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PESTICIDES: BENEFITS AND HAZARDS

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Abstract. Pesticides are an integral part of modern life used to prevent growth of unwanted living organisms. Despite the fact that scientific statements coming from many toxicological works provide indication on the low risk of the pesticides and their residues, the community especially last years is deeply concerned about massive application of pesticides in diverse fields. Therefore evaluation of hazard risks particularly in long term perspective is very important. In the fact there are at least two clearly different approaches for evaluation of pesticide using: the first one is defined as an objective or probabilistic risk assessment, while the second one is the potential economic and agriculture benefits. Therefore, in this review the author has considered scientifically based assessment of positive and negative effects of pesticide application and discusses possible approaches to find balance between them.

Keywords: pesticides, xenobiotics, benefits, hazards, toxicity.

Abbreviations: DDT, dichlorodiphenyltrichloroethane; BHC, benzene hexachloride; 2,4-D, 2,4-dichlorophenoxyacetic acid; FAO, Food and Agriculture Organization of the United Nations.

1. INTRODUCTION

Modern agribusiness includes extensive use of pesticides in their activity and it is absolutely clear that in the near future the use of pesticides will be increased. This is due to growing consumption of food at global scale. But, food production faces different problems. For example, new approaches to cultivate and increase agricultural production from the areas are developed. Mechanization and technological advances and the emergence of new pesticides allow farmers to grow and manage bigger areas of crops with the reduced labor force [7, 29].

Ideal pesticides must act selectively against certain pest organisms without adverse effects to to non-target organisms. However, is difficult to achieve absolute selectively and most pesticides are a toxic also to humans and other non-target organisms. Pesticides are the most important reason of self-poisoning in the developing world. Three million cases of pesticide poisonings, nearly 220,000 fatal, occur world-wide every year [7, 12]. Certain pesticides can be used safely and effectively. But if proper care is not taken, pesticides can harm the environment by contaminating soil, surface and ground water, and ultimately kill wildlife.

Increase in food consumption resulted in enhanced agriculture productivity to big extent relied on extensive use of pesticides. Extensive application of pesticides allowed to prevent or to reduce

agricultural losses to pests and promoted great availability of food at a reasonable price and at any season [12].

However, modern agricultural development has led to great increase in production of agrochemicals. Therefore, pesticides are an integral part of modern life used to prevent growth of unwated species [7]. That is why, in this review the author considers objective assessment of positive and negative effects of pesticides used. In other words, this question can be formulated rhetorically: use or not use the pesticides? Certainly, the question is too radical, and obviously pesticides will be used, but how to minimise their negative effects – that is really matter of life.

2. WHAT ARE PESTICIDES?

The term "*pesticide*" indicates any substance or mixture of substances used to kill, repel, or otherwise control a "*pest*", including insects, snails, rodents, fungi, bacteria, and weeds [7]. Pesticides are used for a long time. Documented history of pesticides began in ancient Rome, but their extensive began after World War II with the introduction of dichlorodiphenyltrichloroethane (DDT), beta-hexachlorocyclohexane (BHC), aldrin, dieldrin, endrin, and 2,4-dichlorophenoxyacetic acid (2,4-D). Food and Agriculture Organization of the United Nations (FAO) defines, pesticide as any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest, including vectors of human or animal disease, unwanted species of plants or animals causing harm during or otherwise interfering with the production, processing, storage, transport or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs, or substances [12].

Pesticides can be classified by target organism (e.g., insecticides, herbicides, fungicides), chemical structure (organochlorines, organo-phosphates, carbamates, phenoxy acids), and physical state (solid, liquid, aerosol) [6]. So, depending on the chemical structure the most popular pesticides may be divided into the following groups [7, 15, 20]:

1. Organochlorines (endosulfan, hexachlorobenzene);
2. Organophosphates (diazinon, omethoate, glyphosate);
3. Carbamic and thiocarbamic derivatives;
4. Carboxylic acids and their derivatives;
5. Urea derivatives;
6. Heterocyclic compounds (benzimidazole, triazole derivatives etc.);
7. Phenol and nitrophenol derivatives;
8. Hydrocarbons, ketones, aldehydes and their derivatives;
9. Fluorine-containing compounds;
10. Copper-containing compounds;
11. Metal organic and inorganic compounds;
12. Natural and synthetic pyrethroids and others.

Any rational approach to pesticide use should include a risk-benefit comparison. Many people want to know more about pesticides, their benefits and risks for them.

3. THE BENEFITS OF PESTICIDES

The primary benefits are known as consequences of the direct pesticides' effects such as protection of people, animal and crop health and protection of recreational turf. The secondary benefits arise from primary and these are the less immediate, less intuitively obvious, or longer term consequences. Table 1 summarizes effects, primary and secondary benefits, and their interactions. The interplay between negative effects and benefits is complex and not easy to follow always.

Primary benefits	*Secondary benefits*
1. Controlling pests and plant disease vectors	**Community benefits**
Improved crop/livestock quality Reduced fuel use for weeding Reduced soil disturbance Invasive species controlled	Nutrition and health improved Food safety/security Life expectancy increased Reduced maintenance costs
2. Controlling disease vectors and nuisances organisms	**National benefits**
Human lives saved Human disturbance reduced Animal suffering reduced Increased livestock quality	National agricultural economy Increased export revenues Reduced soil erosion/moisture loss
3. Prevent or control of organisms that harm other human activities and structures	**Global benefits**
Tree/bush/leaf hazards prevented Recreational turf protected Wooden structures protected	Less pressure on uncropped land Fewer pest introductions elsewhere International tourism revenue

Tab.1. The complexity of the effects, primary and secondary benefits of pesticides [12].

Over last 60 years, farmers achieved significant progress in production of foodstuff by using pesticides. They have done this principally to prevent or reduce agricultural losses due to activity of pests which resulted in improved yield and greater availability of food, at a reasonable price and over all seasons. By the use of pesticides in agriculture, the productivity has increased dramatically in most countries. For example, wheat yields in the United Kingdom [4], corn yields in the USA [23], and total yields in the Russia and other countries were enhanced enormously [11, 21, 32].

It has been long believed that diets containing fresh fruits and vegetables far outweigh potential risks from eating very low residues of pesticides in crops [9]. Improved nutrition and reduced drudgery both improve the quality of life and longevity [16]. Improved medical care and drug treatments along with hygiene have played a significant role in extending lives, but the value of nutritious, safe and affordable food should not be underestimated as a health promoter that increases life expectancy [3, 31].

Control of wide range of human and livestock disease vectors thus reducing the number of infected individuals and deaths accompanied by prevention of international disease spread is among critical obvious benefits of broad pesticide use. Killing of vectors is the most effective method to struggle them. According to the World Health Organization [2] without access to chemical control methods life will be unacceptably dangerous for a large proportion of mankind.

Pesticides play an important role in destruction of various organisms which have a negative impact on human activities, infrastructure and the materials of everyday life. In many specific sectors of human activity, pesticides are used to control unwanted organisms, such as prevention of accelerated corrosion of metal constructions, maintain the turf on sport pitches, cricket grounds and golf courses, helping to facilitate a hugely popular pastime that provides fresh air and exercise for millions of people around the world in domestic and ornamental gardening etc.

4. HAZARDS OF PESTICIDES

Pesticide use raises a number of environmental concerns, including human and animal health hazards. Food contaminated with toxic pesticides is associated with severe effects on the human health

because it is the basic necessity of life. Over 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target species, including non-target species, air, water and soil [28].

Pesticide toxicity can result from ingestion, inhalation or dermal absorption. Continued exposure to these chemicals for a long period may result in various diseases some of which are listed below:

- Neurological, psychological and behavioral dysfunctions;
- Hormonal imbalances, leading to infertility, breast pain;
- Immune system dysfunction;
- Reproductive system defects;
- Cancers;
- Genotoxicity;
- Blood disorders.

Pesticides can contaminate soil, water, turf, and other vegetation. In addition to killing insects or weeds, pesticides can be toxic to a host of other organisms including birds, fish, beneficial insects, and non-target plants.

Recent articles and reports review toxicological and epidemiological evidences for various health effects associated with pesticides [22, 25, 26]. Extensive toxicological studies in animals demonstrate that a number of pesticides to which the general population may be chronically exposed are potential carcinogens, neurotoxins, reproductive toxins, and immunotoxins [5, 8]. González with colleagues [18] showed DNA damages under 2,4-D exposure in Chinese Hamster ovary cells (CHO). There are evidences on involvement of pesticides in development of neurodegenerative diseases [15, 19]. Many scientists reported impact of pesticides on biochemical parameters, in particular on protein metabolism [24], endocrine [13, 17, 30], and reproductive systems [1].

Pesticide contamination of both surface and ground waters can affect aquatic fauna and flora, as well as human health when water is used for public consumption [10]. Aquatic organisms are directly exposed to chemicals resulting from agricultural production via surface run-off or indirectly through trophic chains.

5. PESTICIDE ALTERNATIVES

In fact, modern agricultural business leads to environmental crisis. Excessive use of pesticides and to increase the food production may result in serious environmental "diseases". They may be grouped into two sets [29]:

1. Diseases of ecotopes (erosion, loss of soil fertility, depletion of nutrient reserves, salinization and alkalinization, pollution of water systems);
2. Diseases of biocoenosis (loss of crop, wild plant, and animal genetic resources, elimination of natural enemies, pest resurgence and genetic resistance to pesticides, chemical contamination, and destruction of natural control mechanisms).

Due to this and many other reasons, search for "safest" analogue pesticides of natural origin is for one of the most important problems of our civilization. Potential alternatives to pesticides are available and include specific methods of plant cultivation, use of biological pest controls (such as pheromones and microbial pesticides), plant genetic engineering, and methods of interfering with insect breeding [28]. Application of composted yard waste has also been used as a way of controlling pests [27].

The major alternatives to traditional chemical pesticides are listed below:

1. Natural pesticides;
2. Biological pest control;
3. Plant genetic engineering;
4. Interfering with insect breeding;
5. Application of composted yard waste;
6. Cultivation practices;

7. Release of organisms that fight the pests;
8. Interfering with insects' reproduction;
9. Soil steaming.

These methods become increasingly popular and usually are safer than traditional chemical pesticides. The polyculture (growing multiple types of plants together), crop rotation, planting crops in areas where the pests that damage them do not live and use of trap crops that attract pests away from the real crop are elements of cultivation practices [29]. Another example of an alternative to pesticide is using of other organisms that fight the pest. These organisms can include natural predators or parasites of the pests [28].

There is no enough information on the effectiveness of discussed above alternative methods, but further research in this area may help to replace chemical pesticides by ecologically friendly technologies.

6. CONCLUSIONS

Due to growing consumption of food, modern agribusiness involves extensive use of pesticides in their activity. This has led to significant progress in food production, but many problems in the field of environmental protection and health arised. The data, described in this review, on benefits and environmental-health risk assessment studies may be regarded as an aid towards a better understanding of the problems related to global using of pesticides.

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Максимів І.В. Пестициди: переваги та ризики. *Журнал Прикарпатського університету імені Василя Стефаника*, **2** (1) (2015), 70–76.

Пестициди є невід'ємною частиною сучасного життя і використовуються для запобігання росту небажаних живих організмів. Незважаючи на те, що результати багатьох наукових досліджень свідчать про низький ризик використання пестицидів та продуктів їх перетворень, суспільство, особливо в останні роки, серйозно стурбоване масовим застосуванням пестицидів у різних сферах. Тому так важлива оцінка загроз, зокрема, в довгостроковій перспективі. Насправді, принаймні, є два різні підходи для оцінки пестицидів: перший – це об'єктивна або ймовірнісна оцінка ризиків, а другий представляє потенційні економічні та сільськогосподарські переваги. Тому в даному огляді автор розглянув науково обґрунтовану оцінку позитивних і негативних наслідків використання пестицидів і обговорює можливі підходи для знаходження балансу між ними.

Ключові слова: пестициди, ксенобіотики, переваги, небезпеки, токсичність.