

# **Corporate science fiction -**

**A critical assessment of a Bayer and Syngenta funded HFFA  
report on neonicotinoid pesticides**

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**Editor: Greenpeace e.V., Hamburg**

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**28. October 2013**

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## Executive Summary

In the mid-nineties, a relatively new class of insecticides, the neonicotinoids were first marketed in Europe. The market is dominated by Syngenta and Bayer CropScience the largest pesticide companies in the world. It is estimated that the turnover with neonicotinoids is estimated over two billion Euros.

Neonicotinoids have long been suspected to cause, along with other factors, a massive decline in wild and managed bee populations around the world, in particular the bee colony collapses (a phenomena described as Colony Collapse Disorder - CCD). The European Food Safety Authority (EFSA) recently concluded that these pesticides can pose a high risk to bees and other pollinators, and in consequence the European Commission proposed to partially ban the use of these pesticides in agriculture.

Bayer Crop Science and Syngenta hired the think-tank Humboldt Forum for Food and Agriculture (HFFA) for an 'impact analysis' of a ban of Neonicotinoids (NNi) seed treatment. The analysis is based on five crop-level scenarios taking into account a ban in five arable crops (maize, oilseed rape, sunflower, wheat, barley). The authors have carried out calculations based on economic models. The models rely on one single assumption (decreased yields), which was derived from a survey of selected stakeholders. The number of respondents who participated in the survey was not mentioned.

The HFFA study finds that a ban of three insecticides (imidacloprid, thiamethoxam and clothianidin) used as seed treatment in all five crops would have the following results:

1. five years after a ban the EU economic welfare would decline by €17-23 billion,
2. up to 40.000 job would be lost in agriculture in the first year after a ban,
3. 3,3-5,7 million hectares of 'virgin' land would be converted into additional arable, which would cause more than 1 billion tons of additional CO<sub>2</sub> emissions.

The results presented in the HFFA study are highly questionable, since the study suffers from a number of deficiencies, which are presented and explained in this evaluation. The main points of criticism are the following:

1. Assumptions central to the whole study, such as the alleged yields losses caused by the lack of application of NNi, are presented without any empirical evidence to justify them.
2. Scenarios are not realistic.
3. The methodology adopted and the assumptions made are poorly described.
4. The study does not refer to peer-reviewed scientific literature.
5. The models have not been calibrated correctly, and thus contradict the scenarios.
6. Model results are not or poorly empirically verified. For none of the equations or models the predictive power has been demonstrated, although real data exist.
7. The market model assumes that domestic and foreign goods are perfect substitutes. That neglects, for example the fact, that maize in Europe is mainly

- grown for silage used as fodder and for energy production and silage is not a tradable good in international/overseas trade.
8. The free market model does not consider that the demand for certain crops is artificially increased, due to subsidies and other protective measures, such as for sugar production, biofuel from oil seed rape and bioenergy. .
  9. The study predicts job losses in agriculture by directly linking (alleged) yields losses and with declines in labour. Such a calculation is scientifically wrong. Statistically there is a negative correlation between yields and jobs – over the last decades higher yields were achieved with less labour.
  10. The land use change and CO<sub>2</sub> emission model (ILUC-tool) considers current yields on ‘virtual’ land equal to those in Europe. That does not take into account that in warmer climates annual yields especially of sugar cane and maize are often higher, because of double or multiple harvests.
  11. The HFFA analysis fails to consider negative external (hidden) costs caused by pesticide use .
  12. The HFFA calculations do not consider the benefits that a ban on NNi use may bring to yields and revenues. Since honey bees are the main pollinator of rape seed and sunflower, banning substances that negatively affect them is likely to increase both agricultural yields and revenues.
  13. The presumed ban **of all** insecticides (over 100 active ingredients) in five key crops (Scenario S5) leads to results, which are in the same order of magnitude, than a presumed ban of **three** single insecticides only used for seed treatment. These differences are not discussed.

The authors ignore existing data from countries which have suspended neonicotinoid seed treatment. Data from these countries do not show a yield decrease, and in some cases even find an increase in yield. In corn/maize, where the pesticide industry predicted a 50% yield loss, if NNi would be banned, a yield increase of 12% was reported in Germany after the NNi ban. The highest yield (10,72 t/ha) ever in the last 22 years, was recorded in 2011 – without NNi seed coating. Similarly, yields in Italy and Slovenia still followed a general upward trend after 2008 (see Chapter ‘*The real yields*’). Also agricultural jobs in these countries did not get lost.

As shown by statistics, in five years, between 2003 and 2008 approximately 50% of all marketed pesticide active ingredients disappeared from the EU market, but yields continued to increase (see Chapter ‘*Pesticides and yields*’). In general, the contribution of chemical pest and weed control is overrated. Most of the time, the scale of a pest/weed problem has an anthropogenic background – the farmer in conjunction with the society’s demand for cheap and perfect food often determine the susceptibility of agro-eco systems. Mounting scientific evidence shows that lack of proper education, agronomic and economic choices as well as agricultural policies are the main deterrents of yield respectively pesticide use.

## Introduction

Neonicotinoids are a relatively new class of insecticides which were first authorized for use in the mid-nineties (for example 1994 imidacloprid in USA). The neonicotinoid market is dominated by the two largest pesticide companies Syngenta and Bayer CropScience, with an estimated turnover of two billion Euros<sup>1</sup>.

Neonicotinoids have long been suspected to cause, along with other factors, a honeybee decline.) Most neonicotinoids are highly toxic to bees.

In May 2008 thousands of bee colonies were killed in the state Baden-Württemberg in Germany, when clothianidin was accidentally released from maize seeds coated with such a neonicotinoid insecticide. German authorities suspended the authorization for seed treatments containing certain neonicotinoids (imidacloprid, thiamethoxam and clothianidin) for maize, and later for winter cereals. These bans are still in force (BMELV 2013)<sup>2</sup>. Similar incidents caused by seeds treated with neonicotinoids lead to the death of millions of bees in other European countries. As a consequence, national authorities in some countries restricted the use of neonicotinoids in seed coating. Suspensions have also been adopted in Italy, France and Slovenia in several crops.

Following the large scale bee poisonings, research started at European level. The European Food Safety Authority (EFSA), in charge of assessing the health and environmental risks posed by pesticides, was requested by the European Commission to evaluate the safety of three neonicotinoid pesticides (imidacloprid, thiamethoxam and clothianidin).

In January, EFSA (2013) concluded that these pesticides can pose a high risk to bees and other pollinators and identified major data gaps for a proper assessment of potential negative impacts. As a consequence the European Commission proposed to partially limit the use of these pesticides in agriculture.

In order to prevent or water down possible EU regulatory interventions limiting the use of their best-selling insecticides, Bayer Crop Science and Syngenta mandated the think-tank Humboldt Forum for Food and Agriculture (HFFA) to conduct a ‘policy impact analysis’ of a possible ban of NNI seed treatment. The HFFA study concludes that banning the three pesticides as seed treatment would cause tremendous environmental and economic consequences leading to job losses in the agricultural sector, biodiversity decline and large CO<sub>2</sub> emissions (see Chapter ‘*Results by HFFA*’).

This review provides a critical analysis of the study report. Hereby a many gaps, shortcomings and flaws of the HFFA report are pointed out.

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<sup>1</sup> <http://www.agropages.com/BuyersGuide/category/Neonicotinoid-Insecticide-Insight.html>

<sup>2</sup> <http://www.bmelv.de/SharedDocs/Pressemitteilungen/2013/084-Neonikotinoide.html> in English: <http://www.bmelv.de/SharedDocs/Pressemitteilungen/EN/2013/086-Bienen.html>

## Results by HFFA

The HFFA report presents results for a short-term (one year) and mid-term (five years) analysis. The report concludes that a potential ban or suspension of NNI technology would have the following economic implications on an European level:

- commodity crop revenues would be reduced by more than 2 billion EUR annually
- agricultural production costs would increase by nearly 1 billion EUR across the EU.
- prices of agricultural raw commodities would increase up to 2 per cent,
- the EU economic welfare could experience a loss as large as 6 billion EUR in the first year,
- farmers' incomes are likely to decrease by 5 per cent, and
- more than 40,000 farm jobs could be lost

Within five years, the European economic welfare could decline by up to 17 billion EUR in scenario S1 (ban of NNI in five arable crops) and of up to almost 23 billion EUR in scenario S5 (no NNI substitution by other insecticides). Furthermore, job loss in EU agriculture would sum up to almost 27,000 in scenario S1 and to more than 35,000 in scenario S5.

In scenario S1, more than 3.3 million hectares additional arable land would be converted from 'virgin' land in order to compensate for production losses. That land conversion would cause more than 1 billion tons of additional CO<sub>2</sub> emissions - the value of these emissions is between 11 and 26 billion EUR (HFFA 2013).

## Methodology by HFFA

The authors of the HFFA analysis apply multiple economic models for analysis of a suspension/ban of neonicotinoid (NNi) seed treatment in Europe. The timeframe is five years. Five similar scenarios focusing on different crops are analyzed:

- Scenario S1 analyses the impacts of a NNI seed treatment ban for all key crops (maize, oilseed rape, sunflower, wheat, barley) and all EU member states.
- Scenario S2 assumes a NNI ban only for corn, in all EU member states.
- Scenario S3 refers to a NNI ban for oilseed rape (OSR) and sunflower, in all EU member states.
- Scenario S4 assumes a NNI ban for corn, OSR and sunflower, across the EU
- Scenario S5, analyses the impacts of a NNI ban for all key crops in all EU member states, and assumes that no insecticides will be available to farmers in Europe.

Scenarios 1-4 assume that all other crop protection tools and technologies remain available to the farmers.

None of the five scenarios take into account that several member states have already banned NNi seed treatment in some key crops .

Basically, the methodology selected by the authors is based upon assumptions of yield/revenue changes anticipated by stakeholders, chosen by Bayer CropScience and Syngenta. The results from the assumptions were used in numerous calculations and models to create figures on overall welfare (GDP), impact on agriculture (income, revenues, prices), employment, global trade, land use and land use change. Table 1 shows the methodologies used, their major outcome and some critical observations. Please note that the methodologies are not necessarily in a chronological order, some methods were applied parallel.

**Table 1 Methodologies applied be HFFA 2013, major outcomes and uncertainties associated**

Method	Outcomes	Critical Observations
Questionnaire developed by HFFA		
Questionnaire sent by Syngenta & Bayer CropScience to local expert and 'national champions'		The authors give no numbers how many stakeholders were contacted. ("national champion" is not defined).
Return of information from questionnaire and internal Syngenta/Bayer CropScience databases	Estimation of yield losses, input/cost changes and revenues	The authors give no numbers of how many stakeholders responded. It is not clear if Syngenta/Bayer CropScience processed and aggregated the results or the authors and what share of information came from the selected regional sources and what from internal industry data.
Use of data from above. (Estimation of yield losses, input/cost changes and revenues) in a full-cost (variable <sup>3</sup> and fixed cost)-full-revenue calculation combined with a macro-economic equation, where productivity is the changing variable.  Extrapolation to total acreage per crop and entire EU economy.	Country-wide economic analysis (revenues, GDP – gross domestic production changes)	The authors publish not a single number regarding model input data (yields, costs, revenue changes, elasticity values etc.). It is not clear what output from the full-cost-revenue analysis was used in the macro-economic equation. No explanation is given for some factors in the equations.
Use of partial equilibrium model (multi-region multi-market model [MMM])	Elasticity values for step above and impact on global markets and land use.	The authors give no information on how the NNi seed coating ban is incorporated in the model. It is not clear if data (and if yes which data) from the macroeconomic model are used in the MMM.
Calculation of affected jobs in agricultural sector	Job losses on EU and country level	The information on how job losses are exactly measured is vaguely explained. It seems that workforce per ha from official statistics was related to yields per hectare and then extrapolated. That seems to be a

<sup>3</sup> Variable costs are defined as cost, which are crop specific (seeds, tillage, fertilizer etc.), while fixed cost (land lease, insurances, capital costs, machinery purchase etc.) are independent from the crop.

Method	Outcomes	Critical Observations
		very simplistic and not appropriate approach,; employment and arable yields <sup>4</sup> are not positively correlated.
Calculation of affected employment outside agriculture using 'job multipliers' <sup>5</sup> .	Effect of employment related to agriculture	
Indirect Land Use Change (ILUC) model	Virtual land import and potential land conversion in third countries incl. associated CO2 emission.	Yields per area in third countries are not adjusted, instead considered equal.
Hot spot analysis	Case studies on individual affected stakeholders	

## Critique on HFFA 2013

### The Scenarios

The authors developed five scenarios which were then subject to economic modelling (see above). Using scenarios to formulate predictions in *ex ante* impact assessments is a common approach. However, to be meaningful the scenarios need to be based on realistic conditions. The scenarios developed by HFFA do not meet this criterion. All five scenarios assume that suspensions/bans currently in place in several member states do not exist. Nonetheless, these suspensions are real. The authors give no reason for this negligence nor evaluate its implications for the models.

Scenario S5 (immediate ban of ALL approved insecticides throughout the EU) predicts results with the largest numbers (see Figures 2.8, 2.9, 2.10 and 2.12. in HFFA 2013), but the authors give no reason why they considered that scenario. There are over hundred active ingredients with insecticidal properties on the European market<sup>6</sup> including those used in organic agriculture, and not even the greenest environmental group calls for an immediate ban of all these pesticides.

### The Models

The authors use a mixture of models/equations and it is not transparent what data from what sources go in what model/calculation, and what output is generated. The authors state that a “*powerful economic concept of societal welfare analysis is standard in many scientific applications to agriculture*” (HFFA 2013 pg. 4-5, 13-14 in pdf). A closer look shows that half references given: Nomisma, 2012 and von Witzke and Noleppa, 2011 are

<sup>4</sup> That might be the case where manual labour is required for harvesting: vegetables and fruit, flowers.

<sup>5</sup> The 'job multiplier' shows how many jobs are lost or gained outside the agricultural sector, if one job is lost or gained in agriculture.

<sup>6</sup> See [http://ec.europa.eu/sanco\\_pesticides/public/index.cfm?event=activesubstance.selection](http://ec.europa.eu/sanco_pesticides/public/index.cfm?event=activesubstance.selection) select “Approved” and/or “Pending” and IN – Insecticide resp.AC-Acaricide

working papers which had been produced with funding by the pesticide industry associations<sup>7</sup>.

The so called World Food Equation (WFE) was developed by Kirschke et al. (2011). However, a respective paper on the equation has not been published in a peer-reviewed scientific journal so far—once again this paper (ibid.) is a result of a HFFA project funded by the pesticide industry (ECPA) and EuropaBio - the lobby group representing the biotech industry at the EU level. The elasticity values used to calculate the so called World Food Equation (WFE) have been taken from von Witzke and Noleppa (2012), another industry funded study, where the scenario of a total fungicide ban is modelled. Once more such scenario seems implausible and does not serve as a good counterfactual for the NNI ex-ante impact study

The ILUC-tool, which analyses changes in the virtual trade of land as a consequence of changes in domestic agricultural supply and/or demand was developed in a project also funded by BayerCrop Science and Syngenta (von Witzke & Noleppa 2010).

### **Database and assumptions**

The use of the models/calculation is basically done in a cherry-picking way – the model which shows the most negative impact is used, while another model which would show something different is not applied. While it is almost impossible to follow the non-transparent methodology, a number of concerns arise:

1. The models do not consider that maize for silage used as fodder and energy production is not a tradable good<sup>8</sup>.
2. The models fail to consider that the demand for some crops in some countries is above the social optimum<sup>9</sup>, because of subsidies for biofuel for oil seed rape for instance<sup>10</sup>.
3. Some subsidies are of particular importance for bioenergy production (fixed kWh price) based on maize. Commonly, the producer of maize is also the consumer – the price elasticity derived from the free-trade partial equilibrium model does not reflect that.
4. Subsidies and other regulatory measures affecting agriculture have not been considered at all.
5. The five scenarios ignore the NNI seed treatment suspensions in place in several member states (see above), but the EU/FAO dataset (2009-2011) the authors used for calibrating the partial equilibrium<sup>11</sup> model, contains these data. Furthermore, the authors use the falsely calibrated model to

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<sup>7</sup> Nomisma (2012) has been authored for the European Crop Protection Association- ECPA; von Witzke and Noleppa (2011) was initiated, supported and published by the German pesticide industry association IVA

<sup>8</sup> “*The model is static and assumes that domestic and foreign goods are perfect substitutes in consumption.*” HFFA 2013 pg. 49 resp. 59 in pdf

<sup>9</sup> above the ‘ideal output’ or optimum welfare

<sup>10</sup> 2,5 million hectares in 2012 in Germany alone:

<http://www.nachwachsenrohstoffe.de/basisinfo-nachwachsende-rohstoffe/ueberblick/>

<sup>11</sup> See [http://en.wikipedia.org/wiki/Partial\\_equilibrium](http://en.wikipedia.org/wiki/Partial_equilibrium) for explanation.

- calculate elastic values for the macro-economic analysis. The authors do not discuss the implications of that obvious inconsistency.
6. The authors ignore that sugar prices in the EU would be lower if based on world market conditions leading to increasing consumer rent, their model does not consider the current level of protection of EU sugar.
  7. The authors predict a loss of jobs in agriculture. However, the results seem to be in contradiction to the ‘partial equilibrium’ model: “*The model is closed by the assumption of market equilibrium: Trade flows are such that world supply equals world demand and that total global exports equal total global imports, thus, all world markets are cleared*” HFFA 2013 pg. 49 resp. 59 in pdf). In a market equilibrium (which is fiction), there is no unemployment, because increasing production in non-EU countries (to compensate for the modelled lower EU production) leads to higher demand for labour in these countries.
  8. When all demands are satisfied by the world market ‘*world supply equals world demand*’, the consumer price increases after the NNI ban, resulting in a welfare loss are not consistent with the model. The same is true for the hunger statement (see Box 1) – if supply equal demands than the food balance should remain the same.
  9. The land use change and CO<sub>2</sub> emission model (ILUC-tool) considers yields in the ‘virtual’ land equal to those in Europe. That simplification does not take into account that in warmer climates yields per area and year are often higher because of double or multiple harvests per year. This is especially true for sugarcane and maize.
  10. The underlying concept of the ILUC-tool is the same as for the fictional equilibrium model: perfect substitutes and clear market. Non-tradable goods (such as silage) and subsidies or other measures protecting the market do not exist in that concept.

## Overall issues

### Lack of transparency

The authors Noleppa & Hahn describe their methodology very vaguely, which makes it extremely cumbersome to follow their approach. There are many uncertainties, some of fundamental importance. The authors state for example that they calculated the price elasticity values for the so called World Food Equation in the partial equilibrium model. It seems that results from the World Food Equation were later going back into the partial equilibrium model – that would be a circular process.

In addition, the authors do not provide key input data such as a table presenting what changes in yield, costs and revenues by crop and country would happen when a NNI seed treatment ban is implemented. Other key data, such as the elasticity values from von Witzke and Noleppa (2012) were modified using the partial equilibrium model and cannot be retrieved by any outsider not having access to the model. The same is true for

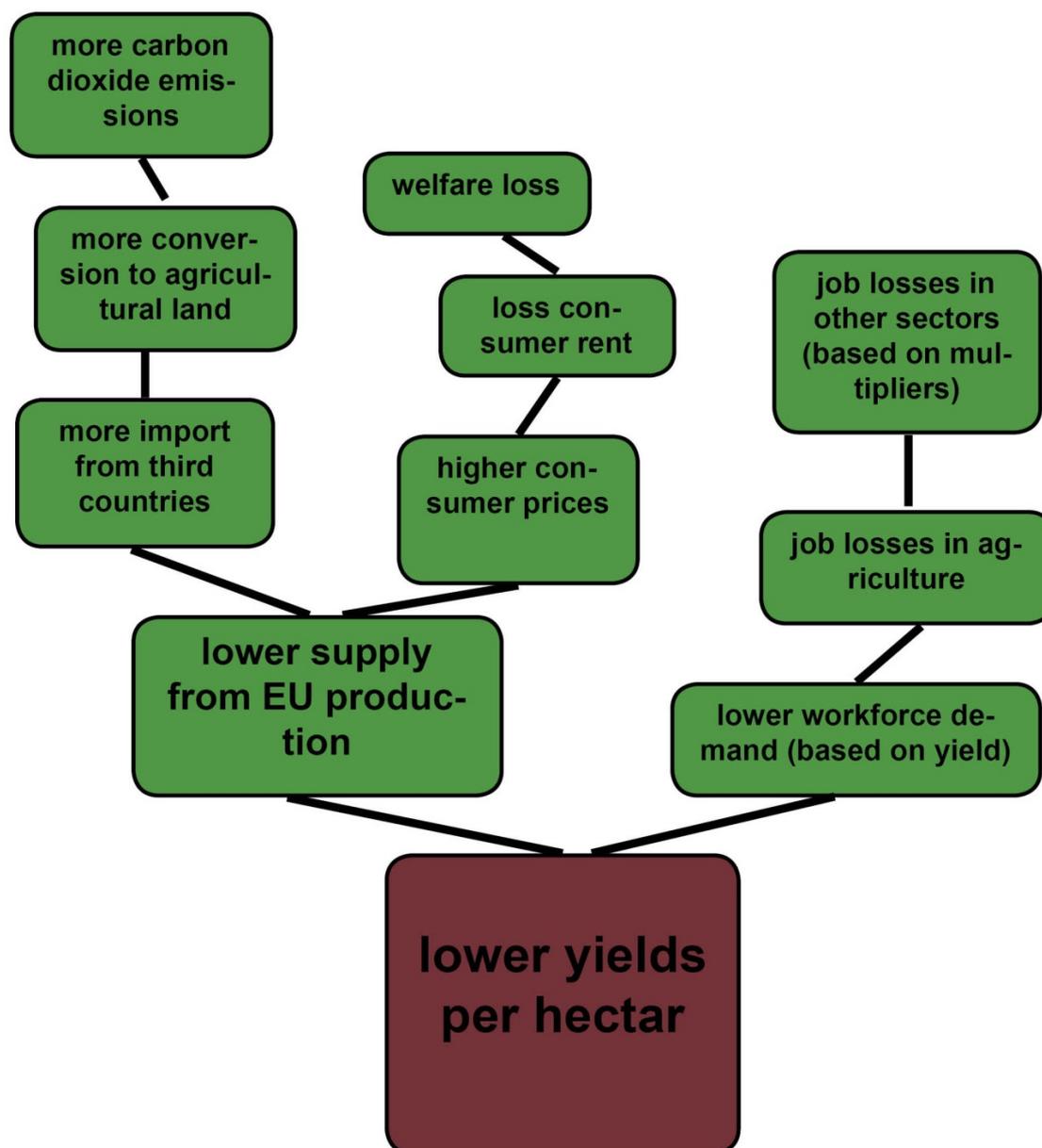
the input-output ratios used to calculate the labour impact. The equation and models applied are basically a black-box only the specific user can use.

### **Poor referencing**

The study is badly referenced. The authors often make powerful statements without citing any reference. It is not clear where in the process official statistics from governments, FAO, Eurostat or data from the pesticide industry have been used. Many key references cannot be considered sound science because they never underwent an independent review and often are paid by the pesticide industry.

### **The wilting argumentation tree**

When analysing the methodology applied by HFFA (2013) it seems that basically all results from the models/equations are based on one single assumption, which was obtained by asking an unknown number of local experts for estimates of yield reduction as a result of an NNi ban. The flow of arguments used by the authors is illustrated in the next figure.



**Figure 1 Argumentation tree by HFFA 2013 (own figure)**

However, that 'argumentation tree' has a weak trunk, because the empirical data does not prove the assumptions the authors made.

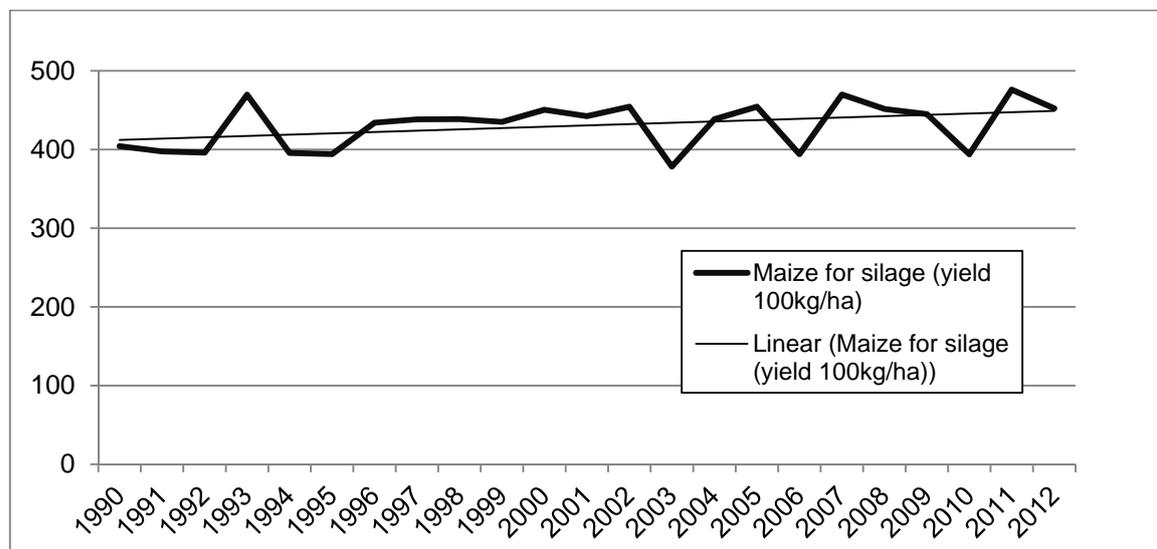
### The real yields

Noleppa & Hahn, the authors of the HFFA (2013) study do not give any number for the estimated yield reductions per crop, which feed in the models/equations. The European pesticide industry (ECPA) states without any empirical proof: '*The loss of neonicotinoid seed treatments could have an impact on yield with potential losses of up to 10% in oilseed rape and cereals, 30% in sugarbeet and 50% in maize.*<sup>12</sup>'. Whether or not HFFA

<sup>12</sup> ECPA (2012): Letter from the European Crop Protection Association (ECPA) to EC Commissioner Dalli. Subject: Possible suspension of certain insecticidal seed treatment application. 13.06.2012.

2013 used these numbers is not clear. A simple look at the statistics would have shown that NNi neither increased yield after introduction nor did the ban decrease yield in corn.

In corn for silage, there is a steady increase in yield over the last 22 years, but no sharp increase in 1997 as imidacloprid was registered for seed treatment in Germany (BVL 2013)<sup>13</sup> and no drop after the ban in 2008 (see Figure 2). In fact, the average yield 2009-2012 was 4,42 t/ha while it was only 4,37 t/ha in the NNi period (1997-2008).



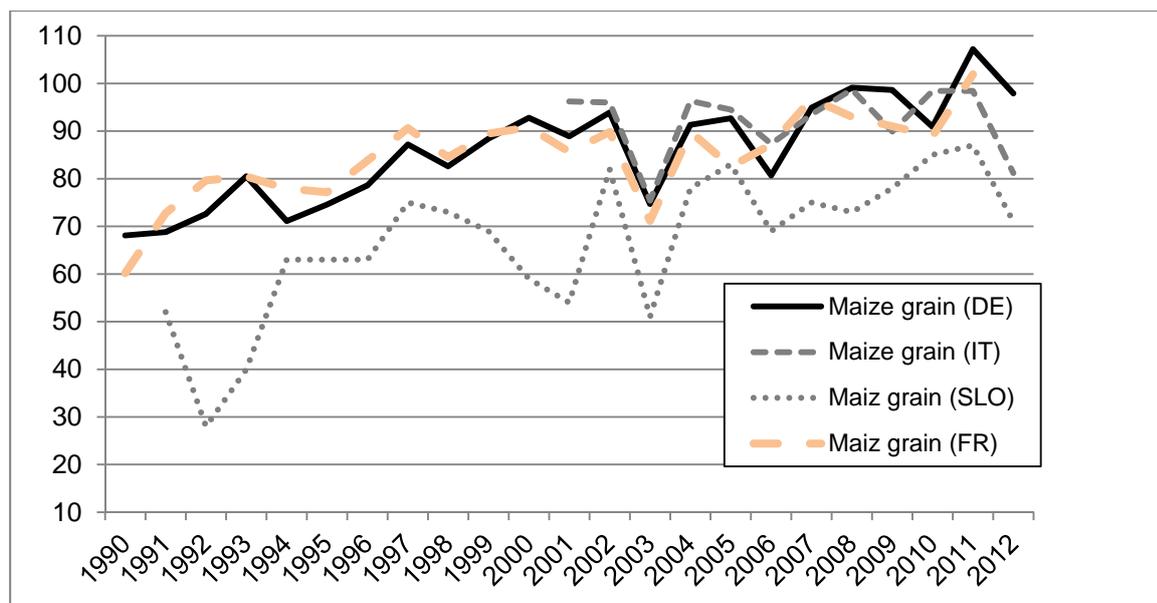
**Figure 2 Maize for silage (Germany 1990-2012, yield in 100 kg/ha) (own graphic).**

An even higher yield increase after the NNi ban in Germany was reported in corn production for grains where the average yield 2009-2012 was 9,87 t/ha (+12%) while it was only 8,89 t/ha in the NNi period (1997-2008). The highest yield (10,72 t/ha) ever in the last 22 years, was recorded in 2011 – without NNi seed coating<sup>14</sup>. Similarly, yields in Italy and Slovenia still followed a general upward trend after 2008 (see Figure 3). France banned maize NNi seed treatment with Gaucho (cont. imidacloprid) in 2004 in maize, but allowed the use of Cruiser (containing thiamethoxam) by 2008. In the time of the ban the yield further increased (see Figure 3).

<sup>13</sup> BVL (2013): Answer to an information request about the first authorization for NNi seed treatment in Germany. E-mail from 15.4.2013 from Bundesamt für Verbraucherschutz und Lebensmittelsicherheit (BVL)

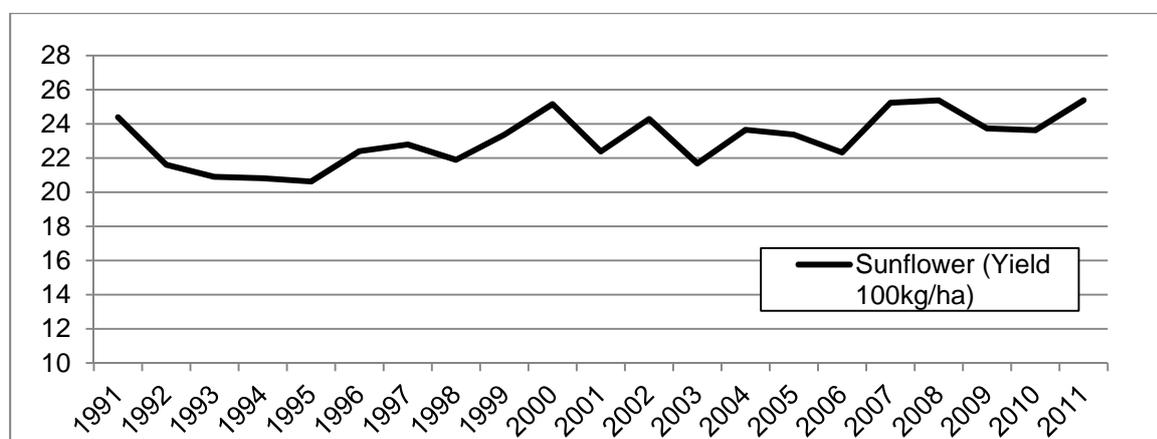
<sup>14</sup> Please note that use of neonicotinoids as granules (e.g. 'Santana' cont. clothianidin) and or sprays ('Biscaya' cont. thiacloprid) were permitted to be used in via emergency derogation in maize in Germany (see:

[http://www.bvl.bund.de/DE/04\\_Pflanzenschutzmittel/01\\_Aufgaben/02\\_ZulassungPSM/01\\_ZugelPSM/02\\_Genehmigungen/psm\\_ZugelPSM\\_genehmigungen\\_node.html](http://www.bvl.bund.de/DE/04_Pflanzenschutzmittel/01_Aufgaben/02_ZulassungPSM/01_ZugelPSM/02_Genehmigungen/psm_ZugelPSM_genehmigungen_node.html)



**Figure 3 Maize grain yield (in 100kg/ha) in Germany, Italy, France and Slovenia<sup>15</sup> (own graphic)**

Sunflower yields also did not drop as France suspended the use of imidacloprid seed treatment in 1999. Despite the extreme heat wave in 2003, the average yield in the four years after the ban 2000-2003 was 6,6% higher than the average yield in the four years 1995-1998 before the ban. Yields further increased after 2004, when seed treatment with fipronil was also banned.



**Figure 4 Sunflower yield (in 100kg/ha) in France (own graphic)<sup>16</sup>**

## Employment

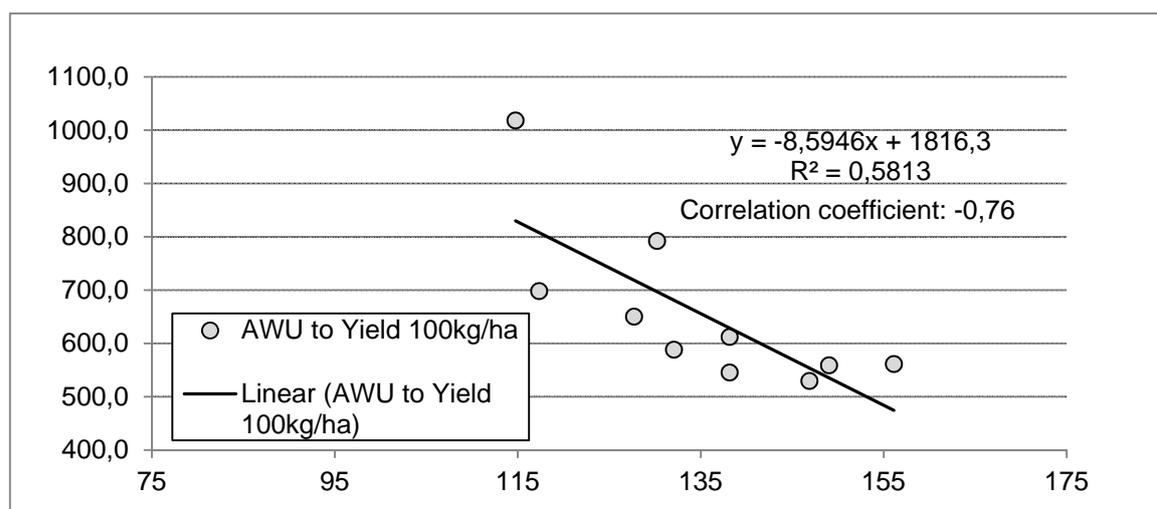
The authors did not provide a detailed and transparent description how they calculated the impacts on labour. They vaguely state: *'Labour impacts of input and output changes in agriculture can be analysed by using input-output ratios and calculator methods;*

<sup>15</sup> Data from Table 41241-0003 „ Ertrag je Hektar (Feldfrüchte und Grünland): Deutschland, Jahre, Fruchtarten“ Genesis-Online Datenbank:Italy: <http://agri.istat.it> Path: Home: data: time series: crops; Slovenia: <http://pxweb.stat.si/pxweb/Dialog/statfile1.asp>

<sup>16</sup> FAO Statistics Database

corresponding data are provided by EC (2012), Handler and Blumauer (2006) and KTBL (2011) and have been used to identify agricultural labour input effects of changing production volumes in arable farming.’ The authors do not explain ‘calculator methods’ sufficiently. It looks like, statistical data on crop area<sup>17</sup> and working hours per hectare<sup>18</sup> were somehow related to the yield (production output). Purpose was to obtain an input (labor)-output (production) ratio like working hours per ton/ha. That input (labor)-output (production) ratio was then applied to yield changes as anticipated by local experts and national champions and acreage per crop. The authors do not discuss why data derived from cereal production or German statistics can be applied to sunflowers and oil seed rape.

However, the positive correlation yield/ha with workforce respectively employment is a very simplistic approach and far from reality. Yields and employment seem rather to be negatively correlated. Rationalization through the use of ever larger machinery and conservation tillage reduced labour demands, while yields are increasing. Figure 5 shows the correlation between average yields (across fruits, vegetables, nuts, arable crops) and agricultural working unit (AWU in 1000) in Germany (1991-2010). It is a negative correlation<sup>19</sup> (correlation coefficient-0,76).



**Figure 5 Correlation between average yields (across fruits, vegetables, nuts, arable crops)<sup>20</sup> and agricultural working unit (AWU in 1000) in Germany (own graphic based on BMVEL<sup>21</sup>)**

The economic advantage of seed treatment is mostly that sowing and pest control is conducted in one step, so that further pest control measures are either reduced or

<sup>17</sup> Cereal areas can be obtained from EC 2012

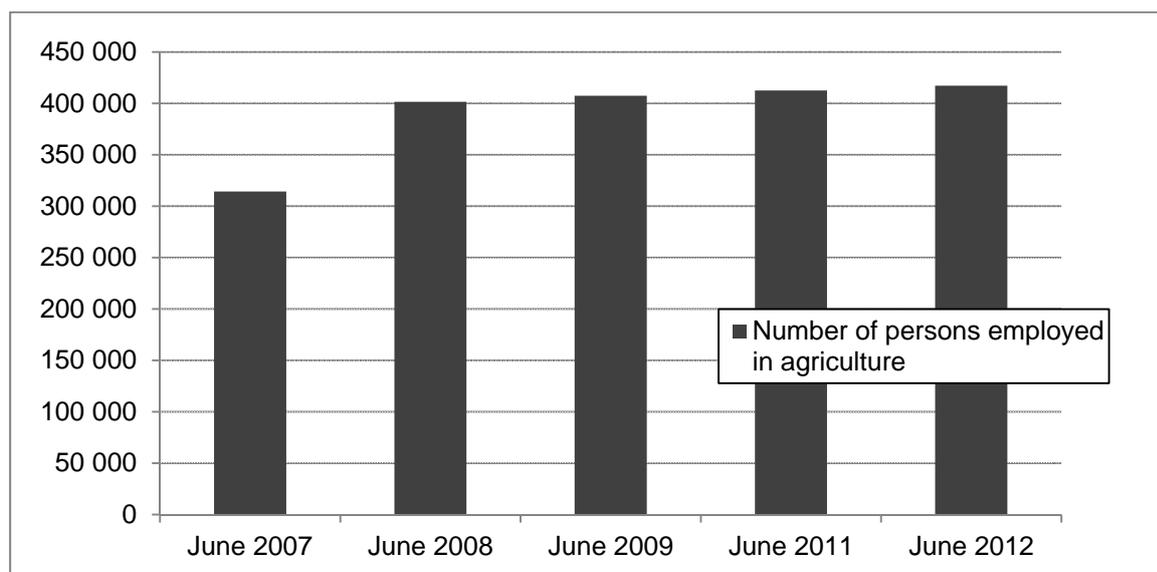
<sup>18</sup> Working hours per hectare in Germany can be obtained from KTBL 2011

<sup>19</sup> Please not that a neg. or pos.) correlation does not imply causality - higher yields do not lead to less labour and vice versa.

<sup>20</sup> FAO Statistics Database: Cereals, Total + (Total), Pulses, Total + (Total), Roots and Tubers, Total + (Total), Oilcrops Primary + (Total), Fruit excl. Melons, Total + (Total) Vegetables Primary + (Total), Treenuts, Total + (Total) (uneven years 1991-2010, adjusted to labour statistics)

<sup>21</sup> BMVEL Statistik. Tabelle: MBT-0108030-0000. Arbeitskräfte in der Landwirtschaft 1991-2010 in two year (uneven years, even years except 2010 are not reported).

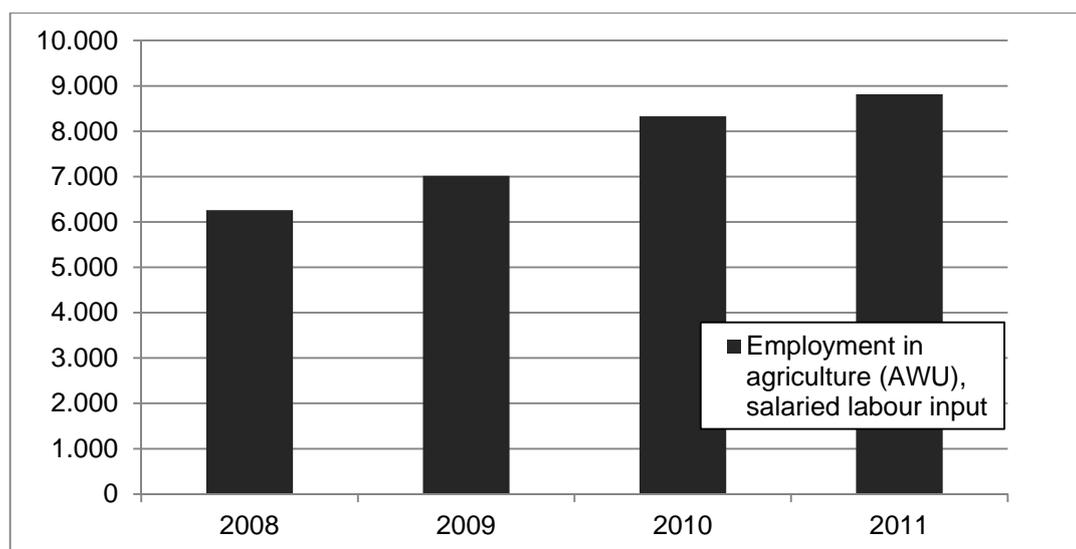
unnecessary. This actually reduces labour costs and should lead to a reduction of workforce. Following that logic and in contrast to the conclusions of HFFA, the ban could actually increase employment. The ban of NNI seed treatment in Germany affects several million hectares (winter wheat app. 3 million, winter barley app. 1 million and maize app. 2,5 million hectares), but according to the statistics employment did not decrease during the suspension. Quite the opposite, while HFFA (2013) calculated, depending on the scenario, an EU wide job loss of 22.000-44.000 due to a ban, the number of people employed in agriculture increased between June 2008 and June 2012 by over 100.000 in Germany alone.



**Figure 6 Number of persons employed in agriculture in Germany before and after the ban of NNI seed treatment (own graphic based on BMVEL 2013)<sup>22</sup>**

A similar picture can be seen in Slovenia which banned seed treatment for maize, sugar beet and oilseed rape in May 2008. These bans are still effective, and the data on employment in agriculture does not show a decrease (see Figure 7).

<sup>22</sup> BMVEL (2013): Sozialversicherungspflichtig Beschäftigte in Land-, Forstwirtschaft, Tierhaltung und Fischerei. Table: (MBT-0109030-0000). Statistik des Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (BMVEL) <http://www.bmelv-statistik.de>



**Figure 7 Employment in agriculture (AWU) – annual working unit) in Slovenia**

## Pesticides and yields

Pesticide use is largely overrated as a yield contributing factor. The yields in organic agriculture are often lower, because mineral fertilizers are not used, and not because of higher pressure from weeds or pathogens. Certainly, there are weeds, pests and diseases, which decrease yields, but the scale of the problem is anthropogenic. Education, agronomy, economy and policy are the main drivers of yield respectively pesticide use.

Pretty et al. (2006) for example showed how education influences yield and pesticide use. The researchers investigated 61 Integrated Pest Management (IPM) projects in 21 developing countries. In 47 projects pesticide use declined by 70.8% ( $\pm 3.9$ ) and yields increased by 41.6% ( $\pm 10.5$ ), in five projects, pesticide use was cut by 93.3% ( $\pm 6.7\%$ ), but yields declined only by 4.2% ( $\pm 5\%$ ). In 10 projects, mainly zero-tillage and conservation agriculture projects, pesticide use as well as yields increased. In those IPM projects, where pesticide use was considerably reduced, pests, weeds and diseases did not simply disappear, but the management changed from a pesticide based to a knowledge based system, making many pesticide applications redundant.

In Denmark, a pesticide action plan with multiple measures was implemented and pesticide use has been reduced from a treatment frequency of 3.1 in 1990-93 to 2.1 in 2001-2003, but Danish investigations have shown that it can be reduced further to 1.4 without significant economic losses neither to the farmers nor the society (Nielsen, in Neumeister 2007).

In Switzerland, wheat is the dominant cereal grown. In 2011, approximately 5,000 farmers produced app. 100,000 tons of IP wheat for bread production. This is about a third of the total Swiss production. In that IP production system use of insecticides, fungicides, plant growth regulators and use of pre-emergence herbicides is not allowed;

The average yields in IP Suisse cereals are about 11% lower than in conventional production in Switzerland, but because of lower input costs, the IP production is more economic (Wirth 2012).

Zhu et al. 2000 showed on large scale, that simple agronomic measures such as mixing varieties reduced rice blast severity by 94% and increased yield by 89%.

Zero-tillage, which is very popular in the USA and Europe often leads to increased pesticide use, especially when crop rotation is very limited. Yields are usually not increased. In addition, pressure from certain fungi, such as Fusarium can increase significantly (Johal & Huber 2009; Fernandez et al. 2009; Dill-Macky & Jones 2000).

A new quality of decoupling yield from pesticides emerged through the introduction of genetically engineered crops.. It has increased the usage and intensity of specific herbicides and lead to the development of resistant ‘superweeds’, which are controlled with additional herbicides (Johnson et al 2009; Benbrook 2009; Johal & Huber 2009). All these uses do not increase yield, they may save revenues of farmers, who are trapped (‘locked in’<sup>23</sup>) in an unsustainable agricultural system.

#### **BOX 1: Pesticides and Hunger – any correlation?**

When certain profitable technologies are at stake, The pesticide industry and its allies, usually threat the world claiming that decreased pesticide use or prohibition of certain pesticides will fuel hunger. The HFFA authors Noleppa and Hahn repeat that threat: *“(...) the use of NNi in the EU alone could currently increase global food availability in terms of energy, protein and vegetable fat for millions of human, thus, helping to combat malnourishment of currently around 1 billion people.”* (pg. 35 resp. 45 in pdf)

This hypothesis can be challenged for several reasons:

1. The NNi ban does not lead to yield decrease (see above).
2. NNi seed treatment has been used on millions of hectares of maize for bioenergy and oilseed rape for biodiesel (with a highly questionable ecological balance [Empa 2012]) not for human consumption.
3. If a liberal pesticide policy would be a key instrument to combat hunger, how does it come that almost 14,9% of US American households are classified as food insecure<sup>24</sup>? Poverty is the main reason for hunger and not low yields.
4. There is high overproduction in Europe, leading to big obesity problems and a waste of food. In Germany alone, private households throw away about 6.7 million tonnes of food every year. This waste costs up to €21.6 billion annually.<sup>25</sup>
5. It is quite naive to think that a transfer of cheap (subsidized) food from Europe would solve the global hunger problem. Quite the opposite – cheap food exports destroy rural economies in developing countries.

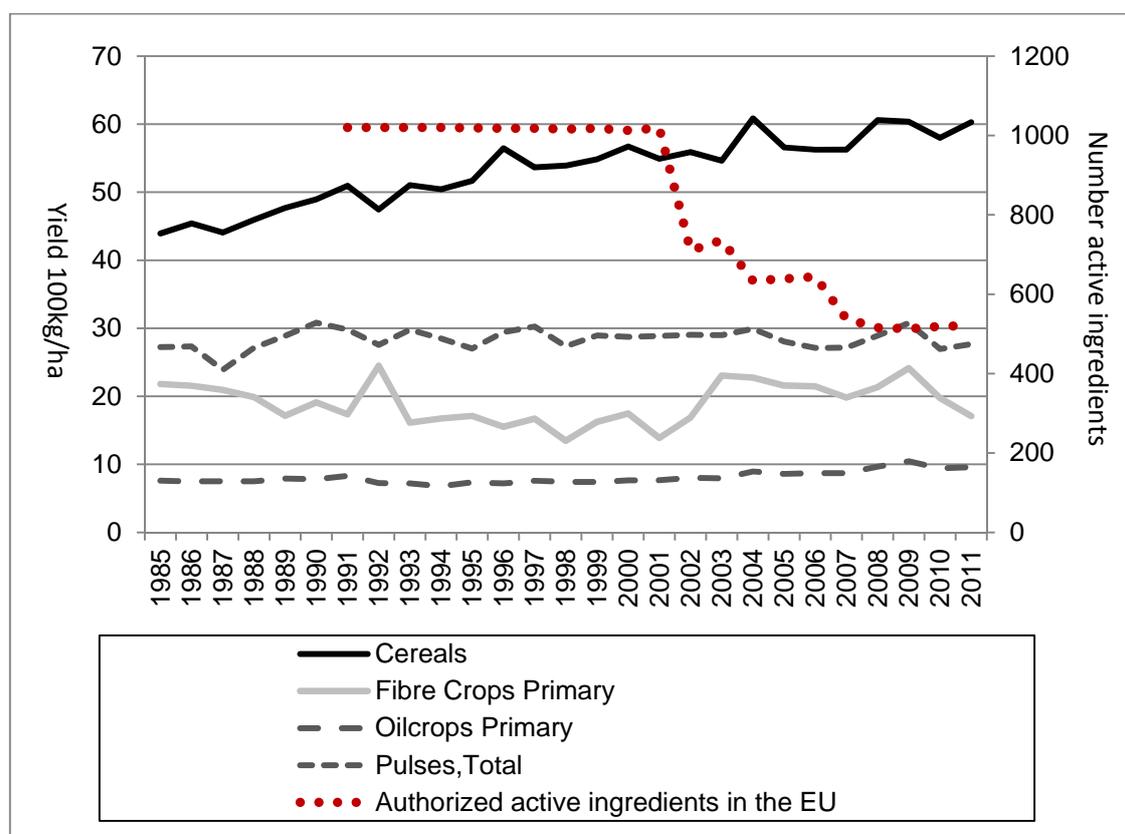
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<sup>23</sup> See more in: Wilson C & Tisdell C(2001): Why farmers continue to use pesticides despite environmental, health and sustainability costs. *Ecological Economics* 39:449–462

<sup>24</sup> <http://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/key-statistics-graphics.aspx#.UWWvZD7h5IU>

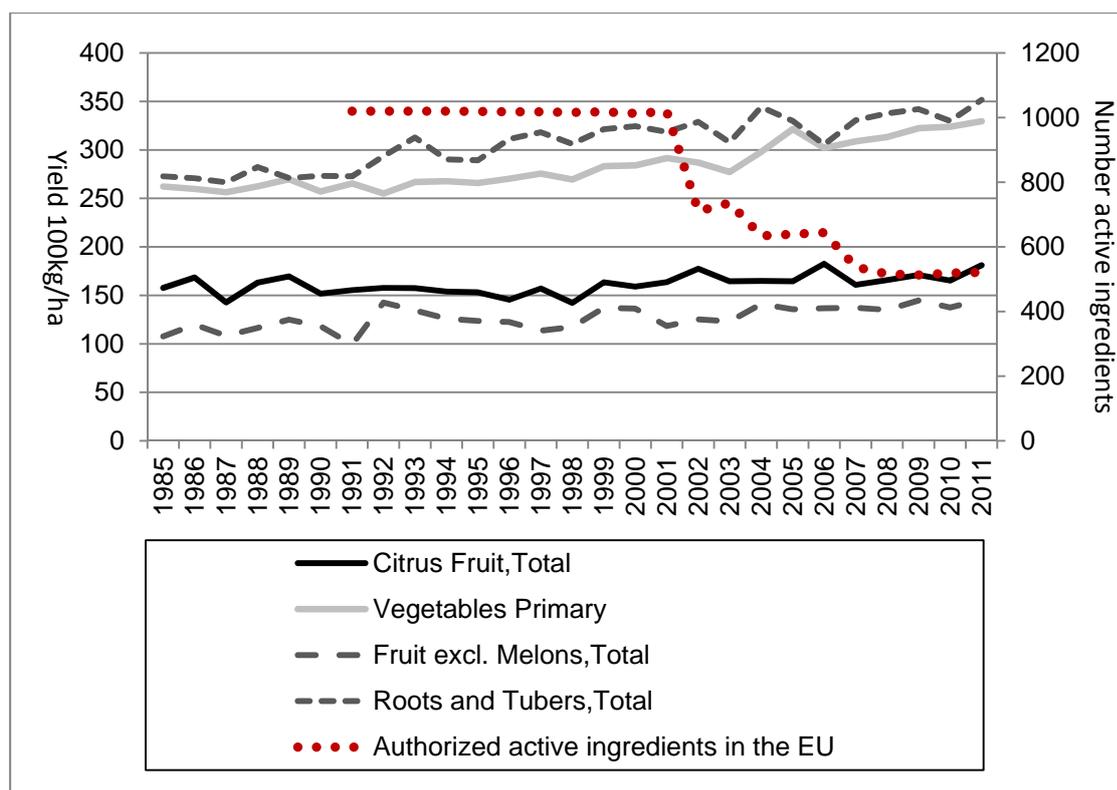
<sup>25</sup> <http://www.bmelv.de/SharedDocs/Pressemitteilungen/EN/2012/66-AI-LMStudie.html>

In 1991, the European Union decided to create a more open market for pesticide active ingredients. Its' aim was a common list of active ingredients assessed by the same standards. In the course of that re-authorization new standards were developed. Because the manufacturer had the obligation to submit new data for the assessment, not all active ingredients were re-registered. Others did not pass through the stricter assessment. As a result, between 2000 and 2011 about 650 pesticides active ingredients were taken off the EU market, and about 140 new (first authorization after 1991) entered the market. Many of the disappeared pesticides were highly toxic, highly used pesticides like paraquat, carbofuran, endosulfan, vinclozolin, trifluralin or procymidone. Despite the significant drop of available pesticides by app. 50%, the yields in the EU-15 states did not decline (see Figure 8 and Figure 9).



**Figure 8 Average Yields (arable crops) in the EU-15 in 100kg/ ha 1995 - 2011 (Data from FAO Stat 2013<sup>26</sup> calculated averages per crop) and number of authorized pesticides in the EU**

<sup>26</sup> FAO Statistics database: <http://faostat3.fao.org/home/index.html#HOME> > Production >> Crops, (Food and Agricultural Organization (FAO) of the United Nation Organization).



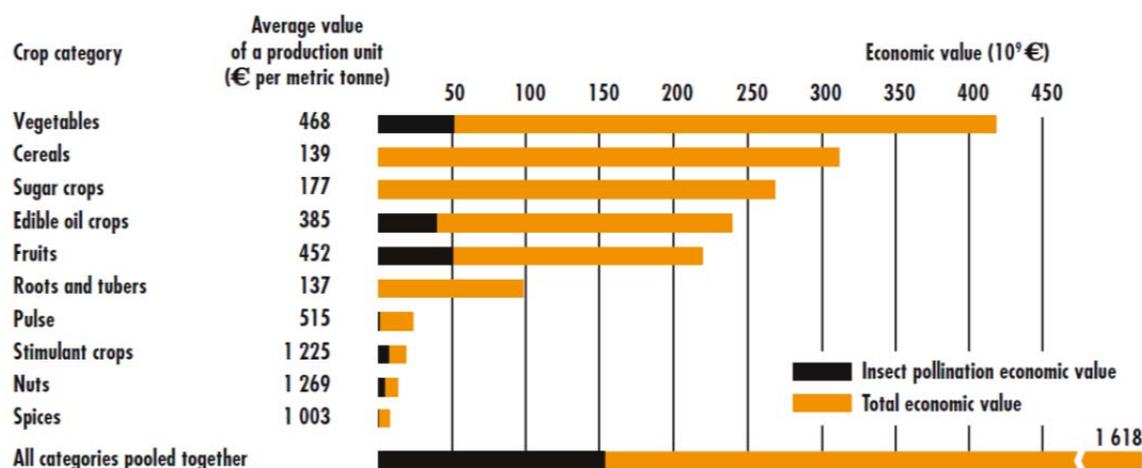
**Figure 9 Average yields (tuber, fruits and vegetables) in the EU-15 in 100kg/ ha 1995 -2011 (Data from FAO Stat 2013<sup>27</sup> calculated averages per crop) and number of authorized pesticides in the EU**

## Negative external costs of pesticide use

In May 2008, farmers in Baden-Württemberg (Germany) sowed of maize coated with the insecticide clothianidin, and part of the coating came off. The dust killed thousands of beehives. The costs for the bee keepers were estimated above €2 million.

Impacts of pesticides on honey bees and wild pollinators are ‘classical’ external costs. There are direct costs, when bee hives and honey production are lost, but more important: honeybees and wild pollinators are crucial for pollination of fruits, vegetables and other crops (see Figure 10). The economic contribution of pollinators to the production of crops used directly for human food has been estimated at €153 billion globally, which is about 9.5% of the total value of human food production worldwide (Fontaine et al. 2006) Wild pollinators may even outmatch their domesticated relatives (Garibaldi et al. 2013). When pesticides interfere with the pollination large agricultural losses are expected.

<sup>27</sup> Ibid.



**Figure 10 Economic value of insect pollination (UNEP 2010 pg. 4)**

Pimentel et al. 1993 already addressed the external costs of pesticides which damage pollinators. They interviewed many experts and researched the literature to determine the costs. The results showed that approximately 20% of all honeybees are adversely affected by the use of pesticides, 5% of the colonies die and the other 15% are seriously weakened.

In California, farmers rented about 1 million colonies (\$20 each) to replace natural pollination. Costs for bee rental were estimated to be about \$40 million per year in the USA. Of this cost Pimentel et al. attributed 10% of the rentals (worth \$4 million) as substitute for natural pollination eliminated by pesticides.

According to Pimentel et al (1993) an expert of the Wyoming University estimated annual agricultural losses due to the reduction in pollination by pesticides to be \$4 billion/year.

Pimentel et al. (1993) used these numbers for an estimation of a 10% crop loss due to reduced pollination e.g. a monetary loss of \$200 million.

**Table 2 Estimated honeybee losses and pollination losses from honeybees and wild bees per year in the USA (Pimental et al. 1993)**

Type of cost	Total costs (\$)/year
Colony losses from pesticides	13,3 million
Honey and wax losses	25,3 million
Loss of potential honey production	27 million
Bee rental for pollination	4 million
Pollination losses	200 million
<b>TOTAL</b>	<b>319,6 million</b>

Waibel and Fleischer started to work on a cost-benefit analysis of pesticides in Germany in 1992 and published a comprehensive book in 1998 (Waibel & Fleischer, 1998). The

book analysis benefits as well as external costs of pesticide use in West Germany (FRG). The direct damage (without pollination) on honey bees was estimated about €1,02 million<sup>28</sup> per year (ibid).

HFFA (2013) completely ignores the inclusion of negative external cost. Hence the net benefits from NNI are overestimated and likewise the costs of an NNI ban.

## **About the author**

Lars Neumeister (M.Sc. Global Change Management & Dipl.-Ing [FH]. Land Utilization and Conservation) has been working as independent pesticide expert for over 10 years, with a professional background in this field since 1998. He has worked in the USA, Asia, Europa and Central America. He published about 40 publications on different pesticide topics.

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<sup>28</sup> Converted from DM to Euro by the author.

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