of the National Academy of Sciences*, 108 (9):3465–3472, Mar 2011. doi: 10.1073/pnas.1100480108.

A. Matthews. Green cap payments: A missed opportunity ? Technical report, Institute of International of European Affairs, 2013.

Carlos D. Mayen, Joseph V. Balagtas, and Corinne E. Alexander. Technology adoption and technical efficiency: Organic and conventional dairy farms in the united states. *American Journal of Agricultural Economics*, 92(1):181–195, 2010. doi: 10.1093/ajae/aap018.

Koen Mondelaers, Joris Aertsens, and Guido Van Huylenbroeck. A meta-analysis of the differences in environmental impacts between organic and conventional farming. *British Food Journal*, 111(10):1098–1119, 2009. doi: 10.1108/00070700910992925.

A. Mosnier, P. Havlìk, H. Valin, J. Baker, B. Murray, S. Feng, M. Obersteiner, B. McCarl, S. Rose, and U. Schneider. The net global effects of alternative u.s. biofuel mandates: Fossil fuel displacement, indirect land use change, and the role of agricultural productivity growth. Nicholas Institute Report 12-01, Duke University, Nicholas Insitute for environmental policy solutions, 2012.

U. Niggli, A. Slabe, O. Schmid, N. Halberg, and M. Schluter. Vision for an organic food and farming research agenda for 2025. Technical report, IFOAM EU and FiBL, 2008.

OECD. *The Environmental Effects of Agricultural Land Diversion Schemes*. Organisation for Economic Co-Operation and Development, 1997. ISBN 9264153667.

R. J. Plevin, M. O'Hare, A. D. Jones, M. S. Torn, and H. K. Gibbs. Greenhouse gas emissions from biofuels' indirect land use change are uncertain but may be much greater than previously estimated. *Environmental Science & Technology*, 44(21):8015–8021, 2010. doi: 10.1021/es101946t.

T. De Ponti, B. Rijk, and M. K. van Ittersum. The crop yield gap between organic and conventional agriculture. *Agricultural Systems*, 108(0):1 – 9, 2012. ISSN 0308-521X. doi: 10.1016/j.agsy.2011.12.004.

Jordi Roca. Do individual preferences explain the environmental kuznets curve? *Ecological Economics*, 45(1):3–10, Apr 2003. doi: 10.1016/S0921-8009(02)00263-X.

Hild Rygnestad and Rob Fraser. Land heterogeneity and the effectiveness of cap set-aside. *Journal of Agricultural Economics*, 47(1-4):255–260, Jan 1996. doi: 10.1111/j.1477-9552.1996.tb00689.x.

Timothy Searchinger, Ralph Heimlich, R. A. Houghton, Fengxia Dong, Amani Elobeid, Jacinto Fabiosa, Simla Tokgoz, Dermot Hayes, and Tun-Hsiang Yu. Use of u.s. croplands for biofuels increases greenhouse gases through emissions from land-use change. *Science*, 319(5867):1238–1240, 2008. doi: 10.1126/science.1151861.

V. Seufert, N. Ramankutty, and J. A. Foley. Comparing the yields of organic and conventional agriculture. *Nature*, 485(7397):229–232, May 2012. ISSN 0028-0836.

D. Sumner and H. Boriss. Bee-conomics and the leap in pollination fees. Technical report, Giannini Foundation of Agricultural Economics, 2006.

M. Sutton, C. Howard, and J. Erisman, editors. *The European Nitrogen Assessment: Sources, Effects and Policy Perspectives*. Cambridge University Press, 2011a. ISBN 1107006120.

Mark A. Sutton, Oene Oenema, Jan Willem Erisman, Adrian Leip, Hans van Grinsven, and Wilfried Winiwarter. Too much of a good thing. *Nature*, 472(7342):159–161, April 2011b. ISSN 0028-0836.

H.L. Tuomisto, I.D. Hodge, P. Riordan, and D.W. Macdonald. Does organic farming reduce environmental impacts? – a meta-analysis of european research. *Journal of Environmental Management*, 112(0):309 – 320, 2012. ISSN 0301-4797. doi: 10.1016/j.jenvman.2012.08.018.

H. Willer. The european market for organic food. Presentation at the conference biofach 2012, FiBL (Research Institute for Organic Agriculture), February 2012.

J. Wu. Slippage effects of the conservation reserve program. *American Journal of Agricultural Economics*, 82(4):979–992, Nov 2000.

J. Wu, D. Zilberman, and B. Babcock. Environmental and distributional impacts of conservation targeting strategies. *Journal of Environmental Economics and Management*, 41(3):333–350, May 2001.

List of Figures

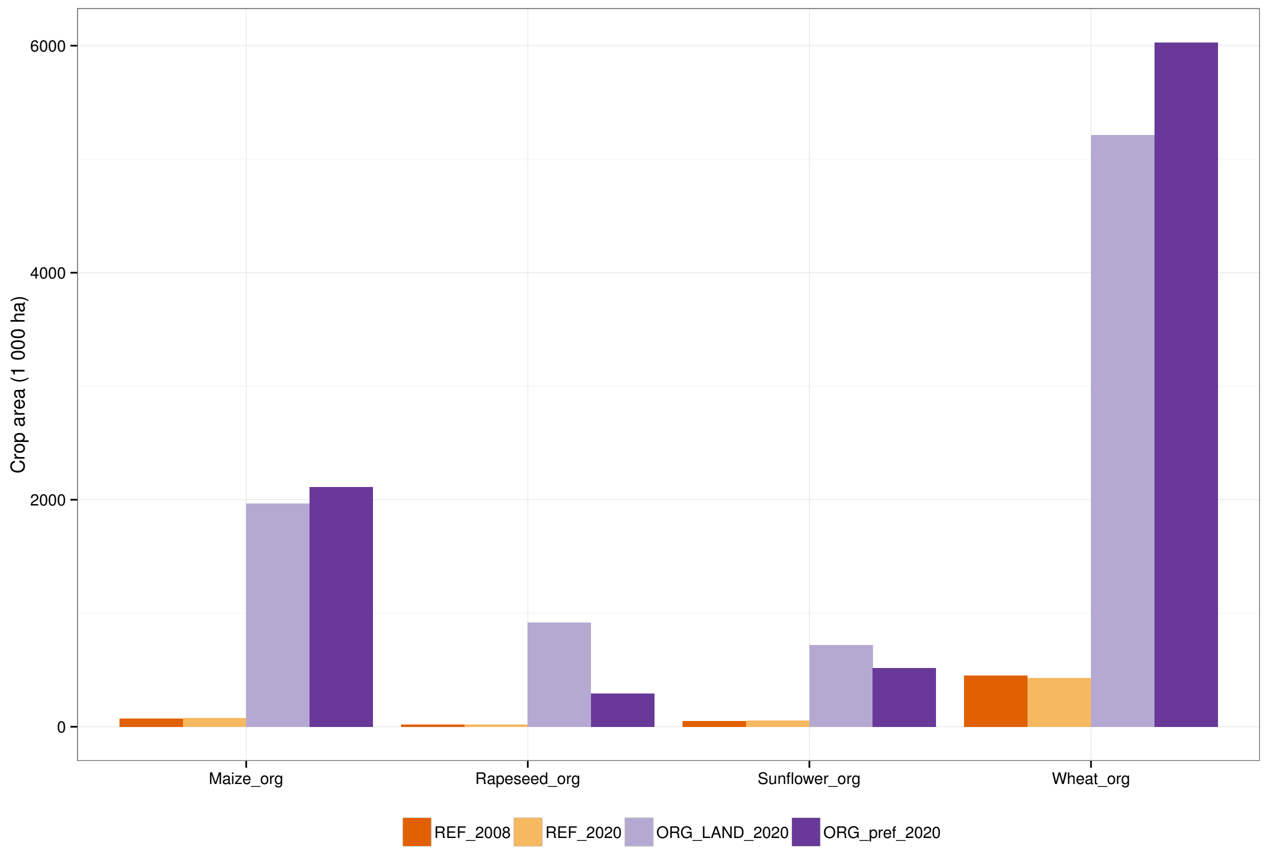

Figure 1: Organic crop area in different scenarios

List of Tables

Table 1: Area and yield changes

		Area (10^3ha)		Yield (t/ha)		
		2010	2020	2008	2020	
		REF	ORG_LAND	REF	REF	ORG_LAND
Maize	Total area	9 934	9 828	7,89	8,9	8,5
Maize norg	share of tot. Area	99,2%	80%	7,91	9,0	9,1
Maize org	share of tot. Area	0,8%	20%	5,42	6,3	6,1
Rapeseed	Total area	4 678	4 589	4,55	5,2	4,7
Rapeseed norg	share of tot. Area	99,6%	80%	4,58	5,2	5,3
Rapeseed org	share of tot. Area	0,4%	20%	2,26	2,6	2,5
Sunflower	Total area	3 680	3 598	2,00	2,3	2,2
Sunflower norg	share of tot. Area	98,5%	80%	2,00	2,3	2,3
Sunflower org	share of tot. Area	1,5%	20%	1,64	1,9	1,8
Wheat	Total area	26 449	26 065	6,20	7,1	6,7
Wheat norg	share of tot. Area	98,4%	80%	6,24	7,1	7,1
Wheat org	share of tot. Area	1,6%	20%	4,16	4,8	4,7
Total organic area			8 817			

Table 2: Market balances (1 000 tons) in the ORG_LAND scenario, with respect to the reference scenario

	EU27	USA	Brazil	RoW	World	World Prices
Maize						
Supply	-1 642	362	410	615	-255	+1,6%
Final demand	-58	-2	-3	-364	-426	
Livestock demand	199	46	-86	679	837	
Other demand	-199	-248	-24	-387	-468	
Rapeseed						
Supply	-936	0	0	12	-924	+1,4%
Final demand	0	-1	0	0	-1	
Livestock demand	2	0	0	8	10	
Other demand	-624	-2	0	-611	-933	
Sunflower						
Supply	-80	0	0	-28	-108	+1,2%
Final demand	0	0	0	0	0	
Livestock demand	20	1	0	17	38	
Other demand	-46	-2	0	-197	-145	
Wheat						
Supply	-7 094	126	56	1 680	-5 232	+2,4%
Final demand	-102	-2	-2	-193	-298	
Livestock demand	-1 251	-196	-4	-2 672	-4 122	
Other demand	-592	-11	-67	-278	-644	

Table 3: European Union net trade in 2020 (1 000 tons)

	2008	2020		
	REF	REF	ORG_LAND	% Variation
Maize	-2 758	6 417	4 834	-24,7%
Rapeseed	-2 063	-1 577	-1 890	-19,9%
Sunflower	-758	-136	-190	-39,7%
Wheat	9 852	33 655	28 506	-15,3%
Soybeans	-23 348	-26 328	-26 802	-1,8%
OilPalm	-2 667	-2 993	-3 047	-1,8%
OilRape	1	-63	-76	-19,7%
OilSoyb	-175	-612	-656	-7,1%
OilSunf	-322	-337	-351	-3,9%
PalmFruit	-65	-91	-92	-1,2%
Cattle	-272	909	924	1,6%

Table 4: European imports in 2020 (1 000 tons)

	2008	2020		
Crop and exporter	REF	REF	ORG_LAND	% Variation
Maize				
Brazil	3 518	5 787	6 267	8,3%
RoW	2 326	1 087	1 193	9,7%
USA	507	153	167	9,1%
World	6 351	7 028	7 626	8,5%
Rapeseed				
RoW	2 449	2 730	2 895	6,0%
USA	11	15	16	5,8%
World	2 460	2 746	2 912	6,0%
Sunflower				
RoW	732	726	752	3,6%
USA	314	268	269	0,5%
World	1 046	993	1 021	2,8%
Wheat				
RoW	3 150	1 970	2 320	17,8%
USA	1 608	987	1 125	14,0%
Brazil	346	442	508	15,1%
World	5 104	3 399	3 954	16,3%

Table 5: Land use changes

	2008	2020	
		Area increase	Carbon emissions
	10^6 ha	10^3 ha	$MtoeCO_2$
Region and land type	REF	ORG_LAND	ORG_LAND
EU27			
Cropland	92,7	1,5	
Pasture	69,4	0,1	
SavnGrasslnd	19,6	-0,3	0,1
Other	51,6	-0,2	
Forest managed	147,5	-1,2	0,3
Forest primary	6,8		
World			
Cropland	1 257,1	407,8	
Pasture	1 245,1	-233,3	
SavnGrasslnd	3 414,7	-40,5	33,9
Other	2 843,5	-37,6	3,5
Forest managed	821,6	-89,7	22,8
Forestprimary	3 100,7	-6,8	1,7
Total			62