# SOCIO-ECONOMIC ISSUES ON PESTICIDE USE

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## Abstract

The intensification and globalization of agriculture, particularly with the advent of the Green Revolution in the 1960s, led to the widespread use of synthetic chemicals, which became an integral part of farming systems. However, the extensive use of pesticides has been criticized for its negative impacts on the environment, human health, beneficial insects, and the ecosystem as a whole. In many cases, the drawbacks of pesticide use may outweigh its benefits. The challenges associated with efficient pesticide management are not solely technical or financial; moral concerns, public perception, and policy-related issues also significantly reduce pesticide usage. Moreover, convincing small farmers of the economic benefits of alternative practices remains difficult due to inefficient markets that fail to value the ecosystem services provided by chemical-free farming adequately. This paper thoroughly discusses overlooked issues in efforts to minimize agrochemical usage and explores economic tools that can help mitigate associated externalities.

**Keywords**: agrochemical usage, market, organic agriculture, pesticide management

## INTRODUCTION

The use of chemicals for plant protection dates back to the fertile period of Mesopotamia where Sumerians used sulfur to protect their crops (Williams & Cooper, 2004). With the beginning of agriculture, products such as grounded tobacco, oils, and limes have been used against pests and diseases. Since the 1950s, the discovery of compounds such as dichloro-diphenyl-trichloroethane (DDT) started the age of synthetic chemicals. With the advent of the green revolution in the 1960s, the use of synthetic chemicals became an integral part of the farming system (Bertomeu-Sanchez, 2019). Pesticide use for agricultural purposes from 1990-2020 was highest in the Americas followed by Asia, Europe, Africa, and Oceania (Food and Agriculture Organization [FAO], 2023).

Pesticide use has been criticized for hurting the environment, human health, beneficial insects, and the overall ecosystem. Carson (1962) shed light on the dangers of the organophosphate pesticide, DDT, in her book "Silent Spring" which led to its eventual ban by the US Environmental Protection Agency. Subsequent research has revealed further risks associated with pesticides, including contamination of groundwater and surface water (Karnik et al., 1993, pp. 111-112; Hurley et al., 1998), harmful impacts on bees, earthworms humans, birds, and aquatic organisms (Ahmand et al.,2024; Cech et al.,2023), and soil health. While these environmental and health concerns have been extensively studied and risk-reduction measures adopted, many underlying economic and social factors have received less attention. Efforts to mitigate pesticide usage include initiatives such as integrated pest management training, subsidies for biopesticide use, e-plant clinics, and the licensing and training of agro-veterinary professionals (Ghimire and GC, 2018). However, public dialogue and programs addressing the socio-economic challenges posed by pesticide use remain largely neglected. This comprehensive review examines the nuanced socio-economic interests of pesticide

usage. The study seeks to generate substantive insights to strategically inform policymakers and extension agents on socio-economic issues of pesticide usage, thus helping to formulate an inclusive program that may foster the reduction of pesticide usage and promote more holistic, sustainable agricultural ecosystems.

## MATERIALS AND METHODS

The research methodology employed a systematic and comprehensive desk review approach, to capture a nuanced understanding of pesticide-related socio-economic dimensions. A wide bibliographic search was conducted through Google Scholar using a set of targeted search terms that captured the socio-economic issues involved with pesticide use. The purposively selected search descriptors included: "Pesticide and human rights", "Pesticide poisoning and drifting", "Financial profitability of organic farming", Perception on pesticide usage", Property rights issues on pesticide", "Market failure on pesticide", " Disposal of pesticide" and "Taxation and Subsidy on pesticide". Relevant peer-reviewed scholarly articles were selected and reports from organizations such as the Food and Agriculture Organization (FAO), the Organisation for Economic Co-operation and Development (OECD), and the United Nations (UN) were referred to gain an international perspective on pesticide usage and management.

### Economic and social issues

#### *Pesticide and human rights*

Pesticides and related technological innovations have contributed significantly to food production, addressing the needs of a rapidly growing human population. While they have helped increase food production and thus its availability access to adequate healthy food remains a challenge. Food production using pesticides "undermines the rights to adequate food and health for present and future generations" (United Nations [UN], 2017 ). The Universal Declaration of Human Rights and Article 11 of the International Covenant on Economic, Social, and Cultural Rights guarantee everyone the right to adequate food, which guarantees that both the quantity and quality of food required to maintain a high standard of living must be provided adequately. Food contaminated with pesticides, however, cannot be considered adequate food because it compromises food quality. This right also encompasses the notion of other health-related rights. This right also carries the belief that other rights to health and life must not be violated while enjoying the right to food, which cannot be realized if food grown with pesticides is consumed. The right to life, enshrined in Article 3 of the Universal Declaration of Human Rights, Article 6 of the International Covenant on Civil and Political Rights (ICCPR), and the Convention on the Rights of the Child (CRC), along with the right to health outlined in Article 25 of the Universal Declaration of Human Rights, Article 24 of the CRC, and Article 12 of the International Covenant on Economic, Social, and Cultural Rights, have all been violated as a result of intentional or unintentional pesticide exposure (Utyasheva & Bhullar, 2021 ). Although it can be difficult to attribute any health issue to pesticides due to daily chemical exposure, pesticide exposure through the air, water, food, or direct contact is unavoidable and hurts human health (UN, 2017; Eyhorn, 2015).

**Underestimation of social problems related to the use of pesticide**

Multiple measures have been put in place to safeguard farmers from the direct health effects of pesticides, such as skin problems and respiratory issues (Neupane et al., 2014; Zhang et al., 2011). However, the social problems associated with pesticide use often go unnoticed and underreported. One such issue is the rate of pesticide-related suicides. World Health Organization (2023, para. 2) estimates that 20% of 703,000 people who commit suicide do so by pesticide self-poisoning. Since the start of the green revolution in the 1960s, an estimated 14 million people have died from pesticide ingestion. In Sri Lanka, paraquat, and propanil account for more than 78% of suicides (Dawson, 2010); Carbosulfan and Profenofos led to higher death by ingestion (Weerasinghe,2020) . Knipe et al. (2017) found that a ban on paraquat, chlorpyrifos, and propanil decreased the suicide rate in Sri Lanka by 21%.

The effects of pesticide exposure extend beyond the sprayer to bystanders. Pesticide exposure after the first half of pregnancy is linked to poor verbal learning outcomes in children (Mora et al., 2020). In Kerela, Endosulfan was routinely sprayed for 2 decades, even after the pesticide was banned. Mental retardation has been observed in 40.4% of males and 39.8% of females who were children of Endosulfan-exposed parents (Embrandiri et al., 2012). Alarcon et al. (2005) reported that among school workers and children exposed to pesticides used in school or through drift from the nearby agricultural fields, 80 percent developed acute illness. Compared to adults, children are even more vulnerable to the dangers of pesticides. They typically have a habit of immediately putting anything in their mouth and are unable to assess the risk. They often accompany their parents to the fields or play near them, exposing themselves to pesticide residues in the air and on the ground.

There have been several tragic incidents linked to pesticide poisoning. In the year 1999, in Peru, parathion was mistakenly mixed into powdered milk, resulting in the death of 24 schoolchildren. In India, 23 children died after consuming monocrotophos-contaminated meals. Similar incidents occurred in China in 2014 and Bangladesh in 2015, where 39 preschool children and 11 children died from pesticide-contaminated food (UN, 2017). Other cases of accidental poisoning include the Bhopal disaster in India in 1984 and the Endosulphan spray incidents in Kasargod, India, from 1977 to 1987 (Utyasheva & Bhullar, 2021).

**Profitability of organic agriculture**

Farmers have been entrapped to use pesticides extensively by the current conventional monoculture system and the very high initial cost of switching to sustainable systems (Wilson & Tisdell, 2001). Alternative farming practices, with organic agriculture being the most prominent, have gained attention because of the sustainability problems associated with conventional systems. Organic farming is practiced in 187 countries by 3.1 million farmers cultivating 72.3 million hectares of land. In 2019, the global sales of organic food reached over 106 billion euros (Willer et al., 2021).

Crowder & Reganold (2015) found that the total cost of organic agriculture was not significantly different from conventional. However, labor costs in organic agriculture made up 13 % of the total cost which was only 7% in conventional systems, signifying organic farming to be more labor-intensive. The increase in demand for the labor force created more jobs and promoted a better standard of living in rural areas. Pesticides are predominantly used by conventional farmers to manage pests, diseases, and weeds (Letourneau & van

Bruggen, 2006, p. 95), whereas organic farming has cost reductions as it does not rely on synthetic pesticides.

Several meta-analyses by researchers such as De Ponti, Rajik, & Van Ittersum (2012), Seufert, Ramankutty, & Foley (2012), Ponisio et al. (2015), and Brandt et al., (2011) have shown that production levels in organic agriculture are generally lower than in conventional systems. Compared to conventional farming, organic farming achieved a 4% higher gross return and a 13% higher benefit-cost (BC) ratio, but the yield in organic systems was 18% lower. Without premium prices, the transition phase to organic farming, which lasts about three years, becomes financially challenging for farmers (Zenter et al., 2011).

In addition to crops, organic livestock production in the European nations also yielded lower by a quarter than conventional farms while production costs are higher. Milk production in the European Union (EU) has been expected to stagnate due to policies of expansion of organic and pasture-based production systems (Organization for Economic Co-operation and Development & Food and Agriculture Organization [OCED & FAO], 2022).

**Perceived threat to human health**

The use of pesticides is also viewed as a perceived threat to human health. Farmers who perceive pesticides as harmful tend to engage in preventive behaviors such as adopting safer methods and inputs for growing food (Lichtenberg & Zimmerman,1999; Furlong et al., 2015). Barraza et al. (2020) found that women perceive a higher threat than men in a study on pesticide risk perception among bystanders in banana fields in Costa Rica. Approximately 83 % of the workers were male, and they viewed banana plantations as a major source of income for them. In Costa Rica, banana production has been considered a main source of revenue. Since pesticide use was necessary to produce exportable bananas, many did not consider it harmful. They saw the economic benefits of pesticide use in banana production, as essential and unavoidable.

**Property Right Issues**

Aerial spraying is a popular method for large-scale farming operations. However, the frequently disregarded issue with the aerial spraying method is property rights. The prohibition of DDT is a notable example of this. DDT was once an inexpensive and efficient method for reducing insect-borne illnesses in developing countries. In the 1930s, it was sprayed on millions of acres in the eastern part of New York to combat the gypsy moth. However, the organic growers and residents who filed lawsuits argued that their property rights were violated as they were exposed to pesticide spraying. Their private property was taken for public use without any compensation. In the 1950s, a farmer could hold a sprayer guilty for damage to crops, livestock, or humans caused by spray drift, except the cause of the spray was of public interest. If property rights had been properly addressed, the use of chemicals might have been limited or reduced. Public interest in the use of DDT was just made a political agenda when Rachel Carson published a book on DDT that led to the banning of pesticides (Morris & Meiners, 2002).

The case of endosulfan aerial spraying in Kasaragod, Kerala is another widely known and tragic example of pesticide poisoning and the violation of property rights. The government-run Plantation Corporation of Kerala began using endosulfan spray in its cashew plantations around 1976 and continued its use until it was outlawed in 2011. Farmers raising bees in the surrounding area and local panchayat protested against the spraying two decades

ago but their voices went unheard. There were more than 5000 victims of the spray in 11 Panchayats (Mishra, 2017). If the government had respected the property rights of those living near the plantations and stopped the spraying, the suffering caused by physical and mental deterioration—reported even many years after the spraying stopped—could have been avoided. The costs of pesticide drift damage should be internalized under the "polluter pays principle" (Blomquist, 1995). However, this is only possible with proper policies and legal provisions to support such measures.

**Market Inefficiencies**

Considering only the price factor of food grown using synthetic pesticides and chemicals, compared to that of organic agriculture systems without the organic premium, the benefits of organic agriculture can be as much as 27% lower than those of conventional systems (Crowder & Reganold, 2015). However, if the external benefits of organic agriculture—such as health improvements and environmental preservation—are taken into account, or if the negative externalities of conventional farming (e.g., health costs and environmental degradation) are considered, the organic system could prove far superior. The total economic value of organic farming is much higher than that of conventional systems when ecosystem service is taken into account (Sandhu et al., 2007; Losey & Vaughan, 2006). The challenge in measuring such services lies in their nature as public goods. Producers of these services do not necessarily receive economic benefits, as the beneficiaries are often people unrelated to the farming system (Power, 2010). Moreover, these beneficiaries may not be willing to pay for the services due to their public nature.

**Disposal of obsolete pesticides and malpractices**

The majority of regulatory frameworks include a list of prohibited agrochemicals; however, there is a significant gap in the regulation of pesticides throughout their entire lifecycle, from manufacturing to disposal. The removal of outdated chemicals has been a major issue for both users and sellers. These older products are often more hazardous than newly produced ones. Agro-vets frequently sell expired pesticides, which are more dangerous to farmers' health, prioritizing profit over human safety. Farmers often purchase and use expired pesticides without fully understanding the environmental risks, driven by lower prices and a lack of information about the dangers they pose (Satyavani et al., 2011). Due to a lack of local disposal options, agro-vets and farmers are unable to safely dispose of pesticide containers. As a result, sellers may be forced to bury the containers in the field or dispose of them in nearby water streams (Khooharo, 2008). An even greater risk exists when waste products are stockpiled in warehouses. In Amlekhgunj, Nepal, for example, children near a warehouse storing 50.9 MT of obsolete pesticide reported symptoms such as reduced concentration, dizziness, eye irritation, headaches, drowsiness, skin problems, and other health issues due to the strong pesticide odor in the area (Shah & Devkota, 2009).

Inappropriate practices also include the mixing of pesticides, as seen in Ghana, where farmers combined paraquat and glyphosate to create a stronger mixture (Sarkar et al., 2021). Other problematic practices include using pesticide containers to store goods for different purposes and counterfeiting products with inadequate or misleading labels (Frezal & Garsous, 2020). The government's regulatory system has paid little attention to these areas of pesticide regulation (Sarkar et al., 2021).

**Tax on Pesticide**

One fiscal tool that can help lower the demand for hazardous products is imposing taxes or duties on pesticides. This can eliminate the price disparity between market and social costs, thereby increasing the product's actual price, reducing demand, and decreasing the production of hazardous products (Sojberg, 2005). A tax on pesticides may address externalities and promote the "polluter pays" principle. Many developing countries have exempted or subsidized the Value Added Tax (VAT) on pesticides, which increases socio-economic and environmental risks. These programs often fail to meet their intended goals of boosting production, increasing income, and reducing poverty, as smallholder farmers rarely benefit (United Nations Environment Program [UNEP], 2020).

Levying taxes or removing subsidies on pesticides, while reducing taxes on organic products, may create an incentive for farmers to either reduce their use of taxed inputs or substitute them with low-polluting alternatives. Since the price of commodities produced using taxed inputs increases, consumers are incentivized to buy less of these products (UNEP, 2020; OECD, 1998). European Union countries such as France, Denmark, Germany, and Norway have offered reductions in VAT, tax revenue benefits, and exemptions for organic inputs, which have helped promote the substitution of chemical inputs with organic farming practices. These fiscal incentives have shown positive results by encouraging the substitution of chemical inputs with organic alternatives (UNEP, 2020).

## CONCLUSION

Apart from the increased production and environmental issues caused by the continued use of pesticides, it is closely linked to social and economic systems, such as human rights, depression leading to suicides, property rights, market externalities, public harm, and profitability. These issues play a crucial role in the development of efficient, long-term public policies, as well as socio-economic development plans and programs aimed at promoting sustainable agriculture and environmental conservation. A holistic approach is needed to foster a prosperous society with a sustainable food and economic system. A stronger regulatory framework is required to ensure the responsible use of pesticides, protect human rights, and reduce associated risks. This could help promote fair competition and encourage a shift towards more environmentally friendly farming practices.

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## REFERENCES

Ahmad, M. F., Ahmad, F. A., Alsayegh, A. A., Zeyaullah, M., AlShahrani, A. M., & Muzammil, K. (2024). Pesticides impact on human health and the environment with their mechanisms of action and possible countermeasures. *Heliyon 10* (7): e29128.

Alarcon, W. A., Calvert, G. M., Blondell, J. M., Mehler, L. N., Sievert, J., Propeck, M., Tibbetts, D.S., Becker, A., Lackovic, M., Soileau, S.B., & Das, R. (2005): Acute illnesses associated with pesticide exposure at schools. *Jama, 294*(4), 455-465.

Barraza, D., Jansen, K., Wesseling, C., & De Joode, B. V. W. (2020): Pesticide risk perceptions among bystanders of aerial spraying on bananas in Costa Rica. *Environmental Research, 189*, 109877.

Bertomeu-Sánchez, J. R. (2019): Introduction. Pesticides: Past and Present. *Journal of History of Science and Technology, 13*(1), 1-27.

Blomquist, R. F. (1995): Applying Pesticides: Toward Reconceptualizing Liability to Neighbors for Crop, Livestock and Personal Damages from Agricultural Chemical Drift. *Oklahoma Law Review., 48*(2), 393.

Brandt, K., Leifert, C., Sanderson, R. & Seal, C. J. (2011): Agroecosystem management and nutritional quality of plant foods: the case of organic fruits and vegetables. *Critical Reviews in Plant Sciences, 30*(1-2), 177-197.

Cech, R., Zaller, J. G., Lyssimachou, A., Clausing, P., Hertoge, K., & Linhart, C. (2023). Pesticide drift mitigation measures appear to reduce contamination of non-agricultural areas, but hazards to humans and the environment remain. *Science of the Total Environment*, 854, 158814.

Crowder, D. W. & Reganold, J. P. (2015): Financial competitiveness of organic agriculture on a global scale. *Proceedings of the National Academy of Sciences, 112*(24), 7611-7616.

Dawson, A. H., Eddleston, M., Senarathna, L., Mohamed, F., Gawarammana, I., Bowe, S. J., ... & Buckley, N. A. (2010). Acute human lethal toxicity of agricultural pesticides: a prospective cohort study. PLoS medicine, 7(10), e1000357.

De Ponti, T., Rijk, B., & Van Ittersum, M. K. (2012): The crop yield gap between organic and conventional agriculture. *Agricultural systems, 108*, 1-9.

Embrandiri, A., Singh, R. P., Ibrahim, H. M., & Khan, A. B. (2012): An epidemiological study onthe health effects of endosulfan spraying on cashew plantations in Kasaragod District, Kerala, India. *Asian Journal of Epidemiology, 5*(1), 22.

Food and Agriculture Organization. (2023). *FAOSTAT statistical database*. http://www.fao.org/faostat/en/#data/RP/visualize

Frezal, C., & Garsous, G. (2020): *New Digital Technologies to Tackle Trade in Illegal Pesticides. OECD Trade and Environment* (Working Paper No. 2020/02). OECD Publishing. https://doi.org/10.1787/9383b310-en.

Furlong, M., Tanner, C.M., Goldman, S.M., Bhudhikanok, G.S., Blair, A., Chade, A., Comyns, K., Hoppin, J.A., Kasten, M., Korell, M., & Langston, J.W. (2015): Protective glove use and hygiene habits modify the associations of specific pesticides with Parkinson's disease. *Environment international, 75*, 144- 150.

Ghimire, K., & Arun, G. C. (2018). Trend of pesticide use in Nepal. *Journal of the Plant Protection Society*, 5, 32-42.

Hurley, P. M. (1998): Mode of carcinogenic action of pesticides inducing thyroid follicular cell tumors in rodents. *Environmental health perspectives, 106*(8), 437-445.

Karnik, A. B., Suthar, A. M., Patel, M. M., Sadhu, H. G., Venkaiah, K., & Nigam, S. K. (1993): Immunological profile in workers exposed to pesticides. *Indian J Indus Med, 39*, 110-112.

Karunarathne, A., Gunnell, D., Konradsen, F., & Eddleston, M. (2020): How many premature deaths from pesticide suicide have occurred since the agricultural Green Revolution?. *Clinical toxicology, 58*(4), 227-232.

Khooharo, A. A. (2008). *A study of public and private sector pesticide extension and marketing services for cotton crop* [PhD Dissertation, Sindh Agriculture University].Academia.https://www.academia.edu/download/72992087/ASTUDYOFPUBLICANDPRIVATE_SECTOR_PES20211017-17057-9m5nen.pdf

Knipe, D. W., Chang, S. S., Dawson, A., Eddleston, M., Konradsen, F., Metcalfe, C., & Gunnell, D. ( 2017): Suicide prevention through means restriction: impact of the 2008-2011 pesticide restrictions on suicide in Sri Lanka. *PloS one, 12*(3), e0172893.

Letourneau, D., & van Bruggen, A. (2006). Crop protection in organic agriculture. Organic agriculture: a global perspective, 93-121.

Lichtenberg, E., & Zimmerman, R. (1999): Adverse health experiences, environmental attitudes, and pesticide usage behavior of farm operators. *Risk Analysis, 19*(2), 283-294.

Losey, J. E., & Vaughan, M. (2006): The economic value of ecological services provided by insects. *Bioscience, 56*(4), 311-323.

Mishra, S., S. (2017, January 17): *Tracking decades-long endosulfan tragedy in Kerela*. Down to Earth. www. downtoearth. org. in/ coverage/ health/ amp/ Tracking-decades-long-endsosulfan-tragedy-in-Kerela-56788.

Mora, A.M., Hoppin, J.A., Córdoba, L., Cano, J.C., Soto-Martínez, M., Eskenazi, B., Lindh, C.H., & de Joode, B.V.W. (2020): Prenatal pesticide exposure and respiratory health outcomes in thefirst year of life: Results from the infants' Environmental Health (ISA) study. *International journal of hygiene and environmental health, 225*, 113474.

Morris, A. P., & Meiners, R. E. (2002): Property Rights, Pesticides, and Public Health: Explaining the Paradox of Modern Pesticide Policy. *Fordham Environmental Law Journal, 14*(1), 1- 53.

Neupane, D., Jørs, E., & Brandt, L. (2014): Pesticide use, erythrocyte acetylcholinesterase level and self-reported acute intoxication symptoms among vegetable farmers in Nepal: a cross-sectional study. *Environmental health, 13*(1), 1-7.

Organisation for Economic Co-operation and Development & Food and Agriculture Organization. (2021): *OECD-FAO Agricultural Outlook 2021-2030*. OECD Publishing.

Organisation for Economic Co-operation and Development. (1998). *The Environmental Effects of Reforming Agricultural Policies.*

Ponisio, L. C., M'Gonigle, L. K., Mace, K. C., Palomino, J., De Valpine, P., & Kremen, C. (2015): Diversification practices reduce organic to conventional yield gap. *Proceedings of the Royal Society B: Biological Sciences, 282*, 20141396.

Power, A. G. (2010): Ecosystem services and agriculture: tradeoffs and synergies. *Philosophical transactions of the royal society B, 365*(1554), 2959-2971.

Reuben, S. H. (2010): *Reducing environmental cancer risk: what we can do now*. Diane Publishing.

Sandhu, H. S., Wratten, S. D., Cullen, R., & Case, B. (2008): The future of farming: The value ofecosystem services in conventional.

Sarkar, S., Gil, J. D. B., Keeley, J., Mohring, N., & Kees, J. (2021): *The use of pesticides in developing countries and their impact on health and the right to food*. The European Parliament.https://www.europarl.europa.eu/cmsdata/219887/Pesticides%20health%20and%20food.pdf

Satyavani, G., Gopi, R. A., Ayyappan, S., Balakrishnamurthy, P., & Reddy, P. N. (2011): Toxicity effect of expired pesticides to freshwater fish, *Labeo rohita*. *Journal of Agriculture and Environment*, *12*, 1-9.

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

Shah, B. P., & Devkota, B. (2009): Obsolete pesticides: their environmental and human health hazards. *Journal of Agriculture and Environment, 10*, 60-66.

Sjöberg, P. (2005): Taxation of pesticides and fertilizers [ Masters Thesis, Lulea University of Technology].Diva Portal repository. https ://www.diva- portal. org/ smash /get / diva2: 1015547/FULLTEXT01.pdf

United Nations Environment Program. (2020). *Study on the effects of taxes and subsidies on pesticides and fertilizers*. UN Environment Docucment Repository. https://wedocs.unep.org/bitstream/handle/20.500.11822/33582/STSPF.pdf?sequence=1&isAllowed=y

United Nations. (2017): *Report of the Special Rapporteur on the right to food*.

Utyasheva, L., & Bhullar, L. (2021): Human rights perspective on pesticide exposure and poisoning in children: A case study of India. *Health and human rights, 23*(2), 49.

Weerasinghe, M., Pearson, M., Konradsen, F., Agampodi, S., Sumith, J. A., Jayamanne, S., ... & Eddleston, M. (2020). Emerging pesticides responsible for suicide in rural Sri Lanka following the 2008–2014 pesticide bans. BMC Public Health, 20, 1-8.

Willer, H., Trávníček, J., Meier, C., & Schlatter, B. (2021): *The world of organic agriculture 2021-statistics and emerging trends*. FIBL and IFOAM-organics International.

Williams, J. S., & Cooper, R. M. (2004): The oldest fungicide and newest phytoalexin–a reappraisal of the fungitoxicity of elemental sulfur. *Plant Pathology, 53*(3), 263-279.

Wilson, C., & Tisdell, C. (2001). Why farmers continue to use pesticides despite environmental, health, and sustainability costs. *Ecological economics, 39*(3), 449-462.

World Health Organization. (2023, August 28). *Suicide*.

Zentner, R.P., Basnyat, P., Brandt, S.A., Thomas, A.G., Ulrich, D., Campbell, C.A., Nagy, C.N., Frick, B., Lemke, R., Malhi, S.S. and Fernandez, M.R. (2011) Input Management and Crop Diversity: Effects on Economic Returns and Riskiness of Cropping Systems in the Semiarid Canadian Prairie. *Renewable Agricultural Food Systems, 26*, 1-16. http://dx.doi.org/10.1017/S1742170510000591

Zhang, W., Jiang, F., & Ou, J. (2011): Global pesticide consumption and pollution: with China as a focus. *Proceedings of the International Academy of Ecology and Environmental Sciences,1*(2):125-144.