

## The Impact of Synthetic Pesticide Applications on Public Health

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### ABSTRACT

*Pesticides are considered as a savior of farmers in the implementation of agricultural cultivation. The practical and effective nature of using pesticides makes it easier for farmers to eradicate plant pests. The existence of a synthetic insecticide, namely DDT (Dichoro Diphenyl Trichlorethane), became a revolution in pest control techniques, which rely on the use of pesticides. Pesticides can increase agricultural production and other supporting commodities such as fisheries and livestock. Large-scale agricultural producers to small farmers with a narrow area are depend on pesticides. However, it also causes damage to the pest ecosystem based on the food chain. It has an impact on human health, such as disability, growth disorders, and even death. Human health and environmental issues related to pesticide handling are often reported in the largest synthetic pesticide user countries, including Indonesia. The accumulation of chemical pesticide compounds causes environmental pollution residues, due to their use in the community. On the other hand, farmers and agricultural actors very often neglect the use of adequate personal protective equipment and safety labels. Based on the very broad impact of pesticides on health, preventive measures are needed to help them so as not to experience pesticide poisoning, including regulation of Pesticide Tolerance Limits for pesticide products that will be traded, and providing information/counseling about pesticide applications in a measurable and safe manner. Proper direction and use are needed in the use of doses, concentrations, timing of pesticide application, and safe use with discipline in the use of Personal Protective Equipment (PPE).*

**Keywords:** pesticides; residu; human health.

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### INTRODUCTION

The term pesticide is a combination based on two words, namely *pest* (harmful insect) and *cida* (killer). Pesticides are a chemical essence that is used as a pest killer. Decree of the Minister of Agriculture of the Republic of Indonesia Number 434.1/Kpts/TP.270/7/2001 states that pesticides are all chemical substances or other materials along with microbes and viruses used for; eradication or prevention of pests, diseases and weeds destroying plants, plant parts, or agricultural products, killing leaves and preventing unwanted growth, regulating or stimulating plant growth or plant parts (but not included in the fertilizer class). Aside from that eradicating or prevention of external pests in pets and livestock and water pests, animals and micro-organisms in households, buildings, and in transportation equipment, and which are capable of causing disease in humans.

The United States Federal Environmental Pesticide Control Act states that pesticides are all or a mixture of specific substances for the eradication or prevention of disturbance by insect pests, microorganisms included as pests, fungi, bacteria, viruses, nematodes, weeds, and rodents, except that exist in humans and other animals.

Pesticides are considered as a savior for farmers in the implementation of agricultural cultivation. The practical and effective nature of using pesticides makes it easier for farmers to eradicate pests that plants they cultivate. This phenomenon has occurred since the emergence of a fundamental innovation towards the beginning of the existence of synthetic insecticides, namely Zeidler's discovery of DDT (Dichoro Diphenyl Trichlorethane) in 1874. Meanwhile, its characteristics as an insecticide were discovered in 1939 by Dr. Paul Muller (Djojsumarto, 2008). This is a revolution in pest eradication, which relies on using pesticides.

The use of pesticides and their industry has increased worldwide after 1950 which has become an icon of a country's successful development. However, happened to be contradictive since the release of Rachel Carson's book entitled *Silent Spring* in September 1962. Such book presents environmental conditions disturbed by synthetic pesticides, especially DDT, so that people have begun to become aware of the dangers of these compounds in their environment. Carson's research and findings in the field show that pesticides could increasing agricultural production and other supporting commodities (fisheries, livestock). However, while on the other hand they caused damage to pest ecosystems based on the food chain, which in turn has an impact on human health, such as disability, growth disorders, even death.

Chemically, DDT (Dichloro Diphenyl Trichloroethane) is included in chlorinated hydrocarbons or organochlorines (Tarumingeng, 1989; Marrs, 2004). In the environment, DDT is resistant to weather influences. This compound has lipophilic properties so that it can be in the lipid layers of animals and humans (Sumardjo, 2008), and after 7 to 12 years it will experience degradation (Marrs, 2004). Based on these characteristics, it is undeniable that pesticide residues have become one of the causes of poisoning for humans. This presentation aims to explain the impact arising from the application of pesticides that have been carried out for a long time, on food commodities, vegetables, and other agricultural commodities on human health in the world's largest pesticide user countries

## **METHOD**

This research is about reviewing the impact of pesticide application on food crops, vegetables, and also flowers on human health. This is done in an effort to reduce the more severe effect on the farmer's health in particular and the environment. The literature study method is used by examining the development of the impact of pesticide application on human health through related journals.

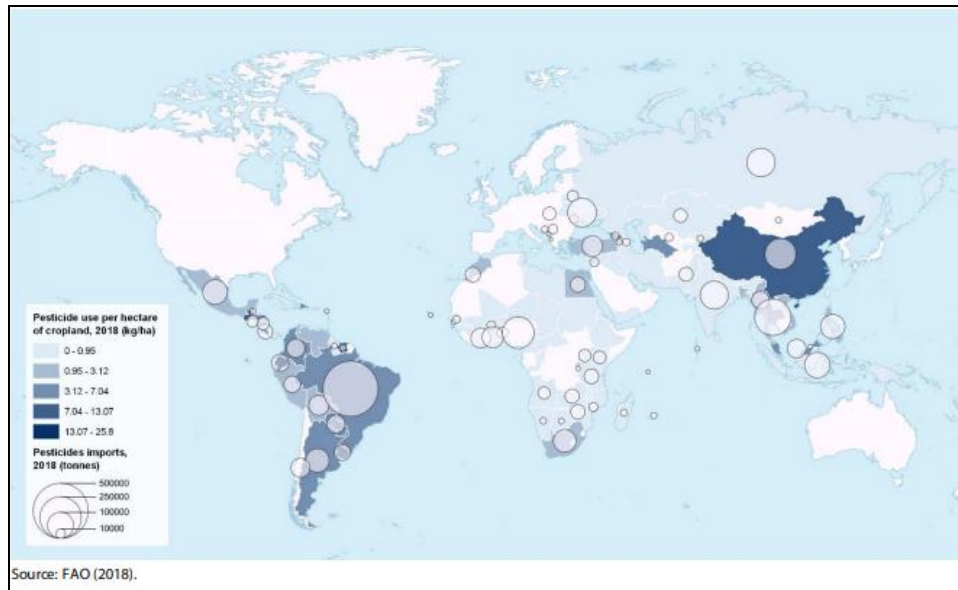
While the data collected is secondary data and is processed from journals related to the influence of pesticides on health and the environment, especially in countries that use the largest pesticides in the world. The data collected includes the use of pesticides in society, the spread of pesticides into the environment, the penetration of pesticides into the human body, the impacts arising from exposure to pesticides, and the prevention of the impact of synthetic pesticides on society, including those applied in Indonesia. The collected data and information are then validated, analyzed and interpreted. Analysis of data and information is descriptive and explanatory. The analysis is intended to explain conceptual phenomena that occur on the impact of synthetic pesticide applications on public health

## **RESULT AND DISCUSSION**

### **Use Of Pesticides In Communities**

Until now, farmers cannot be separated from the use of pesticides as part of plant cultivation. Farmers still think that the wider and more using pesticides, has a significant effect on increasing agricultural production. On the other hand, farmers do not heed the negative impacts caused by the unwise at using pesticides.

Based on the results of a studied by Sarkar *et.al* (2021) which is documented in the Directorate – general for external policies, European Union, reported that pesticides are currently a widely used tool for pest and disease management in developing countries (Figure 1). Based on the pesticide usage map in Figure 1, it shows that in 2018, Brazil was the largest pesticide user with a range of 7.04 kg/ha, and the largest pesticide importer reached 500,000 tons, followed by Argentina. Meanwhile in the Asian region, China is the largest user of pesticides, 13.07 – 25.8 kg/ha, with imports reaching 250,000 tons. Countries in Southeast Asia generally use pesticides in the range of 7.04 kg/ha with imports of 250,000 tonnes. In fact, India is an importer of pesticides, which is a little over 100,000 tons. This has happened, among other things, India is one of the largest synthetic pesticide producing countries besides China.

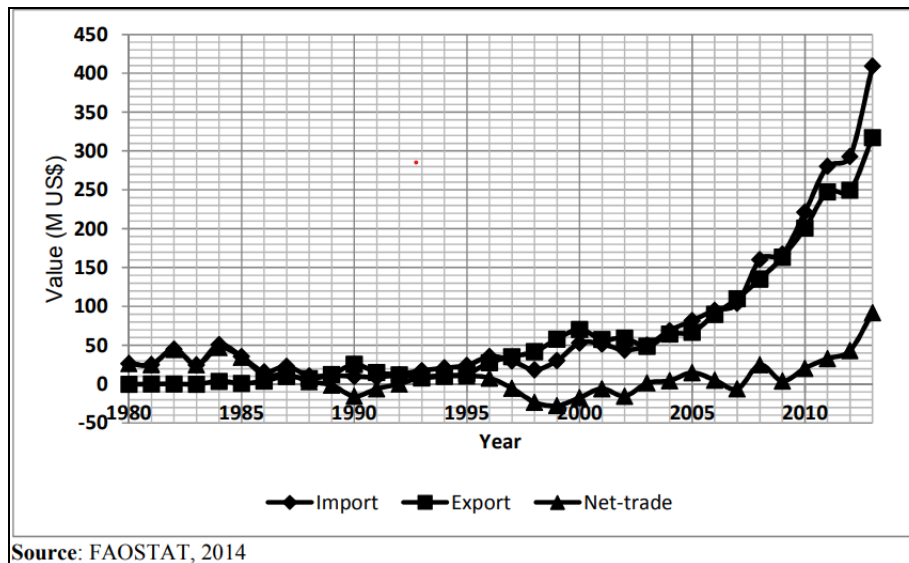


**Figure 1.** The scale of pesticide use in developing countries is taken from FAO, 2018 (Sarkar, *et al.* 2021)

At the same time, human health and environmental issues related to pesticide handling are frequently reported in these countries. This is because farmers and farm operators often do not have and use adequate personal protective equipment and may not be able to read safety label instructions. Pesticide manufacturers consider their products safe when used properly. However, this assumption is sometimes different from the reality in the field when pesticides are applied. This is a significant problem considering that large and small scale farms use pesticides to demand optimal product yields.

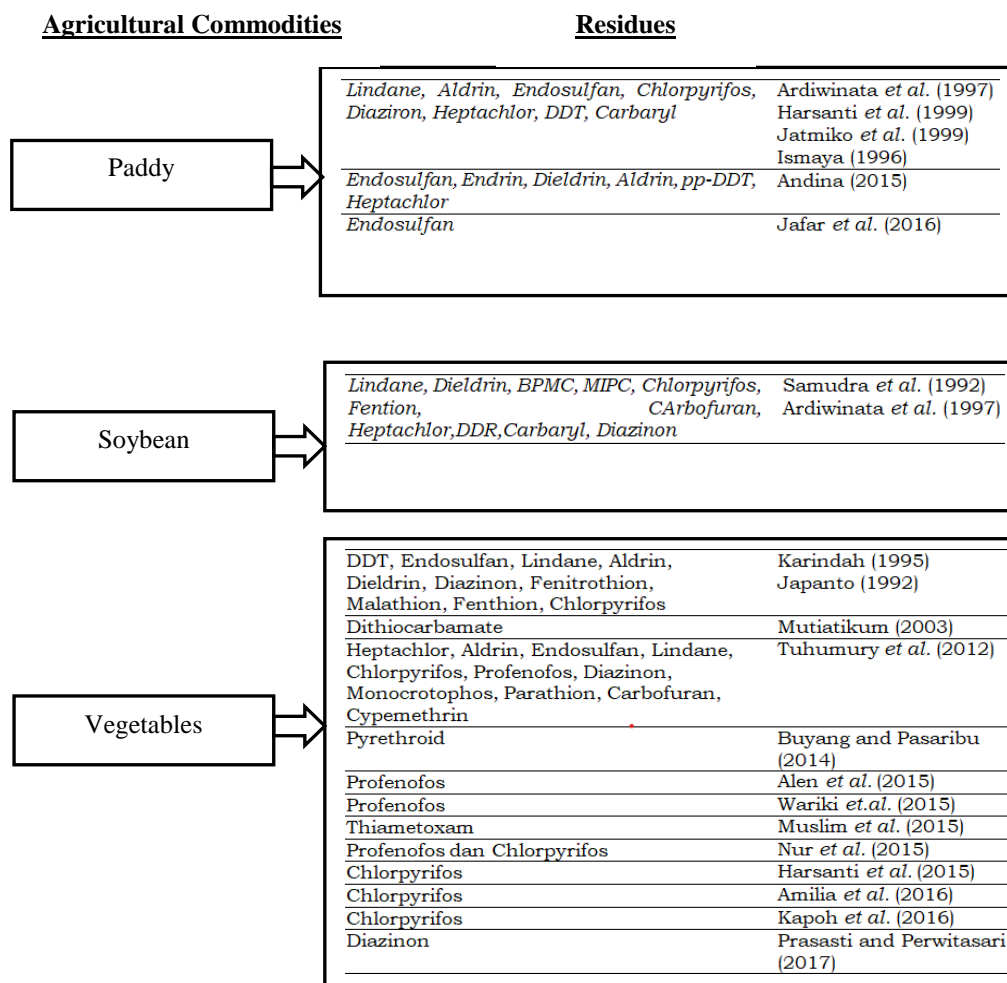
The perceived role of pesticides is to reduce uncertainty about the results of commodities obtained from agricultural/plantation cultivation. So that the use of pesticides is growing rapidly, along with agricultural intensification. Producers of agriculture or plantation on a large scale to small farmers with small areas depend heavily on pesticides. The impact of the use of pesticides has caused the government to start reducing subsidies for pesticides, along with structural adjustment policies and awareness of sustainable agriculture has begun to emerge. Currently, about two million tons are used annually globally, mostly herbicides up to 50 percent, insecticides 30 percent, fungicides 18 percent, other types such as rodenticides and nematicides (Sharma *et al.*, 2019). In addition, the results of research by Sarkar *et al.* (2021) show that regulatory approval for chemicals used in pesticides is declining, while demand is increasing in many developing countries, which together account for a quarter of global pesticide use. Industry group CropLife International (hereinafter referred to as CropLife) said that of the 6,400 crop protection products sold by its members in 2015, 15 percent were Highly Hazardous Pesticides (HHPs), as interpreted by the World Health Organization (WHO), being one of them. This is an indicator of the extent to which dangerous pesticides still exist in many countries.

In Indonesia, the use of synthetic pesticides is in line with the increase in agricultural cultivation which demands good quantity and quality of its commodities. Therefore, the need for pesticides as part of pest and disease control has also increased. Based on the report by Mariyono, *et.al* (2018) regarding the pesticide trade in Indonesia over the last three decades, it has shown a significant increase (Figure 2).



**Figure 2.** Indonesia's pesticide trade for the last three decades taken from FAOSTAT 2014 (Mariyono, *et.al*, 2018)

The graph above showed that at the end of three decades, Indonesia imported more pesticides than it exported, with a difference of around 100 million US. It indicated that Indonesia was still unable to meet domestic pesticide needs, so it requires supplies from abroad. In addition, the graph above also showed that farmers' dependence on synthetic pesticides was still large, and in line with the increase in agricultural production in Indonesia. The increase in population also demands higher fulfillment of the demand for community agricultural commodities. The use of synthetic pesticides on agricultural commodities is recognized as having a significant influence on increasing the quantity and quality of production to meet the demands of food and industrial needs in developing countries. However, on the other hand, exposure to synthetic pesticides has also caused residual effects on these agricultural commodities, which have an impact on public health and the environment.



**Figure 3.** Reported Synthetic Pesticide Residue Diagram in Rice, Soybean, and Vegetable Commodities (Ardiwinata, *et al.* 2019)

Based on the monitoring results of Ardiwinata, *et al.* (2019) on synthetic pesticide residues in rice, soybean and vegetable commodities in Indonesia, they are shown in Figure 3 above. Figure 3 is pesticide residues reported on rice, soybeans and vegetables in Indonesia. Endosulfan residues in rice plants were reported to still exist in 2016, while soybeans were reported to still contain residues of DDT, Diazinon, and 11 other types in 1997. The report by Ardiwinata *et al.*, (2019) also shows the results of research on the content of synthetic pesticide residues in horticultural commodities. Pesticide residues in horticultural commodities, the last reported in 2017 were obtained by Diazinon in these commodities. Reported research results show that DDT is also used for pest control. Even though it is well known that chemically DDT (Dichloro Diphenyl Trichloroethane) is included in chlorinated hydrocarbons or organochlorines (Tarumingeng, 1989; Marrs, 2004). In the environment, DDT is resistant to weather influences. This compound has lipophilic properties so that it can be in the fat layers of animals and humans (Sumardjo, 2008), and after 7 to 12 years it will experience degradation (Marrs, 2004). Based on the characteristics of the compound content in the pesticide, it cannot be denied that it has an impact on human health.

### Impact Of The Use Of Synthetic Pesticides In Communities

**Spread of Pesticides into the Environment.** When pesticide control is carried out in the field, penetration occurs in the environment. Application techniques with liquid formulations, fumigation (smogging), immersion or spreading of pesticides on the ground are means of entry of active pesticide compounds into water, air and soil. In addition, other activities that follow, such as washing equipment contaminated with pesticides, intentional disposal and there can also be random mixing of pesticides with other chemicals, increase the content of active pesticide compounds, especially in water and soil. This causes the accumulation of pesticide chemical compounds that cause environmental pollution. Lushchaka

*et al* (2018) reported that water contaminated with pesticides can travel through evaporation into the atmosphere, short and long distance transfers, then precipitated by rainfall. Furthermore, pesticides through surface runoff into lakes and rivers causing polluted waters. In addition, seepage of pesticides will stick to soil particles. In soil particles, it will experience degradation due to oxidation by bacteria or chemical hydrolysis, then leaching of groundwater occurs into waterways, thereby increasing the area polluted by pesticides.

**Penetration of Pesticides into the Human Body.** In nature, aquatic organisms can absorb dissolved chemicals directly from the water via respiratory organs (eg gills), body surfaces, or through ingestion of contaminated food, suspended particles, or sediment. Animals also absorb pesticides through the respiratory tract, skin surface, and/or digestive tract. Various types of pesticides also enter through the skin and nasal mucosa (Lushchaka, *et.al.*, 2018)

In the humans, the mechanism of entry of pesticide compounds into the human body is through several systems, namely absorption through the skin, oral, and inhalation. Pesticides can enter through the skin if these compounds remain on the skin for a long time. Meanwhile, intake through the respiratory tract occurs when exposed to droplets, vapors, and fine powders. On the other hand, the mechanism of pesticides in poisoning humans is affecting the work of enzymes and hormones. Enzymes and/or hormones cannot work because pesticide compounds deactivate activators (Bolognesi, 2003 *in* Pamungkas, 2016). It was further reported by Bolognesi (2003 *in* Pamungkas, 2016) that pesticides are included in the class of endocrine disrupting chemicals (EDCs), which are capable of disrupting body mechanisms. Pesticides in the body increase the production of serotonin and histamine, which cause hypersensitivity reactions and new compounds that are increasingly toxic (Bolognesi, 2003 *in* Pamungkas, 2016).

Based on the report of Bhandari, *et.al.* (2019) on pesticide residues in vegetables and human health risk assessment, it was found that residues of 23 pesticides (acaricides, fungicides, insecticides of biological origin, organophosphates, and organochlorines) were analyzed in three main vegetable crops grown in Southern Nepal. Pesticide residues were found in 93 percent of eggplant samples and in all chili and tomato samples. Some residues were present in 56 percent of the eggplant samples, 96 percent of the chili samples, and all of the tomato samples. The range of total pesticide residues ( $\mu\text{g}/\text{kg}$ ) detected in eggplant, chili and tomato were 1.71–231, 4.97–507 and 13.1–3465, respectively. chlorpyrifos and carbendazim are the most frequently detected pesticide compounds in these vegetables. Pesticide residues in the eggplant, tomato and chili samples were 4, 44 and 19 percent, respectively, exceeding the EU Maximum Residue Limits (MMR). The residues of triazophos, omethoate, chlorpyrifos and carbendazim exceeded the EU MRL. Carbendazim is more sprayed on tomato plants. Eggplant contains chlorpyrifos, triazophos and carbendazim; whereas in tomatoes there are profenofos, triazophos, dimethoate, omethoate, chlorpyrifos and carbendazim in tomatoes; as well as dichlorvos and chlorpyrifos found in chili peppers.

The impact of the using pesticides in society has been widely reported. In the case study in Malawi, the third largest use of pesticides was studied, namely in the sugarcane industry. Data were obtained based on a questionnaire of 55 sugarcane farmers who were selected purposively and seven key informants representing 1474 farmers in the Districts of Nkhata Bay, Nkhotakota and Chikwawa in Malawi (Kasambala and Eklo, 2018). The results of the study show that fifteen herbicides and insecticides with moderate indicators and one type are very dangerous based on the classification of the WHO, and these pesticides are widely used. Some pesticides containing ametryn, acetochlor, monosodium methylarsonate and profenofos are banned by the European Union. This is due to their toxicity to terrestrial and aquatic life, and/or persistence in water and soil. While most of these compounds are included in pesticides that have been used in the sugarcane industry. Furthermore, Kasambala & Eklo (2018) reported that actually 95% of farmers know the impact of pesticides on the body, and 100% know that pesticides cause pollution of the well water they consume. While the results of the questionnaire on the impact experienced by farmers due to pesticides, 78% of farmers experienced skin irritation, headaches, coughs and colds reaching 67%.

Kontip *et.al* (2018) reported on the health of farmers for the last 3 months regarding the use of pesticides based on cultivated plants, there were significant differences in the symptoms that they caused. Based on research by Kontip *et.al* (2018) it is known that symptoms such as chronic allergies, nasal congestion and flu, occur more frequently in paddy's farmers, reaching forty-four percent, compared to flower's farmers (23%). While headaches were most often reported by vegetable's farmers (55%). Reports of symptoms by farmers in the last 3 months after they used pesticides including dizziness 26%,

nausea/vomiting 13.4%, blurred vision 23%, cramps 17%, and sweating 34% were experienced by many paddy's farmers.

Country	Pesticide poisoning report	Year
Brunei	Not available	-
Cambodia	88% from 89 pesticide sprayers (33)	2010
Indonesia	129 cases (11)	2000
	317 cases (11)	2003
	21 over 117 farmers (34)	2007
Laos	Not available	-
Malaysia	10 cases (11)	2002
	14 death (11)	2005-2010
	490, 678, 841 cases (11)	2006-2009
	38 over 79 patients (21)	2008-2011
Myanmar	413 cases (25)	2004
Philippines	273 cases, 16 cases resulting in death (11)	200-2001
		2002-2009
	905 cases (35)	
Singapore	Not available	-
Thailand	49,000-61,000 cases (20)	For each year
	1427 cases (36) (pregnant woman)	2007
Vietnam	7170 cases due to food contamination:	2002
	277 death in 37 province (11)	
	35% of farmers acute poisoning and 21% were chronically poisoned (37)	2007

**Figure 4.** List of Case Reports of Pesticide Poisoning in Southeast Asian Countries (Mohammad, *et al.* 2018)

Figure 4 above is a report on cases of pesticide poisoning in Southeast Asian countries. Based on the data, it is known that Vietnam has the most reported cases of poisoning and causing death (Mohammad, *et al.* 2018). Meanwhile, there were no reports of deaths caused by pesticide poisoning in Brunei, Laos and Singapore. The above shows how powerful the toxic impact caused by the use of pesticides in agricultural cultivation is for agricultural actors and the environment, causing death.

### **Prevention Of The Impact Of Synthetic Pesticides In The Community**

Based on the wide impact of the use of pesticides on health, preventive measures are needed to help farmers and agricultural actors not to experience pesticide poisoning.

Pesticide Tolerance Limits; addressed to pesticide companies or factories that will issue and distribute their products to agricultural actors, are required to register them with the pesticide commission. In Indonesia, this is regulated in the regulation of the minister of agriculture number: 24/Permentan/SR.140/4/2011 which contains requirements and procedures for implementing pesticide registration. Meanwhile, the pesticide commission in America is handled by the Environmental Protection Association (EPA). The agency's decision in licensing the use of pesticides is based on an evaluation of the impact and use of chemical compounds. These impacts include the potential to cause adverse effects on health; defects, neurological disorders, cancer, and gene changes.

Provision of information/counseling; The results of the analysis of A'yunin, et al. (2020) it was found that the knowledge and position of extension workers had an effect on the accentuation of farmer group members in applying the Six Precise Principles of pesticide application, namely; right in terms of target, quality, time, type of pesticide, and dosage or concentration, and application technique to suppress the application of synthetic pesticides. In this case, the implementation of extension has a major role in the quality of agricultural resources. Therefore, its existence must be improved and maintained in an effort to prevent the impact of losses due to pesticides.

## CONCLUSION

In addition to having a positive impact on increasing crop production, pesticides also have a negative impact on the environment and humans. The use of pesticides has an impact on human health, such as disability, growth disorders, and even death. Symptoms that arise on human health can be influenced by the type of compound contained in the pesticide, based on the cultivated plant, the dose and concentration. Human health and environmental problems related to the handling of pesticides are often informed in countries that use the largest synthetic pesticides, including Indonesia. Based on the very broad impact of pesticides on health, preventive measures are needed to help farmers and agricultural actors not to experience pesticide poisoning, including regulation of Pesticide Tolerance Limits for pesticide products that will be traded, and providing information or counseling about pesticide applications in a measurable and safe manner. Proper direction and use in the use of doses, concentrations, time of application of pesticides, and safe use with discipline in the use of *Personal Protective Equipment* (PPE).

## REFERENCES

- A'yunin, N., Achdiyat, A., & Saridewi, T. (2020). Preferensi anggota kelompok tani terhadap penerapan prinsip enam tepat (6t) dalam aplikasi pestisida. *Jurnal Inovasi Penelitian*, 1(3), 253-264. <https://doi.org/10.47492/jip.v1i3.73>
- Ardiwinata, A.N., Lin Nuriah Ginoga, Eman Sulaeman, & Elisabeth Srihayu H. (2020). Pesticide Residue Monitoring on Agriculture in Indonesia. 12(2):133-144. <https://doi:10.21082/JSDL.V12N2.2018.133-144>
- Bhandari, G., Zomer, P., Atreya, K., Mol, H., Yang, X., & Geissen, V. (2019). Pesticide residues in Nepalese vegetables and potential health risks. *Environmental research*, 172, 511–521. <https://doi.org/10.1016/j.envres.2019.03.002>
- Djojsumarto, P. (2008). Pestisida dan Aplikasinya, *PT. Agromedia Pustaka, Jakarta*.340p
- Kasambala Donga, T., & Eklo, O. M. (2018). Environmental load of pesticides used in conventional sugarcane production in Malawi. *Crop Protection*, 108, 71–77. doi:10.1016/j.cropro.2018.02.012
- Kongtip, P., Nankongnab, N., Mahaboonpeeti, R., Bootsikeaw, S., Batsungnoen, K., Hanchenlaksh, C., Woskie, S. (2018). Differences among Thai agricultural workers' health, working conditions, and pesticide use by farm type. *Annals of Work Exposures and Health*, 62(2), 167–181. doi:10.1093/annweh/wxx099
- Lushchaka, Volodymyr I., Tetiana M. Matviishyna , Viktor V. Husaka , Janet M. Storeyb , Kenneth B. Storeyb. (2018). Pesticide Toxicity: A Mechanistic Approach. *EXCLI Journal* 2018;17:1101-1136 – ISSN 1611-2156. <http://dx.doi.org/10.17179/excli2018-1710>
- Mariyono, J., Kuntariningsih, A., & Kompas, T. (2018). Pesticide use in Indonesian vegetable farming and its determinants. *Management of Environmental Quality: An International Journal*, 29(2), 305–323. doi:10.1108/meq-12-2016-0088
- Marrs, T. C., Ballantyne, B. & Wiley, J., (2004). Pesticide toxicology and international regulation. *J. Wiley, England*.592p
- Mohammad, N., Abidin, E. Z., How, V., Praveena, S. M., & Hashim, Z. (2018). Pesticide management approach towards protecting the safety and health of farmers in Southeast Asia. *Reviews on Environmental Health*, 33(2), 123–134. doi:10.1515/reveh-2017-0019
- Pamungkas, O.S. (2016). Bahaya paparan pestisida terhadap kesehatan manusia. *Bioedukasi* XIV (1 ). 27 - 31
- Sharma, A., Kumar, V., Shahzad, B. Tanveer, M. (2019). Worldwide pesticide usage and its impacts on ecosystem. *SN Applied Sciences* 1(11)
- Sumardjo, D., (2008), Pengantar Kimia: Buku Panduan Kuliah Mahasiswa Kedokteran dan Program Strata 1 Fakultas Bioeksakta, *Penerbit Buku Kedokteran, Jakarta*.650p
- Tarumingkeng, Rudi C. (1989). Pengantar Toksikologi Insektisida. Bogor. *Institut Pertanian Bogor*.
- Sarkar, Swagata., Juliana Dias Bernardes Gil, James Keeley, Niklas Möhring, Kees Jansen, (2021). The use of pesticides in developing countries and their impact on health and the right to food. *Policy Department, Directorate-General For External Policies*. 45p