Pesticide Policy: A One Health Approach

What does an evaluation of the parties involved in pesticide policy contribute to an improvement in dealings with pesticides in the Netherlands?

One Health
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Abstract

At the end of World War Two, it was necessary to rebuild the ruins that the war left behind. Concerns about food security gave rise to a new agricultural revolution in the shape of pesticides. Pesticides or “crop protection products” are extremely beneficial to the efficiency of agriculture. On the other hand, they can have a damaging effect on humans, animals and the environment. After decades of policy making, there is still discontent amongst all parties involved regarding the current pesticide policy in the Netherlands. We used an integrative One Health approach to understand the perspectives of these parties, and how they each influence policy. In this approach, we used a combination of literature from various disciplines, and personal interviews. We limited our search to the use of pesticides in agriculture. Besides, we only examined pesticide policy in the Netherlands, and to a lesser extent the European Union. In our paper, we highlight the controversy regarding pesticide policy and present three possible improvements. Firstly, we think that the current cut-off values used both in the European Union and the Netherlands should be more representative for environmental effects. Secondly, we think the re-approval rules in the Netherlands should be stricter. And lastly, we propose an increase in education about pesticides to farmers, leading to more sustainable farming and a reduction in pesticide waste.

Introduction

Humans have been using pesticides since 2000 BC.[1] In that time, they used sulphur dust to kill off unwanted pests. Since then, the materials used to protect the crops have gotten more and more invasive. In 1910, the first legislation regarding crop protection was enacted, but compared to the current situation, the pesticides used then were "pacifistic" materials.[2] The late 1940s, however, were a turning point, as manufacturers began to produce large amounts of synthetic pesticide and their use became widespread. Since that time, there has been a fierce debate on the use of pesticides and it has only gotten more intense.

In our paper, we use 'pesticides' as an umbrella term for both pesticides used in agriculture and those sold for private use in home gardens. In Dutch law, there is a distinction between these two categories, and pesticides for private and/or medical use are called 'biocides', while those used in agriculture are known as 'crop protection products' (*gewasbeschermingsmiddelen*).[3] This distinction is of importance, because the market entry requirements for crop protection agents and biocides are different. We have chosen to focus our paper on the use of crop protection agents in agriculture, but still refer to these by the general term 'pesticides' for simplicity.

Pesticides are chemical substances intentionally released to kill organisms that interfere with the life cycle of the crop, and damage the harvest. The broad category of pesticides includes those that kill weeds (herbicides), insects (insecticides), fungus (fungicides), and even rodents (rodenticides). Despite their usefulness against pests, there are also downsides to pesticides, because they can be harmful to human and animal health, and damaging to the environment and ecosystems.[4] Therefore, these substances inspire a lot of debate among different parties about the allowance and correct use of certain pesticides, and who should be held responsible for this.

Pesticides have been in use for a long time, but are still an important issue in our society. The main reason for this is that their use is relevant to both food security and food safety. Food security means ensuring there is enough food available to feed the population. The use of pesticides allows for greater food security by increasing crop yield through crop protection. On the other hand, food safety involves ensuring the available food is safe to eat, that is, does not harm those that consume it by exposing them to toxins or pathogens. Pesticide use both increases and decreases food safety. On the one hand, pesticide use prevents, for example, dangerous fungi to grow in fruit and therefore ensures food safety. On the other hand, however, it exposes consumers to the potentially toxic effects of the pesticide. This food safety debate has been going on since the end of World War Two. A report in a

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[1] Rao, G. V., Rupela O. P., Rao V. R. et al. (2007). Role of biopesticides in crop protection: present status and prospects. *Indian Journal of Plant Protection*, *35*(1), 1-9.

[2] Goldman L. R. (2007). Managing pesticide chronic health risks: U.S. policies. *Journal of Agromedicine*, *12*(1), 57-75. doi: 10.1300/J096v12n02_08

[3] Vogelezang-Stoute, E. (2000). Directive 91/414/EEC and the Dutch pesticides Act. *European environmental law review*, *9*(8-9), 237-242.

[4] Alavanja, M. C. R., Hoppin, J. A., Kamel, F. (2004). Health effects of chronic pesticide exposure: Cancer and neurotoxicity. *Annual Review of Public Health*, *25*, 155-197. doi: 10.1146/annurev.publhealth.25.101802.123020

German scientific magazine published in 1972 about the DDT pesticide issue in 1943-1947 nicely illustrates this.[5] After all this time, the debate still has not calmed down. Each year, a growing number of reports are published about this subject.
What is the result of decades of discussion in the Netherlands? The current policy is that a pesticide or pesticide component is only allowed to enter the market when specific data on the effects of this pesticide are available, and the prescribed requirements regarding safety of use are met.[6] The problem is that pesticide effects are extremely complex and depend on many factors. For example, a certain pesticide can have a difference in degradation speed based on the climate it is used in.[7] Environments vary greatly between countries, and can even differ between farms. As a result, the effects of a pesticide are hard to predict. Another factor that contributes to the complexity of pesticide policy are different parties that try to influence the legislative process.[8] Non-governmental organizations (NGOs), agriculture, industry and academia are all trying to push their own agenda's, and scientific evidence plays an interesting role in this.

To further analyse the role of science in dealings with pesticides, we will discuss the theoretical basis of decision making and the appointed role of science in this process. There are three main models of decision making, as shown in figures 1, 2 and 3 below.[9] First, there is the technocratic model (figure 1), which suggests policy making is (only) based on 'objective' science, after which the made decision is communicated to parties involved. This model assumes that scientists are the best judges of risks and therefore should inform the policy makers directly. The second model, the decisionistic model (figure 2), also takes social, economic and technical information into account. In this model, 'science' is used to create a risk assessment. This assessment is used in risk evaluation and will eventually result in decisions made to manage the identified risk. Management consists of policy outcomes, regulations and the enforcement and implementation of these. The involvement of 'technical, economic and social information' means that evaluation and management of the risk are influenced by the societal and political environment. Thus, policy making is open to lobbying by both industry and NGOs. Finally, there is the transparent model (figure 3). This model

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[5] Deichmann, W. B. (1972). The debate on DDT. *Archiv Für Toxikologie*, *29*(1), 1-27. doi: 10.1007/BF00316511

[6] Wet Gewasbeschermingsmiddelen en Biociden (2007, February 17). Retrieved June 18, 2017 from http://wetten.overheid.nl/BWBR0021670/2015-06-01/

[7] Verma, J. P., Jaiswal, D. K., Sagar, R. (2014). Pesticide relevance and their microbial degradation: A-state-of-art. *Reviews in Environmental Science and Biotechnology*, *13*(4), 429-466. doi:10.1007/s11157-014-9341-7

[8] Hunka, A. D., Meli, M., Palmqvist, A. et al. (2014). Ecological risk assessment of pesticides in the EU: what factors and groups influence policy changes? *Journal of Risk Research*, *18*(9), 1165-1183. doi: 10.1080/13669877.2014.913663

[9] Millstone E., van Zwanenberg, P. et al. (2004) *Science in trade disputes related to potential risks: comparative case studies*. Seville, Spain: Institute for Prospective Technological Studies.;
Renn O. (2008) *Risk governance: coping with uncertainty in a complex world*. London, UK: Earthscan.;
Mills, P., Dehnen-Schmutz, K., Ilbery, B. et al. (2011). Integrating natural and social science perspectives on plant disease risk, management and policy formulation. *Philosophical Transactions of the Royal Society B, Biological Sciences*, *366*(1573), 2035-2044. doi: 10.1098/rstb.2010.0411

recognizes the politico-socio-economic environment as an influence on risk evaluation and management, just like the decisionistic model. However, the transparent model adds that these considerations also lead to policies concerning risk assessment. These policies include rules on what a risk assessment should consist of, when it should be carried out, and who is responsible for this task.

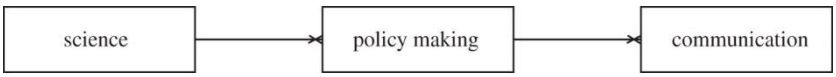

Figure 1: Technocratic model

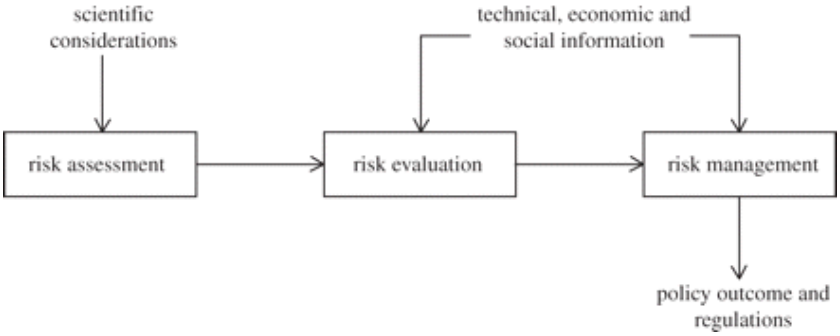

Figure 2: Decisionistic model

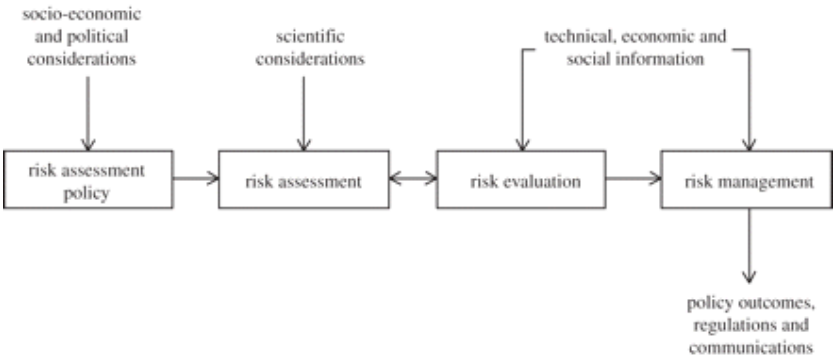

Figure 3: Transparent model
Figures 1-3[10]

[10] Mills, P., Dehnen-Schmutz, K., Ilbery, B. et al. (2011). Integrating natural and social science perspectives on plant disease risk, management and policy formulation. [Illustration]. *Philosophical Transactions of the Royal Society B, Biological Sciences*, *366*(1573), 2035-2044. doi: 10.1098/rstb.2010.0411

These models, that are all limited reflections of reality, all show the main basis of decision making is science. The main advantage of using science as a centre point for decision making is that it is (per definition considered) objective and free of personal interests. Besides, science is based on hard facts and is therefore a good foundation for policy making. Therefore, the technocratic model, the simplest model, shows what could be argued as ideal; policy should only be based on science. The transparent model is, however, more complete and corresponds to the reality. In this model, science is influenced by different parties that each 'produce' their own data, and thereby 'contaminated' by their interests. In practice, science is not an independent party, but a tool used by different parties to influence policy.[11]

The involvement of different parties, ambiguity of scientific evidence and the great impact pesticides have on the social, political and economic environment, results in the fact that problems regarding pesticides are complex, and cannot be fully described by one discipline. What we have noticed in our research is that toxicologists will focus on analysing the toxicity of the pesticides, economists on economic aspects and the amount of money involved in the pesticide industry, and political scientists on the political theories of decision making in these difficult debates. In most of the available literature, as becomes clear from our bibliography, the authors have focused on only one aspect of the situation, corresponding to their discipline (biomedical, economic, agricultural, environmental, etc.), or the journal they are publishing in. Articles integrating the different aspects of the current situation regarding to pesticides are very rare. Such an integrated approach, which transcends disciplines and has a broader focus on society, is the main purpose of what we now call One Health. However, as also indicated by the book '*One Health, The Theory and Practice of Integrated Health Approaches'* by Zinsstag et al. (2015), up until now there has mainly been a focus on uniting aspects of human and animal health (such as zoonoses), while "plant health is frequently missing or only briefly mentioned". The book calls this "surprising", because both human and animal health rely on plants in terms of food safety and food security, and suggests all possible links between plant health and human and animal health should be explored.[12] To contribute to filling this gap in the existing literature, we look at the intersection between plant, human and animal health when pesticides are used.

In our paper, we will analyse and evaluate the interaction between the different parties involved and investigate how they influence the legislation regarding pesticides. At the end, we evaluate all the different perspectives and their need for improvement and then provide a policy proposal if considered necessary. To do so, we have looked at studies from different disciplines that describe pesticides, policy and the different parties involved. The disciplines we have considered involve toxicology, agriculture, economics, politics, environmental sustainability science, ecology, and some history (such as from the book *Merchants of Doubt*,

[11] Mills, P., Dehnen-Schmutz, K., Ilbery, B. et al. (2011). Integrating natural and social science perspectives on plant disease risk, management and policy formulation. *Philosophical Transactions of the Royal Society B, Biological Sciences*, *366*(1573), 2035-2044. doi: 10.1098/rstb.2010.0411

[12] Zinsstag, J., Schelling, E., Waltner-Toews, D. et al (2015). *One health: the theory and practice of integrated health approaches*. Oxfordshire, UK: CABI.

by historians Oreskes and Conway[13]). We have decided to focus on the following research question:

"What does an evaluation of the parties involved in pesticide policy contribute to an improvement in dealings with pesticides in the Netherlands?"

Because this is a very broad research question, we made some further delimitations. The use of pesticides is an international phenomenon causing problems on a much larger scale than discussed in this paper, since we decided to focus on manifestation of different parties and the pesticide policies in the Netherlands.[14] As Dutch legislation is heavily based on that of the European Union, the role of the European Union is also included in this paper.[15] However, we do recognize these issues are harder to address on a global scale, and also involve poverty, less food security and less protected workers exposed to pesticides in countries outside of the Netherlands. Still, this is of concern to the Netherlands, as a lot of import comes from these countries. Therefore, we will shortly discuss an example of pesticide use in poorer countries.

We have chosen to particularly focus on problems regarding pesticides and food consumption, because this is the centre point of the pesticide debate and the most relevant to the public. However, this does not imply that risks from pesticide use in the Dutch floral industry or in home gardens are not considered problematic. These pesticides have the same damaging effects on the environment, ecosystems, and health of those applying the pesticides.[16] We will also not elaborate on the use of pesticides to battle vector-borne diseases like malaria, because we think this is less relevant to the situation in the Netherlands.[17]

To make this paper truly interdisciplinary, it is essential to get a clear image of the perspectives of all the parties involved. We simplified the current situation to a five-party model, otherwise the situation would be too complex to describe and it would be difficult to show that different disciplines are involved. The five parties are: policy makers, the scientific field (academia), agriculture, the pesticide industry and the public/NGOs. These parties overlap in some ways, but we think working with these five is most representative of the real situation. The perspectives of NGOs, policy makers and agriculture is very clear. The NGOs are very vocal in the media and on websites, and their opinion is clearly expressed. The perspective of the policy makers is described on their websites. To fully understand their perspective, however, insight into academic literature from that field is required. The agricultural viewpoint is clearly expressed in the media, and especially on websites. On the other hand, it is more difficult to find the opinions of those in the academic field, and of those in the industry. The industry is relatively private about their point of view and makes use of

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[13] Oreskes, N., Conway, E. (2012). *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming*. Bloomsbury, UK: Bloomsbury Publishing PLC.

[14] Tilman, D., Fargione, J., Wolff, B. et al (2001). Forecasting agriculturally driven global environmental change. *Science, 292*(5515), 281-284. doi:10.1126/science.1057544

[15] European Commission. Pesticides: Who does what? (n.d.). Retrieved from https://ec.europa.eu/food/plant/pesticides/max_residue_levels/actions_en/

[16] Marshall, E. J. P., Moonen, A. C. (2002). Field margins in northern Europe: Their functions and interactions with agriculture. *Agriculture, Ecosystems and Environment, 89*(1-2), 5-21. doi: 10.1016/S0167-8809(01)00315-2

[17] Sutherst, R. W. (2004). Global change and human vulnerability to vector-borne diseases. *Clinical Microbiology Reviews, 17*(1), 136-173. doi: 10.1128/CMR.17.1.136-173.2004

representing organizations to spread their views. The perspective of scientists is also complex, because consensus between different scientists is not always reached. Because of this, we have chosen to interview prominent representatives of these fields. For the perspective of scientific academia, we chose to speak to Martin van den Berg, for he is a leading toxicologist in the Netherlands and plays a role in policy enactment. We think he gives a more objective overview of the science perspective. Regarding the industry, we interviewed Jo Ottenheim. He is the spokesman of Nefyto, the organization that represents the pesticide industry in the Netherlands. We expected him to explain the perspective of the industry on the current situation and possibly suggest policy improvements.

In the first part of our paper, we explain how the law of the land is regarding pesticide legislation. We gathered the required information mainly by using the websites of the Dutch government and the European Union, and we expect this information to be correct and representative for the current situation. In the next two parts, we analyse the perspectives of the different parties and how they influence the legislation. We used academic databases to search relevant academic literature on these subjects, and combined these reports and articles with the interviews to construct the perspective of these parties. Our analysis and evaluation will primarily be based on specific dealings with pesticides as example cases, which allow for identification of the different parties and their influence on policy, but also demonstrates where improvement is needed. The first example we will use is the 2013 European Union ban on neonicotinoid pesticides following public uproar after scientists found the bee population was probably harmed and therefore reduced by these pesticides.[18] This case is very controversial because of the way scientific evidence was treated. Secondly, we will discuss the debate on the use of pesticides that contain glyphosate, such as Roundup. Glyphosate is categorised as 'probably carcinogenic', and under fire, but still on the market[19]. The last case we will use to illustrate the dealings with pesticides is that of the pesticide use in countries known as 'banana republics'.[20] In these countries, farmers use pesticides to produce the fruits we can buy in the Netherlands. However, they have little to no protection against the health effects caused by working with pesticides at the high concentrations used. In this last case, our health and direct environment are not necessarily at risk, but it could be argued that we, as consumers, Dutch businesses or government, share some responsibility for the health of these farmers.

[18] Henry, M., Béguin, M., Requier, F. et al. (2012). A common pesticide decreases foraging success and survival in honey bees. *Science, 336*(6079), 348-350. doi: 10.1126/science.1215039

[19] Koller, V. J., Fürhacker, M., Nersesyan, A. et al. (2012). Cytotoxic and DNA-damaging properties of glyphosate and roundup in human-derived buccal epithelial cells. *Archives of Toxicology, 86*(5), 805-813. doi:10.1007/s00204-012-0804-8

[20] Bakirci, G. T., Yaman Acay, D. B., Bakirci, F. et al. (2014). Pesticide residues in fruits and vegetables from the aegean region, turkey. *Food Chemistry, 160*, 379-392. doi: 10.1016/j.foodchem.2014.02.051

Chapter 1: What is the legislation concerning pesticide usage in the Netherlands as part of the European Union and who are the parties involved in the legislation?

In this chapter, we will describe the legislation concerning pesticide usage in the Netherlands. We will explain how those rules apply to two examples of pesticides: glyphosate and neonicotinoids. In addition to this, we will identify which parties are involved in the legislation regarding pesticides.

In the European Union, the trade and usage of pesticides is governed by Regulation (EC) No. 1107/2009.[21] This Regulation is called 'The placing of plant protection products on the EU market'. A Regulation is a binding legislative act that must be applied in its entirety in all European Union member states, including the Netherlands. It is instantly active across the whole European Union, without the further need for conversion into national law.[22] In Regulation No. 1107/2009, the rules regarding the authorization for the sale and use of pesticides are laid down.[23] This includes the evaluation of a new application of a certain pesticide, but also the renewal or withdrawal of an already existing authorization.[24] The aim of laying down the procedure for admission is to standardize the risk assessment of pesticides in all member states.[25] This way, the European Union prevents that a certain pesticide is approved in one country, while it is prohibited in another. Furthermore, the Regulation states that pesticides must not have harmful impacts on human, animal and environmental health. Another requirement states they should be effective.[26]
The Regulation No. 1107/2009 is based on the Precautionary Principle.[27] This Principle implies that if there is a chance a pesticide causes harm to public or environmental health based on its characteristics, it should not be approved by the European Union. Even when there is scientific uncertainty whether a pesticide is harmful or not, the pesticide is not allowed to be on the market. Thus, until there is scientific proof of and consensus on the

[21] Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC. *Official Journal L 309 of 24.11.2009*, 1-50.

[22] European Union. (n.d.). Regulations, Directives and other acts. Retrieved June 12, 2017, from https://europa.eu/european-union/eu-law/legal-acts_en

[23] EUR-Lex. Pesticide safety on the EU market. Summary of: Regulation (EC) No 1107/2009 – the placing of plant protection products on the EU market. Retrieved June 17, 2017 from http://eur-lex.europa.eu/legal-content/EN/LSU/?uri=CELEX:32009R1107/

[24] European Commission (n.d.). Procedure to apply for authorization of a Plant Protection Product. Retrieved June 17, 2017 from https://ec.europa.eu/food/plant/pesticides/authorisation_of_ppp/application_procedure_en/

[25] Villaverde, J. J. (2013). Biopesticides in the framework of the European Pesticide Regulation (EC) No. 1107/2009. *Pest Management Science, 70*(1), 2-5. doi: 10.1002/ps.3663.

[26] Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC. *Official Journal L 309 of 24.11.2009*, 1-50.

[27] Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC. *Official Journal L 309 of 24.11.2009*, 1-50.

safety of a pesticide, the pesticide will not be authorized. This way, the Precautionary Principle protects public and environmental health against potential risks.[28]
Apart from the Regulation on the authorization of pesticides, the European Union has also set a Regulation on pesticide residues, called 'Pesticide residues in human food and animal feed'.[29] This Regulation, No. 396/2005, makes a record of the maximum residue levels (MRL) of pesticides on food for consumption, such as fruit and vegetables. The maximum residue level is the highest concentration of pesticide residue on food that is legally allowed. By setting these maximum residue levels, the chance of human and animal exposure to high concentrations of pesticide residues is reduced. If maximum residue levels are not exceeded, the amounts of residues in food should be safe for consumers.[30]
Alongside these two Regulations, the European Union has set out Directive 2009/128/EC, also called 'EU action to achieve the sustainable use of pesticides'.[31] A Directive is a different type of European legal act. In a Directive, the European Union states goals and results that member states must achieve.[32] In this case, the objective is to reduce risks from pesticide use and promote non-chemical alternatives.[33] EU countries are free to write their own action plans, consisting of measures to achieve the goals stated by the European Union. Further on in this paper, we will elaborate on this Directive.

Besides legislation on European level, every member state has their own laws regarding the authorization, sale and use of pesticides. After all, each country has its own nation-specific characteristics, and therefore requires more explicit rules concerning pesticides. To meet the need for country-specific legislation, the Netherlands have developed the 'Plant protection products and biocidal products Act' (*Wet gewasbeschermingsmiddelen en biociden*).[34] This legislation gives a global overview of the rules regarding trade, distribution and use of pesticides. Moreover, the legislation focuses on control on pesticide use and enforcement of the law. In addition, it is laid down which organization is responsible for authorization in the Netherlands, namely the Board for the Authorization of Plant Protection Products and

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[28] EUR-Lex. (2000). Communication from the Commission on the precautionary principle. Retrieved June 17, 2017 from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52000DC0001/

[29] Regulation (EC) No 396/2005 of the European Parliament and of the Council of 23 February 2005 on maximum residue levels of pesticides in or on feed and feed of plant and animal origin and amending Council Directive 91/414/EEC. *Official Journal L 70 of 16.3.2006,* 1-16.

[30] European Commission (n.d.). Maximum Residue Levels. Retrieved June 19, 2017 from https://ec.europa.eu/food/plant/pesticides/max_residue_levels_en/

[31] Directive 2009/128/EC of the European Parliament and of the Council of 21October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides. *Official Journal 309 of 24.11.2009,* 71-86.

[32] European Commission (n.d.). Types of EU law. Retrieved June 18, 2017 from https://ec.europa.eu/info/law/law-making-process/types-eu-law_en/

[33] Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides. *Official Journal 309 of 24.11.2009,* 71-86.

[34] Wet Gewasbeschermingsmiddelen en Biociden (2007, February 17). Retrieved June 18, 2017 from http://wetten.overheid.nl/BWBR0021670/2015-06-01/

Biocides (*College voor de Toelating van Gewasbeschermingsmiddelen en Biociden, Ctgb*).[35] In the underlying Decree and Regulation, the laws stated in the Act are further specified. They also provide rules for practical implementation of the Plant protection products and biocidal products Act.[36]

Before a pesticide can be brought to the market, the active substance it contains must be approved by the European Commission.[37] Pesticide companies themselves must apply for approval of the active substance in their product in one of the European Union member states. This country is then called the 'Rapporteur Member State'. The Rapporteur Member State must carry out the risk assessment of the active substance.[38] Thus, if the Netherlands is chosen as Rapporteur Member State, the head of the authorization will be the Board for the Authorization of Plant Protection Products, as is laid down in the Plant protection products and biocidal products Act.[39] At the same time, the other European Union countries will monitor the evaluation carried out by the Rapporteur Member State.
Pesticide producers must deliver their own scientific data regarding the active substance in the pesticide to the leading Board.[40] These studies must be carried out under Good Laboratory Practice. The European Union requires that these data also include potential negative effects on human health.[41] First and foremost, the executive Board assesses the active substance on its potential toxicity to humans.[42] Moreover, possible risks of the substance's residues in food are closely studied.[43] Subsequently, the Board identifies its fate and behavior in the environment, such as persistence in soil, water and air. In connection to environmental fate

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[35] Wet Gewasbeschermingsmiddelen en Biociden (2007, February 17). Retrieved June 18, 2017 from http://wetten.overheid.nl/BWBR0021670/2015-06-01/

[36] Ctgb, Board for the Authorization of Plant Protection Products and Biocides (n.d.). Laws and Regulations. Retrieved June 18, 2017 from http://www.ctgb.nl/en/about-the-ctgb/what-is-our-primary-task-/laws-and-regulations/

[37] European Commission (n.d.). Approval of active substances. Retrieved June 18, 2017 from https://ec.europa.eu/food/plant/pesticides/approval_active_substances_en/

[38] European Commission (n.d.). Approval of active substances: Application and report. Retrieved June 18, 2017 from https://ec.europa.eu/food/plant/pesticides/approval_active_substances_en/

[39] Wet Gewasbeschermingsmiddelen en Biociden (2007, February 17). Retrieved June 18, 2017 from http://wetten.overheid.nl/BWBR0021670/2015-

[40] Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC. *Official Journal L 309 of 24.11.2009,* 1-50.

[41] Damalas, C. A. (2011). Pesticide Exposure, Safety Issues, and Risk Assessment Indicators. *International Journal of Environmental Research and Public Health, 8*(5), 1402-1419. doi: 10.3390/ijerph8051402

[42] Ctgb, Board for the Authorization of Plant Protection Products and Biocides (2016). EU Evaluation framework and national parts: Human Toxicology. Retrieved June 19, 2017 from http://ctgb.nl/gewasbescherming/toetsingskader/handleidingen/evaluation-manual-v2-1-em/

[43] Ctgb, Board for the Authorization of Plant Protection Products and Biocides (2016). EU Evaluation framework and national parts: Residues. Retrieved June 19, 2017 from http://ctgb.nl/gewasbescherming/toetsingskader/handleidingen/evaluation-manual-v2-1-em/ ; European Commission (n.d.). Guidelines on Active Substances and Plant Protection Products. Retrieved June 18, 2017 from https://ec.europa.eu/food/plant/pesticides/approval_active_substances/guidance_documents_en/

and behavior, the possible toxic effects on all the organisms within the ecosystem are evaluated.[44] Thereafter, all the findings of the Rapporteur Member State are combined in a Draft Assessment Report. In addition to the report of the Rapporteur Member State, the European Food Safety Authority must conduct a peer review of risk assessments of the active substance.[45] The organization within the European Food Safety Authority (EFSA) responsible for this review is the Pesticides Unit.[46] The evaluated risk assessments also include the one carried out by the Rapporteur Member State. In short, the European Food Safety Authority evaluates all information available on the active substance. In the end, both the Rapporteur Member State and the European Food Safety Authority have issued their conclusions in their reports. Based on these reports, the Standing Committee for Food Chain and Animal Health will vote whether the active substance will be approved or not.[47] The European Commission then adopts the voting result of the Committee and, in case of approval, adds it to Regulation No. 540/2011, which contains a list of approved active substances.[48] According to Regulation No. 1107/2009, new active substances are granted approval for a period of ten years. When the permit has expired, pesticide companies can apply for renewal. This involves a new authorization process and re-assessment of the active substance.[49] Approval of a renewal request is then permitted for a maximum of fifteen years.[50]

Before a pesticide product containing an approved active substance can be brought to the market, it is obligated to set a maximum residue level.[51] Maximum residue levels are set on European level, in Regulation No. 396/2005, as mentioned earlier. The European Food Safety Authority's Pesticides Unit is responsible for the determination of the maximum residue

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[44] Ctgb, Board for the Authorization of Plant Protection Products and Biocides (2016). EU Evaluation framework and national parts: Ecotoxicology. Retrieved June 19, 2017 from http://ctgb.nl/en/plant-protection/assessment-framework-plant-protection-products/manuals/evaluation-manual-em/ecotoxicology/

[45] Fontier, H. (2011). Procedure for the approval of an active substance under Regulation No 1107/2009. Retrieved June 18, 2017 from https://ec.europa.eu/food/sites/food/files/plant/docs/pesticides_ppp_app-proc_efsa-proc.pdf/;
European Food Safety Authority. (n.d.). Pesticides: EFSA's role. Retrieved June 18, 2017 from http://www.efsa.europa.eu/en/topics/topic/pesticides/

[46] European Food Safety Authority. (n.d.). Pesticides: EFSA's role. Retrieved May 29, 2017 from http://www.efsa.europa.eu/en/topics/topic/pesticides/

[47] European Commission (n.d.). Guidelines on Active Substances and Plant Protection Products. Retrieved June 18, 2017 from https://ec.europa.eu/food/plant/pesticides/approval_active_substances/guidance_documents_en/

[48] Commission Implementing Regulation (EU) No 540/2011 of 25 May 2011 implementing Regulation (EC) No 1107/2009 of the European Parliament and of the Council as regards the list of approved active substances. Retrieved June 18, 2017 from http://data.europa.eu/eli/reg_impl/2011/540/2015-09-03

[49] European Food Safety Authority (n.d.). Peer Review of Active Substances. Retrieved June 19, 2017 from http://www.efsa.europa.eu/en/topics/topic/pesticides/

[50] Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC. *Official Journal L 309 of 24.11.2009*, 1-50.

[51] Ctgb, Board for the Authorization of Plant Protection Products and Biocides (n.d.). Application for setting Maximum Residue Limit. Retrieved June 19, 2017 from http://ctgb.nl/en/plant-protection/types-of-applications-for-plant-protection-products/application-for-setting-mrl-rm/

levels by carrying out a risk assessment. Again, pesticide companies themselves must deliver data concerning use, toxicity, and expected residues of the pesticide. Based on this information the European Food Safety Authority formulates an advice on the recommended maximum residue level, which is presented to the European Commission.[52] The Commission then votes for or against setting of the new maximum residue level, based on the opinion of the European Food Safety Authority. When a maximum residue level is approved, it is incorporated in Regulation No. 396/2005.[53]

Once an active substance is permitted and the maximum residue level is set, pesticide companies can apply for the authorization of their product. Concerning the authorization procedure of a product, Regulation No. 1107/2009 divides the European Union into three climatically similar zones: The Northern, Central and Southern Zone. The Netherlands are part of the Central Zone, as are the United Kingdom, Belgium, and Germany.[54]

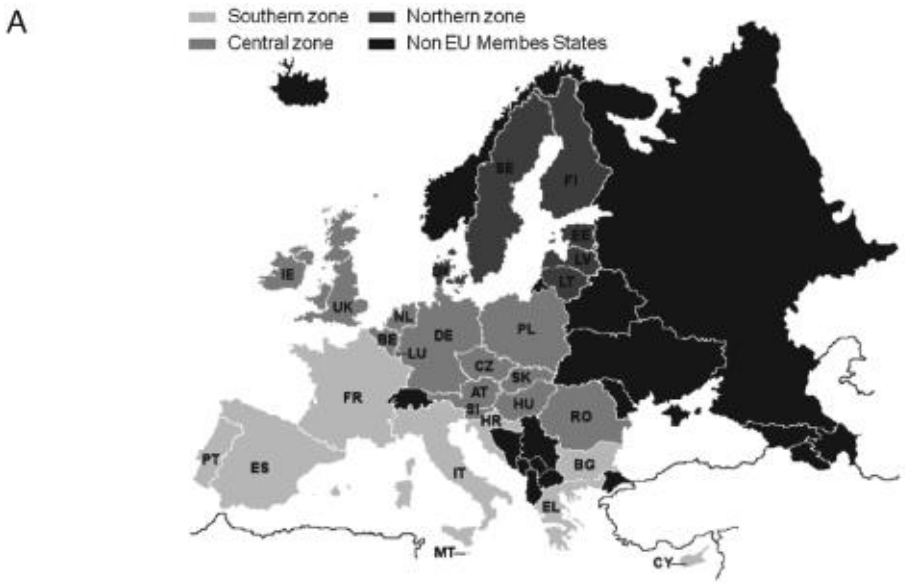

Figure 1: The zonal procedure of pesticide product authorization.[55]

This way, pesticide companies can request authorization of their product for a whole European zone at once. One of the member states is chosen by the company as 'zonal

[52] Ctgb, Board for the Authorization of Plant Protection Products and Biocides (n.d.). Registration process and instructions for submission: new EU-MRL. Retrieved June 18, 2017 from http://ctgb.nl/en/plant-protection/types-of-applications-for-plant-protection-products/application-for-setting-mrl-rm/registration-process/

[53] European Commission (n.d.). Maximum Residue Levels: Who does what? Retrieved June 18, 2017 from https://ec.europa.eu/food/plant/pesticides/max_residue_levels/actions_en/

[54] Villaverde, J. J. (2013). Biopesticides in the framework of the European Pesticide Regulation (EC) No. 1107/2009. *Pest Management Science*, *70*(1), 2-5. doi: 10.1002/ps.3663.

[55] Villaverde, J. J. (2013). Biopesticides in the framework of the European Pesticide Regulation (EC) No. 1107/2009. *Pest Management Science*, *70*(1), 2-5. doi: 10.1002/ps.3663.

rapporteur', who will coordinate the authorization process.[56] Even though authorization is carried out via the zonal procedure, the national authority of each member state may require its own additional demands and restrictions.[57] The European Union member states are left free in the design of their own legislation at this point, because differences can exist between countries with respect to environmental conditions and the occurrence of pests.[58] Thus, in the Netherlands, the Board for the Authorization of Plant Protection Products and Biocides can further define how and when exactly the approved pesticide may be used by consumers.[59]

The active substance glyphosate, best known for its use in Monsanto's controversial Roundup, has been approved by the European Union since 2002, as can be found in the EU Pesticides Database. Because the approval in 2002 concerned a renewal request, authorization has been permitted for fifteen years. Thus, by the end of 2017, its license will expire and it will be up for re-evaluation.[60] In the Netherlands, Roundup has been granted new approval by the Board for the Authorization of Plant Protection Products and Biocides in 2016. The approval is valid until December 2018.[61]
Furthermore, the active substances of neonicotinoids, such as imidacloprid, are both approved by the European Union and the Board for the Authorization of Plant Protection Products and Biocides. The authorization of imidacloprid by the European Union runs from 2009 till 2019.[62] In 2014, the Board for the Authorization of Plant Protection Products and Biocides received several objections from environmental non-governmental organizations (NGOs) - Greenpeace, Bee Foundation, Pesticide Action Network - against the allowance of several neonicotinoids containing imidacloprid. The Board for the Authorization of Plant Protection Products and Biocides maintained the approval of all neonicotinoids, except for PotatoPrid.[63]

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[56] Ctgb, Board for the Authorization of Plant Protection Products and Biocides (n.d.). Procedure zonal application. Retrieved June 18, 2017 from http://ctgb.nl/en/plant-protection/types-of-applications-for-plant-protection-products/procedure-zonal-application/

[57] Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC. *Official Journal L 309 of 24.11.2009*, 1-50.

[58] European Commission (n.d.). Maximum Residue Levels: Who does what? Retrieved from https://ec.europa.eu/food/plant/pesticides/max_residue_levels/actions_en

[59] Ctgb, Board for the Authorization of Plant Protection Products and Biocides (n.d.) Laws and regulations. Retrieved June 19, 2017 from http://ctgb.nl/en/about-the-ctgb/what-is-our-primary-task-/laws-and-regulations/

[60] EU Pesticides Database (n.d.). Search Active Substances: Glyphosate. Retrieved June 19, 2017 from http://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/public/?event=activesubstance.selection&language=EN/

[61] Ctgb, Board for the Authorization of Plant Protection Products and Biocides. (2016). Roundup Pro. Retrieved June 19, 2017 from http://ctgb.nl/en/pesticides-database/authorisation?id=15167/

[62] EU Pesticides Database (n.d.). Search Active Substances: Imidacloprid. Retrieved June 19, 2017 from http://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/public/?event=activesubstance.selection&language=EN/

[63] Het College voor de Toelating van Gewasbeschermingsmiddelen en Biociden. (2015). Besluit op bezwaar. *Staatscourant, 42248.* Retrieved June 19, 2017 from https://zoek.officielebekendmakingen.nl/stcrt-2015-42248.html/

The admission of this pesticide was withdrawn in 2016, and is still not re-approved to this day.[64]

The control of correct use of pesticides and enforcement of the law is performed on member state level.[65] In the Netherlands, the supervisory authorities, who are responsible for the control of compliance with the law, are laid down in the Plant protection products and biocidal products Regulation. These authorities include the 'Netherlands Food and Consumer Product Safety Authority' (*Nederlandse Voedsel- en Warenautoriteit, NVWA*), The Inspectorate of Social Affairs and Employment, The Human Environment and Transport Inspectorate, the Health Care Inspectorate and the Water Boards.[66] These parties assess if producers and consumers of pesticides abide by the laws, namely the Dutch Plant protection products and biocidal products Act and European Union Regulation No 1107/2009.[67] Furthermore, monitoring is done by the industry itself.[68] The Food and Consumer Product Safety Authority carries out inspection on farms for correct use and storage of pesticides. They also evaluate if spraying licenses are valid or expired.[69] Moreover, the Food and Consumer Product Safety Authority monitors pesticide residues on food by sampling on a random basis. In this assessment, they apply the maximum residue levels set by the European Union. If infringements of the law are identified – for example, if maximum residue levels are exceeded – producers or consumers can be fined according to the law.[70] The Food and Consumer Product Safety Authority itself is inspected on European level by The Food and Veterinary Office.[71]

In the Netherlands, there are different parties involved in the legislation regarding pesticides. Each of these parties has its own interests in the making and implementation of the law.

The Dutch government is responsible for the creation of the Plant protection products and biocidal products Act. The Dutch government is based on the 'trias politica', also called separation of powers, designed by the French philosopher Charles Montesquieu. According to Montesquieu, the state is divided into three branches: a legislative, an executive, and a

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[64] Ctgb, Board for the Authorization of Plant Protection Products and Biocides. Toelating databank: PotatoPrid. Retrieved June 19, 2017 from http://www.ctgb.nl/toelatingen/toelating?id=14345/

[65] European Commission (n.d.). Authorisation of Plant Protection Products. Retrieved June 19, 2017 from https://ec.europa.eu/food/plant/pesticides/authorisation_of_ppp_en/

[66] Regeling Gewasbeschermingsmiddelen en Biociden (2007, September 26). Retrieved June 18, 2017 from http://wetten.overheid.nl/BWBR0022545/2017-01-01#Hoofdstuk9_Paragraaf1

[67] Nederlandse Voedsel- en Warenautoriteit (n.d.). Gewasbescherming: rol NVWA en andere partijen. Retrieved June 19, 2017 from https://www.nvwa.nl/onderwerpen/gewasbescherming/inhoud/rol-nvwa-en-andere-partijen/

[68] Voedingscentrum (n.d.). Bestrijdingsmiddelen: Veiligheid. Retrieved June 19, 2017 from http://www.voedingscentrum.nl/encyclopedie/bestrijdingsmiddelen.aspx#blok4/

[69] Nederlandse Voedsel- en Warenautoriteit (n.d.). Gewasbescherming: Hoe de NVWA controleert. Retrieved June 19, 2017 from https://www.nvwa.nl/onderwerpen/gewasbescherming/inhoud/hoe-de-nvwa-controleert/

[70] Regeling Gewasbeschermingsmiddelen en Biociden (2007, September 26). Retrieved June 18, 2017 from http://wetten.overheid.nl/BWBR0022545/2017-01-01#Hoofdstuk9_Paragraaf1

[71] Food and Consumer Product Safety Authority. (n.d.). International contacts. Retrieved from https://english.nvwa.nl/about-us/contents/international-contacts/

judiciary part. In the Netherlands, this distinction is not this clear, because the Dutch government is not only legislative, but also executive. [72]
The government needs a parliamentary majority of coalition parties. This way, the parliament can adopt laws more easily. Political parties are divided in groups of supporters and opponents of pesticides. For example, the 'Partij voor de Dieren' has a clear view on this matter. They have multiple objections against the use of (specific) pesticides.[73] Another example is the 'Christen-Democratisch Appèl' (CDA) that clearly has a different view on pesticides. According to them, the assessment of pesticides is highly based on emotions. According to the CDA, the European Food Safety Authority and the Board for the Authorization of Plant Protection Products and Biocides must not be influenced by emotions and the approval of products with low risks should be simplified.[74]
Policy makers of four different departments have dealt with designing the Act as we know it today. These four departments responsible for pesticide legislation are the Ministry of Economic Affairs, the Ministry of Infrastructure and the Environment, the Ministry of Social Affairs and Employment and the Ministry of Health, Welfare and Sport.[75] The policy makers of these four ministries design the Dutch law based on the European Union Regulation No. 1107/2009.[76]

Secondly, scientific research plays a role in the establishment of the legislation and forms the second party involved. Policy makers are informed and advised by various studies and reports about pesticides. However, 'science' cannot be used as an umbrella term, as not all scientists share the same interests. Therefore, the science party should be divided into several different groups. First, there are the Universities, conducting their own scientific research. Universities form an independent source of academic scientific knowledge, or at least, to the extent that their funding is independent of specific interests or aims. Second, there are scientific researchers who are affiliated to pesticide producers and agriculture. For example, pesticide manufacturer company Monsanto has its own research division.[77] This division is, among other things, responsible for carrying out studies on the safety and effectiveness of Monsanto's own products. The scientists in this division work for and are paid by Monsanto.

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[72] Samuels, D. (2009). *The Oxford Handbook of Comparative Politics: Introduction.* Oxford, United Kingdom: Oxford University Press. doi: 10.1093/oxfordhb/9780199566020.001.0001;
Parlement en Politiek (n.d.). Trias politica: machtenscheiding en machtenspreiding. Retrieved June 19, 2017 from https://www.parlement.com/id/vhnnmt7lidzx/trias_politica_machtenscheiding_en/

[73] Partij voor de Dieren. (2014, February 19). Omwonenden beter beschermd tegen landbouwgif. Retrieved from https://www.partijvoordedieren.nl/news/omwonenden-beter-beschermd-tegen-landbouwgif/;
Partij voor de Dieren. (2009, July 1). Marianne Thieme eist maatregelen voor bescherming honingbij. Retrieved from https://www.partijvoordedieren.nl/news/marianne-thieme-eist-maatregelen-voor-bescherming-honingbij/

[74] Agridirect. (n.d.). Jaco Geurts van het Christen-Democratisch Appèl (CDA) reageert. Retrieved from https://www.agridirect.nl/cda/

[75] Wet gewasbeschermingsmiddelen en biociden. (2007, February 17). Retrieved May 28, 2017 from http://wetten.overheid.nl/BWBR0021670/2015-06-01/

[76] Wet gewasbeschermingsmiddelen en biociden. (2007, February 17). Retrieved May 28, 2017 from http://wetten.overheid.nl/BWBR0021670/2015-06-01/

[77] Monsanto. (n.d.). Research at Monsanto. Retrieved from http://www.monsanto.com/careers/pages/research.aspx/

Third, there are public research institutes and organisations linked to public health. In the Netherlands, the National Institute for Public Health and the Environment (*Rijksinstituut voor Volksgezondheid en Milieu, RIVM*) advises the government about the possible health effects of pesticide residues by publishing reports.[78] On European level, the already mentioned European Food Safety Authority is an important Advisory Board.[79] The European Food Safety Authority is funded by the European Union to conduct risk assessment of pesticides. Their duty is to produce accurate scientific opinions and advice on which European policy makers base their legislation. They also play a large part in the authorization process of a new product. The European Food Safety Authority aims to ensure the independence of its scientists and experts.[80] Another public health party is the World Health Organization.[81] In the International Programme on Chemical Safety, they assess safety and health risks of all different types of chemicals, including pesticides. Furthermore, experts of both the World Health Organization and the Food and Agriculture Organization of the United Nations work together in the Joint Meeting on Pesticide Residues (JMPR).[82] This group meets once a year to evaluate and review toxicological data, and to estimate maximum residue levels and acceptable daily intakes.

The third party involved in legislation are pesticide producers. The total global value of the pesticide market is estimated to be more than 80 billion United States Dollars by 2019.[83] Examples of large manufacturers are Bayer CropScience, Monsanto, Syngenta Crop Protection and BASF. In the Netherlands, they join forces in the Dutch Crop Protection Association, Nefyto.[84] Nefyto promotes the interests of companies who develop pesticides for the Dutch market. The European equivalent of Nefyto is the European Crop Protection Association, who represents the crop protection industry in Europe.[85] On a global scale, representation is carried out by CropLife International.[86] As already mentioned, the pesticide companies each have their own scientists employed to carry out research for their sakes.

Fourthly, pesticide consumers form a party of interest. Farmers who use pesticides on their crops fall within this group, but pesticides are also used by civilians in their private gardens.

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[78] Rijksinstituut voor Volksgezondheid en Milieu. (n.d.). Bestrijdingsmiddelen. Retrieved from http://www.rivm.nl/Onderwerpen/B/Bestrijdingsmiddelen/

[79] European Food Safety Authority. (n.d.). How we work. Retrieved from https://www.efsa.europa.eu/en/about/howwework/

[80] European Food Safety Authority. (n.d.). Values. Retrieved from https://www.efsa.europa.eu/en/about/values/

[81] World Health Organization. (n.d.). Pesticides. Retrieved from http://www.who.int/topics/pesticides/en/

[82] World Health Organization. (n.d.). Joint FAO/WHO Meeting on Pesticides Residues (JMPR). Retrieved from http://www.who.int/foodsafety/areas_work/chemical-risks/jmpr/en/

[83] Oristep Consulting (2015). Global Pesticide Market – By Regions and Vendors: Market Size, Demand Forecasts, Industry Trends and Updates, Supplier Market Shares 2014-2020. Retrieved June 19, 2017 from https://www.researchandmarkets.com/publication/mdxunlv/global_pesticide_market_by/

[84] Dutch Crop Protection Association; Nefyto. (n.d.). Organisatie: Over Nefyto. Retrieved from http://www.nefyto.nl/Home/

[85] European Crop Protection. (n.d.). About us. Retrieved from http://www.ecpa.eu/about-us/

[86] CropLife International. (n.d.). Retrieved from https://croplife.org/

Farmers in the Netherlands are represented by the Organization for Agriculture and Horticulture (*Land- en Tuinbouw Organisatie, LTO*).[87] This organisation represents the economic and social interests of more than fifty thousand farmers on local, regional, national and international level. Organic farmers are united in the organization Biohuis.[88] The Consumers' Association (*Consumentenbond*) represents the interests of consumers who use pesticides in their private gardens.[89]

Lastly, several environmental NGOs try to have some influence on the legislation regarding pesticides. Their main concern lies within the possible harmful effects of pesticides on human, animal and environmental health. Examples of NGOs concerned with pesticides are Greenpeace[90], Friends of the Earth in the Netherlands (*Milieudefensie*)[91] and the Health and Environment Alliance.[92] An NGO that specifically focuses on pesticides is the Pesticide Action Network. This is an international network with over six hundred joint NGOs and institutions.[93]

[87] Land- en tuinbouworganisatie. (n.d.). Over LTO Nederland. Retrieved from http://lto.nl/over-lto/lto-organisatie/

[88] Biohuis (n.d.) Retrieved from http://www.biohuis.org/

[89] Consumentenbond (n.d.) Retrieved from https://www.consumentenbond.nl/

[90] Allsop, M., Huxdorff, C., Johnston, P. et al. (2015). *Pesticides and our Health – A growing concern.* Retrieved from http://www.greenpeace.org/eu-unit/Global/eu-unit/reports-briefings/2015/Pesticides%20and%20our%20Health_FINAL_web.pdf/

[91] Milieudefensie. (n.d.). Dossier Bestrijdingsmiddelen. Retrieved from https://milieudefensie.nl/bestrijdingsmiddelen/gif-op-groente-en-fruit/hoe-veilig-is-ons-groente-en-fruit/

[92] Health and Environment Alliance. (n.d.). Pesticides. Retrieved from http://www.env-health.org/policies/pesticides//

[93] Pesticide Action Network International (n.d.). About. Retrieved from http://pan-international.org/about/

Chapter 2: What are the perspectives of the parties involved?

In this chapter, the perspectives of all parties involved with pesticides will be reviewed. Some of the parties do not have anything to do with legislation directly, but are still involved in the debate on pesticides. Two specific pesticides, glyphosate and neonicotinoids, will be used as examples to clarify the viewpoint of each party. First, it is important to determine the effects of pesticides on human, animal and environmental health, as studied by academic researchers. Next, we will consider pesticide producers, who profit from the sale of pesticides. These pesticide companies deliver their products to farmers and other individual consumers. Consumers then use the pesticides on their crops and plants to eliminate insects, fungi and weeds. However, there are also farmers who deliberately do not consume pesticides, from an ecological and environmental point of view. The perspective of these organic farmers is also considered in this chapter. Additionally, environmental non-governmental organizations (NGOs) play an important role in the whole debate on pesticides and therefore need to be considered. In line with their outlook on pesticides, these organizations campaign against their use. It is interesting to notice the difference in perspectives between environmental NGOs and pesticide producers. Lastly, we will consider the general public's view on pesticides, and pay attention to their concerns about possible exposure.

Pesticides contain chemicals that are supposed to be selectively toxic to specific insects, rodents, weeds or fungi. However, some of the chemicals used in pesticides can also have an impact on human health.[94] These harmful consequences include dermatological, neurological, reproductive, carcinogenic, and endocrine effects. According to the World Health Organization, three million people get poisoned by pesticides every year, resulting in 220,000 deaths.[95] Pesticide residues can be ingested by consuming foods that have been sprayed with pesticides, or by drinking polluted water. Exposure to the toxic chemicals in pesticides can also be established through inhalation or contact with skin. These last-mentioned routes can especially pose a risk to farm workers.[96] Apart from the farmers themselves, non-farmers living close to the agricultural lands could be exposed to pesticides used by the nearby farmers. The pesticides reach neighbours directly by drift of spray vapour. Moreover, soil or dust particles can contribute to the dispersion of pesticide elements. Neighbours can also be indirectly exposed through skin contact with surfaces contaminated with pesticides.[97] In the Netherlands, there is still a research gap concerning the degree of pesticide exposure to people

[94] Nicolopoulou-Stamati, P. (2016). Chemical pesticides and Human Health: The Urgent Need for a New Concept in Agriculture. *Frontiers in Public Health, 4*(148). doi: 10.3389/fpubh.2016.00148

[95] World Health Organization (1992). *Our Planet, Our Health: Report of the WHO Commission on Health and Environment.* Geneva, Switzerland. Retrieved from http://apps.who.int/iris/bitstream/10665/37933/1/9241561483.pdf/

[96] Alewu, B., Nosiri, C. (2011). Pesticides and Human Health. In Stoytcheva, M. (Ed.), *Pesticides in the Modern World – Effects of Pesticides Exposure*. Rijeka, Croatia: InTech. doi: 10.5772/18734.

[97] Lewis, K., Tzilivakis, J. (2017). Review of the published exposure data to pesticides for residents and bystanders, and for environmental risk assessment: Final Report. *EFSA Supporting Publications, 14*(5). doi: 10.2903/sp.efsa.2017.EN-1204;
Health Council of the Netherlands (2014). Crop protection and local residents. The Hague: Health Council of the Netherlands, publication no. 2014/02.

living nearby farms. Therefore, the National Institute of Public Health and the Environment is conducting research on this exposure and its potential effects on neighbours.[98]

When assessing pesticides or other potentially toxic chemicals, toxicologists make a distinction between 'hazard' and 'risk'. The hazard is the intrinsic characteristic of a chemical substance that could lead to health problems. 'Risk' is the likelihood of the hazard to cause harm at a certain exposure.[99] In other words: a pesticide may have intrinsic characteristics that make it to be toxic to humans or other animals, but because exposure to this pesticide is non-existent, the risk is estimated to be very low. This relation can also be depicted by the following equation: risk = hazard x exposure.[100]

In the glyphosate discussion, we can see the hazard versus risk debate in action.[101] Herbicides such as Monsanto's Roundup, which are the most widely used pesticides worldwide, contain glyphosate. There is a lot of commotion about the possible carcinogenic effects of this pesticide.[102] Scientists have found that glyphosate may have a stimulating effect on estrogen receptors in human breast tissue, and by this could induce breast cancer[103]. This study supports the argument that glyphosate may also be an endocrine disruptor. Additional studies also encountered hepatorenal, reproductive, cardiovascular and foetal damage.[104] The International Agency for Research on Cancer, part of the World Health Organization, conducted an assessment regarding the carcinogenicity of glyphosate. Based on this assessment they classified glyphosate as probably carcinogenic to humans (grade 2A).[105]

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[98] National Institute for Public Health and the Environment (n.d.). Research on exposure of residents to pesticides (OBO-project). Retrieved from http://www.bestrijdingsmiddelen-omwonenden.nl/en/

[99] Toxicology Education Foundation (2016, August 2). Hazard VS Risk. Retrieved from http://toxedfoundation.org/hazard-vs-risk/

[100] Toxicology Education Foundation (2016, August 2). Hazard VS Risk. Retrieved from http://toxedfoundation.org/hazard-vs-risk/

[101] Vandenberg, L. N. (2017). Is it time to reassess current safety standards for glyphosate-based pesticides? *Journal of Epidemiological Community Health, 71*(6), 613-618. doi: 10.1136/jech-2016-208463

[102] Neslen, A. (2016). EU Scientists in row over safety of Glyphosate weed killer. Retrieved from https://www.theguardian.com/environment/2016/jan/13/eu-scientists-in-row-over-safety-of-glyphosate-weedkiller/

[103] Thongprakaisang, S. (2013) Glyphosate induces human breast cancer cells growth via estrogen receptors. *Food and Chemical Toxicology*, *59*, 129-136. doi: 10.1016/j.fct.2013.05.057

[104] Mesnage, R. (2015). Potential toxic effects of glyphosate and its commercial formulations below regulatory limits. *Food and Chemical Toxicology, 84*, 133-153.;
Vandenberg, L. N. (2017). Is it time to reassess current safety standards for glyphosate-based pesticides? *Journal of Epidemiological Community Health, 71*(6), 613-618. doi: 10.1136/jech-2016-208463.;
Romano, M. A. (2012). Glyphosate impairs male offspring reproductive development by disrupting gonadotropin expression. *Archives of Toxicology, 86*, 663-673. doi: 10.1007/s00204-011-0788-9.;
Gress, S. (2015). Glyphosate-Based Herbicides Potently Affect Cardiovascular System in Mammals: Review of the Literature. *Cardiovascular Toxicology, 15*(2), 117-126. doi: 10.1007/s12012-014-9282-y

[105] Tarazona, J. V. (2017). Glyphosate toxicity and carcinogenicity: a review of the scientific basis of the European Union assessment and its differences with IARC. *Archives of Toxicology,* 1-21. doi: 10.1007/s00204-017-1962-5.

As a reaction to these conclusions, the European Food Safety Authority carried out its own risk assessment. In contrast to the World Health Organization, the European Food Safety Authority stated that "glyphosate is unlikely to pose a carcinogenic hazard to humans and the evidence does not support classification to its carcinogenic potential".[106] In line with this, the European Chemicals Agency, part of the European Union, came with an assessment in the beginning of 2017, in which glyphosate was also not classified as carcinogenic.[107] Another party, The Joint Meeting on Pesticide Residues, said in their 2016 report on pesticide residues in food that even though the carcinogenic potential of glyphosate cannot be excluded, it is unlikely to pose a risk from exposure through diet.[108]
Besides the potential risks for human health, we must also consider the ecological effects of glyphosate. Because of its high solubility in water, glyphosate can easily end up and persist in the aquatic environment. Organisms living in the water, such as algae, microorganisms, amphibians and fish, are hereby exposed to the pesticide. If aquatic concentrations are high enough, glyphosate poses a threat to these water organisms.[109] Because some organisms are more sensitive to glyphosate exposure than others, the variety of species in the environment is reduced.[110] According to Relyea (2005), Roundup caused a decrease in species richness by 22%.[111] So, biodiversity will decline. Furthermore, glyphosate does not have specific toxicity to certain weed species, but also kills non-target plants.[112] These plants are part of the ecosystem, and killing them will lead to attenuation of the landscape and a decrease in biodiversity, according to toxicologist Martin van den Berg.[113] Another aspect that should be taken into account is that some genetically modified crops have been made to be resistant to

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International Agency for Research on Cancer (2015, March 20). IARC Monographs Volume 112: evaluation of five organophosphate insecticides and herbicides. Retrieved from http://www.iarc.fr/en/media-centre/iarcnews/pdf/MonographVolume112.pdf/

[106] European Food Safety Authority (2015). Conclusion on the peer review of the pesticide risk assessment of the active substance glyphosate. *EFSA Journal, 13*(11), 4302-4409. doi: 10.2903/j.efsa.2015.4302

[107] European Chemicals Agency (2015, March 15). Glyphosate not classified as a carcinogen by ECHA. Retrieved from https://echa.europa.eu/-/glyphosate-not-classified-as-a-carcinogen-by-echa/

[108] Joint FAO/WHO Meeting on Pesticide Residues. (2016). *Pesticide Residues in Food 2016*. Geneva, Switzerland. Retrieved from http://www.fao.org/3/a-i5693e.pdf/

[109] Bai, S. H. (2016). Glyphosate: environmental contamination, toxicity and potential risks to human health via food contamination. *Environmental and Pollution Research, 23*(19), 18988-19001. doi: 10.1007/s11356-016-7425-3

[110] Tsui, M. T. K. (2003). Aquatic toxicity of glyphosate-based formulations: comparison between different organisms and the effects of environmental factors. *Chemosphere, 52*(7), 1189-1197. Doi 10.1016/S0045-6535(03)00306-0

[111] Relyea, R. A. (2005). The impact of insecticides and herbicides on the biodiversity and productivity of aquatic communities. *Ecological Applications, 15*(2), 618-627. Doi 10.1890/03-5342

[112] Bai, S. H. (2016). Glyphosate: environmental contamination, toxicity and potential risks to human health via food contamination. *Environmental and Pollution Research, 23*(19), 18988-19001. doi: 10.1007/s11356-016-7425-3

[113] Van Den Berg, M. (2017, June 9). Personal interview.

glyphosate herbicides.[114] This herbicide-resistance will result in crop monocultures, because it is easier to eliminate the weeds from the farm land. Herbicide-resistance therefore also contributes to loss of biodiversity.[115]
Another topic of controversy are the neonicotinoid pesticides, now the most widely used insecticides in the world. Their neurotoxicity can lead to the death of individual honey bees, who can be exposed through pollen and nectar of the sprayed plants[116]. Furthermore, studies show that especially neonicotinoids can have detrimental impacts on bee behaviour, because of its effects on their brain. Homing, feeding and flight behavior turn out to be impaired. Moreover, scientists have seen that, at field concentrations, the immune system and response of bees are compromised.[117] Weakening of the immune system could lead to a higher susceptibility to various diseases, such as an infection with the Varroa mite.[118] Field research reveals that neonicotinoids lead to a decrease in bee colony growth and reproduction, and as a result reduce wild bee density.[119] Especially harmful are the negative consequences for the reproductive system of the honey bee queens.[120] After all, the survival of queen bees is of the greatest importance to the overall survival of the bee colony. Without the pollinating function of bees, thriving of healthy ecosystems is compromised; bees are essential for biodiversity.[121] Besides their harmful effects on bees, neonicotinoids can have a negative influence on the environment, because of their persistence in water and soils.[122] This way, all organisms living in this environment, not only the bees, are exposed to the pesticide residues via the food chain. This exposure can lead to negative effects on the reproduction of vertebrates, or even directly result in their death.[123]

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[114] Schütte, G. (2017). Herbicide resistance and biodiversity: agronomic and environmental aspects of genetically modified herbicide-resistant plants. *Environmental Sciences Europe, 29*(5). doi: 10.1186/s12302-016-0100-y

[115] Schütte, G. (2017). Herbicide resistance and biodiversity: agronomic and environmental aspects of genetically modified herbicide-resistant plants. *Environmental Sciences Europe, 29*(5). doi: 10.1186/s12302-016-0100-y

[116] Fairbrother, A. (2014). Risks of neonicotinoid insecticides to honeybees. *Environmental Toxicology and Chemistry, 33*(4), 719-731. doi: 10.1002/etc.2527

[117] Brandt, A. (2016). The neonicotinoids thiacloprid, imidacloprid, and clothianidin affect immunocompetence of honey bees. *Journal of Insect Physiology, 86*, 40-47. doi: 10.1016/j.jinsphys.2016.01.001

[118] Fairbrother, A. (2014). Risks of neonicotinoid insecticides to honeybees. *Environmental Toxicology and Chemistry, 33*(4), 719-731. doi: 10.1002/etc.2527

[119] Rundlöf, M. (2015). Seed coating with a neonicotinoid insecticide negatively affects wild bees. *Nature, 521*, 77-80. doi: 10.1038/nature14420

[120] Williams, G. R. (2015). Neonicotinoid pesticides severely affect honey bee queens. *Nature, International Journal of Scientific Reports, 13*(5), 14621. doi: 10.1038/srep14621

[121] Williams, G. R. (2015). Neonicotinoid pesticides severely affect honey bee queens. *Nature, International Journal of Scientific Reports, 13*(5), 14621. doi: 10.1038/srep14621

[122] Goulson, D. (2013). An overview of the environmental risks posed by neonicotinoid insecticides. *Journal of Applied Ecology, 50*(4), 977-987. doi: 10.1111/1365-2664.12111

[123] Goulson, D. (2013). An overview of the environmental risks posed by neonicotinoid insecticides. *Journal of Applied Ecology, 50*(4), 977-987. doi: 10.1111/1365-2664.12111

Pesticide producers are represented by several organizations who promote their interests on different levels. Of course, these interests are of an economic nature. The producers develop pesticides for the market and benefit from the sales of their products. Nefyto, the Dutch Crop Protection Association, emphasizes the importance of the use of pesticides.[124] They argue pesticides are needed because their use has led to less crop failure. As a result, there has been an increase in security of food supply. Because of pesticides, farmers can produce a higher yield of better quality, and food can be sold as cheap as it is today, according to producers. Pesticides are necessary to cater to the increasing global demand for food. Before their products can be brought to the European market, companies must submit an application to the European Food Safety Authority – as already mentioned before.

Nefyto regrets the fact that certain pesticides are prohibited based on the Precautionary Principle that is used by the European Food Safety Authority. The European Food Safety Authority uses certain 'hazard based cut-off criteria'. This means that even though the exposure to the pesticide is virtually non-existent, the pesticide will still be disapproved because of the presence of certain hazards. This way, these rejected pesticides cannot contribute to the production of safe and cheap food, even when they don't influence public or environmental health in practice. Nefyto is opposed to the use of these hazard based-cut off criteria.[125] This point of view also came forward from our interview with Jo Ottenheim, secretary and spokesman at Nefyto.[126] He would rather see the European Food Safety Authority evaluating the risks in practice, instead of only looking at the intrinsic hazards of the pesticide.

Besides, Nefyto argues that the assessment of the European Food Safety Authority is too costly, long and complex.[127] With regards to neonicotinoids and their harmful effects on bees, Nefyto director Maritza van Assen states that "a possible ban on these pesticides is an overreaction".[128] She argues that the study the European Food Safety Authority has conducted contains insufficient data to support such a ban. Syngenta, a major pesticide producing company, supports this claim by stating that "the European Food Safety Authority found itself under political pressure to produce a hurried and inadequate risk assessment, which contains a high level of uncertainty".[129] The Dutch Crop Protection Association is sceptical about the

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[124] Nefyto. (2015, May). Belang van gewasbescherming. Retrieved from http://www.nefyto.nl/Nefyto/media/Nefyto/Themas/Nefyto-position-paper-Het-belang-van-gewasbescherming-mei-2015.pdf/

[125] Nefyto. (2017, May). Beginselen beoordelingsregelgeving gewasbeschermingsmiddelen. Retrieved from http://nefyto.nl/Nefyto/media/Nefyto/Themas/Nefyto-Position-Paper-Beginselen-beoordelingsregelgeving-gewasbeschermingsmiddelen-mei-2017.pdf/

[126] Ottenheim, J. (2017, June 9). Personal interview.

[127] Nefyto. (2017, May). Beginselen beoordelingsregelgeving gewasbeschermingsmiddelen. Retrieved from http://nefyto.nl/Nefyto/media/Nefyto/Themas/Nefyto-Position-Paper-Beginselen-beoordelingsregelgeving-gewasbeschermingsmiddelen-mei-2017.pdf/

[128] Wildenbeest, G. (2013, March 22). 'Mogelijk verbod op neonicotinoïden is overreactie.' *Bloembollen Visie*. Retrieved from http://nefyto.nl/Nefyto/media/Nefyto/Documenten/Nefyto%20in%20de%20media/Interview-Van-Assen-in-Bloembollenvisie-20130327.pdf/

[129] Syngenta (2015). Neonicotinoid seed treatment technology in Europe. Retrieved from http://www3.syngenta.com/eame/plightofthebees/en/blog/Pages/neonicotinoid-seed-treatment-technology-in-europe.aspx/

assumed influence of pesticides on bee mortality. They bring forward other reasons for bees dying in winter, such as an infection with the Varroa mite.[130]

Farmers use pesticides to protect their crops against all sorts of pests: insects, rodents, weeds and fungi. By doing this, they make sure they can deliver a constant supply of good quality products. Often, wholesale businesses and other consumers of a farmer's products require that certain pesticides have been used to insure the safety and quality of the product. Thus, farmers are reliant on pesticides to take care of their income. Pesticides resulted in more efficient agriculture that is less labour-intensive, which improves productivity.[131] Another benefit is the use of pesticides against plant lice in seed potatoes.[132] Seed potatoes are important export products for the Netherlands, and form a large source of income for our country. In 2014, more than half a billion euros worth of seed potatoes were exported. [133] So, pesticides also contribute to the economic interests of the Netherlands.
Regarding the controversy around glyphosate and its potential carcinogenic effects, the Dutch Agriculture and Horticulture Organization (LTO), has the following point of view. They argue that a ban on glyphosate would be a mistake, because this pesticide is of great importance to the Dutch agricultural and horticultural farmers. A prohibition of glyphosate would force farmers to use other pesticides, which have a bigger negative impact on the environment.[134] The Dutch Agriculture and Horticulture Organization is also worried about the growing influence politicians have on the admission of pesticides by the European Food Safety Authority and the Board for the Authorisation of Plan Protection Products and Biocides.[135] They would rather see that politics and what they call the 'independent institutes' stay as separate as possible. Regarding this point of view, they are supported by the CDA. This political party states authorization should be an independent procedure that is not based on emotions. The CDA represents the stance of the farmers in this matter.[136]
In the discussion about neonicotinoids and their negative impacts on bees, the Dutch Agriculture and Horticulture Organization emphasizes the importance of neonicotinoids for

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[130] Nefyto. (2016, June). Het gaat goed met de bijen: invloed van gewasbeschermingsmiddelen vaak overschat en niet van betekenis. Retrieved from http://www.nefyto.nl/getmedia/1b048ce7-4213-4725-bd8f-3ceea80d3d18/Bijenflyer.aspx/

[131] Aktar, W. (2009). Impact of pesticides use in agriculture: their benefits and hazards. *Interdisciplinary Toxicology, 2*(1), 1-12. doi: 10.2478/v10102-009-0001-7.; Damalas, C.A. (2009). Understanding benefits and risks of pesticide use. *Scientific Research and Essay, 4*(10), 945-949. Retrieved from http://www.academicjournals.org/article/article1380540217_Damalas.pdf/

[132] Ottenheim, J. (2017, June 9). Personal Interview.

[133] Centraal Bureau voor de Statistiek (2016, April 11). Pootaardappelen winnen terrein. Retrieved from https://www.cbs.nl/nl-nl/nieuws/2016/15/pootaardappelen-winnen-terrein/

[134] Baecke, J. (2016). Verbod op glyfosaat levert geen milieuwinst op. Retrieved from http://lto.nl/media/default.aspx/emma/org/10869198/Verbod+op+glyfosaat+levert+geen+milieuwinst+op.pdf/

[135] Land- en Tuinbouw Organisatie Nederland (2016). LTO bezorgd over politieke invloed toelating gewasbeschermingsmiddelen. http://lto.nl/zoeken/10869239/LTO-bezorgd-over-politieke-invloed-toelating-gewasbeschermingsmiddelen/

[136] Agridirect. (n.d.). Jaco Geurts van het Christen-Democratisch Appèl (CDA) reageert. Retrieved from https://www.agridirect.nl/cda/

crop protection, and they take a stand against a possible ban. Furthermore, they bring forward the argument that by using neonicotinoids the need for additional pesticide use is reduced.[137] On the other hand, not all farmers are in favour of the pesticide use. Organic farmers in the Netherlands are united in the organization Biohuis.[138] They deliberately do not use chemical pesticides, because according to the organic farmers, they have negative impacts on the environment, nature and landscape. Crop protection is achieved using natural enemies of pests, more resistant crops, and mechanical weed control.[139]
However, pesticides are not only used on a large scale: civilians are also able to buy and use certain pesticides for their own garden. So, both farm workers and civilians are exposed to the potential health risks of pesticides.

Non-governmental organizations such as Greenpeace are concerned about the negative effects of pesticides on humans, animals and the environment. Rather than suggesting the current Acceptable Daily Intakes for individual pesticides are incorrect, Greenpeace mainly argues the now poorly investigated effects of the mixture of pesticides we ingest everyday can pose a threat to human health. These 'cocktail effects' also cause the most damage to ecosystems. According to Greenpeace (2015): "In agricultural areas in which pesticides are used, these substances drift in the air, pollute the soil and waterways, and are sometimes absorbed by non-target plant species. In cities, spraying of recreational areas also exposes people nearby to a mixture of chemicals. Everyday use of various household pest control substances can also contaminate homes and gardens."[140] Greenpeace argues for stricter regulation of pesticides in farming, with the intention to eventually eliminate pesticide use altogether.[141] By publishing reports about health risks and setting up campaigns they try to convince policy makers to improve the legislation regarding pesticides.[142] Greenpeace is an advocate for sustainable organic farming without the need for pesticide use.[143] The NGO fights for the safety of bees

[137] EFSA-rapport (2013). Nefyto, Plantum en LTO pleiten voor een uniforme Europese aanpak in het belang van de bij. http://lto.nl/media/default.aspx/emma/org/10822896/statement%2b%2bnav%2brondetafelconferentie%2bzaaizaad%2ben%2bneonicotinoiden%2b20130123.pdf/

[138] Biohuis (n.d.) Retrieved from http://www.biohuis.org/

[139] AgriHolland (2016). Dossier Biologische Landbouw. Retrieved from https://www.agriholland.nl/dossiers/bioland/#wat/

[140] Allsop, M., Huxdorff, C., Johnston, P. et al., Greenpeace Research Laboratories (2015). Pesticides and our Health: a growing concern. http://www.greenpeace.org/international/Global/international/publications/agriculture/2015/Pesticides-and-our-Health.pdf/

[141] Allsop, M., Huxdorff, C., Johnston, P. et al., Greenpeace Research Laboratories (2015). Pesticides and our Health: a growing concern. http://www.greenpeace.org/international/Global/international/publications/agriculture/2015/Pesticides-and-our-Health.pdf/

[142] Buurma, J. S. (2012). Transition to consumer-driven value chains in The Netherlands. *Acta Horticulturae, 930*, 69-76.

[143] Allsop, M., Huxdorff, C., Johnston, P. et al., Greenpeace Research Laboratories (2015). Pesticides and our Health: a growing concern.

and the environment, and is therefore strongly opposed to neonicotinoids.[144] They do not doubt the relation between the use of this pesticide and bee mortality during winter, in contrast to Nefyto. Greenpeace is convinced of the negative impacts of neonicotinoids on bees and the (aquatic) environment. [145]
Concerning the other mentioned pesticide, glyphosate, environmental and health organizations across Europe have joined forces and started a petition to ban glyphosate.[146] These organizations include Greenpeace, the Health and Environment Alliance, and the Pesticide Action Network Europe. By collecting signatures, they want to convince the European Commission to propose a ban on glyphosate, but also to set reduction targets for overall pesticide use. The joint NGOs base their campaign on the conclusion from the International Agency for Research on Cancer, which classifies glyphosate as carcinogenic. They see this classification as reason to withdraw the European approval for glyphosate.[147] In line with supporting the report of the International Agency for Research on Cancer, NGOs are very critical of the reports of the European Food Safety Authority and the European Chemicals Agency. In an open letter, they question the independency of the European Chemical Agency, implying that the agency shares interests with the pesticide industry.[148] Besides, they state that the European Chemical Agency uses unpublished scientific evidence provided by the industry to support their claims. All in all, it is clear these NGOs do not agree with the conclusions that dismiss glyphosate as carcinogenic to humans.[149]

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http://www.greenpeace.org/international/Global/international/publications/agriculture/2015/Pesticides-and-our-Health.pdf/

[143] Allsop, M., Huxdorff, C., Johnston, P. et al., Greenpeace Research Laboratories (2015). Pesticides and our Health: a growing concern. http://www.greenpeace.org/international/Global/international/publications/agriculture/2015/Pesticides-and-our-Health.pdf/

[144] Wood, T., Goulson, D., Greenpeace (2017). The Environmental Risks of Neonicotinoid Pesticides: a review of the evidence post-2013. Retrieved from http://www.greenpeace.org/international/Global/international/publications/agriculture/2017/neonicotinoid-pesticides.pdf/

[145] Wood, T., Goulson, D., Greenpeace (2017). The Environmental Risks of Neonicotinoid Pesticides: a review of the evidence post-2013. Retrieved from http://www.greenpeace.org/international/Global/international/publications/agriculture/2017/neonicotinoid-pesticides.pdf/

[146] Health and Environment Alliance (2017, February 8.) Environmental and health organizations launch European citizens' initiative to ban glyphosate. Retrieved from http://www.env-health.org/resources/press-releases/article/environmental-and-health/

[147] Greenpeace (2017, February 8). Stop Glyphosate: Ban Glyphosate and protect people and the environment from toxic pesticides. Retrieved from https://act.greenpeace.org/page/5212/petition/1/

[148] Riss, J., Director, Greenpeace European Unit. (2017, March 6). Open letter on the independence and transparency of ECHA's Risk Assessment Committee. Retrieved from http://www.greenpeace.org/eu-unit/Global/eu-unit/reports-briefings/2017/20170306_Open_Letter_ECHA_CoI_Concerns.pdf/

[149] Greenpeace (2017, March 15). *EU Chemicals Agency sweeps glyphosate cancer evidence under the carpet* [Press release]. Retrieved from http://www.greenpeace.org/eu-unit/en/News/2017/EU-chemicals-agency-sweeps-glyphosate-cancer-evidence-under-the-carpet/

According to a research conducted by the Netherlands Nutrition Centre, the health risks of pesticides are unjustly overestimated by the public.[150] In comparison to food scientists, consumers assess the risk of pesticide residues on fruit and vegetables more highly. Consumers assign a risk score of 2,92 out of 5, while scientists give a score of 1,9 out of 5. This underlines the growing concern of the public about pesticides, which has been seen since the 1960s.[151] This concern especially increased since the publishing of Rachel Carson's *Silent Spring* in 1962.[152] This book is one of the first ones to mention the damaging impacts of DDT and other pesticides on human and environmental health, resulting in pesticides being a subject of debate.[153] According to Khondker (2015), *Silent Spring* has played an important role in raising awareness about the environmental effects of pesticides.[154] That the concern about pesticides is still present, becomes clear from a report of the Dutch Consumers Association. It turns out that 70,5 percent of the people considers the use of prohibited pesticides to be a very large problem.[155] Besides, according to a 2016 poll, the petition of European NGOs to ban glyphosate is supported by two-thirds of Europeans.[156] The resistance against pesticide use could partly be caused by (negative) news reports.[157] Extensive media coverage of an event, for example the debate about glyphosate, can contribute to a heightened risk perception.[158] Another element that could contribute to the concern of civilians is the fact that the benefits of pesticides often go unnoticed by the general public, like the increase of agricultural productivity.[159]

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[150] Peters, S., Breedveld, B., Wieringa, D. (2009). Onderzoek naar perceptie van de consument: Verkeerde inschatting van voedselrisico's. *Voeding Nu*, *10*, 12-14.

[151] Sachs, C. E. (1993). Growing Public Concern Over Pesticides in Food and Water. In D. Pimentel, *The Pesticide Question* (380-389). doi: 10.1007/978-0-585-36973-0_15.

[152] Sachs, C. E. (1993). Growing Public Concern Over Pesticides in Food and Water. In D. Pimentel, *The Pesticide Question* (380-389). doi: 10.1007/978-0-585-36973-0_15.

[153] Sachs, C. E. (1993). Growing Public Concern Over Pesticides in Food and Water. In D. Pimentel, *The Pesticide Question* (380-389). doi: 10.1007/978-0-585-36973-0_15.

[154] Khondker, H.H. (2015). From 'the silent spring' to the globalization of the environmental movement. *Journal of International and Global Studies*, *6*(2), 25-37. Retrieved from http://web.b.ebscohost.com/ehost/pdfviewer/pdfviewer?sid=a4b19d09-8844-4302-9c2a-fa3dcc76ae20%40sessionmgr103&vid=1&hid=116/

[155] Polderman, N., Cammelbeeck, T., Uitslag, H. et al. Consumentenbond (2016). Voedselfraude & Voedselintegriteit. Voedselfraude: de mening van consumenten en de opsporing van authenticiteitsafwijkingen. Retrieved from: https://www.consumentenbond.nl/binaries/content/assets/cbhippowebsite/actie-voeren/voedselfraude/onderzoeksrapport-voedselfraude-nl.pdf/

[156] Nelsen. A. (2016, April 11). Two-thirds of Europeans support ban on glyphosate, says Yougov poll. Retrieved from https://www.theguardian.com/environment/2016/apr/11/two-thirds-of-europeans-support-ban-on-glyphosate-says-yougov-poll/

[157] Huang, Y. M. S. (2016). Low-Income Shoppers and Fruit and Vegetables: What do they think? *Nutrition Today*, *51*(5), 242-250. doi: 10.1097/NT.0000000000000176

[158] McCluskey, J. (2011). The media and food-risk perception. *EMBO reports*, *12*(7), 624-629. doi: 10.1038/embor.2011.118

[159] Damalas, C. A. (2011). Pesticide Exposure, Safety Issues, and Risk Assessment Indicators. *International Journal of Environmental Research and Public Health*, *8*(5), 1402-1419. doi: 10.3390/ijerph8051402

Chapter 3: How do the different parties influence legislation?

It is evident from the way in which pesticide policies are made, implemented and enforced that some perspectives, and some parties, can play a larger role than others in specific dealings with pesticides. Over the years, the legislation regarding pesticides has developed towards 'stricter' regulations, and there are more requirements before a pesticide can enter the market.[160] This means there has been a shift in the perspectives that are deemed more valuable by European Union, the Dutch government or the public. As mentioned in the previous chapter, each of the parties involved will try to influence the process of policy making and enforcement to ensure these policies comply to their perspectives as much as possible. These parties each have their own ways of doing so. The interesting thing about dealings with pesticides is the way science is used by each party. Scientific evidence, interpretation and uncertainty often form the basis of a decision, and are therefore a way of influencing legislation. To demonstrate this, at the end of this chapter we will discuss in which way different parties contributed to the establishment of a two-year ban on neonicotinoid pesticides in 2013.

First, we will discuss the way the EU regulations are argued to have become 'stricter'. For this, we will consider the concept that over time has been given a more prominent role in pesticide dealings: The Precautionary Principle. A great part of the European legislation regarding pesticides and other crop protection agents is based on this principle. Theoretically, a pesticide is not allowed on the market until it is tested and the decided requirements are met. In practice, however, the Precautionary Principle is not always applied. This has everything to do with the way science is treated in dealings with pesticides. It is argued that the Precautionary Principle is only applied when considered convenient.[161] From our interview with toxicologist Martin van den Berg, it became clear that "there is a tendency to search for mistakes in a study that points in a direction where the Precautionary Principle should be applied". This is especially the case for studies suggesting an often-used pesticide should be taken off the market due to potentially harmful effects, since these results require political intervention. On the contrary, a study that shows no significant results - indicating there is no problem with the assessed pesticide - is usually evaluated less critically.
The pesticide industry is also sceptical about the Precautionary Principle. According to The Council of Agricultural Science and Technology, it is "bias[ed] against new technologies".[162] If the Precautionary Principle is only used for the entry of pesticides on the market, meaning only new pesticides would be held to the Precautionary Principle - while pesticides already on the market are accepted -, this would indeed indicate a bias. However, it could also be argued the Precautionary Principle is biased for old technologies, preventing old technologies to be improved.

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[160] European Union. (2017, June 12). Regulation, Directives and other acts. Retrieved from https://europa.eu/european-union/eu-law/legal-acts_en/

[161] Van Den Berg, M. (2017, June 9). Personal interview.

[162] McGrath, P. F. (2014). Politics meets Science: The case of neonicotinoid insecticides in Europe. *Sapiens (online)*, 7(1).;
Council for Agricultural Science and Technology (CAST). (2013). Impact of the Precautionary Principle on Feeding Current and Future Generations. *CAST Issue Paper*, *52*, 1-20.

It should be noted that, in this debate, environmental NGOs often use the Precautionary Principle to urge the public and government to take measures against pesticides. Therefore, it is not surprising industries consider the Precautionary Principle inconvenient when used against them.[163]

Apart from being critical of the Precautionary Principle, the industry and academic scientists are sceptical about the use of 'cut-off values' in risk assessments. According to the industry, cut-off values disregard the 'exposure' component in a risk assessment. The argument they bring forward is that, even though a substance is intrinsically toxic, the risk can still be small due to exposure being very little.[164] The academic community also criticizes these cut-off values, but stresses they should be improved, rather than abolishing them, as the industry would like to see. They suggest improvement can be achieved by performing ecological relevant experiments and standardizing test species.[165] However, the cut-off values still prevail, as they have been used for a long time.

In the European Union, institutions that are responsible for providing independent scientific expertise to the decision-making bodies, such as the European Food Safety Authority, may not be as independent as intended.[166] Filling in the Transparent model, the EU agencies are responsible for risk assessment and can only offer expertise and advice to the EU Commission and Parliament. The Commission and Parliament are then responsible for risk evaluation and management through policy. The risk assessment policy is influenced by the different parties we have mentioned before, since the data assessed can be provided by the producers, NGOs and academics. This indirectly involves these parties in the decision-making process. It should also be noted that to survive in the political environment, an agency such as the European Food Safety Authority needs to gain status, trust and credibility. In difficult pesticide cases with a lot of scientific uncertainty, an agency such as the European Food Safety Authority is under a lot of pressure from lobbying companies and NGOs. Therefore, they may resort to 'strategic substantiating'. This is defined as using "expertise strategically to advance their individual or organizational interests, or those of the most influential actors".[167] Thus, scientific evidence is used and data is analysed, but conclusions are presented in such a way the needs of the most influential parties - which the agency requires to survive - are met.

The European process of decision making can be illustrated by the neonicotinoid case that resulted in a two-year ban on neonicotinoid pesticides in 2013, but remains controversial.

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[163] McGrath, P. F. (2014). Politics meets Science: The case of neonicotinoid insecticides in Europe. *Sapiens (online)*, 7(1).;
Council for Agricultural Science and Technology (CAST). (2013). Impact of the Precautionary Principle on Feeding Current and Future Generations. *CAST Issue Paper*, *52*, 1-20.

[164] Ottenheim, J. (2017, June 9). Personal interview.

[165] Hunka, A. D. et al. (2014). Ecological risk assessment of pesticides in the EU: what factors and groups influence policy changes? *Journal of Risk Research*, 18(9), 1165-1183.

[166] Rimkutė, D. (2015). Explaining Differences in Scientific Expertise Use: The Politics of Pesticides. *Politics and Governance*, 3(1), 114-127. doi:10.17645/pag.v3i1.82

[167] Rimkutė, D. (2015). Explaining Differences in Scientific Expertise Use: The Politics of Pesticides. *Politics and Governance*, 3(1), 114-127. doi:10.17645/pag.v3i1.82

This case is also relevant for the Netherlands as the allowance of pesticides in the Netherlands follows the policies made by the EU, and the Board for the Authorization of Plant Protection Products only makes additional norms. In this case, the European Food Safety Authority, by order of the European Commission, conducted a risk assessment on the ecological damage of neonicotinoids. The assessment particularly focused on the effects on bees, since the percentage of bees surviving the winter had decreased. The European Food Safety Authority reviewed over 30 scientific papers, some of them supplied by the industry and some of them originating from individual European Union member states. Based on these papers, the Authority proposed to restrict the use of neonicotinoids. The European Parliament voted on this proposal, but reached no consensus. In the six-week interim period to the second voting round (in which in the end no consensus was reached either), public interest and media coverage of the issue peaked, and campaigns and lobbying by industry and NGOs were at its strongest. At the same time, the European Food Safety Authority was flooded with papers from academia, industry and NGOs, which supported or refuted the proposed ban. All in all, the European Food Safety Authority and European Commission had to operate in a high-pressure environment. [168]

It is worthwhile to consider which countries changed their voting behaviour in the European Parliament in the second round, and to analyse what caused this change. In the first voting round, out of the 27 EU member states, 13 voted in favour of the ban (including France, Netherlands and Italy), 9 opposed the ban (including Czech and Hungary) and 5 abstained (including Germany and the UK). Since the votes of the different members are weighed by the population, there was no overall majority vote, even though most countries voted in favour of the ban. In the interim period, Italy, originally in favour of the ban, changed to voting against it. Italy already had laws in place preventing the use of neonicotinoids, and was therefore expected to support the ban. However, during the interim period, the agricultural community strongly advocated against the ban. They were afraid that without these pesticides, they would get pushed out of the market by other countries that do allow neonicotinoids. In Italy, farmers apparently have a lot of problems with insects harming their crops, and neonicotinoids are highly effective insecticides. Ireland, on the other hand, originally opposed the ban, but because of the great media attention they were unable to keep this position and then choose to abstain from voting. Furthermore, the lobbying of the industry behind the scenes is thought to have had great effect in some countries, especially in the UK, who switched from abstaining to voting against the ban.

After the interim period, 15 countries voted in favour, 8 against and 4 abstained. Considering population markers, this still was not a majority. If the UK had abstained in the second round as well, or if Italy had remained in favour of the ban, a majority would have been achieved in favour of the ban. This indicates the lobbying of different parties has affected the outcome of the second vote significantly. After the second undecided vote, the

[168] McGrath, P. F. (2014). Politics meets Science: The case of neonicotinoid insecticides in Europe. *Sapiens (online)*, *7*(1).;
Hunka, A. D. et al. (2014). Ecological risk assessment of pesticides in the EU: What factors and groups influence policy changes? Journal of Risk Research, *18*(9), 1165-1183.

European Committee exercised their right and imposed the ban, based on the scientific foundations of the European Food Safety Authority, and the Precautionary Principle.[169]

Nevertheless, a question raised by this case is whether the decision to go through with the ban was truly based on science, or on the Precautionary Principle. To what extend have the European Committee or the European Food Safety Authority been influenced by lobbying or public campaigns? As mentioned before, in a high-pressure environment, a scientific-expertise agency such as the European Food Safety Authority may resort to 'scientific substantiating'. To support this claim, we would need to identify the 'most influential party' that the European Food Safety Authority would have needed for its survival. It is reasonable to believe that it is important for a scientific agency to prove to the public they are credible and independent. It is also clear that the NGO campaigns were particularly successful, and caused a lot of public emotion. Internet activist site Avaaz.com gathered over 2.6 million signatures opposing the use of neonicotinoids in an online petition called 'Save the bees from extinction', which proves this success.[170] Furthermore, the image of pesticide businesses and industries has not been very good, and they are often attacked claiming they would do everything for money. By not providing supporting evidence for the ban, the European Food Safety Authority and the European Commission would be accused they gave in to the lobbying tactics of businesses, calling their independence and credibility into question.[171] Therefore, it is possible to accuse the European Food Safety Authority of scientific substantiating, and to argue that in this case the public emotion, stimulated by NGO campaigns, weighed heavier than business lobby in terms of influence on policy.

Apart from this, it is also curious that after the two-year ban, the neonicotinoid pesticides simply entered the market again. Only one neonicotinoid product, Potatoprid, is no longer allowed in the Netherlands since 2014. Even though the NGOs and media had managed to rile up the public, who became concerned and signed petitions to make this ban happen, there was little to no uproar and media coverage when the ban was over in 2015. The neonicotinoids that were banned, are still the most widely used insecticides in agriculture today. NGOs such as Greenpeace continue to protest their use.

In short, the European Commission imposed a two-year ban, with a lot of media coverage and under a lot of public pressure. However, when the period of the ban was over, the pesticides silently entered the market again. Still, there is a lot of scientific uncertainty and debate about these substances. This shows it was not the use of the Precautionary Principle that led to the ban to be imposed, but that other motives, such as satisfying the public, played a part.

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[169] McGrath, P. F. (2014). *Politics meets Science: The case of neonicotinoid insecticides in Europe*. *Sapiens (online), 7*(1).; Hunka, A. D. et al. (2014). Ecological risk assessment of pesticides in the EU: What factors and groups influence policy changes? *Journal of Risk Research, 18*(9), 1165-1183.

[170] McGrath, P. F. (2014). Politics meets Science: The case of neonicotinoid insecticides in Europe. *Sapiens (online)*, 7(1).; Hunka, A. D. et al. (2014). Ecological risk assessment of pesticides in the EU: What factors and groups influence policy changes? *Journal of Risk Research*, *18*(9), 1165-1183.; Avaaz.org. (n.d.). Avaaz.org, 8 Saving Bees from killer pesticides. Retrieved from https://secure.avaaz.org/page/en/highlights/

[171] Rimkutė, D. (2015). Explaining Differences in Scientific Expertise Use: The Politics of Pesticides. *Politics and Governance*, *3*(1), 114-127. doi: 10.17645/pag.v3i1.82

The neonicotinoid case also shows the similarities and differences in ways of influencing legislation between environmental NGOs and pesticide industries. In this case, the industry has mainly employed lobby techniques and worked behind the scenes. Their main arguments have been, and still are, that the decreasing number of bees surviving the winter cannot be due to the pesticides, but is caused by a combination of factors, such as the Varroa mite that specifically attacks honey bees and lack of biodiversity causing the bees to have a very one sided diet.[172] They use scientific data to prove the safety of their products. Their websites, such as those of Bayer and Monsanto, focus on green and sustainable use of pesticides, which is in line with the current (ongoing) trends. They have also tried to share their perspective using media.

The NGOs have employed many similar techniques, and undoubtedly had some lobby going on as well, but their focus has always been on the public. NGOs such as Avaaz.com and Greenpeace have formed alliances with beekeepers and other groups and organized campaigns and protests, such as the march on Downing Street, home to the British Prime Minister. Their campaigns have made good use of the importance of the bee as pollinator and roused the concern of the public effectively. It should also be mentioned again that Avaaz.com called their petition 'Save the bees from extinction'[173], and by doing so, according to some, exaggerated the problem. NGOs are always accused of appealing to emotion, rather than reason of the public, and of oversimplifying complex problems. In the same way, industries have been accused of creating uncertainty and complexity to appeal to the people's unwillingness to change or to act.

The difficulty in dealings with pesticides is that these cases are always characterized by scientific uncertainty, and it could be argued that in some cases this uncertainty is artificial, deliberately created. In their book *Merchants of Doubt,* historians of science Oreskes and Conway elaborate on this and explain how scientists created a lack of scientific consensus on important topics, such as the harm done by using the pesticide DDT. In hindsight, we now know DDT was truly harmful. While the pesticide industry at that time (1960s) claimed it was harmless, it still threatened those that raised concerns and published 'scientific' conclusions to raise confusion.[174] An article from *The Guardian* from 2013 has compared neonicotinoids to DDT, not in terms of toxicity as is easily refuted (DDT harmed birds, neonicotinoids supposedly harms bees, and the risk depends on the exposure[175]), but in terms of the denial of industries and that the same tactics (spreading confusion) are employed to make sure the

[172] Ottenheim, J. (2017, June 9). Personal interview.; McGrath, P. F. (2014). Politics meets Science: The case of neonicotinoid insecticides in Europe. *Sapiens (online)*, 7(1).; Van Den Berg, M. (2017, June 9). Personal interview.

[173] Avaaz.org. (n.d.). Avaaz.org, 8 Saving Bees from killer pesticides. Retrieved from https://secure.avaaz.org/page/en/highlights/ ; McGrath, P. F. (2014). Politics meets Science: The case of neonicotinoid insecticides in Europe. *Sapiens (online)*, 7(1).

[174] Oreskes, N., Conway, E. (2012). *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming*. Bloomsbury, UK: Bloomsbury Publishing PLC.

[175] Ottenheim, J. (2017, June 9). Personal interview.

pesticides stay on the market.[176] *Merchants of Doubt* also explains why these tactics work so well; namely because the public wanted to believe the scientists were wrong, so they did not have to take action and did not have to change their habits.[177]

[176] Monbiot, G. (2013, August 5). Neonicotinoids are the new DDT killing the natural world. *The Guardian*. Retrieved from https://www.theguardian.com/environment/georgemonbiot/2013/aug/05/neonicotinoids-ddt-pesticides-nature

[177] Oreskes, N., Conway, E. (2012). *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming*. Bloomsbury, UK: Bloomsbury Publishing PLC.

Chapter 4: Is there demand for improvement from the parties involved and which adjustments are possible?

This chapter evaluates the demand for improvement from the parties involved, using scientific literature and primary sources, including the conducted interviews. We will consider general improvements such as biological control and the introduction of pesticide taxes. In addition, we will focus on improvements derived from the views of parties themselves.

As can be concluded from their perspectives described in Chapter 2, environmental NGOs and the public demand alternatives to the current use of chemical pesticides. One of the ways to reduce pesticide use is the implementation of biological control. This kind of pest management has less ecological impacts than the chemical substances used in pesticides. Simply put, biological control is the use of one population of organisms to reduce the population of another. This method has been in use for at least two thousand years, but has been modernized since the nineteenth century. There are four different types of biological control: natural, conservation, classical and augmentative biological control. First, natural control includes the reducing of pest organisms by naturally occurring beneficial organisms. This phenomenon can occur without any human intervention. In economic terms, this type of biological control forms the greatest benefit to agriculture. After all, the farmer doesn't have to pay for this kind of natural control. Secondly, conservation biological control consists of human actions that protect and stimulate the survival of occurring natural enemies. Thirdly, in classical biological control, natural enemies are collected in a secluded area and subsequently released in the area where the pest is invasive. Finally, in augmentative biological control, natural enemies are captured in massive quantities for release in large numbers. Currently, Europe is the biggest commercial market for this kind of biological control. According to Van Lenteren (2017), a researcher of biological control at Wageningen University, this is a result of pressure of NGOs such as Greenpeace, consumer demand and political support.[178]

Another option for reduction of pesticide use is the introduction of pesticide taxes in the Netherlands. Economic instruments such as pesticide taxes can be efficient components of an optimal pesticide policy. This 'improvement' is described in a 2017 article by Robert Finger et al.[179] Finger's research focuses on risks and risk management in agriculture, evaluation and design of agricultural policies, sustainable farm-environment interactions and agro-environmental measures. It uses three criteria to evaluate pesticide policy measures: the effectiveness and efficiency of the measures, the 'polluter pays principal' and the acceptability of the measure among stakeholders including the effects of policy measures on farmers' income. In the Netherlands, the inelastic demand structure for pesticides was claimed in political debates as a major reason to not introduce a pesticide tax. Research shows that,

[178] Van Lenteren, J.C., Bolckmans, K., Köhl, J. et al. (2017). Biological control using invertebrates and microorganisms: plenty of new opportunities. *BioControl,* 1-21. doi: 10.1007/s10526-0179801-4

[179] Finger, R., Möhring, N., Dalhaus, T. et al. (2017). Revisiting Pesticide Taxation Schemes. *Ecological Economics, 134,* 263-266. doi: 10.1016/j.ecolecon.2016.12.001

due to the introduction of a tax, a significant change in pesticide use is to be expected.[180] Increasing pesticide prices due to a tax could, especially in the short run, result in lower farm incomes. However, a few recent studies show that income reduction could be smaller than expected. Skevas et al. (2014), a scientist studying agricultural and applied economics, shows that one hundred percent of the farms in the Netherlands overuse herbicides, eighty-six percent overuses fungicides and sixty-seven percent overuses insecticides.[181] Thus, the introduction of pesticide taxes can prevent the excessive use of pesticides and motivate farmers to spend less on pesticides altogether. Finger et al. (2017) draws the conclusion that pesticides taxes can effectively reduce risks for human health and the environment, by reducing the use of chemical pesticides. When pesticides are taxed according to their potential risks, substitution with less harmful pesticides and non-chemical plant protection strategies will be stimulated.[182]

Greenpeace has written a report about pesticides and their risks for human health. In this report, they voice their concerns about the (excessive) use of pesticides around the world.[183] According to them, the general population is exposed to a cocktail of different pesticides through the food we consume every day. Considering this and the other negative effects of pesticides, they would like to move towards a more long-term and sustainable approach to producing food. To them, this sustainable approach means the immediate phase-out of all pesticides that are toxic to non-target organisms. This requires legally-binding agreements, implemented at both national and international level. Greenpeace proposes the introduction of ecological farming, which is a modern and effective approach that does not rely on toxic chemicals, but still delivers healthy and safe food. Crops must be protected through a multilevel approach that increases heterogeneity of the landscape to provide habitat for pollinators and natural pest control species. In line with this, the use of biological control is supported by Greenpeace. In '*Pesticides and Our Health: A Growing Concern'* they describe four national and global strategies towards ecological farming. The first one is to eliminate the use of synthetic-chemical pesticides in agriculture. Secondly, they want to ensure proper implementation of the Sustainable Use Directive. Thirdly, Greenpeace requires improvement of the EU risk assessment process for pesticides. At last, they demand for a shift in public research spending towards ecological farming. This contributes to the concrete uptake of ecological farming practices by farmers.

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[180] Böcker, T. G., Finger, R. (2017). A Meta-Analysis on the Elasticity of Demand for Pesticides. *Journal of Agricultural Economics, 68*(2), 518-533. doi: 10.1111/1477-9552.12198

[181] Skevas, T., Stefanou, S. E., Oude Lansink, A. (2014). Pesticide use, environmental spillovers and efficiency: A DEA risk-adjusted efficiency approach applied to Dutch arable farming. *European Journal of Operational Research, 237*(2), 658-664. doi: 10.1016/j.ejor.2014.01.046

[182] Finger, R., Möhring, N., Dalhaus, T. et al. (2017). Revisiting Pesticide Taxation Schemes. *Ecological Economics*, *134*, 263-266. doi: 10.1016/j.ecolecon.2016.12.001

[183] Allsop, M., Huxdorff, C., Johnston, P. et al., Greenpeace Research Laboratories (2015). Pesticides and our Health: a growing concern. http://www.greenpeace.org/international/Global/international/publications/agriculture/2015/Pesticides-and-our-Health.pdf/

According to Greenpeace, future generations are another reason to eliminate the use of chemical pesticides. Due to epigenetic transgenerational inheritance, future generations may also be at risk of diseases. Epigenetic inheritance is the transmittance of changes in gene expression from one generation to the next, without alteration of the primary structure of the DNA. According to a study, endocrine disruptors found in certain pesticides can induce these epigenetic changes. These changes could lead to an increased susceptibility for disease. This high susceptibility could then be passed on to later generations.[184]

In the Netherlands, legislation and policy concerning pesticide use and maximum residues limits is strict. As a result, farmworkers and food consumers are not adversely affected by pesticides used on crops. However, this situation of strict regulation does not apply to farmers abroad. Many fruit and vegetables in Dutch supermarkets have been imported from other countries. The situation going on in the 'banana republics' can illustrate this problem.

The bananas in the Netherlands are imported from Costa Rica, Panama, Honduras, Suriname, the Philippines, Guatemala and Colombia. Due to bananas being one of their main export products, these countries are also called the banana republics. In these countries, the legislation concerning authorization and use of pesticides is not as strict as in Europe and the Netherlands. Therefore, the people who work on these plantations risk health problems in conditions of extreme poverty. Even though they have some general knowledge on pesticides and crop protection, the native farm workers know little about acute and chronic health effects. They are also not aware via which routes they are exposed to the chemicals in the pesticides they work with.[185] A lot of people in the western world, including the Netherlands, are not aware of the poor circumstances these farmers work and live in.

The willingness or unwillingness of the public to change their habits can have great influence on dealings with pesticides, besides exercising demanding a change in legislation. In a capitalistic society, one of the most common ways for the public to influence the world is by their shopping choices.[186] If a big part of the population decides they do not want to buy the product, it is going to resonate in the corporate decision making.[187] This concept, sometimes called 'voting with your fork', also applies to the field of pesticides.[188] This way, the public can control the pesticide choices of the agriculture, and the agriculture in turn can influence the producers with *their* pesticide choices.[21] Therefore, a lot of environmental

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[184] Collota, M., Bertazzi, P. A., Bollati, V. (2013). Epigenetics and pesticides. *Toxicology, 307*, 35-41. doi: 10.1016/j.tox.2013.01.017;

Skinner, M. K., Mannikam, M., Guerroro-Bosagna, C. (2011). Epigenetic transgenerational actions of endocrine disruptors. *Reproductive Toxicology, 31*(3), 337-343. doi: 10.1016/j.reprotox.2010.10.012

[185] Barazza, D., Jansen, K., Van Wendel de Joode, D. et al. (2011). Pesticide use in banana and plantain production and risk perception among local actors in Talamanca, Costa Rica. *Environmental Research, 111*(5), 708-717. doi: 10.1016/j.envres.2011.02.009

[186] Lockie, S., Salem, N. (2005). Governing consumption: mobilising 'the consumer' within genetically modified and organic food networks. In V. Higgins, G. Lawrence (Eds.), *Agricultural Governance: Globalisation and the New Politics of Regulation* (pp. 153-168). London, England: Routledge.

[187] Shaw, D., I. Black (2009). Market based political action: a path to sustainable development? *Sustainable Development*, *18*(6), 385-397. doi:10.1002/sd.415

[188] Parker, C. (2015). Strawberry fields forever: Can consumers see pesticides and sustainability as an issue? *Sustainability Science*, *10*(2), 285-303. doi: 10.1007/s11625-014-0267-3

activist movements are focused on convincing the public rather than the legislation.[189] A very well-known food authority, Michael Pollan, wrote: "*You can simply stop participating in a system that abuses animals or poisons the water or squanders jet fuel flying asparagus around the world. You can vote with your fork, in other words, and you can do it three times a day*."[190] The 'voting with your fork' mantra originated from this famous quote, indicating the amount of effect this had on society. In practice, this mantra is also undermined by uncertainty in scientific data, because if there is uncertainty that the pesticides are harmful, people will not be willing to adjust their lifestyle. For example, start buying more expensive and less good looking fruits and vegetables from an organic farmer.

As mentioned in the introduction, we conducted interviews with two people from the different parties involved with pesticides. One of the questions asked was the following one: "*What is your vision on the current policy, and do you think adjustments or improvements are needed?*"

Professor doctor Martin van den Berg answers this question by stating that the re-registration of pesticides by the Board for the Authorization of Plant Protection Products and Biocides must not be treated lightly.[191] Currently, the registration validity period for pesticides in Europe is ten years. This means that every ten years, the Board will reassess whether the pesticide meets all the current requirements. In this assessment, newly discovered risks are considered.[192] According to Professor Van den Berg, it is more difficult to take a pesticide off the market than to prevent a new one from entering it. Nevertheless, this should not mean old, well-known and widely used pesticides should not be questioned, just because we are familiar with them, like with Roundup. When new testing techniques and data are available, these old pesticides should be judged the same way as new ones.

Martin van den Berg also states the Dutch Authorization Board is under fire from different institutions, such as Greenpeace, European organizations, scientists and ministries. His advice in this matter is to stay objective. The Board should be critical of old and new data. By doing this, he believes improvement can certainly be achieved.

Jo Ottenheim, a lobbyist at Nefyto, believes improvement can be achieved by imposing less regulations on pesticide producers.[193] According to him, the rules are too general and strict. Furthermore, the cut-off values used by the European Food Safety Authority do not allow for consideration of the exposure to a certain pesticide. Nevertheless, Nefyto also understands some regulations are necessary at times.
Nefyto would like to improve the public image of pesticides. They believe the bad reputation of pesticides is due to farmers using them the wrong way. When problems involving a pesticide arise, politicians and the public will blame the substance itself, rather than the way it

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[189] Willis, M. M., Schor, J. B. (2012). Does Changing a Light Bulb Lead to Changing the World? Political Action and the Conscious Consumer. *The ANNALS of the American Academy of Political and Social Science*, *644*(1), 160-190. doi: 10.1177/0002716212454831

[190] Pollan, M. (2006, May 7). Voting With Your Fork. *The New York Times*. Retrieved from http://michaelpollan.com/articles-archive/voting-with-your-fork/

[191] Van den Berg, M. (2017, June 9). Personal interview.

[192] Pelaez. V., Da Silva, L. R., Araújo, E.B. (2013). Regulation of pesticides: A comparative analysis. *Science and Public policy*, *40*(5), 644-656. doi: 10.1093/scipol/sct020

[193] Ottenheim, J. (2017, June 9). Personal interview.

is used. To aim for a better understanding of pesticide use, they are currently setting up information programs for farmers. In these programs, Nefyto raises awareness about the consequences of incorrect use of pesticides. After all, misuse can lead to stricter regulations. In short, Nefyto states legislation will not have to become stricter if pesticides are used the right way. So, they state we should lay the responsibility with the farmers themselves.

Discussion

We will first give a concise summary before we discuss the strengths, limitations, new insights and hypotheses of our paper.

Pesticide legislation is firstly provided by the European Union. The European Union set out multiple Regulations that are instantly active across the whole European Union, without further need for conversion in national law. Besides, the EU has set out a Sustainable Use Directive stating goals Member States must achieve. However, member states still have their own laws regarding the authorization, sale and usage of pesticides, because of their own nation-specific characteristics. In the Netherlands, legislation regarding pesticides is laid down in the Plant protection products and biocidal products Act.
There are various authorities involved with the approval of active substances and pesticide products. The European Food Safety authority is responsible for the authorization on European level; in the Netherlands, this responsibility lies with The Board for the Authorization of Plant Protection Products and Biocides. Maximum residue levels on foods are set on European level and are determined by the European Food Safety Authority. Multiple organizations are responsible for the control of correct use of pesticides and enforcement of the law, including the industry itself.

In the Netherlands, there are different parties involved in the legislation regarding pesticides. Each of these parties has its own interests in the making and implementation of the law. The following parties are involved: the Dutch government, academia, pesticide producers, consumers and environmental NGOs.

These parties have their own specific perspectives on pesticide use. It is a fact that chemicals used in pesticides can have an impact on human and environmental health via different exposure routes. As a result, the public is concerned about the use of pesticides. In contrast, pesticide producers emphasize the advantages of pesticide use. Producers argue pesticides are needed because their use had led to less crop failure, farmers can produce a higher yield of better quality and food can be sold very cheap. Besides, farmers need to make sure they can deliver a constant supply of food of good quality products and are therefore reliant on pesticides to take care of their income. Of course, not all farmers are in favor of pesticide use: organic farmers do not use chemical pesticides. On the other hand, NGOs such as Greenpeace are concerned about the negative effects of pesticides on humans, animals and the environment. They bring forward the poorly investigated effects of the mixture of pesticides we ingest every day. These ‘cocktail effects’ also cause damage to ecosystems.

All the parties involved try to influence the current legislation based on their point of view on pesticides. Environmental NGOs lobby against approval of pesticides, while on the other hand pesticide producer representatives, such as Nefyto, lobby for a more flexible legislation. They each bring forward their own different data and evidence to prove their points. In an ideal situation, legislation is based on scientific evidence. However, regarding pesticides, we have seen that science cannot not be considered as an independent institution that provides hard facts. Science is used as a tool by the different parties to influence policy, which can be illustrated by the neonicotinoid case.

As can be concluded from the different perspectives of the parties involved, there is a demand for improvement of policy. Pesticide producer companies argue for a quicker and more flexible authorization process. In addition, they place responsibilities for correct use of pesticides with the farmers themselves. Environmental NGOs suggest a move towards

biological control to eliminate the dependency on the use chemical pesticides. Furthermore, they bring forward other practical implementations, such as pesticides taxes.

In the text below we will discuss the strengths, limitations, new insights and hypotheses of our paper.

We have analyzed the current policy making process and to what degree it is influenced by the different parties and examined their perspective on this process. We concluded that all, if not most parties are relatively satisfied with how pesticides are handled in the Netherlands. There is not one party that it extremely unsatisfied with how it is currently handled. That is not to say the system is perfect right now. We have observed proposed improvements from all parties, and some of these solutions are agreed upon by most of them.

First, there is criticism from a lot of parties on the current usage in cut-off values in the European Union. The use of cut-off values is undoubtedly necessary to make quick policy decisions. However, since the NGOs, the industry and the academia all criticize the current usage, we think some improvement can be made. All three of them stress that the current tests do not sufficiently test the impact of the pesticide on the environment. According to them, the current values are not representative of the actual impact on the environment. The academic community thinks they are based on outdated data. That is why we propose a re-evaluation of these cut-off values. Cut-off values can better be considered as guidance values and not as the absolute truth.[194] We expect that a lot can be gained by improving the current standardized test methods, and thus making sure that the values are representative for the actual effect.

Secondly, it was mentioned that there are different rules for the registration and re-registration of pesticides in the Netherlands. The already approved pesticides do not have to submit the same test results as the new ones. Right now, it would be unrealistic to ask the industry to constantly test their old pesticides with the new standardized rules. Nevertheless, we think it is very important that the re-registering pesticides are considered with extra caution and that the authorities should demand new information if there are uncertainties regarding effect on health or environment. The current approach involves a risk assessment every ten years, but it would be better to do a risk assessment when well-founded uncertainties regarding impacts on health and environment emerge.

Thirdly, we think there is a lot to gain by informing farmers on proper use of pesticides. As mentioned in Chapter 4 and by Nefyto, currently there is a big amount of over usage of pesticides. We believe that better education can cause a reduction in pesticide usage, and thus a reduction in environmental damage and public health problems. We think that the industry should cooperate with the government on this, especially because it is in their both best interest. The industry knows the most about their product and is therefore best suitable to give advice on usage to the farmers.

We think that a pesticide tax, or prohibition of pesticides is not expedient. The current approved pesticides in the Netherlands have very little impact on public health, and most pesticides also have very little impact on the environment (outside the farm). On the other hand, the economic impact of these actions will be high. This means a lower income for farms

[194] Wennig, R. (2002). Threshold values in toxicology – useful or not? *Forensic Science International, 113*(1-3), 323-330. doi:10.1016/S0379-0738(00)00254-1

and could mean bankruptcy or drastic reform for small farms. It will also mean that prices of local grown food will rise, giving Dutch farmers a big disadvantage on the Dutch market. Especially, the export of produce will receive a big hit. The Netherlands import different food products, while some of them also grow here for trade. When prices of domestic food products rise, Dutch farmers will become the victims. That is why we think it is unnecessary to prohibit pesticide usage or to implement a pesticide tax.

Another mentioned solution is the usage of biological control, the use of one organism to reduce the population of another organism. We think this can be situationally applied, but it will not solve the big problem. There is a great deal of examples of biological control, and many of them increased the problem. For example, a big number of current environmental problems are caused by the introduction of a natural predator in a new environment and hereby complete disruption of the ecosystem, leading to a big reduction in biodiversity.[195] Because the effect of biological control is situational and quite risky, we think this can be used in some cases, but we do not think this is suitable for national or global application.

Over the past few decades, the entire field of pesticides has grown to huge proportions. This means that it is impossible to fully describe everything in detail. Therefore, we had to make limitations to the scope of our paper. Firstly, we only focused on the pesticide usage in agriculture and no other uses, such as home-use, floral usage or disease prevention. Secondly, we did not include analysis about every pesticide but we only described the most debated ones. We do think these are representative for the debate that is going on about pesticides. Thirdly we focused only on the issues in the Netherlands and, to a lesser extent, the European Union. This means we did not pay attention to the large issues with pesticides in agriculture in third-world countries. Lastly, we did not make an intensive analysis of the main advantage of pesticides, namely the increase in food security. We think there is more than enough research on and attention for this subject, and we expected that further analysis in this paper would not have resulted in relevant information and results.

The disadvantage of basing our argument on these examples of dealings with pesticides, is that these are individual cases that are not representative for other cases. However, they do show how an interaction between the parties and their perspectives can lead to a policy decision in different circumstances, under different pressures and with different kinds of scientific evidence, and may show if, and if so what, could be changed to improve these dealings with pesticides.

We think this paper makes a solid contribution to the scientific community, for it is unique in its interdisciplinarity. Based on searching through multiple search engines, we concluded that the amount of reports that investigate the multiple aspects of this issue is low. We have not found a report that describes the perspectives of different parties on the current legislation and we think this is one of the strengths of our paper.

Besides, another strong point is the One Health perspective that we used to research this issue. We used the approach defined in the book One Health: The Theory and Practice of Integrated

[195] Wajnberg, E., Scott, J.K.., Quimby, P.C. (2001). *Evaluating Indirect Ecological Effects of Biological Control.* Wallingford, UK: CABI International.

Health Approaches.[196] This book includes practical content on methodological tools and data gathering, monitoring techniques, study designs, and mathematical models is included. Zoonotic diseases, with discussions of diseases of wildlife, farm animals, domestic pets and humans, and real-world issues such as sanitation, economics, food security and evaluating the success of vaccination programs are covered in detail. Discussing how to put policy into practice, and with case studies throughout, this book combines research and practice in one broad-ranging volume. Right now, the focus of the One Health concept is on the issue of zoonoses and the cooperation between veterinarians and medical scientists, but we expect this to shift more in the direction of general interdisciplinarity in terms of looking at society as a whole.[197]

We used a five-party model in our paper to map the different perspectives. This five-party system is more of a continuum. For example, our interviewee Martin van den Berg is a renowned toxicologist, but also helps the Ctgb in deciding which pesticides should be allowed. There are many more examples like this, especially for the science party. They have alliances with nearly all the other parties, and therefore we think an argument could be made to remove the science party and split them between the other parties. Despite this, we still think the model we used is a good illustration of the different perspectives of the parties and how they influence the legislative process.

Another example are the different opinions about the hazards of Roundup. World Health Organization's International Agency for Research on Cancer (IARC) classified glyphosate as probably carcinogenic, while the Joint FAO/WHO Meeting on Pesticides Residues (JMPR), the European Food Safety Authority and the European Chemicals Agency concluded the opposite. IARC reviews published studies to identify potential cancer hazards. It does not estimate the level of "risk" to the population associated with exposure to the hazard. In contrast, JMPR reviews both published and unpublished studies to assess the level of health risk to consumers associated with dietary exposure to pesticide residues in food. This explains the different outcomes of the WHO institutions, but it shows the inconsistency in the case of pesticides.

Emotions play a big role in this matter. The involvement of multiple parties causes the inconsistency around pesticides. All parties have opposite interests which makes it difficult to have a clear vision. Most of the emotions come from food consumers and producers of pesticides. People are worried about traces of pesticides on their food, while the health risks are often overestimated.[198] However, studies about pesticides and their health effects keep emerging. Opponents of pesticides, NGOs like Greenpeace, use the outcome of these studies in their advantage.
Producers of pesticides, such as Monsanto and Bayer CropScience, earn their money with the trade in pesticides. It is not unimaginable they defend the approval, trade and usage of it.

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[196] Zinsstag, J., Schelling, E., Waltner-Toews, D. et al. (2015). *One health: the theory and practice of integrated health approaches*. Oxfordshire, UK: CABI.

[197] Gibbs, E. P. J. (2014). The evolution of One Health: a decade of progress and challenges for the future. *Veterinary Record, 174***,** 85-91.

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The impact of pesticides on consumers' health is maybe not as big as we thought it was. In the Netherlands and the European Union, the requirements and guidelines for the approval, trade and usage of pesticides are clearly written down in laws. During a risk assessment two terms are important: 'hazard' and 'exposure'. A pesticide can have hazardous characteristics, but when the ''exposure'' is low, the health effects on humans will be nihil. Traces of pesticides can be found on food, but these will have no toxicological effects, because of the Maximal Residue Limits stated in the law. However, farmers and farm residents have a higher chance to get exposed to toxic chemicals, because it reaches them directly by drift of spray vapor.[199] In the Netherlands, it is not certain what the degree of pesticide exposure to people living nearby farms is. A research on this is still going on.[200] Besides, the impact of pesticides on consumers' health is more evidently present in other parts of the world. The legislation in South-America, Asia and Africa contains fewer protecting rules than that in the European Union.

As a final point, writing this paper made the ecological impacts of pesticides even clearer. Glyphosate (Roundup) is a broad-spectrum herbicide and does not only kill the pest it is used for, resulting in a shrinkage of the landscape. Neonicotinoids pesticides are associated with bee mortality, although the exact cause is unclear. Obviously, pesticides do not only destroy the pest it is used for, but also have great ecological impacts on other species.

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