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Economics and policy of moving from chemistry to biology in plant protection

Annual Biocontrol Industry Meeting 2022
24 - 26 October 2022, Basel

Robert Finger (ETH Zürich, Switzerland)

AECP

Plant protection is crucial

- Pest management is crucial for food security and ecosystem service provision of agricultural sector

- Large losses in crop quantity and quality without pest management (e.g. Oerke 2006, Savary et al. 2019, Deutsch et al. 2018)

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AECP Agricultural Economics and Policy

Deutsch, C. A., Tewksbury, J. J., Tigchelaar, M., Battisti, D. S., Merrill, S. C., Huey, R. B., & Naylor, R. L. (2018). Increase in crop losses to insect pests in a warming climate. *Science*, *361*(6405), 916-919.
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Pesticide use has negative impacts on the environment and human health

nature COMMUNICATIONS

ARTICLE

DOI: 10.1038/s41467-017-00349-2 OPEN

Agricultural pesticide use and adverse birth outcomes in the San Joaquin Valley of California

Ashley E. Larsen[1], Steven D. Gaines[1] & Olivier Deschênes[2]

Virtually all agricultural communities worldwide are exposed to agricultural pesticides. Yet, the health consequences of such exposure are poorly understood, and the scientific literature remains ambiguous. Using individual birth and demographic characteristics for over 500 000 birth observations between 1997–2011 in the agriculturally dominated San Joaquin Valley, California, we statistically investigate if residential agricultural pesticide exposure during gestation, by trimester, and by toxicity influences birth weight, gestational length, or birth abnormalities. Overall, our analysis indicates that agricultural pesticide exposure increases adverse birth outcomes by 5–9%, but only among the population exposed to very high quantities of pesticides (e.g., top 5th percentile, i.e., ~4200 kg applied over gestation). Thus, policies and interventions targeting the extreme right tail of the pesticide distribution near human habitation could largely eliminate the adverse birth outcomes associated with agricultural pesticide exposure documented in this study.

ARTICLES
https://doi.org/10.1038/s41561-021-00712-5
nature geoscience
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Risk of pesticide pollution at the global scale

Fiona H. M. Tang[1], Manfred Lenzen[2], Alexander McBratney[3] and Federico Maggi[1]

Pesticides are widely used to protect food production and meet global food demand but are also ubiquitous environmental pollutants, causing adverse effects on water quality, biodiversity and human health. Here we use a global database of pesticide applications and a spatially explicit environmental model to estimate the world geography of environmental pollution risk caused by 92 active ingredients in 168 countries. We considered a region to be at risk of pollution if pesticide residues in the environment exceeded the no-effect concentrations, and to be at high risk if residues exceeded this by three orders of magnitude. We find that 64% of global agricultural land (approximately 24.5 million km²) is at risk of pesticide pollution by more than one active ingredient, and 31% is at high risk. Among the high-risk areas, about 34% are in high-biodiversity regions, 5% in water-scarce areas and 19% in low- and lower-middle-income nations. We identify watersheds in South Africa, China, India, Australia and Argentina as high-concern regions because they have high pesticide pollution risk, bear high biodiversity and suffer from water scarcity. Our study expands earlier pesticide risk assessments as it accounts for multiple active ingredients and integrates risks in different environmental compartments at a global scale.

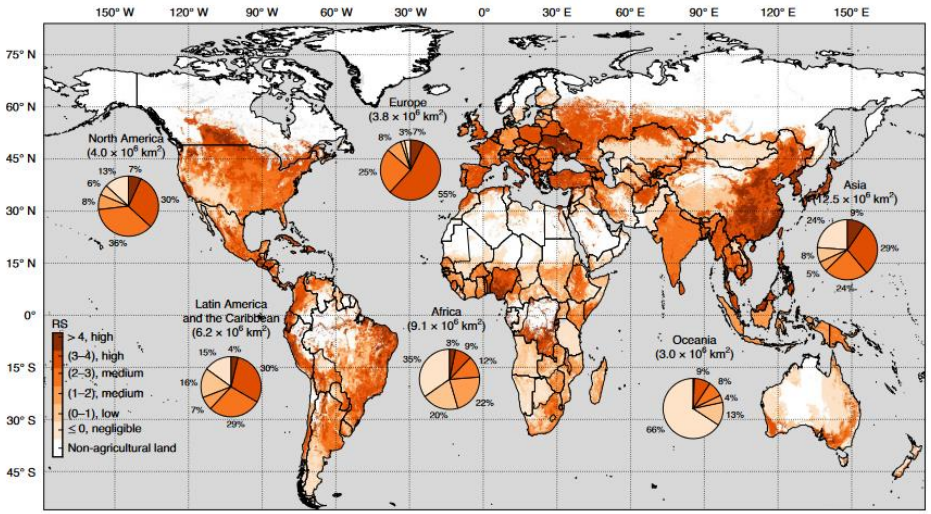

Fig. 1 | Global map of pesticide RS. The map has a spatial resolution of 5 arcmin, which is approximately 10 km × 10 km at the Equator. The pie charts represent the fraction of agricultural land classed under different RS in each region, and the values in parentheses above the pie charts denote the total agricultural land in that region.

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Larsen, A. E., Gaines, S. D. & Deschênes, O. Agricultural pesticide use and adverse birth outcomes in the San Joaquin Valley of California. *Nat. Commun.* **8**, 302 (2017).
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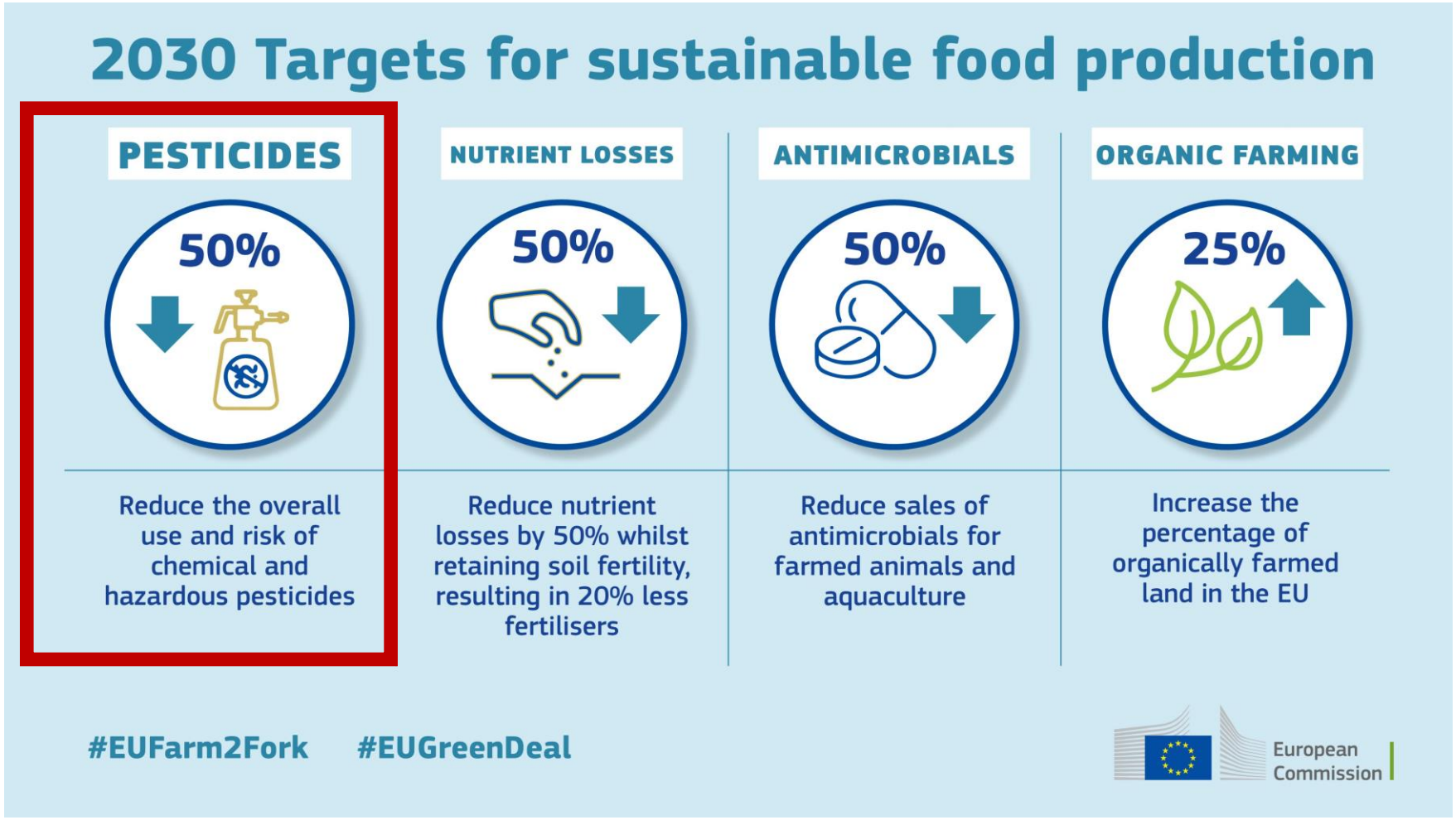
Tang, F. H., Lenzen, M., McBratney, A., & Maggi, F. (2021). Risk of pesticide pollution at the global scale. *Nature Geoscience*, *14*(4), 206-210.



Schebesta, H., & Candel, J. J. (2020). Game-changing potential of the EU's Farm to Fork Strategy. *Nature Food*, *1*(10), 586-588.

(No) pesticide-free Switzerland

comment
Check for updates

No pesticide-free Switzerland

On 13 June 2021, the people of Switzerland voted on two popular initiatives that aimed to introduce stricter pesticide policies. Both initiatives were rejected, but the political and societal debate led to large changes in governmental and industry policies.

Robert Finger

Pest management is critical for food security and the provision of various ecosystem services from the agricultural sector[1]. However, the use of pesticides has negative effects on human health and the environment[2,3]. Many countries have placed the reduction of pesticide risks on the top of policy agendas, but most fail to meet pesticide-risk reduction targets[4]. Bans of important pesticides are also subject to policy and societal debates. For example, widely used pesticides such as neonicotinoids are already banned in several European countries, and bans of other pesticides such as glyphosate other ecosystems regularly exceed legally defined thresholds throughout the entire country[6,7]. Overall, strong negative effects of pesticide use on flora, fauna and biodiversity have been reported[8]. Pesticide use also has effects on health[9]. The total external costs of pesticide use in Switzerland are estimated to range from 100 to 500 million Swiss francs (about US$111–557 million) per year[8]. The mismatch between these observed problems and adequate policy responses triggered increased societal debates and policy pressure, which led to the launch of both popular initiatives[5,10].

The first popular initiative, entitled 'For

for direct payments (cross compliance requirements). For example, it included the non-use of pesticides, the non-application of preventative antibiotics and avoidance of fodder imports. In theory, farms could avoid such adjustments simply by opting out of receiving direct payments. However, this is impossible for most Swiss farms, as direct payments represent a major part of their income. The Drinking Water Initiative also proposed to restrict public support exclusively to research aimed towards pesticide- and antibiotic-free agriculture. A transition period of 8 years was foreseen.

Both popular initiatives thus

- Both initiatives rejected, but 40% voted for initiatives
- But: large adjustment processes in agriculture, policy, industry as compromise
- Alternatives to chemical plant protection needed, urgently

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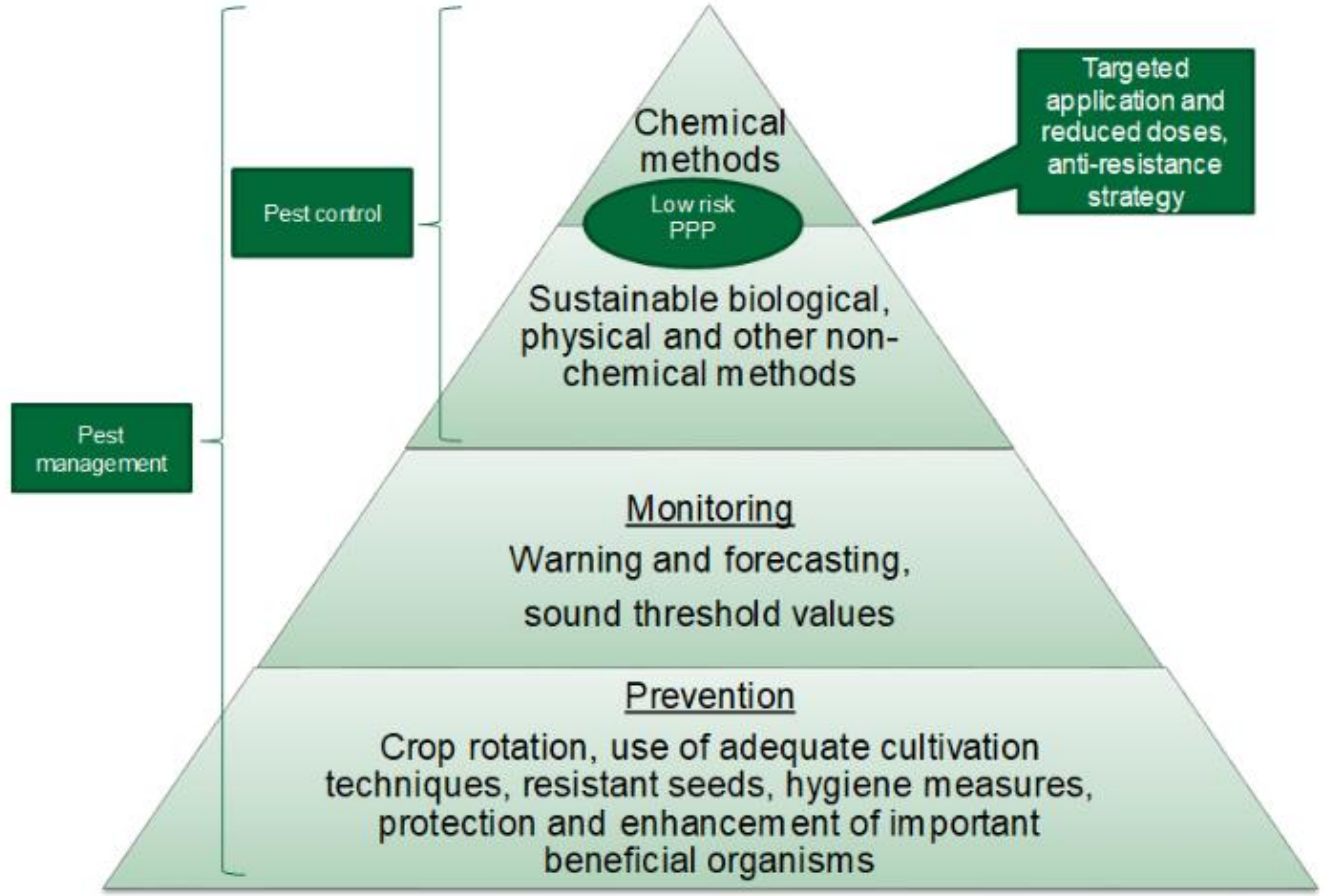
Finger, R. (2021). No pesticide free Switzerland. Nature Plants 7, 1324–1325



Source: ECA, based on Annex III to Directive 2009/128/EC.

https://www.eca.europa.eu/Lists/ECADocuments/SR20_05/SR_Pesticides_EN.pdf

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Agronomy for Sustainable Development (2022) 42: 8
https://doi.org/10.1007/s13593-021-00742-8

REVIEW ARTICLE

Pesticide-free agriculture as a new paradigm for research

Florence Jacquet[1] · Marie-Hélène Jeuffroy[2] · Julia Jouan[1] · Edith Le Cadre[3] · Isabelle Litrico[4] · Thibaut Malausa[5] · Xavier Reboud[6] · Christian Huyghe[7]

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Abstract

Reducing pesticide use has become a goal shared by several European countries and a major issue in public policies due to the negative impacts of pesticides on the environment and on human health. However, since most of the agri-food sector relies on pesticides in these countries, substantially reducing pesticide use is a complex issue. To overcome this situation, we argue that agricultural research has a major role to play and must adopt a pesticide-free paradigm to expect a deep impact on pesticide use. In this article, we explain why this new paradigm is needed and outline research fronts that it will help address. These research fronts are related to five strategies: (1) redesigning cropping systems to enhance prophylaxis, (2) diversifying biocontrol strategies and associated business models, (3) broadening the scope of plant breeding to include functional biodiversity and evolutionary ecology concepts, (4) setting new goals for agricultural machinery and digital technologies, and (5) supporting development of public policies and private initiatives for the transition toward pesticide-free agri-food systems. The corresponding research activities must be managed conjointly to develop systemic and coupled innovations, which are essential for reducing pesticide use significantly. We therefore provide examples of cross-cutting objectives that combine these fronts while also highlighting the need for interdisciplinary research projects. By doing so, we provide an overall orientation for research to achieve sustainable agriculture.

Food Policy 106 (2022) 102188

Contents lists available at ScienceDirect

Food Policy

journal homepage: www.elsevier.com/locate/foodpol

Pesticide-free but not organic: Adoption of a large-scale wheat production standard in Switzerland

Niklas Möhring [a, b, *], Robert Finger [a]

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[b] Centre d'Etudes Biologiques de Chizé, UMR 7372, CNRS and La Rochelle Université, Beauvoir-sur-Niort, France

ARTICLE INFO

Keywords:
Pesticide
Pesticide-free
Sustainable agriculture
Adoption
Wheat
Public–private
Sustainability standard
Switzerland

ABSTRACT

The sustainable intensification of agriculture requires solutions for a large-scale reduction of pesticide use while sustaining agricultural yields. Pesticide-free production standards, which bring together the strengths of all the food value chain actors, could be a cornerstone of this transformation. In Switzerland, a non-organic, private–public standard for pesticide-free wheat production is currently being introduced by the producer organization IP-SUISSE. It is the first of its kind in Europe and may reach a market share of 50% of Swiss wheat production. We here assess the determinants of farmers' participation and willingness to participate in the future. For our analysis, we combine a survey of the entire population of IP-SUISSE wheat producers (4749 farmers, 23.3% response rate) with data on historical farm-level wheat yields, soil properties, weather, climate, weed pressure, and spread of herbicide resistance. Our results indicate that a large-scale establishment of pesticide-free wheat production in Switzerland is possible. We find that farmers' perceptions of positive environmental effects of the production program are key for adoption. Moreover, farmers' expectations of the program's production effects play a central role. Farmers perceiving large yield losses and increases in production risks are less likely to enter the program. Based on our results, we discuss implications, leverage points, and challenges for designing and implementing large-scale pesticide-free production programs.

Jacquet, F., Jeuffroy, M. H., Jouan, J., Le Cadre, E., Litrico, I., Malausa, T., ... & Huyghe, C. (2022). Pesticide-free agriculture as a new paradigm for research. *Agronomy for Sustainable Development*, *42*(1), 1-24.
Möhring, N., Finger, R. Pesticide-free but not organic? Adoption of a large-scale pesticide-free wheat production standard in Switzerland. Food Policy 106: 102188

Involvement of all actors required

nature food

PERSPECTIVE

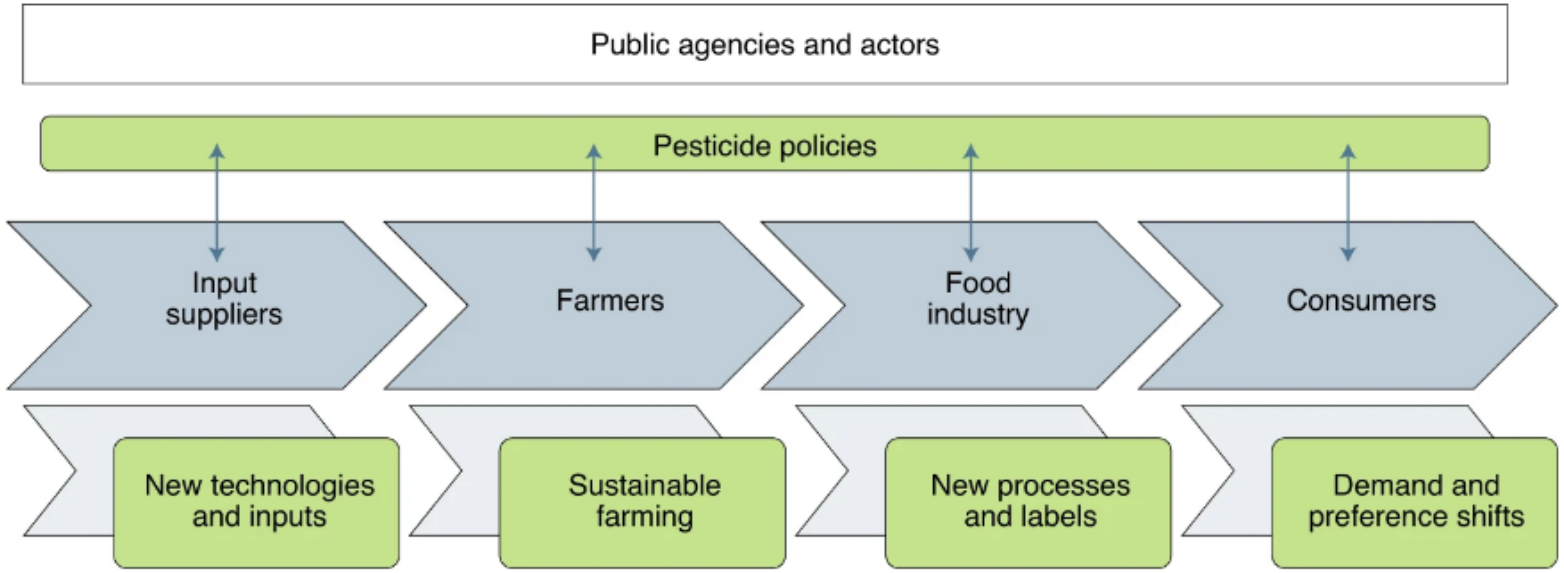
https://doi.org/10.1038/s43016-020-00141-4

Check for updates

Pathways for advancing pesticide policies

Niklas Möhring[1]✉, Karin Ingold[2,3], Per Kudsk[4], Fabrice Martin-Laurent[5], Urs Niggli[6], Michael Siegrist[7], Bruno Studer[8], Achim Walter[9] and Robert Finger[1]✉

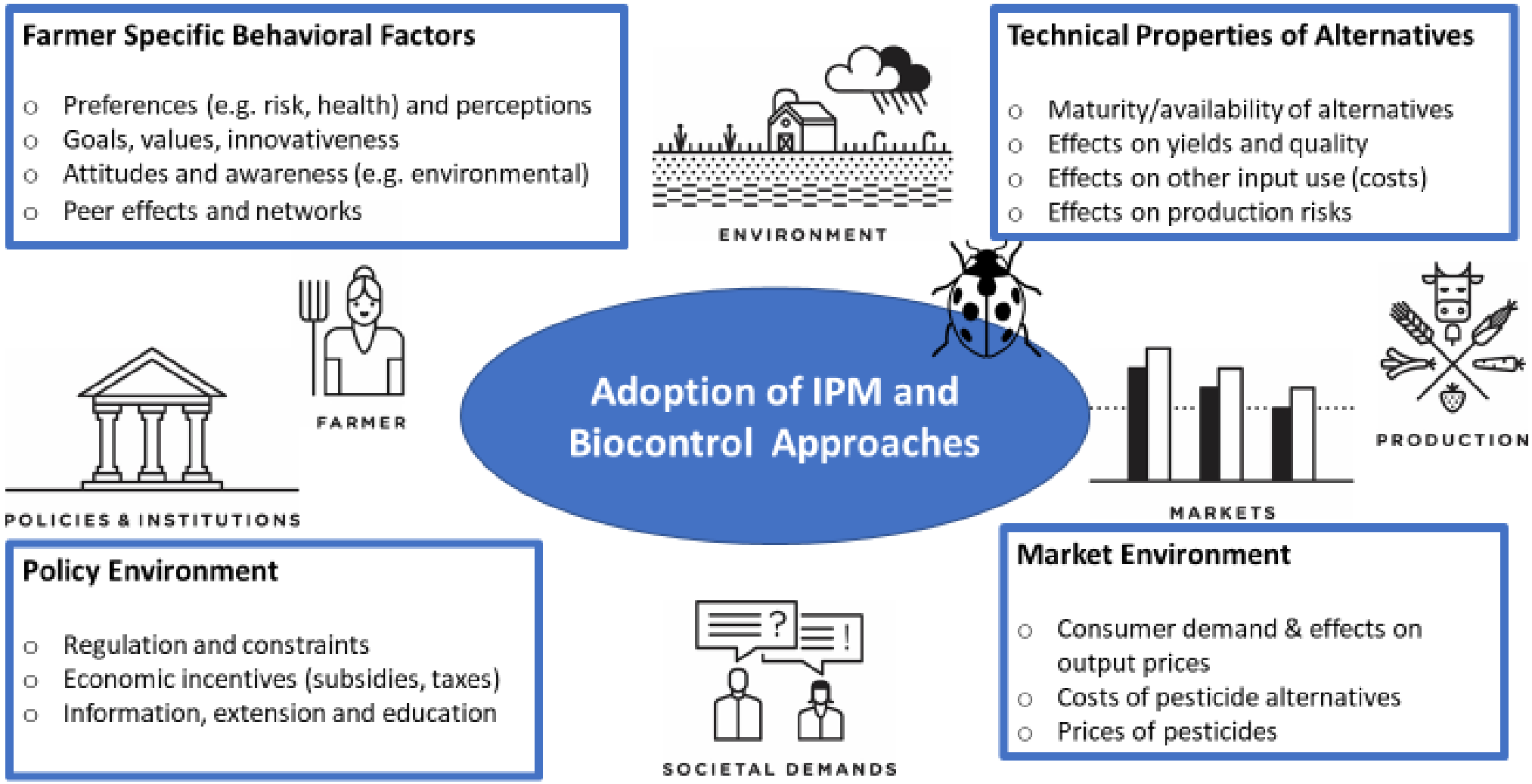
Numerous pesticide policies have been introduced to mitigate the risks of pesticide use, but most have not been successful in reaching usage reduction goals. Here, we name key challenges for the reduction of environmental and health risks from agricultural pesticide use and develop a framework for improving current policies. We demonstrate the need for policies to encompass all actors in the food value chain. By adopting a multi-disciplinary approach, we suggest ten key steps to achieve a reduction in pesticide risks. We highlight how new technologies and regulatory frameworks can be implemented and aligned with all actors in food value chains. Finally, we discuss major trade-offs and areas of tension with other agricultural policy goals and propose a holistic approach to advancing pesticide policies.



Pesticide policies interact with input suppliers, farmers, the food industry and consumers – each actor can contribute towards sustainable food systems with actions specific to their role (bottom row). Current policy measures can be classified as command and control measures (for example, pesticide authorization, bans and use regulations), market-based measures (for example, pesticide taxes, financial support of new technologies and direct payments) and information-based measures (for example, education, labelling and awareness raising). Many specific, national or regional measures are contained in each of the three categories and may target conflicting policy goals[78].

Möhring, N., Ingold, K., Kudsk, P., Martin-Laurent, F., Niggli, U., Siegrist, M., Studer, B., Walter, A., Finger, R. (2020). Pathways for advancing pesticide policies. *Nature Food* 1, 535–540.

Farmer behavior is key



Möhring, N., Ingold, K., Kudsk, P., Martin-Laurent, F., Niggli, U., Siegrist, M., Studer, B., Walter, A., Finger, R. (2020). Pathways for advancing pesticide policies. *Nature Food* 1, 535–540
Knapp, L., Wuepper, D., Finger, R. (2021). Preferences, personality, aspirations, and farmer behavior. Agricultural Economics 52(6): 901-913
Lefebvre, M., Langrell, S. R., & Gomez-y-Paloma, S. (2015). Incentives and policies for integrated pest management in Europe: a review. *Agronomy for Sustainable Development*, *35*(1), 27-45

Lessons learned in Swiss case studies

Pesticide free wheat

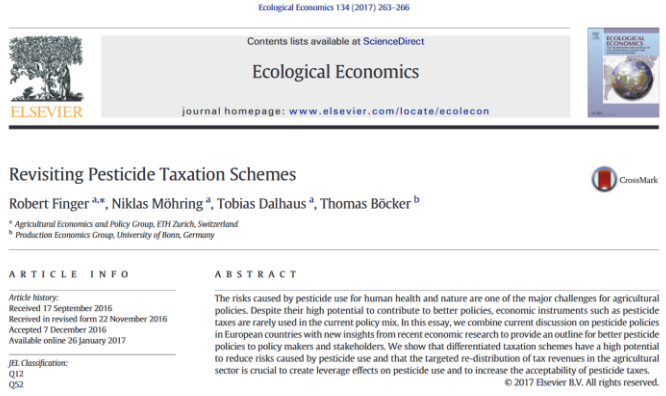
Control of invasive species

Low pesticide grapevine

Lessons learned in Swiss case studies (I/II)

- Low/no-pesticide practices often imply lower revenues and/or higher costs → Farmers need compensation. → Public policy: push (pesticide tax) and pull (subsidies)

- Markets matter! Price markups & short supply chains enable adoption → More downstream industry involvement & create new market channels for ‘value added’



Ecological Economics 134 (2017) 263–266

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

Revisiting Pesticide Taxation Schemes

Robert Finger [a,*], Niklas Möhring [a], Tobias Dalhaus [a], Thomas Böcker [b]

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Q12
Q52

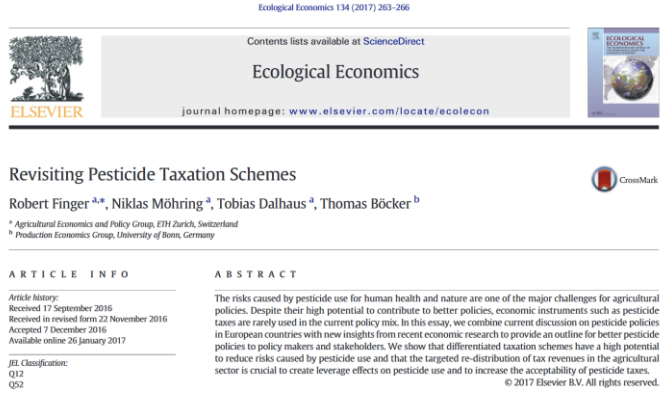
ABSTRACT

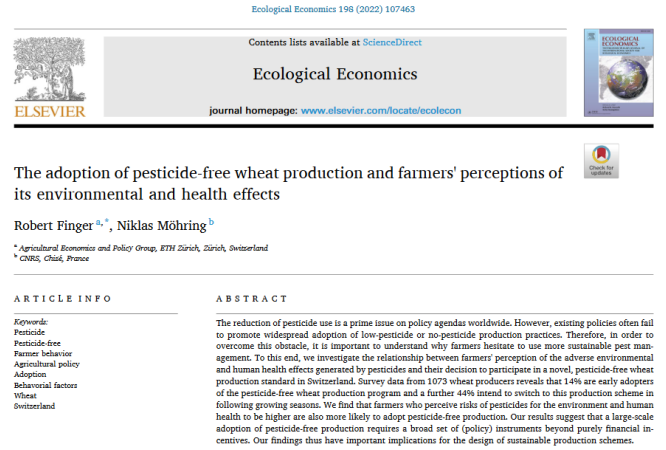
The risks caused by pesticide use for human health and nature are one of the major challenges for agricultural policies. Despite their high potential to contribute to better policies, economic instruments such as pesticide taxes are rarely used in the current policy mix. In this essay, we combine current discussion on pesticide policies in European countries with new insights from recent economic research to provide an outline for better pesticide policies to policy makers and stakeholders. We show that differentiated taxation schemes have a high potential to reduce risks caused by pesticide use and that the targeted re-distribution of tax revenues in the agricultural sector is crucial to create leverage effects on pesticide use and to increase the acceptability of pesticide taxes.

Möhring, N., Finger, R. Pesticide-free but not organic? Adoption of a large-scale pesticide-free wheat production standard in Switzerland. Food Policy 106: 102188
Finger, R., & Möhring, N. (2022). The adoption of pesticide-free wheat production and farmers' perceptions of its environmental and health effects. *Ecological Economics*, *198*, 107463.
Finger, R., Möhring, N., Dalhaus, T., Böcker, T. (2017). Revisiting pesticide taxation schemes. Ecological Economics 134: 263–266
Knapp, L., Wuepper, D., Finger, R. (2021). Preferences, personality, aspirations, and farmer behavior. Agricultural Economics 52(6): 901-913
Finger, R., Zachmann, L., McCallum, C. (2022). Short supply chains and the adoption of fungi-resistant grapevine varieties. Revised & Resubmitted

Lessons learned in Swiss case studies (I/II)

- Low/no-pesticide practices often imply lower revenues and/or higher costs → Farmers need compensation. → Public policy: push (pesticide tax) and pull (subsidies)
- Markets matter! Price markups & short supply chains enable adoption → More downstream industry involvement & create new market channels for ‘value added’
- Risk are often (perceived to be) higher → Reducing risks and risk perceptions is key
- More than money matters (e.g. perceived risks for environment and health) → Go beyond monetary incentives, e.g. via targeted information (nudges)





Möhring, N., Finger, R. Pesticide-free but not organic? Adoption of a large-scale pesticide-free wheat production standard in Switzerland. Food Policy 106: 102188
Finger, R., & Möhring, N. (2022). The adoption of pesticide-free wheat production and farmers' perceptions of its environmental and health effects. *Ecological Economics*, *198*, 107463.
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Knapp, L., Wuepper, D., Finger, R. (2021). Preferences, personality, aspirations, and farmer behavior. Agricultural Economics 52(6): 901-913
Finger, R., Zachmann, L., McCallum, C. (2022). Short supply chains and the adoption of fungi-resistant grapevine varieties. Revised & Resubmitted

Lessons learned in Swiss case studies (II)

- Extension service and information channels determine uptake → Targeted information and extension needed
- Farmer networks and interaction enables efficient diffusion → Exploiting the power of (farmer) networks
- Often policy goal trade-offs (e.g. yields, costs, labor, other environmental goals) → Key trade-offs need targeted policy and industry action

Food Policy 99 (2021) 101995

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Food Policy

journal homepage: www.elsevier.com/locate/foodpol

Does it matter who advises farmers? Pest management choices with public and private extension

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ARTICLE INFO

JEL:
Q16
Keywords:
Extension service
Pest management
Insecticides
Preventive measures
Drosophila Suzukii

ABSTRACT

Does it matter whether farmers receive advice on pest management strategies from public or from private (pesticide company affiliated) extension services? We use survey data from 733 Swiss fruit growers who are currently contending with an infestation by an invasive pest, the fruit fly *Drosophila Suzukii*. We find that farmers who are advised by public extension services are more likely (+9–10%) to use preventive measures (e.g. nets) while farmers who are advised by private extension services are more likely (+8–9%) to use synthetic insecticides. These results are robust to the inclusion of various covariates, ways to cluster standard errors, and inverse probability weighting. We also show that our results are unlikely to be driven by omitted variable bias. Our findings have implications for the current debates on both the ongoing privatization of agricultural extension and concerns regarding negative environmental and health externalities of pesticide use.

Möhring, N., Finger, R. Pesticide-free but not organic? Adoption of a large-scale pesticide-free wheat production standard in Switzerland. Food Policy 106: 102188
Knapp, L., Wuepper, D., Finger, R. (2021). Preferences, personality, aspirations, and farmer behavior. Agricultural Economics 52(6): 901-913
Wuepper, D., Roleff, N., & Finger, R. (2021). Does it matter who advises farmers? Pest management choices with public and private extension. Food Policy, 101995
Wang, Y., Möhring, N., Finger, R. (2022) When my neighbors matter: spillover effects in the adoption of large-scale pesticide-free wheat production. Revised & Resubmitted

Conclusions

- Reduction of pesticide risks requires holistic pesticide policies
- Public policies matter: next to regulation, also economic instruments (e.g. subsidies, taxes), provision of extension services, information, education etc. are key
- Markets matter and corporate policies need to be adjusted too. Accounting also for up- and downstream actors
- Optimal policy packages highly dependent on specific agricultural and food systems
- (we hope) Switzerland may serve as role model for innovation in terms of pesticide reduction

Get in touch!

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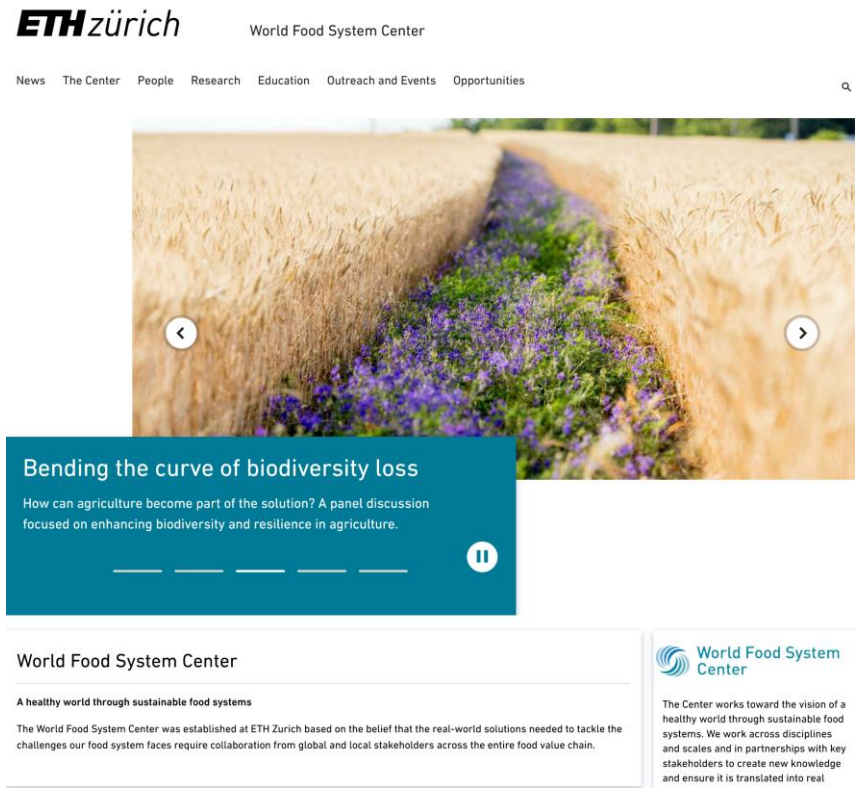
https://agrarpolitik-blog.com

https://worldfoodsystem.ethz.ch/



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AECP
Agricultural Economics and Policy

Selected relevant papers with links

- Finger, R., Möhring, N. (2022). The adoption of pesticide-free wheat production and farmers' perceptions of its environmental and health effects . Ecological Economics. 198, 107463 https://doi.org/10.1016/j.ecolecon.2022.107463.
- Möhring, N., Finger, R. (2022). Pesticide-free but not organic: adoption of a large-scale wheat production standard in Switzerland . Food Policy 106: 102188 >>
- Finger, R. (2021). No pesticide free Switzerland. Nature Plants 7, 1324–1325 >>
- Mesnage , R. Straw, E.A., Antoniou, M.N. Benbrook, C. Brown, M.J.F., Chauzat, M-J., Finger, R., Goulson, D., Leadbeater, E., López-Ballesteros, A., Möhring, N., Neumann, P., Stanley, D., Stout, J.C., Thompson, L.J., Topping, C.J., White, B., Zaller, J.G., Zioga, E. (2021). Improving pesticide-use data for the EU. Nature Ecology & Evolution 5: 1560 >>
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