

Haddad, Florentina; Toma, Ioana; Nicola, Mirela Daniela; Garlea, Cristina

Conference Paper

Pro and cons opinions on use of pesticides in modern agriculture: Critical review

Provided in Cooperation with:

The Research Institute for Agriculture Economy and Rural Development (ICEADR), Bucharest

Suggested Citation: Haddad, Florentina; Toma, Ioana; Nicola, Mirela Daniela; Garlea, Cristina (2019) : Pro and cons opinions on use of pesticides in modern agriculture: Critical review, In: Agrarian Economy and Rural Development - Realities and Perspectives for Romania. International Symposium. 10th Edition, The Research Institute for Agricultural Economy and Rural Development (ICEADR), Bucharest, pp. 227-235

This Version is available at:

<https://hdl.handle.net/10419/221865>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

PRO AND CONS OPINIONS ON USE OF PESTICIDES IN MODERN AGRICULTURE –CRITICAL REVIEW

FLORENTINA HADDAD¹, IOANA TOMA², MIRELA DANIELA NICOLA³,
CRISTINA GARLEA⁴

Abstract: *With a growing population there is an increasing challenge for agriculture to produce more and more food. Use of herbicides, insecticides and fungicides in agriculture reduces the loss of crops, and increases the yield, however regarding the benefits and impact of the use, opinions are divided. Some scientists suggest that the use of these chemicals involve risks for human and animal health and is not sustainable for the environment. Other groups claim that the use of pesticides in agriculture is safe and sound and is very beneficial for human kind. Real life, nevertheless, shows today that we are facing a lot of challenges, such as: import of banned pesticides from one country to another, poisoning of people by accident, residues in food and environment, disruption of ecosystems, human and animal dangerous exposure etc. So, the aim of this paper is to review the pro and cons of the use of pesticides in agriculture and to enrich the knowledge concerning the possible impact of these chemicals on future generations and the dimension of correlated environmental damages.*

Keywords: *pesticides, agriculture crisis management, economy, trade.*

Classification JEL: *Q16*

INTRODUCTION

This article is looking to review **the Pro and Cons opinions** concerning the use of pesticides in agriculture and to enrich the current knowledge concerning the benefits and the possible negative impact of these chemicals on future generations and the dimension of correlated environmental damages.

Literature shows that there are many benefits consequently the use of the pesticides in agriculture, nevertheless there are also assessments carried out over the use of pesticides in agriculture which shows the negative impact on human and animal health, and on environment or bad experiences.

Therefore the article is questioning if the benefits of using pesticides are worthing the negative impact on the human, animal health and environment, or not?

In addition, we are also looking to identify a more realistic management approach for decisions making system in case of the use of pesticides, in order to reduce the negative impact of pesticides on the human and animal health, and the environment.

MATERIALS AND METHODS

In order to assess the Pro and Cons opinions concerning the use of pesticides in agriculture we proceeded to collect and review bibliographic data, legislative, reports, scientific materials available, worldwide, from all the stakeholders involved.

¹ Haddad Florentina, University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Biotechnology, 59 Mărăști, Boulevard, District 1, 011464, Bucharest, Romania, Phone: +40213182564, Fax:+40213182888, Mobile: 0766669752, Emails: haddad.florentina@ansvsa.ro

² Toma Ioana, University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Biotechnology, 59 Mărăști, Boulevard, District 1, 011464, Bucharest, Romania, Phone: +40213182564, Fax:+40213182888, Mobile: 0766669752, Emails: ioana.toma@madr.ro

³ Nicola Mirela Daniela, University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Biotechnology, 59 Mărăști, Boulevard, District 1, 011464, Bucharest, Romania, Phone: +40213182564, Fax:+40213182888, Mobile: 0766669752, Emails: nicola.mirela@ansvsa.ro

⁴ Garlea Cristina, CSCBA-INCE, Romanian Academy, Calea 13 Septembrie nr 13, sector 5, Bucuresti, Romania email: marianapipirigeanu@yahoo.com, cgarlea@yahoo.com

RESULTS AND DISCUSSIONS

WHAT ARE THE CONS?

WHY TO BREAK DOWN THE VICIOUS CIRCLE OF PESTICIDE USE?

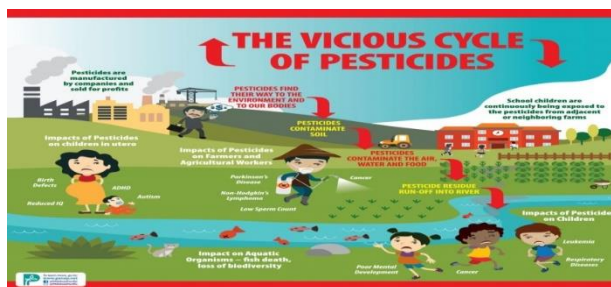
Pesticide residues resulting from the use of plant-protection products in agriculture presents risks. Today when we are talking about pesticides we linkage with routine use, significant quantities, exposure, spreading, remnants, polluting, poisoning, toxicity diseases, deaths, economical impact. Unfortunately in our days for most farmers and many other people, the treatment with pesticides of different agricultural crops **has now become rather a routine** than a last solution in rare cases of very harmful infestations. This means that on an agricultural crop, during growth season time's chemicals are applied too many times.

Some statistics data concerning the use of pesticides are showed in the tables below (6)

	Number of people using PPP in agriculture	People using PPP occupationally for public health programs	People using PPP for lawn and garden applications and in and around the home
worldwide	1.8 billion	No data found	No data found
		Quantity of PPP used/year	
United States	1 billion pounds		
worldwide	5.6 billion pounds		

In addition besides the **significant quantity** used, in some countries **the control exposure is limited or non-existent** (6). An example is that in our days in some countries (EU, USA) you can't sell pesticides without a licence in other yes. Worst since marketing through internet has established some pesticides can be bought on Internet (again India, China).

Moreover some of the pesticides have proprieties such as high volatility, solubility etc that facilitate the spread far away from the crop it is intended. In this way **they are polluting** air, water soil and consequently all the environments.



The literature cites that as many as 25 million agricultural workers worldwide experience **unintentional pesticide poisonings** each year. In United States, in the Agricultural Health Study, it was estimated that 16% of the cohort had at least one pesticide poisoning or an unusually **high pesticide exposure** episode in their lifetime Although attempts to reduce pesticide use through **organic agricultural practices** and the use of other technologies to control pests continue, exposure to pesticides occupationally, through home and garden use, through termite control or indirectly through spray drifts and through residues in household dust, and in food and water are common (6). The US Department of Agriculture has estimated that 50 million people in the United States obtain their **drinking water** from groundwater that is potentially contaminated by pesticides and other agricultural chemicals (7, 8). Children from 3-6 years old received most of their dermal and non-dietary oral doses from playing with toys and while playing on carpets which contributed the largest portion of their exposure (9-12).

In USA the **costs estimated for harm** because the use of pesticides is around **9.6 billion dollars/year**.

Harm	Annual US cost
Public health	\$1.1 billion
Pesticide resistance in pest	\$1.5 billion
Crop losses caused by pesticides	\$1.4 billion
Bird losses due to pesticides	\$2.2 billion
Groundwater contamination	\$2.0 billion
Other costs	\$1.4 billion
Total costs	\$9.6 billion

The WHO classification of pesticides by hazards is described below. The classification is based primarily on the acute oral and dermal toxicity to the rat since these determinations are standard procedures in toxicology.

WHO Class		LD ₅₀ for the rat (mg/kg body weight)	
		Oral	Dermal
Ia	Extremely hazardous	< 5	< 50
Ib	Highly hazardous	5–50	50–200
II	Moderately hazardous	50–2000	200–2000
III	Slightly hazardous	Over 2000	Over 2000
U	Unlikely to present acute hazard	5000 or higher	

Pesticides impact

Organophosphates & Carbamates:

Literature mention that organophosphates have been used worldwide **for more than 50 years**, as insecticides. The use declined in last 20 years.

These pesticides are like nerve gas; they attack the brain and the nervous system, interfering with nerve signal transmission. Symptoms include headaches, nausea, dizziness, vomiting, chest pain, diarrhea, muscle pain and confusion. In severe poisoning incidents, symptoms can include convulsions, difficulty breathing, involuntary urination, coma and death. Acute poisoning of the nervous system by these pesticides affects hundreds of thousands of people around the world each year.

3,000,000 people were exposed in USA to organophosphate or carbamate yearly, with up to **300,000 fatalities**

Figure 1

Route of entry:

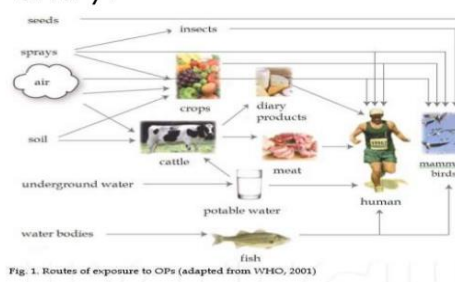


Fig. 1. Routes of exposure to OPs (adapted from WHO, 2001)

Literature indicate that **Mortality rates are from 3-25% worldwide**.

Fumigants: Fumigants like methyl bromide and metam sodium can severely injure any tissue they touch. Effects from even minor exposures can include burning and itching of the eyes and skin,

respiratory tract irritation as well as coughing and nose bleeds. Fumigants can severely injure the lungs.

Today there are regulatory restrictions on the use of soil fumigants. They have negative impact over the environment, Without control, can be emitted into the atmosphere due to its highly volatile nature. Many pesticide active and inert ingredients are also identified as volatile organic compounds (Segawa, 2008). Methyl iodide does not contribute to ozone formation. VOCs are compounds which are defined such that upon release to the atmosphere they can react with nitrogen oxides under sunlight to form harmful ground level ozone:

Organochlorines: Organochlorines are central nervous system stimulants that can cause tremors, hyperexcitability and seizures. Although these pesticides are generally less acutely (immediately) toxic than organophosphates or carbamates, since they persist in the environment and tend to accumulate in tissue as they pass up the food chain, they are extremely hazardous.

Pyrethroids: These organic compounds, similar to the natural pyrethrins produced by chrysanthemum flowers, are promoted by their manufacturers as harmless to humans, and are in increasingly wide use. In fact, pyrethroids are a synthetic copy of a natural poison. While pyrethroids are among the least toxic pesticides to humans, they are an excitatory nerve poison and known carcinogen. They are also highly toxic to insects, fish and birds, even in very small doses. While natural pyrethrum breaks down in as little as twelve hours, the synthetic forms have been engineered to be more stable, and persist in the environment for weeks.

The "Europe's pesticide breakdown: How it harms our environment" makes reviews of the use of synthetic pesticides in Europe, the serious and widely effects they have on the environment, including how they degrade some essential ecosystems and also the urgency to strengthen regulations aimed at controlling their use.

HOW THE USE OF PESTICIDES IS IMPACTING OUR FOOD SECURITY?

"Food does not know borders." With a growing global population, food security is increasingly threatened and there is a growing challenge for agriculture to produce more food, safe and sustainable.

Therefore a huge number of synthetic chemicals are produced and used in agriculture, to prevent and combat animal and vegetal disease and pests of cultivated plants. These substances are characterized by high toxicity to diseases and harmful organisms, some duration of action, persistence and simple application (1).

As a result of our pesticide dependence, and because of their persistent and ubiquitous reality, almost every ecosystem of the world has already been adversely affected by these harmful chemical compounds.

CONTAMINATION OF THE FOOD

Literature cites three categories of food contamination: physical, chemical, biological.

Chemical contamination

Many groups of chemicals contaminates may enter accidentally into foodstuffs at various stages of production or during transport, becoming the chemical contaminants of the food concerned.

Contaminants may be organic and inorganic. A special group of chemical contaminants is represented **by pesticides**.

For example in USA, more than 900 synthetic pesticides are used in more than 60,000 commercial products. In Romania approximately 3000 commercial preparations are approved for use as pesticides in agriculture.

Sometimes, small amount of pesticides used in these ways, remains in food. They are known as pesticide residues. Pesticide residues are a public health concern and have been linked to a range of diseases and disorders. To avoid the contamination of food with pesticides, farmers should use alternative methods like integrated pest management (IPM), crop rotation or organic farming.

Consumers should also consume organic food products to escape from the harmful effects of pesticides. The pesticides originated in feedingstuffs administered to animals, in water etc. Even low concentrations of pesticides in their feedingstuffs/water may result in contamination of milk because their liposolubility. They accumulate in the livestock body.

BEEES AND HONEY

Bee-toxic pesticides in dozens of widely used products, on top of many other stresses are killing our bees and threatening our livelihoods.- Steve Ellis, MN & CA beekeeper. New 'safe' pesticides to replace banned chemicals still hurt bees, scientists say.

Therefore a recent example of re-thought decisions on pesticides in the EU is on some systemic insecticides.

On 1 December 2013, E. Tyamethoxam (Syngenta product), imidacloprid and cloreanide (Bayer's products) have been forbidden in the EU due to an increasing number of scientific evidence which contest the initial positive evaluation of these systemic insecticides, demonstrating serious negative effects on bees and other pollinators.

Researchers in Switzerland asked around the world to provide locally sourced honey in order to get an idea of the extent of the threat to pollinators from pesticides. They found **neonicotinoids most frequently in samples from North America**, where 86% had one or more neonicotinoid, and least often in South America, where they occurred in 57% of samples.

IMPACT OF PESTICIDES ON THE ENVIROMENT – PESTICIDES FAILING IN TOUCHING THEIR OWN TARGET

Chemicals and pesticide compounds affects the environment and they have potentially serious consequences. In environment pesticides undergo oxidation, hydrolysis reactions which generally produce non-toxic products or reduced toxicity.

We can talk about quick decomposition in case of some pesticides, (for example, of organ phosphorus pesticides) to others decomposition is slow, so the toxicity is reduce. However, the toxicity of pesticide residues in foodstuffs is influenced, in addition to the decomposition speed, by the nature of the decomposition products, and the volatility of these pesticides, namely, is inversely proportional to them. The residual part of the product and therefore their toxicity is still influenced by others factors such as: the applied dose, the time of application, the temperature and the precipitation.

In general, a toxic action of a substance can be divided in two

- immediate and short-term effects, namely acute toxicity
- long-term effects, chronic toxicity.

The acute toxicity of a substance as such and of pesticides is expressed by lethal dose 50 (LD50) which represents the quantity of substance, expressed in mg of the substance at kilocorp causing the death of 50 % of the test organisms.

The literature indicates that the chronic toxicity is prevented by maintaining concentrations below the daily intake (ADI) for each pesticide. The maximum permitted levels of pesticides shall be determined from these dose levels by products or groups of foodstuffs, expressed in mg per pesticide/kg a food product, which is regulated.

The use of agri-chemical products is well known that pose a risk to fauna and natural environments. In particular, pesticides have a major impact on loss of biodiversity - almost one of four species (24.5 %) among vulnerable are threatened in the EU by pesticides and chemical fertilizers, such as nitrates and phosphates.

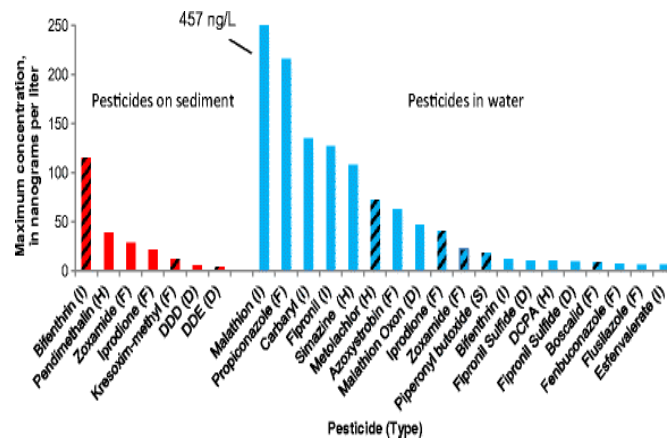
The data also shows a large-scale decline in the diversity of fauna in all groups of bodies studied. For example, 27 % of european mammalian populations are declining; although alarmingly this value could mask a much more serious tendency, as the situation of 33 % of mammalian species is not known. despite the growing evidence of serious problems produced by chemical pesticides, still :

1. no substantial policy-change or measures were taken to reduce their negative environmental effects and this may be considered a European failure,
2. children are more vulnerable to pesticide exposure

Children are more vulnerable to pesticides exposure because their organs, nervous systems and immune systems are still developing; their higher rates of cell division and lower body weight also increase children's susceptibility to pesticide exposure and risks. Most pesticide exposure occurs through the skin and children have more skin surface for their size than adults. Children have a higher respiratory rate and so inhale airborne pesticides at a faster rate than adults. With their increased contact with floors, lawns and playgrounds, children's behavior also increases their exposure to pesticides.

WATER CONTAMINATION

Rainwater usually is safe to drink. However lately has become increasingly **contaminated** due to air **pollution** in various places of the world. Then the toxic storm water runoff pollutes rivers, streams and lakes. Much of the **contamination has been demonstrated that comes from** agriculture and industry, one source being the pesticides



Maximum concentrations of pesticides in stormwater runoff. Sampling included 15 streams and 5 outfall sites, each sampled once. Bar cross hatches indicate pesticides with maximum concentrations in stormwater outfalls. Pesticide types: F, fungicide; H, herbicide; I, insecticide; S, synergist; D, degradate

WHAT ARE THE PRO? - WHY WE SHOULD NOT GIVE UP TO THE USE OF PESTICIDE?

Chemicals which inhibit or destroy harmful biological agents are defined as pesticides. These substances are now indispensable for intensive agriculture. The world necessity has led to the increase and diversification of the levels of pesticides used and of very efficient substances. In terms of both - composition and destination. Therefore pesticides are much diversified. The use of herbicides, insecticides and fungicides **reduces crop loss**, before and after harvesting, increasing crop yield. Farmers use pesticides **to control** the growth of weeds, prevent crop damage by insects, rodents and molds. After harvest, pesticides are used to **increase the storage life** and **prevent spoilage**. Pesticides may also be used on **animal farms** to control insect-pests.

More precisely, based on **their use** each type of pesticides control a specific pests, such as:

Algaecides - kill / slow the growth of algae.

Antimicrobials - control germs and microbes such as bacteria and viruses.

Disinfectants - control germs and microbes (bacteria, viruses)

Fungicides - control fungals (molds, mildew, and rust)

Herbicides kill / inhibit growth of unwanted plants (weeds)

Insecticides control insects

Insect Growth Regulators - disrupt growth reproduction of insects.

Rodenticides kills rodents (mice, rats, and gophers)

Wood Preservatives make wood resistant (insects, fungus, pests)

Other advantages

In Asthma and Allergies they help us to control indoor household pests (**cockroaches**). So, they have a say in controlling asthma and allergies.

Bacillus anthracis spores are a threat to public health. Pesticides can be used in anthrax spore decontamination

Various microorganisms (bacteria, protozoans) can contaminate hospitals, clinics, food processing facilities. etc There are many antimicrobial products registered out there intended to control microorganisms and help prevent the spread of numerous diseases.

For Avian flu and viruses in general there are antimicrobial pesticide products (sanitizers or disinfectants) that may be used to kill viruses on inanimate surfaces and to help prevent the spread of avian flu viruses (poultry industry).

IN ORDER TO PROTECT US GOVERNMENTS HAVE CREATED A REGULATORY SYSTEM FOR CONTROL THEIR USE

The establishment of the presence or absence of pollution factors in foodstuffs is a major concern of governments in order to protect consumers. Per se, the competent authorities all over the world and international bodies pursue food contaminants in food. These constitute an important task of them, including those related to international trade.

Their control must identify the presence or absence of polluting substances in the product undergoing investigation, and in the event of their presence their concentration must be determined in order to establish whether the contents are within established limits, **according to the world current knowledge**.

Having regarded the toxic nature of pesticides, consumption of products treated with such substances **pose a risk** (the products contain the substances in question or any toxic products resulting from their degradation at concentrations beyond permissible limits.

Therefore, the legal framework for the pursuit of hygiene and the safety of foodstuffs, and in particular of pesticide contents, is established by public health legislation, food production legislation, environmental legislation, legislation on the use of plant protection products, the regime of toxic and dangerous substances and on plant protection, hygiene rules for foodstuffs, hygiene standards and public health, relevant standards.

In 2013, the European Union and a few non EU countries restricted the use of certain neonicotinoids; In 2018, the EU banned the three main neonicotinoids clothianidin, imidacloprid and thiamethoxam for all outdoor uses.

Austria becomes the first Member State in the European Union to outlaw this controversial herbicide. The Vienna Parliament approved the amendment of the law by which the use of glyphosate in Austria is completely forbidden.

Determination of pesticide residues requires preliminary processing of samples:

- The extraction consists of passing the pollutant from the sample feed into a suitable solvent, which will be analyzed when it has been further processed pesticides of an organic nature are generally soluble in fats (are propellants) and organic solvents. Extraction is therefore done with organic solvents (ethyl ether, light petroleum, benzene, etc.). The hydrosoluble pesticides are extracted with polar solvents such as acetonitrile. Extraction is carried out by passing the appropriate solvent over the product with agitation and heating. An example of an extraction apparatus is the Soxhlet apparatus.
- Purification of the extracts is carried out in order to remove from the extract substances which might disturb the analysis. Purification can be carried out by repeated washing of extract with distilled water and retention by absorption of pesticides in suitable filling columns followed by desorption with appropriate selective solvents.

- The concentration is intended to reduce the volume of the samples obtained from extraction and the solvent is distilled under vacuum.
- The methods of analysis of the residual levels of pesticides are the methods of physicochemical, high-performance, which are currently widely applied in analytical chemistry in general and the analytical chemistry of particular food.

The following give a summary statement of the principles of methods:

- ✓ colorimetric and spectrophotometric methods are based on measuring the dimming of the radiation light through a layer solution of a colored compound. The decrease in intensity is proportional to the concentration of the solution. Previously, pesticides are converted by appropriate chemical reactions into soluble color compounds.
- ✓ the chromatographic methods are based on the differential absorption of the components of a mixture on the surface of the porous absorber material which they pass. there are a large number of chromatographic methods which may be grouped according to the nature of the medium to which the absorption takes place.

The main chromatographic methods are:

- ✓ Thin-layer chromatography using a layer of silica gel deposited on a glass plate subjected to a known quantity of the prepared sample and then the mobile phase (light petroleum) which produces a differentiated migration of the test components as a stationary phase;
- ✓ Gas chromatography, using a porous material saturated with a suitable substance selected and introduced into a column as the stationary phase. The stationary At this stage is driven by an inert gas (argon) which carries the sample in very small quantities. The sample components move at different speeds due to different affinity from the absorbent substance. At the end of the column, the separate components are highlighted by a detector measuring their physical properties (thermal conductivity, ultraviolet radiation absorption).
- ✓ Liquid chromatography works on a similar basis - in the gas phase but that the mobile phase is a liquid and the detector is of a construction corresponding to those conditions. A more modern and rapidly expanding version of a great degree of accuracy is that created at high pressure (HPLC - high pressure LIQUID).

CONCLUSIONS

Pesticides are the agrochemicals used in agricultural lands, public health programs, and urban green areas in order to protect plants and humans from various diseases.

However, due to their known ability to cause a large number of negative health and environmental effects, their side effects can be an important environmental health risk factor.

The urgent need for a more sustainable and ecological approach has produced many innovative ideas, among them agriculture reforms and food production.

Agriculture must be radically reoriented in the direction of viable, chemical-free methods,

- organic farming
- full use of ultrasound services,
- natural methods against vermin.
- development and selection of certain plant varieties, disease resistant, helping to reduce and even eliminate insects and harmful fungus
- crop rotation, closely planned,
- as well as diversification of agricultural systems
- the use of biculturists or multii culturists may increase significantly and reduce infestation by Pests.
- Protection of soil and reinforcement of its organic matter,

For now on it is advisable for all countries to practice large-scale ecological agriculture.

BIBLIOGRAPHY

1. Agricultural Inputs, 2013? – Grupul ETC, septembrie 2013,
2. CartelBeforeHorse11Sep2013.pdf; accesat la 23.09.2015. , Putting the Cartel before the Horse: Who Will Control,
3. Capitolul 2. Utilizarea pesticidelor în Europa.IUCN 2015, căutare în baza de date, la 09.10.2015
4. (<http://www.iucnredlist.org/search/link/56178c5c-dbe482f8>)
5. Capitolul 2., Figura 2. Evoluția populațiilor de mamifere din Europa (UE 2015a).
6. Capitolul 4. Pesticidele și păsările.
7. Capitolul 3. Pesticidele în mediul înconjurător. <http://www.pesticidesatlas.nl/>; accesat la 08.09.2015.
8. Capitolul 5. Pesticidele și organismele acvatice.
9. Capitolul 3. Pesticidele în mediul înconjurător.
10. Capitolul 5. Pesticidele și organismele acvatice.
11. Conspecte.com
12. Exposure, toxicity, and risk of home pesticide use the who recommended classification of pesticides by hazard, guideline to classificatuin 2009
13. Global Pesticides Industry 2012-2017: Trend, Profit, and Forecast Analysis, apr.2012, Lucintel
14. KIurt d. carpenter torm-event-transport of urban-use pesticides to streams likely impairs invertebrate assemblages
15. R. Davis, in encyclopedia of food sciences and nutrition (second edition), 2003,
16. pesticides found in honey around the world by [erik stokstad](#)oct. 5, 2017 , 2:00
17. Pesticides Use and Exposure Extensive Worldwide
18. www.agerpres.ro
19. www.lucintel.com/reports/chemical_composites/global_pesticides_industry_2012_2017_trends_foreacast_april_2012.aspx; accesat la 23.09.2015
20. <http://www.etcgroup.org/sites/www.etcgroup.org/files/>