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PROJECT REPORT

Practices on use and application of pesticides in Armenian village and possibilities to improve these practices

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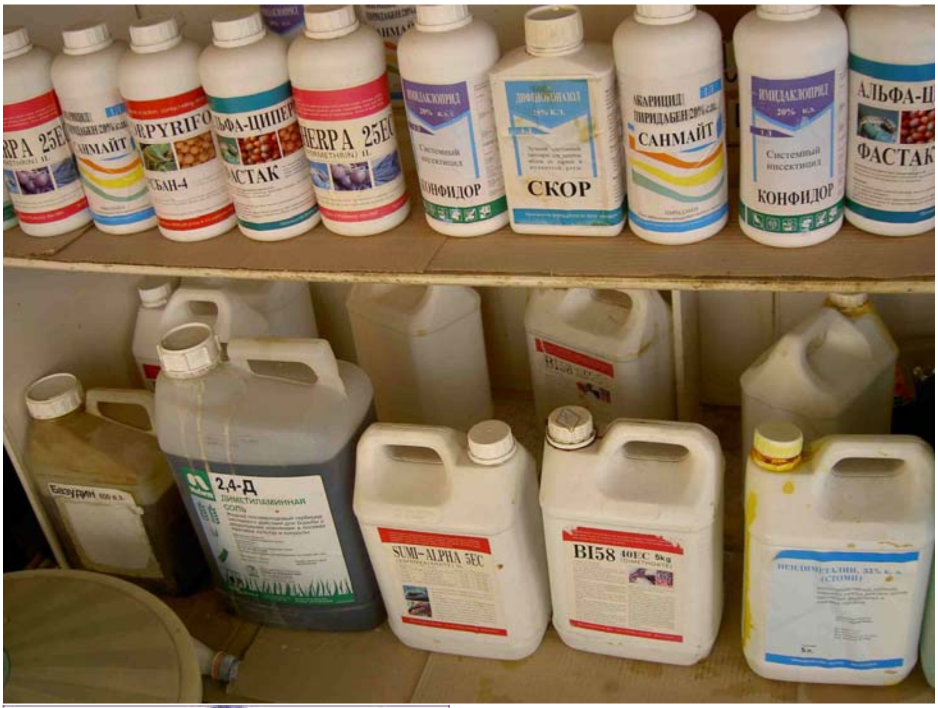

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Preface and acknowledgements

Being a very international group of students of several different MSc courses, it was a bumpy journey to finish this project. However, we are all very satisfied with the result. We all worked with enthusiasm and a bit of idealism on this project, hoping that it will be beneficial for some people in Armenia.

We would like to thank everybody that helped us with the process of making this report. First of all, we would like to thank our coach Marloes van der Kamp, for helping us with the group process and for pushing us in the right direction when needed. We further want to acknowledge the WECF, with in particular Margriet Samwel, for giving us the opportunity and financial ability to conduct this research. Emma of the AWHHE is thanked for all the help in conducting the survey in Armenia and both students are thanked for conducting the questionnaire. Finally, we would like to acknowledge our teachers of the AMC course: Ad van der Weide for useful discussions on our project proposal and Chiel Zwart for the useful lessons in communication skills.

Summary

Armenia, as a former Soviet Republic, has several developmental problems after becoming independent; problems such as poverty, educational standard, violence and a recent environmental disaster. One problem that the ‘Women in Europe for a Common Future’ (WECF) are particularly interested in, are the practices on the use and application of pesticides, since pesticide misuse is a big problem in rural Armenia. The objective of this study is to provide information about the current situation in Armenia and to develop alternatives. Our main focus is on one particular village in Armenia: Hayanist.

Background information on this problem was gained by means of literature research and a survey in Hayanist village. From the information gained, it was clear that pesticide use is a big problem, not only in Armenia but in many other countries. The pesticides have negative effects on human health and the environment. Most people in Hayanist use pesticides; they are aware of the negative effects it has on their health, but almost half of the villagers do not wear protective clothing because of the costs involved. Many villagers want to use an alternative for pesticide use, but the knowledge is lacking.

We developed a guideline for ‘Armenian Women for Health and Healthy Environment’ (AWHHE) to start an awareness program in Hayanist. In the guideline, we suggest a method of sustainable agriculture which is a combination of both integrated pest management and organic agriculture. Our prediction is that within 10 to 15 years from the start of the awareness project, the sustainable agriculture will replace all pesticides. Above, we give some short term solutions in the guideline which focus on safe use and a reduction of pesticide use.

CHAPTER I Introduction

1.1 General Information of Armenia

Armenia is the smallest of the former Soviet Republics, located in the Trans-Caucasus range. It is a mountainous country and sharing borders with Turkey on the west, Georgia on the north, Azerbaijan on the east and Iran on the south. Armenia has wide seasonal variations with a mean midwinter temperature of 0ºC and a midsummer temperature exceeding 25ºC on the plateau area. According to UNDP (2000), the population of this country was estimated at 3.1 million and the second most densely populated of the former Soviet Republics (Babayan *et al*., 2004). Due to an economic crisis during the transition period, a lot of people migrated from town to countryside, where they could gain access to some land for subsistence agriculture (Kharatyan, 2003). During the Soviet period, the Armenian people had achieved a high level of education, but during the social and economic transformation, many teenagers left school at the upper grade according the National Survey in 1995 (Poghosyan, 2005).

United Nations Economic Commission for Europe (UNECE) reported that Armenia relies on imports from Soviet for its food, including 65 percent of its demand for grain because Armenia only has little arable land; about 16 percent of the country's total area (UNECE, 2000). Before the transition - becoming independent from the Soviet Union in 1991 - Armenia was a relatively industrialized country, with agriculture playing a minor role in the economy. When Armenia was still a part of the Soviet Union, agriculture only contributed 20 percent of the net material and 10 percent of the employment. During the transition period, there was a high incidence of poverty, due to financial, physical, institutional and marketing constraints, poor infrastructure, natural disaster and violence. Furthermore, to reduce poverty, the Armenian government was preparing an agricultural Sustainable Development Strategy for food security and food safety.

During the last decade of the 20th century, Armenia transformed from an industrialized state to an agrarian country. According to UNECE, in 1994 agriculture employed 15 percent of the active population, in 1996 25 percent, and in 1997 agriculture became the largest employer in the country with 41 percent of employment (UNECE, 2000). Nowadays, rural households draw their income from a range of sources, most important is farming, which generates cash income from sales and in-kind income from own consumption (Bezemer *et al*., 2003).

Agriculture is an essential sector of the Armenian economy and recently experienced a rise of 50 to 55 percent in the share of GDP due to the sharp decline in the industrial sector. Cereal crops such as wheat, potatoes and vegetables are extensively cultivated, mainly in the foothill areas of Armenia. Intensification is a choice to increase food production, leading to the increase of pesticide use. In Armenia, as in other developing countries, there are problems regarding the use of pesticides, derived from a lack of knowledge. This leads to inefficient and incorrect application of pesticides and hence an increased risk of pollution. Often, the use of pesticides is not proportional and even harmful for the people. Soil pollution from toxic chemicals such as DDT is one of the environment current issues. In agricultural regions such as Ararat and Oktemberian, the most persistent agrochemicals are still found in soil, water and food. According to UNECE, contamination with pesticides such as DDT, DDE, dieldrin, aldrin and endrin also was found in 2.56 percent of tested products, mainly in meat, with potentially adverse effect on the human through accumulation in the food chain (UNECE, 2000). Other facts showed that breast milk of Armenian women contained traces of organochlorine pesticides (86.2 percent), 59 percent contained traces of both DDE and lindane and 26.6 percent contained either DDE or lindane according to the results of studies in 1993-2003 (Tadevosian, 2004). These facts prove that the use of unauthorized pesticides and illegal import because of weak policies is also a major problem in Armenia. Dealing with the problems regarding the use of pesticides, awareness of properly targeted and limited use of pesticide, respecting human health and the environment needs to be raised in the rural areas of Armenia.

1.2 Objective

1.2.1 Purpose

The overall objective of this study is to provide information for improvement of human health and environment in rural Armenia. Human health and environment can be improved by responsible pesticide use and introduction of alternatives for pesticides.

The main objective of this project is to provide guidelines to improve the pesticide practices in a small village in Armenia: Hayanist. Our aim to achieve this objective is to provide information about the current pesticide practices in Armenia and the impact these practices have on human health and environment. The next aim is to get an overview of the existing Armenian laws related to pesticide application and our final aim is to provide information about different alternatives for pesticide use and to develop specific alternatives for Hayanist village.

1.2.2 Output

As a result of this study, we want to provide WECF (Women in Europe for a Common Future) and AWHHE (Armenian Women for Health and Healthy Environment) with a guideline to improve pesticide practices in Hayanist. Our objective is to raise the awareness of the villagers and consequently raise health and environment in Hayanist village. The information in this report and the guideline provided for Hayanist village will hopefully be useful to raise awareness and change practices in other regions of Armenia and countries with similar problems.

CHAPTER II Background Information

2.1 Pesticides in Armenia

The use of pesticides in agriculture is one of the persistent organic pollutants (POPs) contamination sources in Armenia. The POPs contaminations cause both environmental and health problems based on several studies. One of the studies detected the traces of organochlorine pesticide (HCCH and DDE) in Lake Sevan during 1996-1999 even though HCCH was already banned since 1981 (Tadevosian, 2004). The studies of POPs traces detection, conducted in 2003, also confirmed that the levels of POPs contamination in environment are high enough to expect the migration from environmental media to food products and living organisms (Tadevosian, 2004).

The use of the most hazardous organochlorinated pesticides (DDT, pentachlor, heptachlor) has been banned and DDT was already prohibited in agriculture since 1970, however, the studies have shown that contamination of both local and imported food with organochlorinated pesticide is still present. There are also data on the presence of DDE and gamma-HCH in breast milk of women in rural area of Armenia (Aleksandryan & Tatesvoyan, 1998).

Due to urgency of POPs contamination problems in the environment and their migration to living organisms, the Armenian government has to elaborate a program on identifying and reducing POPs sources. In this report, we will also give an overview of pesticide problems in several other Central and Eastern European (CEE) countries which have from our point of view similar problems as Armenia.

2.2 Pesticide use in other countries

Central and Eastern European (CEE) countries such as Bulgaria, Czech Republic, Hungary, Poland and Slovenia have similar problems in agriculture due to political changes which bring impact on reduction of agricultural productivity. Before the accession to the European Union (EU), the use of pesticides in CEE countries was very low compared to Western European Countries. But nowadays, the accession of CEE countries to the EU leads to agricultural intensification and therefore increased use of pesticides (PAN Germany, 2004). Incorrect use of pesticide due to poor knowledge, lack of operator training, the use of unauthorized pesticides, illegal imports and poor storage of pesticides are also major issues in CEE countries. In this report we will give an overview of pesticide use in some CEE countries.

2.2.1 Slovenia

Agriculture is less important for Slovenia compared to other CEE countries due to disadvantageous of its natural condition for agriculture. At the beginning of the 1990s total pesticide use in Slovenia decreased, but over the last years total pesticide use has been increasing due to intensification of fruit and vegetable growing. According to GIS

(2003), average use of pesticide product in 2000 was estimated at 3.1 kg/ha of agricultural land (PAN Germany, 2004).

According to Neumeister (2003), 240 pesticides were authorized in 2000, 19 of them classified as highly hazardous (acute toxicity, WHO), 30 substances were toxic (acute toxicity, EU), 17 pesticides were possibly carcinogenic (carcinogenicity category 3, EU) and 6 possible mutagenic (mutagenicity category 3, EU), and 99 pesticides were dangerous for the environment (PAN Germany, 2004). In 2002, the evaluation of 406 registered pesticide products was done and showed that five active ingredients of pesticides (vinclozolin, thiram, linuron, atrazine and alachor) that are characterized as endocrine disruptors of high concern according to EU, were still available and possible to buy in Slovenia. The most dangerous poisons of organophosphorus insecticide (azinphos methyl, demeton, diazinon, dichlorvos, methidathion and parathion) are still allowed in Slovenia (Komat & Pretnar, 2003 in PAN Germany).

Ministry of health report (2002) showed that pesticide residues up to maximum residue limit (MRL) were determined in 69 samples of food (41.1 percent) and in 33 samples of agricultural products (21.9 percent) (PAN Germany). The threshold value of atrazine and desethyl-atrazine was found in four sampling places in 2003 (MESPA, 2003 in PAN Germany). MESPA (2003) also found that bromacil which is not on the list of authorized pesticides was higher than the limit in a well of the village pump.

2.2.2 Slovac Republic

Slovak Republic (SR) is characterized as rural country according to EUROSTAT statistics and about 48 percent of its population lives in rural areas. In this country, structure of farming is dominated by large cooperate farms. Farmers which hold over 10 ha are required to report pesticide use data. Nowadays, the use of pesticides has increased with 17 percent compared to pesticide use in 2001.

Department for Plant Products and Animal Products of State vetinary and food products are responsible of pesticide residues (PRs) controlling in Slovak Republic whereas Slovak Hydrometeorological Institute (SHMU), Departments for Groundwater and Department for Surface Water Quality are responsible to control pesticide residues in water. In 2002, the official monitoring analyzed 39 different pesticides and found no residues exceeding the maximum residue limit (MRL), but in 2003, 54 different kinds pesticides were detected in 13,165 domestic samples, 62 different pesticides were detected in 7,734 imported product samples and in 16 cases residues exceeded the maximum residue limit according to official food and feedstuffs control. Pesticide residues in groundwater have been regularly monitored by Slovakia government since 1982 twice per year but since 1997 only once due to financial reasons. In 2003, the Slovak government also conducted regular monitoring of pesticide residues in 60 places which were chosen by their level of agricultural intensity (PAN Germany, 2004).

In order to implement the Stockholm POPs treaty (2001), Slovakia government supported by UNDP conducted investigation concerning POPs pesticides (aldrin, dieldrin, DDT, DDE, HCB, heptachlorine, Mirex) in all different environment. This investigation showed the decrease of POPs residues in Slovakia environment.

2.2.3 Poland

Agriculture plays an important role in the economy of Poland. This country has about 59 percent arable land, but Polish soils are quite poor in fertility. About 38 percent of the Polish population lives in rural areas and 19 percent of them work in agriculture. The environmental conditions in Poland are healthy due to low usage of pesticides and fertilizers. Therefore, arable land could be converted into organic agriculture quite easily. However, nowadays, there is a tendency to intensify agriculture production due to structural changes.

The use of pesticides in Poland is very low compared to industrialized EU countries, but it is different for each region and it depends on the farm's size. Poland started a new pesticide residue monitoring system in 2002, which was a four-year-cycle of monitoring 10 of the most important Polish crops (potatoes, cereals, legumes, sugar beets, etc). This research showed that Poland is divided in terms of pesticide use with the very high amount of pesticide product in Western part (6 kg/ ha) and very low in eastern part (1.5 kg/ ha). The main pesticide problem in Poland is the old forgotten storage places which lead to environmental damage caused by leaching of pesticides into the groundwater.

Poland also harmonized its policy related to pesticide issues with EU legislation. Technical conditions and safety rules during storage and handling of plant protection products are also implemented from FAO recommendation (PAN Germany, 2004)

2.2.4 Hungary

In Hungary, agriculture contributed to 4.2 percent of the gross added value in year 2000. Agriculture also plays an important role in the trade balance in 1990s and in preserving the rural value. Above, it plays an important role in developing the rural areas and reducing social problems and regional disparities (PAN Germany & CES, 2004)

In Hungary, pesticide use has been very low over the last decade due to economic transition and financial difficulties in the agricultural sector, but nowadays pesticide use starts to rise due to accession of Hungary to EU which makes Hungary intensify its agriculture.

Hungary was recognized as one of the pesticide producers worldwide until the beginning of the 1990s and produced about 60 out of the 200 most important pesticides. But in the last decade Hungary became an importer of pesticides and due to the high price of this import, pesticides contributed to the low level of their use and high rate of illegal use. Hungary is included in the least polluted countries in Europe regarding the Persistent Organic Pollutants (POPs). The Hungarian government has been conducting pesticide residues monitoring in surface and ground waters since 1976 in the frame of the National Environmental Health Program. This research found that from 62 sample points, 21 pesticides were analyzed, 8 pesticides were found and in 8 cases it exceeded the EU limits. For pesticide residues in food, in 60 percent of the analyzed home produced food, no measurable residues were found and only 1 percent was above the Maximum Residue Limit (MRL) (PAN Germany & CES, 2004).

2.2.5 Turkey

Turkey is a border country of Armenia on the west side and it exhibits the ecological characteristics of Europe, Asia and even Africa. Nowadays, Turkey develops into an industrializing country, even though agriculture still plays an important role in its economy (Besbelli, 1998). The cultivated area is continuously reducing in Turkey and to obtain the highest yield per unit area they therefore use different methods such as biotechnology and also chemical control (Burçak& Kaya, 2005).

Insecticides contributed to 47 percent of pesticide in Turkey followed by herbicide (24 percent) and fungicide (15 percent). All pesticides in the POPs list, such as dieldrin, aldrin, endrin, heptachlor, chlordane, DDT, toxaphene and HCB were all banned. In 1995, the most frequent cause of pesticide poisoning is accidental (55 percent), followed by intentional self poisoning around 30 percent. Organophosphosphorous are the main cause of poisonings, followed by pyrethroids and organochlorine.

2.3 Introduction of Hayanist village

2.3.1 General information

Hayanist village is situated at a crossroads of major highways in the valley of Ararat, about 15 kilometers from the capital Yerevan. Hayanist has a secondary school, kindergarten, medical care centre with pediatrician, therapist, dentist and midwife and a village council.

The village was inhabited during Sovjet times by Azeri (people from Azerbajdzhan), but after the conflict in 1988, Azeri people moved to Azerbajdzan en Armenian refugees moved to Hayanist. Nowadays, 90% of the population are refugees and 10% are native Armenian people. The majority of the approximately 2500 inhabitants are pensioners. Almost half of the families that lived in Hayanist migrated abroad recently, mostly to Russia. The majority of the refugee population in Hayanist used to work in manufactures, service delivery fields and construction works. These enterprises collapsed or were shut down after 1992-1993 and people did not have learned how to organize farming. The majority of refugees are Russian-speakers causing problems when they, for example, want to start their own business, because they cannot read the laws of Armenia.

The majority of the population lives under the poverty line. 30-40% of the households are very poor (extremely low pensions) and it is most likely that these people are suffering from malnutrition.

2.3.2 Agriculture

Agriculture is not a profitable activity in Hayanist due to several reasons. First of all, there is an urban population living in Hayanist now, meaning that there are no skills in agricultural practices. Unfortunately, the traditions of agricultural activities for this specific area have not been transmitted to the current inhabitants. Second, the soil in

Hayanist is not suitable for agriculture due to high groundwater level (0.3 m) and high salinity of the soil.

There is one part of the village where the soil seems to be better and the people who live there grow vegetables (tomato, pepper, egg-plants, cucumber) and a few of them wheat in their fields and gardens. The production is mainly used for own consumption. There is a drainage system in the streets and the fields for irrigation; however, due to lack of caretaking, these are not functioning well. 80% of the villagers are engaged in cattle breeding. The primary source of income for the households is considered to be cattle breeding and vegetable sales are secondary income. The products are sold in Yerevan to middleman traders for very low prices. The dairy products are usually sold by themselves by going from home to home. The women in Hayanist are mainly responsible for the sale of the products, since the common opinion is that such a small-scale trade is not honorable for men.

Within the grocery shops, agricultural products that are produced in the village are sold. Many families have old people that are unable to cultivate land. The majority of goods are bought from shops on money sent by migrant relatives working outside the country.

2.3.3 Health and hygiene

People from Hayanist drink the water from 17 artesian wells; many households are connected to these wells. Officially, this water was meant as irrigation water. This means that there is no special treatment of the drinking water and no protection zones near the water sources. Regular outbreaks of diarrhea are reported, probably due to poor drinking water and poor hygiene. People cannot afford to visit a doctor; medical care is free until 7 years of age.

There is no central sewage system in Hayanist. The majority of the households have pit-latrines with depths less than 1 meter due to high groundwater level. Most pit-latrines are not sealed, which means that ground water gets easily polluted with faecal material. There are a few flush toilets, but the waste water goes directly without any treatment into the drainage system, which is used for irrigation. The people of Hayanist have a very low awareness about the influence of the state of hygiene and the quality of drinking water on their health.

2.3.4 Pesticide use

It is very common in Hayanist village to use pesticides; these are mainly used for vegetables, including potatoes. In a socio-economic survey on the use and handling of pesticides in Hayanist, the interviewed villagers mentioned many different pesticides. Mostly used are ‘Karate’ and ‘B-58’, other pesticides mentioned are ‘Metaphos’, ‘DDT’, ‘Chlorophos’ and ‘Diametoat’. According to the saleswoman of the agricultural kiosk, the mostly sold pesticide is ‘Durzban’. More details about these pesticides can be found in appendix 2.

Two thirds of the interviewed people use pesticides every season in their garden. On average, they apply 3-5 times per season. The awareness of the villagers about the handling of pesticides is very low. Only less than one third of the interviewed villagers that use pesticides, wear protective clothing, and almost half of the respondents were complaining about their or their family's health.

2.4 General information about pesticides

2.4.1 Definition and pesticide names

Pesticides are physical, chemical or biological agents intended to prevent, destroy, repel and mitigate undesirable plant and animal pest or disease caused by micro-organisms. Though they often are misunderstood to refer only to insecticides, the term pesticide also applies to herbicides, fungicides, and various other substances used to control pests. Most pesticides are synthetic substances or a mixture of substances that can affect the harmful pest animals and micro-organisms through feeding, direct contact or other kinds of effective exposure during growth stages. Furthermore, they are harmful to human and environment (EPA, 2005).

Because the full chemical names of pesticides are difficult to remember and read, a code name is normally used. The code name might be a shortened version of a full chemical name, referring to the active ingredient that controls the pest. Another common name that is often given is a shorter name of the chemical structure. For example, carbaryl is the common name for 1-naphthyl N-ethylcabamate. At last, different pesticide companies can produce different pesticides with the same active ingredient, in this case, several trade names are given for same active ingredient, but also the same common name are marked on different pesticides products with the same active ingredient (FAO, 2005). These pesticide names have been agreed and standardized internationally.

2.4.2 Categories of pesticides

There are three different categories for pesticides. These three categories are classified to target organisms, to compounds and to their working mechanism. These three categories are not independent and sometimes have overlap with each other.

The first category divides the pesticides in the target organism they focus on. All the different categories are presented in table 2.1.

Table 2.1
Classification of pesticides to their target organism (EPA, 2005)

Category	**Activity**
Algicides	Control algae in lakes, canals, swimming pools, water tanks, and other sites
Antifouling agents	Kill or repel organisms that attach to underwater surfaces, such as boat bottoms
Antimicrobials	Kill microorganisms (such as bacteria and viruses
Attractants:	Attract pests (for example, to lure an insect or rodent to a trap).
Biocides	Kill microorganisms
Disinfectants and sanitizers	Kill or inactivate disease-producing microorganisms on inanimate objects
Fungicides	Kill fungi (including blights, mildews, molds, and rusts).

Fumigants	Produce gas or vapor intended to destroy pests in buildings or soil
Herbicides	Kill weeds and other plants that grow where they are not wanted
Insecticides	Kill insects and other arthropods
Miticides	:Kill mites that feed on plants and animals
Microbial pesticides	Microorganisms that kill, inhibit, or out compete pests, including insects or other microorganisms.
Molluscicides	Kill snails and slugs
Nematicides	Kill nematodes (microscopic, worm-like organisms that feed on plant roots).
Ovicides	Kill eggs of insects and mites
Pheromones	Biochemical used to disrupt the mating behavior of insects
Repellents:	Repel pests, including insects (such as mosquitoes) and birds
Rodenticides	Control mice and other rodents
Desiccants	Promote drying of living tissues, such as unwanted plant tops
Insect growth regulators	Disrupt the molting, maturity from pupal stage to adult or other life processes of insects.
Plant growth regulators	Substances (excluding fertilizers or other plant nutrients) that alter the expected growth, flowering, or reproduction rate of plants.

The second category is based on the compounds and function of the pesticide. This pesticide category is composed of inorganic compounds, synthetic organic chemical pesticides and biopesticides.

- Inorganic compounds

These are chemical compounds that can not be decomposed and have serious environmental and toxicological effects in their use. These chemicals were used in the early ages of pest control and include sulphur, lead arenate, borax and chlorates, copper and lime mixtures, and mercury elements.

- Synthetic organic chemical pesticides

Most synthetic organic chemical pesticides are produced from mineral oil products and are divided into four main types.

- Organophosphate pesticides
  These pesticides affect the nervous system by disrupting the enzyme that regulates acetylcholine, a neurotransmitter. Most organophosphates are insecticides. They were developed during the early 19th century, but their effects on insects, which are similar to their effects on humans, were only discovered in 1932. Some are very poisonous chemicals and were for example used in World War II as nerve agents. Although they have a negative effect on humans and pests, they usually are not persistent in the environment.

- Carbamate pesticides
  This category of pesticides also affects the nervous system by disrupting an enzyme that regulates acetylcholine. The enzyme effects are usually reversible. There are several subgroups within the carbamates category.

- Organochlorine insecticides
  These were commonly used in the past, but many pesticides in this group have been removed from the market due to their impact on health and environmental and their persistence (e.g. DDT and chlordane).

- Pyrethroid pesticides
  This group of pesticides was developed as a synthetic version of the naturally occurring pesticide pyrethrin, which is found in chrysanthemums. They have been modified to increase their stability in the environment. Some synthetic pyrethroids are toxic to the nervous system. (Tomlin, 2003; EPA, 2005)

- Biopesticides

Biopesticides are certain types of pesticides derived from natural materials as animals, plants, bacteria, and certain minerals. For example, canola oil and baking soda have pesticidal applications and are considered biopesticides. At the end of 2001, there were approximately 195 registered biopesticide active ingredients and 780 products. Biopesticides are divided into three major classes: microbial pesticides, plant-incorporated-protectants (PIPs) and biochemical pesticides (Copping, 2001).

- Microbial pesticides
  This group of biopesticides consists of microorganisms (e.g., a bacterium, fungus, virus or protozoan) as the active ingredient. Microbial pesticides can control many different kinds of pests, although each separate active ingredient is relatively specific for its target pest. For example, there are fungi that control certain weeds, and other fungi that kill specific insects. The most widely used microbial pesticides are subspecies and strains of Bacillus thuringiensis, or Bt. Each strain of this bacterium produces a different mix of proteins, and specifically kills one or a few related species of insect larvae.

- Plant-Incorporated-Protectants (PIPs)
  These are pesticidal substances that plants produce from genetic material that has been added to the plant. For example, scientists can take the gene for the Bt pesticidal protein, and introduce the gene into the plant's own genetic material. Then the plant, instead of the Bt bacterium, manufactures the substance that destroys the pest.

- Biochemical pesticides
  Biochemical pesticides are naturally occurring substances that control pests by non-toxic mechanisms. Conventional pesticides are generally synthetic materials that directly kill or inactivate the pest. Biochemical pesticides include substances, such as insect sex pheromones that interfere with mating, as well as various scented plant extracts that attract insect pests to traps (www.biopesticides.org).

The last category is based on the functional mechanism that is the action site of the pesticide on target organisms. They are listed in table 2.2 (Coats, 1982; Corbett *et al.*, 1984).

Table 2.2
Categories of pesticides based on their site of action.

Action Site	**Pesticides**
Nervous system	Organophosphorus compounds, *N*-methyl or *N,N*-dimethyl carbamates, pyrethroids, most organochlorine compounds avermectins, nicotine, and chlorodimeform and related compounds.
Respiration	Arsenicals, copper compounds and those which can form copper chelates, oxathiin carboxanilides, dinitroaniline herbicides (secondary site of action), dinitrophenols, pentachlorophenol, tri-substituted organotins, hydroxybenzonitriles, rotenone, hydrogen cyanide, phosphine.

Photosynthesis	Herbicides: straight chain, substituted and cyclic ureas, triazines, acylanilides, phenylcarbamates, triazinones, phenolic herbicides, nitrodiphenyl ethers. Cell growth and development: Benzimidazoles and related compounds, dicarboxamides, N-phenyl-carbamates, dinitroanilines, phosphoramidates, sulphonylureas, maleic hydrazide, juvenile hormones and analogues and precocenes.
Biosynthesis	Acylalanines, hymexazole, cycloheximide, pyridazinones, aminotriazole, thiocarbamates, imidazoles, triazoles, pyrimidines, dichlobenil, diflubenzuron, glyphosate, ethirimol, and tricyclazole.
Non-specific	Mercury compounds, sodium fluoride, captan-type fungicides, petroleum and tar oils, long-chain guanidino fungicides, chloracetanilides, chlorinated short-chain aliphatic carboxylates, alkyl *bis*-dithiocarbamates, chlorthalonil.

2.4.3 Pesticide Formulations

To improve the efficiency of the pesticide, formulation of the pesticide has to be done. Formulation means that the final form of the pesticide is established in which a pesticide can be sold for application (Boland *et al*., 2004). Formulated ingredients may include emulsifiers, dispersing agents or stabilizers, spreading or wetting agents, sticking agents etc. These are used to formulate the active ingredient as for example dusts, granules, aqueous concentrates, wettable powders and emulsifiable concentrates (Hassall, 1982). Every type of formulations has its own advantages and disadvantages. In practice, the pesticide producer always balances these and uses the most suitable formulation method to efficiently apply the pesticide function and control the target organisms. Each formulation has its own trade name and therefore, pesticides have many commercial names.

2.5 Effect of pesticides on environment

Pesticides are poisonous to unwanted organisms and the number of existing active ingredients currently used as pesticides are quite large. The majority of the pesticides have been tested to have extensive toxicological and environmental impact. It is estimated that often less then 0.1 percent of applied pesticides can reach the target organism and 99.9 percent of them are left to the environment including in the soil, air, water or nearby vegetation (Pimentel, 1995). Therefore, increasingly more attention has been paid to the pesticides impact on environment.

2.5.1 Dispersal of pesticides in the environment

When the pesticides are released into the environment, several processes are affected. Only one of these processes, pesticide degradation such as microbial degradation, chemical degradation and photo degradation, is beneficial. Other processes are harmful to the environment, most importantly drift, volatilization, leaching and runoff (Jess & Becky, 2001).

- Drifting

Drifting is the process that pesticides are carried away from the target area by wind or air and it can account for the loss of 2 to 25 percent of the applied pesticides. Drifting can spread over a distance from a few yards up to several hundred miles (Schueler, 1995).

- Volatilization

This is the process that pesticides evaporate from soil, foliage or surface waters. Fumes and vapors in the air can move away from the site of application and reach non-target vegetation or soil. It is the main dissipation route for many pesticides and it has been confirmed that up to 90% of applied pesticides volatilize from the soil and surface waters within a few days after application (Majewski & Capel, 1995).

- Leaching

Leaching is the movement of pesticides through water in the soil. Several factors influence the leaching of pesticides including the pesticide water solubility, soil structure and texture, and pesticide adsorption, the latter one being the most important. Groundwater contamination is the main problem caused by leaching.

- Runoff

Runoff is the process that rainfall and watering carries pesticides off the soil or the surface of the plant into the storm drains and nearby waterways, resulting in contamination of surface waters.

2.5.2 Contamination due to pesticides

After the above determined process related to pesticides, the environment is the main victim of the pesticide application. Contaminated soil, water, turf and vegetation can cause serious problems and it is therefore important to understand environmental contamination and where the pesticides end up.

- Soil Contamination

Soil contamination may result from direct application to soil or drift and wash-off from foliar application. Pesticides have various characteristics that determine how they behave once in the soil. Mobility, half life and persistence are the most important factors for the pesticides soil contamination. Mobility is how much a pesticide will move around in the soil; half life is the length of time it takes for half of applied substance to degrade or move away; and persistence is the length of time until all measurable residues of a substance are gone. (Jess & Becky, 2001).

- Surface and Ground Water Contamination

Surface water refers to the visible bodies of water such us lakes, rivers, and oceans. Ground water is the water beneath the earth’s surface occupied by the saturated zone. There is only little difference between surface and ground water contamination. Surface water contamination is mainly caused through runoff of pesticides from treated plants and soil. The contamination of surface water can be widespread. Pesticides can leach to contaminate ground water. The leaching of pesticides to the groundwater is affected by both pesticide and soil properties. On the soil surface or within a few inches of the soil, pesticides can be volatilized, adsorbed to soil particles, taken up by plants or broken down by sunlight, soil microorganisms and chemical reactions. Also the contamination extent is affected the geological characteristics, such us the depth of the water table and the presence of sinkholes.

- Non-target organisms

  - Plants
  Herbicides are not only produced to kill plants, but also can injure or kill non-target plants if they are directly applied on them or drift or volatilize onto them. In addition to killing non-target plants directly, pesticides exposure can cause sub lethal effects on plant through drift or volatilization onto the leaves. Exposure to certain herbicided can also reduce seed quality and increase the susceptibility of certain plants to pathogens (Locke & Moseley, 1995). This is especially a threat to endangered plant species. Besides a direct effect of pesticides, plants can also suffer indirectly from the loss of beneficial soil microorganisms that are affected by the pesticides application.

  - Insects, spiders and birds
  Insecticides have the potential to harm non-target insects such as natural enemies of the target insect. For example, one study found that exposure to Roundup can kill over 50 percent of three species of beneficial insects. Over 80 percent of a fourth species, a predatory beetle was killed (Hassall, 1988). Oxidizing herbicides can also be toxic to bees. Herbicides may hurt insects or spiders also indirectly for example when they destroy the foliage that these animals need for food and shelter. Some pesticides can be toxic for birds, they will be intoxicated by eating poisonous grains for example. Finally, herbicides also has the potential to affect birds by destroying their habitat (Extoxnet, 1996).

  - Beneficial Soil Microorganisms
  In the soil there are many organisms including fungi and bacteria, and many of these microorganisms play a positive role to help the plants grow. They also help the storage of water and nutrients in the soil, and regulate water flow and filter pollutants (Marx, 1999). Without a population of beneficial soil microorganisms, the soil degrades heavily due to a loss of nutrients. Overuse of pesticides and chemical fertilizers will change the soil population and degradation of the soil will definitely occur (Savonen, 1997).

Concluding, pesticides have the potential to contaminate every part of our environment; their residues are found in soil, in air, and in surface and ground water. Pesticides contamination cause significant risk to the environment and non-target organisms.

2.6 Effect of pesticides on human health

2.6.1 General health issues concerning pesticide-use

Pesticides are designed to kill or repel pests, however, due to their biological nature, they will also harm other organisms than their target organisms. Besides affecting non-target organisms as micro-organisms, plants, birds etc., pesticides are also harmful for humans, resulting into serious problems when they are used intensively. According to the latest estimates of WHO in 1990, a minimum of three million acute severe cases of pesticide poisonings occur each year and estimates of 20.000 unintentional deaths. This is excluding chronic pesticide intoxication (Jeyaratnam, 1990; Dinham, 1993). These figures are believed to be underestimated nowadays.

The exposure to pesticides in developing countries is worsened by the illiteracy of the people and the lack of unaffordable and/or availability of protective clothing (reviewed in Maumbe & Swinton, 2003). Above, no or poor labeling of bottles of pesticides results in a higher risk of intoxication of pesticides. For example, a citation from a survey from the WECF: *"The therapist of Hayanist informed us about cases of intoxication by pesticides when people mistakenly drank them instead of alcohol or other beverages"* (Babyak, 2005). In many third world countries, doctors and nurses have never received training to recognize, treat or prevent acute and chronic pesticide exposure (Amr, 1999).

However, problems concerning pesticide use are not exclusively a third world problem. There are many studies from all around the world that show the negative consequences of pesticide use to human health. For example, research has been conducted among farmers in the US (Stallones & Beseler, 2002), fruit tree growers in The Netherlands (de Cock *et al.*, 1995), industrial workers in China (Zhang *et al.*, 1992), cotton growers in Zimbabwe (Maumbe & Swinton, 2003) and pesticide formulators and applicators in Egypt (Amr, 1999). All studies agree on the harmfulness of pesticides for human health, showing that pesticides are a world wide health problem.

Most research focuses on the consequences of pesticide-use for reproduction, mainly for women such as foetal loss, preterm delivery, birth weight and childhood malignancy. For example, in a study in a rural area in central Poland, it was found that women that were exposed to pesticides in the first two trimesters of their pregnancy, delivered children with a lower birth weight than mothers that were not exposed to pesticides during their pregnancy (Hanke *et al.*, 2003).

Another important research topic is the development of cancer as a consequence of pesticide exposure. A number of pesticides have shown to be carcinogenic. For example, different studies argue for a link between DDT intoxication and breast cancer. However, different studies have published conflicting results (reviewed in García, 2003; Amr, 2003). Research on pesticides in Armenia also showed that there is a strong link between pesticide-use and cancer (Avagyan *et al.*, 2003).

A final important part of research is on the organophosphates, a class of pesticides that consists of highly poisonous compounds. They can be absorbed through the skin, mucous membrane, gastro-intestinal and respiratory tract. The organophosphates inhibit an enzyme, which results in a decreased functioning of the peripheral and central nervous system (Stallones & Beseler, 2001).

2.6.2 Possible health and environmental issues for Armenian villagers

As already mentioned in the introduction, 86.2 percent of the women in Armenia had traces of organochlorine pesticides in the breast milk. Of the pesticides endrin, aldrin, dieldrin, DDT, DDE and lindane, traces were found in breast milk and soil, therefore,

these are pesticides that Armenian people most likely use to control pests. All of these pesticides are organochlorines, one of the most toxic pesticides around.
Above, there are also some other pesticides are used and sold in Hayanist, as already mentioned in the introduction of Hayanist village (paragraph 2.3.4).

In literature, it is often mentioned that organochlorine pesticide levels can be very high in developing countries. High levels of, among others, DDT have been found in water, soil, fish and milk in for example Egypt. Organochlorine pesticides can cause hormonal disruptions, resulting in breast cancer. However, different studies have published conflicting results (García, 2003). Above, organochlorine pesticides have a disruptive impact on the environment, mainly on aquatic ecosystems. A complete list of all above mentioned pesticides with their impact on health and environment can be found in a table in appendix 2.

2.7 Laws about pesticide use in Armenia

Since several pesticides have negative effects to human health and environment, some organizations initiated the pesticide substances that can be safely used, such as Stockholm Treaty on Persistent Organic Pollutants (POPs) (Porta & Zumeta, 2005). This project is an international project supported by United Nation Environment Programme (UNEP) and private organizations. Eight pesticide substances are covered by this project, i.e. aldrin, chlordane, DDT, diedrin, endrin, heptachlor, mirex, and toxaphene.

There are no laws in Armenia concerning pesticide use, therefore, the yearly list of registered and banned pesticides are used (personal communication AWHHE). So far 26 kinds of pesticide are registered (Table 2.3). Eight of them have been banned due to acute toxicity and environmental impacts. The banned pesticides in Armenia are 2,4,5-T, aldrin, chlordimeform, DDT, dieldrin, dinoseb, heptachlor, and PCP (Table 2.3). Further information on these pesticide statuses in other countries are shown in table 2.4.

Table 2.3
Pesticide registration in Armenia (PAN pesticide database).

Chemical	Register for use	Banned or restricted	Consent to Import
2,4,5-T	No	Banned	No consent
Aldrin	No	Banned	No consent
Aroclor			No consent
Asbestos			No consent
Captafol (cis isomer)			No consent
Chlordane			No consent
Chlordimeform	No	Banned	No consent
Chlorobenzilate			No consent
DDT	No	Banned	No consent
Dieldrin	No	Banned	No consent
Dinoseb	No	Banned	
Dinoseb and dinoseb salts			No consent
Ethylene dibromide			No consent
Fluoroacetamide			No consent
Heptachlor	No	Banned	No consent
Hexachlorobenzene			No consent
Hexachlorocyclohexane			No consent
Lindane			No consent
Mercury and mercury compounds			No consent
Methamidophos			No consent
Methyl parathion			No consent
Monocrotophos			No consent
Parathion			No consent
PCP	No	Banned	No consent
Phosphamidon			No consent
Polychlorinated terphenyls			No consent

Table 2.4
The status of pesticides that are banned in Armenia in other countries in Europe and Central Asia (PAN pesticide database).

Country	Banned Pesticide in Armenia													
	2,4,5-T		Aldrin		Chlordimeform		DDT		Dieldrin		Dinoseb		Heptachlor		PCP	
	Registered for use	Banned or restricted	Registered for use	Banned or restricted	Registered for use	Banned or restricted	Registered for use	Banned or restricted	Registered for use	Banned or restricted	Registered for use	Banned or restricted	Registered for use	Banned or restricted	Registered for use	Banned or restricted
Armenia	No	Banned	No	Banned	No	Banned	No	Banned	No	Banned	No	Banned	No	Banned	No	Banned
Austria	No	Banned	No	Banned	No	Banned	No	Banned	No	Banned			No	Banned	No	Banned
Cyprus	No	Banned	No	Banned	No	Banned	No	Banned	No	Banned			No	Banned	No	
Denmark	No		No				No		No		No		No		No	
Estonia			No													
Europena Union	Yes		No	Banned			No	Banned	No	Banned			No	Banned	Yes	Severly restrict
Finland	No		No	Banned	Yes	Restrict	No	Banned	No	Banned			No	Banned	No	
Germany	No	Banned	No	Banned	Yes	Restrict	No	Banned	No	Banned	No		No	Banned	No	Banned
Hungary	No	Banned	No				No	Banned	No	Banned	No				No	
Kazakhatan																
Latvia																
Malta																
Netherlands	No	Banned	No	Banned			No	Banned	No	Banned	No		No	Banned	No	Banned
Norway	No	Banned	No	Banned			No	Banned	No	Banned						
Portugal	No		No		Yes	Restrict	No		No		No		No		No	
Slovakia			No	Banned			No	Banned					No			
Slovenia	No	Banned	No	Banned	No	Banned	No	Banned	No	Banned			No		No	Banned
Sweden	No	Banned	No	Banned	Yes	Restrict	No	Banned	No	Banned					No	Banned
Switzerland	No	Banned	No	Banned	No	Banned	No	Banned	No	Banned			No	Banned	No	Banned
Turkey		Banned														Banned
United Kingdom	No		No	Banned	Yes	Restrict	No	Banned	No	Banned	No	Banned	No	Banned	No	

CHAPTER III Methodology and Data

To understand the current situation concerning pesticide use in Hayanist, we conducted survey in the village. This survey was conducted by two students of the Armenian Agricultural Academy in June 2005. The questionnaire that we provided to the students can be found in appendix 1. Fifty villagers, one employer of a pesticide shop and the village doctor have been interviewed.

3.1 Survey of villagers

From the survey of the villagers, we know that the average land owned by the villagers ranges on average from 1000 to 1500 m^2 in Hayanist village. The main plants that are frequently applied with pesticides are vegetables such as potato, tomato and eggplants. Table 3.1 contains a list with all crops and their main pests. Among the 50 interviewed villagers only two villagers don't use pesticides. Most of the villagers that use pesticides give the reason that they want to protect their crop against pests and get good harvest, other answers are that they want to earn good living and get a profit. The most used pesticides are Karate, B58, Malathion and Arivo. Some of them are toxic pesticides but these pesticides are not banned according to the in PAN list of Armenia (table 2.3). More detailed information about the usage of pesticides and their prices is listed in table 3.2.

Table 3.1
Main cultivated crops and their pests according to the villagers in Hayanist

Crops	Pest
Potato	Coloradian bug
Tomato	Grilotalpha-grilotalpha (young bear), flea
Eggplant, pepper	Coloradian bug, Grilotalpha-grilotalpha (young bear), flea
Fruit trees	Flea, caterpillar
Onion, beans	Flea
Beans	Grilotalpha-grilotalpha (young bear), flea Coloradian bug
Cucumber	Grilotalpha-grilotalpha (young bear), flea
Grapes	Birds
Corn	Blach itch
Garlic	

Table 3.2
Most used pesticides in Hayanist with their price and popularity among the villagers

Pesticide (Brand)	Price	Percentage of villagers that use the pesticide
Karate(cyhalothrin)	12.7 Euro/liter	56%
B58	6 Euro /liter	40%
Malathion	6 Euro/liter	30%
Arivo	9.5 Euro /liter	18%
Metafos	12.7 Euro/liter	4%
Ridomil gold	9.5 Euro/liter	4%
Vertimeh	15.8 Euro/liter	4%
Cuprason	3.2 Euro/100gram	2%
Durspan	15.8 Euro/liter	2%

Funduzol	9.5 Euro/liter	2%
Metaphos	9.5 Euro/liter	2%

Table 3.3 contains the results of the questionnaire concerning pesticide application, awareness of risk factors and precautions taken.

Table 3.3
Results of the survey of 50 villagers concerning pesticide use, application, awareness and precaution.

Questions	Answers	Note
What is the purpose of your crop production?	54% own consumption; 4% for trade; 42% for both	
How often do you normally apply pesticides?	32% 2-3 times during vegetation; 20% 3-4 times; 14% 1-2 times; 34% one time	
How do you apply for pesticides?	40% spraying; 29% pouring with broom; 16% pouring on soil directly; 15% pollination and with water	
Who normally applies these pesticides?	48% man; 32% women; 20% both.	For man, the main reason is that is male job; for women, 31% of them is because no husband or husband is abroad.
Have you observed any illness due to pesticide exposure?	74% No; 18% Yes; 8% maybe	Only 5 villagers give symptoms: Headache; allergy; spots on face after usage
Are you aware of the health effects caused by pesticide exposure?	86% yes; 8% No; 6% a little bit	Only 6 among 86% villagers give: leaflets(1), television (1), from uncle, he is doctor(1), from everyday life(2), from examples (1);
Are you aware of the necessity of wearing protective clothing?	98% Yes; 2% No	
Do you wear protective clothing when you apply pesticides?	50% yes; 40% no; 10% sometimes	No protective clothing: 10 villagers don't because they are too expensive; one thinks it is not necessary
If your crops get a serious pest threat, do you use pesticides on all your crops?	64% on large region of crops; 37% only on local infected region	Reasons in large region: Not to infect other part (4), for general cleaning (2); In local region: Picking infected plant and throw them away (2); lack of pesticides (2); save money (4);
What is your educational level?	60% high school; 18% university; 14% primary school; 8% others	
Do you use any pest control methods besides using pesticide?	54% Yes; 47% No	Yes: Other methods including mechanical (11); by hand (8); home made pesticide; pour with cold water in fruit tree (1); diesel fuel during planting (1); with $Ca(OH)_2$ and cut dry branch (1).
Is there been any advertisement about pesticide application?	58% No; 42% Yes	Television advertisement
Do you have health complaints yourself due to pesticide application?	86% No; 2% Yes; 12% maybe	Symptoms: only one is bloody hand
Are you interested in using the IPM methods instead of pesticides?	90% Yes; 6% No; 4% maybe	Only one give reason for No: I don't have enough time

The results of survey show that males are the main persons who apply pesticides. They use pesticides more often during the vegetation with very simple application methods. Almost all of villagers know it is necessary to wear protective equipment, however nearly half of them don't wear that because they don't have enough money to buy it. After pesticides application, some of them keep left pesticides in safe places or equipment, others pour them in sewer. Although most of them know the effects caused by pesticides exposure, less of them observed symptoms caused by pesticides. The observed symptoms are only headache, allergy and spots on face. Besides pesticides application, more half of them also use other methods including mechanical method for example picking by hand and home made pesticides. Fewer advertisements are brought to villagers and the only one is television for villages to know more about pesticides application. Although most of villagers only have primary education level, they desire IPM method to control pests. This means there is more possibilities for IPM application in Hayanist in the future.

3.2 Survey of pesticides shop employer

From the pesticide shop employer, we know that pesticide shop in Hayanist has been operated three years and is profitable. All of pesticides in the shop are imported from China and the employer thinks there are no highly poisonous pesticides in the shop because he or she knows the banned pesticides by government, such as cuprazon, chlorofos and izofen. However the popular pesticides for villagers in the shop are vertimeh (abomektin), andracol (mancotsep), funtazol (benomel), arivo (supermetrin) and ridomil gold (metalaxil). These pesticides are not consistent with most used pesticides obtained from villagers. The employer knows about the health effects caused by poisonous pesticides from the literature and newspapers purchased by this shop. Customers of the shop are from Hayanist and nearby villages. When customers buy pesticides in this shop, he or she always gives advice how to apply these pesticides. He or she also thinks the best way to provide health effects of pesticides for villagers is through leaflets and labels on packing. The pesticide shop employer would like to cooperate with an awareness project to investigate pesticides impact, because this project will be helpful for the villagers in the future.

3.3 Survey of doctor

The doctor knows about some symptoms caused by pesticides application, for example headache, vomiting, rash and eruption, but he or she didn't observe any other illness except headache in Hayanist. He or she thinks there are firm relations between pesticide exposure and problems in pregnancy, breast cancer, miscarriage, reproductive health and child birth complications, but he or she also indicated that there is no serious patient caused by pesticides exposures in Hayanist. According to this survey, it is free of charge to visit the doctor in Hayanist. The doctor has already brought some information to the villagers about the negative effect of pesticides and thinks the best way to do this is through leaflets and labels on packaging. To reduce pesticide application in Hayanist, he would like to cooperate with an awareness project and suggests villagers to use IPM method to control the pests. The results of this survey of the doctor are different with previous research conducted in Hayanist, especially that it is free of charge to visit the doctor. There is no patient caused by pesticides application according to this survey, whereas in other surveys, the doctor has seen many patients with pesticide related issues. However, there might some changes about the doctor ideas and the current situation.

The surveys from the villagers, the employer of pesticides shop and the doctor give us a bright understanding of the current situation related to pesticides. Although, some information is not consistent with previous research, this information will be useful for making alternatives and the guideline. Also, this information will give a brief introduction for future projects.

CHAPTER IV Alternatives

4.1 Conventional agriculture

The mostly used farming system in the world and the farming system used in Armenia is conventional agriculture. Conventional agriculture developed along with the green revolution period. The typical characteristics of conventional farming are the dependence on the use of advanced technology instead of relying on nature, such as the utilization of synthetic pesticides, fertilizers, heavy machine and monogenic crop. Although the production of a conventional farming system gives a high output in the beginning, the yield of several crops get stabilized or slows down due to a decline in ecological functioning. Especially the reduction of soil quality and the increase in environmental pollution will result in a smaller yield during time.

The reductionistic approach influences the way of problem solving in this farming style. The problems in agriculture are sectioned into the small parts that the solutions of each problem are formulated separately. This leads to the expansion of the knowledge in only narrow aspects. Such as there are the development and application of pesticides and synthetic fertilizers, the use of homogeneity breed and crop, and the utilization of mechanization and technology. As the consequences the nature has been forgotten to take in to account.

This type of farming system is considered as unsustainable due to many reasons. The use of tillage system by the heavy machines and application of pesticides and synthetic fertilizer reduces the soil quality and ecosystem functioning. The environment is polluted with the leaching of a surplus of chemical substances. The use of mono crop and single animal breed leads to genetic erosion. Dependent on limited resources such as fossil fuel for the synthetic of fertilizer also make the future of conventional agriculture insecure.

There are many alternatives for conventional farming, which will be discussed in the following paragraphs. There are short term alternatives to start with (paragraph 4.2), which are to improve the responsibility in pesticide use. Looking at a long term alternative, we suggest two possible alternatives: Integrated pest management (paragraph 4.3) and organic farming (paragraph 4.4).

4.2 Short Term Alternatives

To reduce the impact of pesticides on users, personal protective equipments and pesticide application practices are the major factors concerned. These two factors can be done immediately and will give results soon after application of the knowledge. Also some methods of integrated pest management are easy and cheap to use in the field and give an immediate result.

4.2.1 Personal protective equipment (PPE)

Pesticides are considered as poisoned substances which not only have a direct impact on target pests, but also give side effects to other organisms, including pesticide users. To be protected from pesticides, users need protective clothing. Users have to read the labels carefully. The label provides information important for considering suitable protective clothing. The information also contains product composition, active compound, formulation, warning signal words, statement of practical treatment, and pictograms of safety and protection measures (Boland *et al.*, 2004).

The basic protective clothing is coverall, apron, water-proof raincoat, gloves, rubber boot, head cover, face shield, and safety goggles (Boland *et al.*, 2004; USDA, 2005). Respiratory equipments are also of help to prevent inhalation of pesticides. Dust mask and half face mask are the most basic equipments used widely.

4.2.2 Pesticide application practices

Good practice in pesticide application can also reduce the risk of pesticide contamination to users. Moreover, it can also reduce the impact of pesticides to environment and food web. In order to effectively apply pesticides, there are several factors that the users should take into account (Boland *et al.*, 2004).

- The right choice of pesticide products: Determination of necessity of pesticide application is as important as knowing the right pesticide for the right pests.
- The right concentration and amount: After knowing the right pesticide, the right amount and concentration of pesticides are also important to provide the maximum pesticide effectiveness for the minimum costs on non-target organisms and environment.
- The right time: Application of pesticides when target pests are at their highest activity is the best timing. However, the climatic factors such as rain, temperature, and wind are also important factors. Users should not apply pesticide when it is rainy or expected to be rain, strong sunshine, strong wind or no wind at all.
- Determination of pesticide application effectiveness. Farmers have to compare pest population in the time before and after pesticide application. In the effective application, population of pest after application should be less than 1% comparing to that before application.
- Harvest interval: After pesticide application, farmers have to provide a period of time for pesticide to degrade, before harvesting can be done. The harvest intervals are different according to pesticide intergradient.

4.2.3 Mechanical and physical control

Mechanical and physical controls are methods from IPM farming. These methods are suitable for different kinds of vegetables in the garden and small scale fields. Although they are quite simple, it is very effective on short term basis.

- Hand picking

Hand picking is to control the insects in the gardens, especially ideal for small and young plantings. Hand picking is labor intensive but an effective method to control insects large enough to be seen. This method will make the farmer familiar with all the insects in the field or garden: pest or a non harmful insect. Above, this is together a good way to monitor the crops.

- Row Cover

A floating row cover can keep insects away from the planting. It is not expensive for the garden farmers who want to cut back off the use of pesticides. The cover is very light-weight materials which is laid over the rows leaving enough slack in them so when the plants grow, they push the row cover up. Sunlight and water can get through the cover easily. The cover can prevent most of the common vegetable pests. The material works by excluding the adult female and preventing them from laying eggs on or near the crop. It stops the development of larva and pupae that need soil for completion of their life cycle and keep them from further spreading. There is also another advantage, which is that the cover can let the sunlight, rain and air reach the crop and protect the crop when the temperature dropped at night. The minimum temperature that float row cover can protect is depends on the thickness of the cover.

- Trap pest

It is possible to use the stick board or card in the garden or greenhouse to trap winged insects. By using this method, the farmers can also check the kinds of the insects in the garden (Kogan, 2000).

More information and practical knowledge about short term alternatives can be found in the guideline.

4.3 Integrated Pest Management (IPM)

4.3.1 Definition

"*Integrated pest management (IPM) is a pest management strategy that focuses on long-term prevention or suppression of pest problems with minimum impact on human health, the environment, and non-target organisms. Preferred pest management techniques include encouraging naturally occurring biological control, using alternate plant species or varieties that resist pests, selecting pesticides with lower toxicity to humans or non-target organisms; adoption of cultivating pruning, fertilizing, or irrigation practices that reduce pest problems; or changing the habitat to make it incompatible with pest development* "(Flint 1991).

This is the definition of IPM from Flint *et al.* in 1991, and it is a good way to define IPM from our project's point. However, the knowledge and methods of IPM are developing very fast nowadays, so that is not suitable for the real IPM now. Till now, there is no definition which can conclude the factors of IPM completely, most of them pay more attention on the perception of entomology in IPM because of the emphasis on pest populations and economic injury levels (Sorensen, 1994). Furthermore, most definitions think that the important things are the use of combinations of multiple control methods, ignoring informed inaction that in some cases can be a better IPM option for arthropod pest management (Sterling, 1994). A numerical analysis of the key words suggests that we attempted to capture the concept's essence in terms of (a) the appropriate selection of pest control methods, used singly or in combination; (b) the economic benefits to growers and to society; (c) the benefits to the environment; (d) the decision rules that guide the selection of the control action; and (e) the need to consider impacts of multiple pests.

IPM has a number of control tactics which can be combined to an integrated pest management strategy. In the following paragraphs, these different control tactics will be discussed.

4.3.2 Biological control

Biological control is a component of an integrated pest management strategy. It is defined as the reduction of pest populations by natural enemies and typically involves an active human role. All pests are suppressed by natural organisms and environmental factors, with no human input. Not only biological control of insects but biological control of weeds and plant diseases is also included. Biological control agents of plant diseases are most often referred to as antagonists. Initially, biological control was used to manage pests that had become resistant to pesticides and it is commercially applied on large areas in various cropping systems worldwide. Now it is applied for reasons of efficacy and cost, which are comparable with conventional chemical control (van Lenteren, 2000).

Natural enemies of insect pests, known as biological control agents, include predators, parasitoids, and pathogens.

- Parasitoids

  This wasp is laying its egg inside an aphid where its young will develop. The immature parasitoids develop on or inside a host, killing it as they mature. They emerge as adults and continue the cycle.

- Predators

  Lady beetles are well-known examples of predatory insects. A predator consumes many preys during its lifetime.

- Pathogens

  The use of pathogens is also a way to kill the pests. Nematodes are often used for this, but other pathogens may include bacteria, viruses, fungi and protozoa (Landis, 1996).

4.3.3 Cultural Control

There are many agricultural practices that make the environment less favorable to insect pests. Examples include cultivation of alternate hosts (e.g., weeds), crop rotation, selection of planting sites, trap crops, and adjusting the timing of planting or harvest.

- Crop rotation

  Crop rotation is a component of cultural control. The greatest benefit of a good crop rotation is an increased yield. A well-planned crop rotation will help with insect and disease control and will aid in maintaining or improving soil structure and organic matter levels. Using a variety of crops can reduce weed pressures, spread the workload, protect against soil erosion and reduce risks. Research and experience has proven that a good crop rotation will provide more consistent yields, build soil structure and increase profit potential.

The basic rule of crop rotation is that a crop should never follow itself. Continuous cropping of any crop will result in the buildup of diseases and insects specific to that crop, and cause a reduction in crop yields. The more often the crop has grown in the field in the past, the greater this impact will be. Three factors are involved in this process.

Soil depletion**:** Each crop uses different types and amounts of minerals from the soil. If the same crop is planted every year in the same place, after several years the soil is depleted of the minerals essential for plant growth and health. A different crop will sometimes return the missing minerals to the soil as the plant dies and decomposes, or is turned into the soil.

Insect control**:** Insects over winter in the soil of the field. They enter the leaves and vines of the plants. When the farmers plow or turn the garden over, some of those insects find a home for the winter inside decaying plant matter under the soil. When they become active again in the spring, they are hungry to re-infest the new crop. When using crop-rotation, the insects will not find their host plant above the soil.

Disease prevention**:** Just like insects, plant diseases can also over winter in plant leaves and vines under the soil. The farmers can also help guard against this by removing and destroying any diseased plants.

- Trap cropping

Trap cropping is the planting of a trap crop to protect the main crop from a certain pest. The trap crop can be from the same or different family group, as the main crop, as long as it is more attractive to the pest. There are two types of planting the trap crops; perimeter trap cropping and row intercropping. Perimeter trap cropping (border trap cropping) is completely surrounding the main crop with the trap crop. It prevents a pest attack that comes from all sides of the field. It works best on pests that are found near the borderline of the farm. Row intercropping is the planting of the trap crop in alternating rows within the main crop.

The principle of trap cropping rests on the fact that virtually all pests show a distinct preference to certain plant species, cultivars, or a certain crop stage. Manipulations of the stands in time and space so that attractive host plants are offered at the critical time in the pests and the crop’s phenology leads to the concentration of the pests at the desired site, the trap crop. Techniques of manipulation range from establishing an early or a late trap crop of the same cultivar as main crop to panting a completely different plant species (Hokkanen, 1991).

Farmers are motivated to utilize trap cropping because of the difficulties in coping with the pest situation in other ways. Sometimes the cost of chemical pesticides and the number of treatments required are high, therefore more economical ways have to be developed (Swezey & Daxl, 1988). Additionally, the pests have often evolved resistance to commonly used pesticides (Swezey & Salamanca, 1987), which requires some alternative control strategies. In some cases, no effective chemical pesticides are available.

Besides its potential role in improving the environmental health and overall performance of conventional agriculture, trap cropping techniques may have special importance to subsistence farming in the developing countries such as China and India. Additionally, the increasing sector of organic farming also could exploit this strategy of pest control (Hokkanen, 1991). Another function of trap crops is their use for attracting natural enemies of pest insects to the fields and concentrating them there to enhance naturally occurring biological control.

- Intercropping

Intercropping is the cultivation of two or more crops simultaneously on the same field. It also means the growing of two or more crops on the same field with the planting of the second crop after the first one has completed its development. The rationale behind intercropping is that the different crops planted are unlikely to share the same insect pests and disease-causing pathogens and to conserve the soil.

There are four main types of intercropping which are quite efficient for the farmers.

<u>Mixed cropping</u> is the cultivation of two or more crops simultaneously on the same field without a row arrangement.

<u>Relay cropping</u> is the growing of two or more crops on the same field with the planting of the second crop after the first one has completed its development.

<u>Row intercropping</u> is the cultivation of two or more crops simultaneously on the same field with a row arrangement.

<u>Strip cropping</u> is the cultivation of different crops in alternate strips of uniform width and on the same field. It has two types: contour strip cropping and field strip cropping. Contour strip cropping follows a layout of a definite rotational sequence and the tillage is held closely to the exact contour of the field. Field strip cropping has strips with uniform width that follows across the general slope of the land (ICIPE, 2003).

- Timing of planting

Adjusting the timing of planting or harvest is another cultural control method. The earlier planted processing tomatoes grown in the western United States (Database of IPM Resources, 2005) are far less likely to be infested by the tomato fruit worm than those planted later in the season. It is also important to use pest-free transplants. Some vegetable crop transplants can be infested with insect pests, and growers using these transplants are put at a considerable disadvantage.

4.3.4 Physical and mechanical control

The use of physical barriers such as row covers or trenches prevents insects from reaching the crop. Row covers can help prevent early-season damage to cucurbits by cucumber beetles, and plastic-lined gaps are effective in trapping large numbers of dispersing Colorado potato beetles in the spring and fall. Cold storage is also considered a physical control and although it does not necessarily kill the insect pests, at least it stops their development and further feeding on the stored crop. Other methods include hand picking of pests, sticky boards or tapes for control of flying insects in greenhouses and various trapping techniques.

4.3.5 Chemical control

If all other integrated pest management tactics are unable to keep an insect pest population below an economic threshold, then the use of an insecticide (pesticide) to control the pest and prevent economic loss is necessary. However, the aim is always to keep the amount of pesticides used as low as possible. In most cropping systems, insecticides are still the principal methods of controlling pests once the economic threshold has been reached. They can be relatively cheap and are easy to apply, fast-acting, and in most instances can be relied on to control the pest. Because insecticides can be formulated as liquids, powders, aerosols, dusts, granules, baits, and slow-release forms, they are very versatile (van Lenteren, 2000).

4.3.6 Other controls

There are may other controls which are also quite important parts of integrated pest management. Such as genetic control, microbial control (these two belong to biological control), semi chemical control and legislative control (Kogan, 2005).

4.3.7 The key components of IPM

Successful integrated pest management usually has several key components.

- Knowledge

  Understanding the biology and ecology of the pest, and the crop is essential. Information about interactions within agricultural ecosystems (agroecosystem) is also important. IPM draws on the fundamental knowledge of plant and insect biology accumulated by biologists.

- Monitoring

  Farmers can use relatively simple techniques to keep track of what kinds of pests at which places. This information, combined with knowledge of pest life cycles, can enable farmers to implement control measures at the most effective times.

- Economic threshold

  This takes into account the income losses resulting from pest damage and the costs of treatment to prevent the damage. Below the economic threshold, the presence of the pest is tolerated. Only when pest numbers increase above the threshold does the farmer take action.

- Adaptability

  Farmers must keep informed about what is happening in their fields or farms so that they can adapt their strategies to changing circumstances. Research scientists also must aim to keep at least one step ahead of the pest, which is also undoubtedly changing and adapting over time.

4.3.8 Advantages and Disadvantages

Integrated pest management is used as a pest control strategy because:

- It reduces the amount of pesticides that used to be sprayed
- It is safer for humans and the environment
- It reduces the risk of pests developing resistance to pesticide
- It is good for the image of the industry that employs it as a standard

Integrated pest management is not always used because:

- It can be expensive to set up in the short term
- It requires research into the biology of the pest organism and makes great use of biological control, genetic engineering and plant breeding, all of which take time to develop
- Sometimes pests are controlled satisfactorily using simple pest control strategy.

4.4 Organic agriculture

4.4.1 Definition

'*Organic agriculture is an ecologically, economically, and socially responsible way of farming, providing an enduring supply of safe and healthy food and fibers, with least possible nutrient and energy losses and the least possible negative environmental impact, and respect of the integrity of plants, animals and life sustaining soil, as regulated by certified agencies.'* (van Bruggen, 2003).

The organic farming system mimics the characteristic of traditional agro-ecosystem and natural ecosystem. The system relies on internal resources with least artificial input. The control of diseases and pests are depended on internal and self-regulating mechanisms. Other distinctive points of the sustainable agriculture are the dependence of human labors and of local resources. Alternative agricultural methods are used instead of intensive technology and energy (Gliessman, 2000).

Sustainable agriculture is characteristic for its dependency on internal inputs and its emphasizing of nutrient recycling such as biological nitrogen fixation and mycorrhizal relationships. The renewable sources are used instead of nonrenewable sources as a source of energy. Therefore, the artificial, external and purchased inputs are minimized or they are eliminated in the case that those inputs have potential to harm humans and environment. It minimizes negative impacts on the on- and off-farm environment while the benefits are maximized. In stead of controlling the environment to suit the system, the system adapt to the local conditions. The diseases, pests and weeds are being managed rather than being controlled. It is also able to take the advantage of micro-environment variations by adaptation of cropping systems, farms and regions. The optimally use of the resource is also the essence. Emphasizing of outputs is done without devoting the long term production capacity. The diversities are conserved in the aspect of cultural and biological. Therefore, systems promote the reestablishing of the biological relationship occurring naturally rather than simplifying them. The priority aim of the production is fulfilling the local need. Therefore the systems are relatively independent of external economic factors. Finally, the knowledge and culture are built together with the local citizens (Gliessman, 2000).

4.4.2 Long term management

The operation of the organic farming systems has both long-term and short-term managements. The factors that are required to be taken into account in the long-term management are capital infrastructure, soil health management, crop sequences, general tillage decisions (van Bruggen, 2003).

- Capital infrastructure

Before crop production is considered, the capital infrastructure has to be considered, i.e. building, farm roads and machinery. The decision is whether the production will be in a greenhouse or in open air. This is according to climate and budged. The farm roads are also important for the movement of the internal resource, as well as the transportation of the product to the community. Sharing machinery can help to reduce costs.

- Soil health management

Soil health is more or less similar to soil quality. It is defined as '*The capacity of a soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health*' (Doran *et al*., 1996). Organic agriculture tends to conserve and develop soil functions, i.e. water retention and conductivity, soil food webs, nutrient cycling and root support. Soil health is a part of the ecosystem health which the stability is composted of biodiversity and the connection between functional units at different levels. In organic farming systems, soil and ecosystem health is a very important subject because it is the key component in pest and disease management. A disease outbreak can not take place in soil that is in stability. Soil health can be improved by increasing the level of available nutrients both carbon and nitrogen sources. This can be achieved by enhancing the microbial activities and diversity in soil. Therefore the nutrient turn-over rate can be accelerated. This also means that organic matter needs to be added regularly and sufficiently. Moreover the tillage should be reduced in order to prevent disturbance of soil food web.

- Crop sequences

Crop rotation is the other important factor of successfulness, as also explained in paragraph 4.3.3. The rotation is necessary in both annual crop and perennial crop. The aim of rotation is not only to disturb the pathogen life cycle, but it is also help to maintain the quality of soil. It is since different types of plants have the different nutrient requirements, and different types of roots have the different pattern in soil anchorage.

- General tillage decision

Disking and harrowing is the tillage operation done in conventional farming. In this way of tillage, it turns the surface of soil deeply (20-30cm) to expose soil lower layer to the sun or other management such as fumigating. Therefore, the soil is sterile for a fine seedbed. Nevertheless, in the long run, it gives rise to changes in soil structure such as soil compaction, crush formation and erosion. As a consequence, the soil looses fertility and structure. Therefore no-till system has been developed and used, but it still needs some herbicides in order to associate seed germination. This method cannot be used in organic farming, because of herbicide using and no tillage. Thus, the minimum tillage (tilling at 10-15 cm depth) has been used instead. This system proved that it can conserve soil food web as evidence (Fan *et al.*, 1993). One disadvantage of minimum tillage is the lower soil temperature in the spring time which is not proper for seed germination. Therefore the ridge tillage is developed. In the ridge tillage, the permanent seedbed is used and the tillage is done only on top of the bed. By this way seed can germinate easier than no-tillage or minimum tillage system and it can also conserve soil food web compared to conventional tillage.

4.4.3 Short term management

For short term management, factors such as selection of seed or plant material, spatial diversity, weed control measures, biological control of insects and diseases, additional fertilizations and refuse managements need to be considered.

- Selection of seed or plant materials

Although the result of plant breeding and selection cause the loss of some special smell and taste of the plants, organic agriculture still relies on almost the same seed sources of conventional agriculture. Organic agriculture requires seeds that have different characteristic from those of conventional system. The cultivars which are proper to organic agriculture need to have high capacity in nutrient searching, in weed-suppressing and horizontal pest and disease resistance. Genetic modified organisms are not allowed. Plant cultivar or cultivar mixer that suit for organic farm must have self-reproducing capacity, autonomous adaptability, and high genetic diversity. The breeding method should come from the cross between two species, therefore biotechnology techniques such as embryo rescues, and protoplast fusions will be prohibited soon. Furthermore, the use of chemical substances in plant breeding will be also forbidden. Besides choices of cultivars, the farmers also have to choose whether direct seed use or transplant methods are more suitable (van Bruggen, 2003).

- Spatial diversity

Stand-alone crop can prevent the nutrient competition and minimize the labor use in terms of cultivation and harvesting. However, it gives negative effects in terms of disease spreading and genetic erosion. Therefore, mixed cropping or intercropping are preferred in organic systems. It is crucial which crops are used for mixed and intercropping. Plants in such cropping should have the different preference of nutrients and have different crucial periods under the growing seasons. The advantages of mixed and intercropping are the resistance to plant disease outbreak and the better unitization of nutrients due to variable of root systems.

- Weed control measure

Unlike the conventional system that the control of weed relies on one single strategy, i.e. pesticide application, in the organic farm, weed management depends on several methods. Moreover the weed elimination can be done in different growing stages of the weeds. Firstly, avoidance of weed growing in the early season can be done by prevention of over-nutrition in the soil. Secondly, soil is continuously covered by the crop, even in the winter time. Thirdly, crop rotation of plants that produce allelopathic chemicals (chemicals that are toxic to other plants), such as red clover and alfalfa, can also help to reduce weed seed germination. Fourthly, the cover crop may also attract soil insects that might feed on weed seedlings. Fifthly, conservation tillage can also help in terms of preservation of plant debris which also suppresses weed growth. Additionally, certain irrigation systems i.e. trickle irrigation can also help to prevent weed germination since the soil surface is kept dry. During the growing season, mechanical weed control, hand-weeding, flaming or biological control can be used.

- Biological control of insects and diseases

In organic farms, the habitat management is used to enhance natural enemies. The use of pheromones and release of predators, parasites or competitors are also used. Moreover, plant resistant cultivars and application of plant toxic extracts can reduce disease and pest occurrence. Nevertheless, habitat management and the use of resistant cultivars are the most preferable (Pickett & Bugg, 1998; van Bruggen, 2003).

- Additional fertilization

In the long term management, the rotation of nutrient enhancing crops, application of compost and animal manure are used before planting particular crops. However, during the growing season, animal slurries, blood meal, fish emulsion and seaweed extracts may be used. However, all of these applications can also give potential weed problems.

- Refuse management:

In ordinary farming, crop debris is usually burned to make it break down faster and get rid of disease; however in organic farm, burning is not the first choice. The alternative used in organic farming is accumulation of debris to make a compost pile. The piles have to be big enough to reach high temperature for killing diseases and pathogens. Sometimes animal manure can also be mixed.

4.5 Comparison between the alternatives

Here, we suggest two possible alternative solutions for conventional agriculture, i.e. integrated pest management and the organic farming system. Although they have differences in detail, they both aim for the reduction of the use of synthetic chemical, i.e. pesticides and fertilizers. Table 4.1 gives a summary of the most important characteristics of these two farming systems.

Table 4.1
An overview of the important characteristic of the farming systems.

Farming systems	Objectives	Space	Orientation
Conventional	Personal and national income	Primary production farm	Technology
Integrated	Individual and national income and environment	Primary farm production and surrounding	Technology
Organic	Individual and National income Animal welfare, environment	Ecosystem (regional and national)	Ecology

	and natural value		

As motioned, IPM and organic farming both aim to reduce the application of synthetic chemicals. To make a choice of one of these systems is depend on each person's vision and on how they want to have their farming structured. Table 4.2 gives a comparison between these two different farming systems, based on personal criteria.

Table 4.2
A comparison between IPM and organic agriculture based on several criteria

Criteria	IPM	0rganic agriculture
Habit of people	Part of the controls are easy to be accepted by farmer	Organic agriculture does not allow the use of pesticides; the farmers might have difficulty to accept this point.
Costs	Cheaper than the only using pesticides in the long term, more expensive in the short term	Very cheap since there is very less input
Technology & knowledge	Basic agricultural knowledge and special biology and entomology, sometimes microbiology. Pesticide and fertilizer are allowed at a certain level	Basic agricultural knowledge. No high technology equipment (in the case of self sustainable not in the case of economical production)
Education	Does not require high level of education	Not require high level of education but farmer might need associate party to give basic education.
Equipment facility	Normal agricultural equipments	Does not require high equipment facility especially not in small scale production.
Amount of labor	Some monitoring work should be added for farmers	Intensive labor due to monitoring work as well as eradication of the diseased plants.
Flexibility	Integrated control, therefore more flexible	Not very flexible, crop rotation and recycling of waste should be done.
Range/scale	Only the crops and the pest	Focuses broadly on the harmony of factors in the ecology.
How long to reach the aim	Short term (in a short time already reach target by using low amounts of chemicals) and long term (by using no chemical methods).	It depends on how much the ecology is out of stability. If the ecology is not much damage, the aim can be reached in a short term around 2-3 years.

4.6 Conclusion of alternatives

In the above sections of this report, we gave an overview of two farming systems which would be suitable alternatives for the conventional agriculture methods in Armenia. Above, we give short term alternatives for the methods the villagers are using already. These short term solutions do not require radical changes in farming methodologies, but are given to increase the awareness for responsible pesticide use.

However, it is necessary to change the farming systems used in Armenia, and in particular for this report, in the village Hayanist. This does require a radical change in farming methodologies; some adaptations to responsible pesticide use will not be sufficient.

However, it is not realistic to change agricultural methods in one day; much preparation and gradual changes step by step are needed for this.

We do not want to make a clear distinction between IPM and organic agriculture for Hayanist, since we believe that there is a possibility in combining these two types to one type of alternative for conventional agriculture that will work for the Hayanist villagers. This alternative will be referred to as sustainable agriculture. A broader clarification of this method can be found in the guideline.

CHAPTER V Discussion & Future Perspective

5.1 Start of an awareness program

In order for our overall objective – to provide information for improvement of human health and environment in rural Armenia – to succeed, the results of our study have to be put into action. Therefore, we developed a guideline, separate from this report. The guideline contains practical information about responsible pesticide use and step by step information about alternatives for the conventional agriculture practices. Above, there are many examples that focus on the agriculture in Armenia, which can be followed by the Armenian villagers.

The guideline is not meant to go directly to the villagers, but is written for organizations that want to improve life in Armenia. Our guideline will go directly to the AWHHE (Armenian Women for Health and Healthy Environment), who will start an awareness project in Hayanist, based on the information we provide in the report and guideline. Hopefully, this guideline is broad enough to be able to put into action in other villages in Armenia and maybe also in other countries with similar problems.

The awareness project can make use of several information sources. From our survey in Hayanist, it was clear that people receive information by means of television commercials, so this is a very important tool. Next, handing out leaflets with information would also help to raise the awareness in Hayanist. Above, the doctor and pesticide shop owners can have a big influence on people and it would therefore be essential for them to help to raise the awareness as well. During questioning, they were interested in helping with an awareness project. An expert an agricultural school is also needed to educate people and to help them with changing their agricultural practices. More detailed information on how we want to raise the awareness in Hayanist is given in the guideline.

5.2 Discussion

This short project has much potential to gain success in Armenia; the guideline contains clear practical information, supported by theory in the report and the AWHHE agreed on starting on awareness project. However, this is not a guarantee that the awareness project will have success.

We all believe that it is a difficult task to educate people from a different country with a different culture and background. The people in Hayanist are mostly refugees who have been working in the industry for most of their lives. There are no agricultural skills in the village that were passed on from previous generations. An extra difficulty is the fact that most people in Hayanist have reached an elder age and might distrust the new techniques more than younger people, who tend to be more open for new innovated practices. Above all this, the villagers are quite poor. Most of them live from the production of their homestead garden and they probably do not want to take the risk of changing to a new system. However, the survey revealed that most of the villagers are interested in the IPM method. But even if the villagers refuse to accept the new ideas of agriculture, there are also some short term solutions which will result in safer and reducing usage of pesticides. Unfortunately, not all villagers might be able to purchase protective gear due to the costs involved. Hopefully, the awareness on the side of the government or city council will also rise and some necessary equipment will be made available for the community.

Besides the question whether or not it is possible to change the practices in Hayanist, the success of reaching our objective also depends on the cooperation from AWHHE. Our influence ends with the finishing of the report and guideline. However, we believe in the experience of the Armenian organization and that they will do their best in starting an awareness project in Hayanist.

This report is mostly based on information from trustable sources such as books, papers from acknowledged journals, and websites from internationally recognized organizations. However, our knowledge about Hayanist village is based on some previous surveys and the survey that was done for our project. In some aspects, the gained information from several of these sources was contradictory with each other. Unfortunately, we were not capable of traveling to Armenia to question the people ourselves. Therefore, the results of all surveys should be interpreted with caution.

5.3 Future perspective

We are quite optimistic about the future of the villagers in Hayanist; awareness about responsible pesticide use should be a reachable target. This would surely result in better health and environment of the village. However, pesticide misuse is not the only problem in Hayanist. If the aim is to improve the overall conditions in Hayanist, other aspects have to be dealt with as well, for example improvement of the irrigation channels, drinking water and the sewage.

It is going to be a difficult task to change the agricultural practices in the village. However, with the right method and some help from outside of the village, it should be possible to change the practices in the village from a conventional way to sustainable agriculture. We assume that from 10 to 15 years from now, all pesticides are replaced by a more organic farming system. It will probably be a slow process, but step by step, things will get better for the Hayanist villagers!

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Appendix 1 Questionnaire

Villagers:

1. What are the main crops cultivated in your field, home garden and what are their main pests?

Crops	Pest
a. wheat	
b. corn	
c. potato	
d. tomato	
e. others..	

2. How much area (of land) is owned by your family?
3. What is the purpose of your crops production?
A. Own consumption B. Trade C. Both D. Others
4. What pesticides do you normally use in your field and home garden? What are their prices?

Pesticides (Brand)	Price

5. Why do you use pesticides?
6. How often do you normally apply pesticides?
Explanation: toward different crops
7. What are the application methods for the pesticides?
Explanation: if they use different methods, give more details about that.
8. Who normally applies these pesticides?
A. Woman B. Man C. Both D.Children
Explanation: they should give reason for that
9. Have you observed any illness due to pesticide exposure?
A. Yes B. No C. Maybe
Explanation: if yes, what are the symptoms and what kind of medication do they use?
10. Are you aware of the health effects caused by pesticide exposure?
A. Yes B. No C. a little bit
Explanation: if yes, from where they got the information
11a. Do you wear protective clothing when you apply pesticides?
A. Yes B. No C. Sometimes
Explanation: if no, what is the reason for that
11b. Are you aware of the necessity of wearing protective clothing?
A. Yes B. No
Explanation: they should give reason for both answers
12. If your crops get a serious pest threat, do you use pesticides on all your crops?
A. Yes, on a large region of crops B. No, only on local region of infected crop
Explanation: they should give the reason for both answers
13. Are you aware of the negative effects of using excessive pesticides on crops?

A. Yes B. No C. A little bit
14. What is your educational level?
A. Primary school B. High school C. University D. others
15a. Do you use any pest control methods besides using pesticide?
A. Yes B. No
Explanation: If yes, what kind of methods do they use?
15b.What do you think are the advantages and disadvantages of these methods?
16. Is there been any advertisement about pesticide application?
A. Yes B. No
Explanation: if yes, what is that?
A. television B. paper C. government officer D. Agricultural school E. others
17. Do you have health complaints yourself due to pesticide application?
A. Yes B. No C. Maybe
Explanation: if yes, give more details about that?
18. Are you interested in using the IPM methods instead of pesticides?
A. Yes B. No C. Maybe
Explanation: if they don't know what IPM is, explain shortly.
19. What do you do with left-over pesticides?

Pesticide shop owners:
1. Are you the owner of this shop?
A. Yes B. No
2. How long have you operated the pesticide shop?
3. Do you think your shop is profitable?
A. Yes B. No
Explanation: both answers should give reason
4. How did you get these pesticides?
5. Who are your customers?
A. Haianist villagers B. Other villagers C. Both
A. Specific company B. Government C. Others
6. Which pesticides of your shop are mostly used by farmers?

Pesticides(brand and active compound)	Price

7. Do you think there are highly poisonous pesticides in your shop?
A. Yes B. No C. Maybe
Explanation: if yes, why you still sell them in your shop and are they allowed to sell in your shop based on your country law?
8a.Do you know any pesticides which are banned by the government?
A. Yes B. No
Explanation: if yes, they should mention them
8b.Do you know the health effects about some poisonous pesticides?

A. Yes B. No
Explanation: if yes, from where do they get the information and why are they still selling them
8c.If you don't know, do you want to know that?
A. Yes B. No
8d.What do you think is the best way to provide this kind of information?
Explanation: For example by leaflets, tv commercials, labels on packaging
9. Do you give your customers advice on how to apply pesticides?
10. Do you want to cooperate with an 'awareness project' about the effects of pesticides?
A. Yes B. No
Explanation: Both answers should give reasons.
Example of awareness project is giving leaflets that contain information about the health effect of pesticides,

Doctor:
1. Can you tell us some symptoms related to the pesticide effect?
2. Have you observed any illness due to pesticide exposure?
A. Yes B. No
Explanation: how often do you find patient related to pesticide impact?
3. What kinds of symptoms related to pesticide exposure are mostly observed by you in this village?
4. Do you know what kind of pesticides can harm human health in this village?
6. Where do your patients, ill due to pesticide exposure, come from?
5. What is the main gender (who is) affected by pesticides?
A. Male B. Female C. Both
6. What is the serious extent of symptoms caused by pesticides?
7. What are the normal costs to visit you?
8. Do you think there are relations between pesticide exposure and problems in pregnancy, breast cancer, miscarriage, reproductive health and child birth complications?
A. Yes B. No C. Maybe
9. What kind of suggestion can you give to villagers to reduce the pesticides impact on their health?
10. Do you want to cooperate with an awareness project related to pesticides?
A. Yes B. No C. Maybe
Explanation: give reasons for answer
11. Do you already give information to people about the negative effect of pesticides?
11b.What do you think is the best way to bring the messages to villagers?

Appendix 2 Detailed information about pesticides used in Armenia

Pesticide name	Use type	Chem. class	Human Health		Environment		
			Toxicity information	Effect	Ecotoxicity		Characteristics
					Organism	Effect	
Aldrin Dieldrin	Insecticide	Organochlorine	-Carcinogen -Suspected as endocrine disruptor	-Accute intoxication Sympptoms: -Headaches - Dizziness -Unconsciousness	Amphibians	Behavior, Biochemistry, Histology, Mortality, Population	-does not dissolve in water very well -decomposes very slowly in water and soil -sticks to soil, it can stay there for years. -also attaches to sediments, ponds and streams. -attaches to sut particles therefore spread by wind. -plant takes up dieldrin from soil and store its leaves, roots.
					Crustaceans	Accumulation, Avoidance, Behavior, Biochemistry, Enzyme(s), Growth, Histology, Intoxication, Mortality, No Effect Coded, Physiology, Population	
					Fish	Accumulation, Behavior, Biochemistry, Cell(s), Development, Enzyme(s), Genetics, Growth, Histology, Morphology, Mortality, Physiology, Population, Reproduction	
					Insects	Accumulation, Intoxication, Mortality, Population	
					Molluscs	Accumulation, Development, Growth, Morphology, Mortality, Physiology	
					Zooplankton	Accumulation, Behavior, Intoxication, Mortality, Population	
Endrin	Insecticide	Organochlorine Rodenticide	-Developmental and reproductive toxin -Suspected as endocrine disruptor	-Accute intoxication effect to nervous system. Symptoms: -Excitability -Convulsions	Amphibians	Accumulation, Behavior, Mortality	- It volatilize when applied to crops and soil -It can stay, be degraded or transported in soil depend on different factors. -Its half –life in soil up to 12 years. -It can disappeare from soil surface through volatization and photodecomposition. -Effect of endrin on soil bacteria is minimal. -The main impact of endrin is aquatic environment.
					Crustaceans	Intoxication, Mortality, No Effect Coded, Physiology	
					Fish	Accumulation, Avoidance, Behavior, Biochemistry, Development, Enzyme(s), Genetics, Growth, Histology, Hormone(s), Intoxication, Morphology, Mortality, Physiology, Population, Reproduction	
					Insects	Accumulation, Behavior, Intoxication, Mortality	
					Molluscs	Accumulation, Behavior, Development, Feeding Behavior, Growth, Histology, Morphology, Mortality, Physiology, Reproduction	
					Zooplankton	Accumulation, Avoidance, Behavior, Growth, Intoxication, Mortality, Physiology, Population, Reproduction	

Pesticide name	Use type	Chem. class	Human Health		Environment		
			Toxicity information	Effect	Ecotoxicity		Characteristics
					Organism	Effect	
DDT DDE	InsectIcide	Organochlorin	-Carcinogen - Developmental or reproductive toxin -Suspected as endocrine disruptor	- DDT and its metabolites considered to be natural estrogen - Effect on reproductive abnormalities -Decrease fertility -Congenital defects among the offspring	Amphibians	Accumulation, Behavior, Cell(s), Development, Enzyme(s), Growth, Histology, Hormone(s), Morphology, Mortality, Physiology, Pop	-Both DDT and DDE are resistant to breakdown and are easily adsorbed to sediments and soils. -Harmful sources for soil microorganism. -Both have high lipid solubility, and low water solubility and they can be stable metabolites in fatty tissue - Both have main impact on aquatic environment.
					Crustaceans	Accumulation, Avoidance, Behavior, Biochemistry, Development, Enzyme(s), Genetics, Growth, Histology, Intoxication, Mortality, No Effect Coded, Physiology, Population	
					Fish	Accumulation, Avoidance, Behavior, Biochemistry, Cell(s), Development, Enzyme(s), Feeding Behavior, Growth, Histology, Injury, Intoxication, Morphology, Mortality, Physiology, Reproduction	
					Insects	Accumulation, Behavior, Development, Enzyme(s), Intoxication, Mortality, Population, Reproduction	
					Molluscs	Accumulation, Behavior, Development, Enzyme(s), Growth, Histology, Morphology, Mortality, Physiology, Population, Reproduction	
					Zooplankton	Accumulation, Avoidance, Behavior, Biochemistry, Cell(s), Growth, Histology, Intoxication, Mortality, No Effect Coded, Physiology, Population, Reproduction	
LIndane	InsectIcIde RodentIcIde	Organochlorine	-Carcinogen -Suspected as endocrine disruptor	- Lindane can disrupt the formation of platelets and white blood cells, resulting a disease called aplastic anaemia.	Amphibians	Accumulation, Behavior, Cell(s), Development, Growth, Histology, Morphology, Mortality, Physiology	• Lindane -Can be found in soil, air, water and rier - The main impact of lindane is on aquatic environment.
					Crustaceans	Accumulation, Behavior, Biochemistry, Development, Genetics, Growth, Mortality, No Effect Coded, Physiology, Population, Reproduction	
					Fish	Accumulation, Avoidance, Behavior, Biochemistry, Cell(s), Development, Enzyme(s), Feeding Behavior, Genetics, Growth, Histology, Hormone(s), Immunological, Intoxication, Morphology, Mortality, Physiology, Reproduction	
					Insects	Accumulation, Behavior, Development, Enzyme(s), Genetics, Growth, Histology, Intoxication, Mortality,	

Pesticide name	Use type	Chem. class	Human Health		Environment		
			Toxicity information	Effect	Ecotoxicity		Characteristics
					Organism	Effect	
						Physiology, Population, Reproduction	
					Molluscs	Accumulation, Behavior, Biochemistry, Development, Enzyme(s), Feeding Behavior, Growth, Intoxication, Morphology, Mortality, Physiology, Reproduction	
					Zooplankton	Accumulation, Behavior, Biochemistry, Development, Enzyme(s), Feeding Behavior, Growth, Histology, Intoxication, Mortality, No Effect Coded, Physiology, Population, Reproduction	
Karate (lambda cyhalothrin)	**Insecticide**	**Pyrethroid**	-Suspected as endocrine disruptor	-Irritation of skin and eyes - The substance may cause effects on the peripheral nervous system, resulting in convulsions, ataxia.	Amphibians	Population	- Very toxic to aquatic organism -Special attention should be given to mammals and honey bees -This substance may cause long term effect on aquatic environment
					Crustaceans	Ecosystem Process, Population	
					Fish	Behavior, Growth, Mortality, Population, Reproduction	
					Insects	Development, Intoxication, Mortality, Population	
					Molluscs	Intoxication, Population	
					Zooplankton	Intoxication, Mortality, Population	
Metaphos ParathIon–methyl	**InsectIcIde NematIcIde**	**Organophosphorus**	-Cholineesterase inhibitor -Suspected as endocrine disruptor	- It may be absorbed through the skin, by inhalation and via the gastro-intestinal tract. It is active upon metabolism. -An increase in chromosomal aberrations has been reported in	Amphibians	Behavior, Enzyme(s), Growth, Histology, Mortality, Physiology, Population	- Parathion-methyl is too toxic for-household use -It is not persistent in the environment -Potential as groundwater contaminant -Methyl parathion is retained longer in soil than in air or water -Residues on plant surfaces
					Crustaceans	Accumulation, Behavior, Biochemistry, Development, Enzyme(s), Intoxication, Mortality, Physiology, Population	
					Fish	Accumulation, Behavior, Biochemistry, Development, Enzyme(s), Feeding Behavior, Genetics, Growth, Histology, Hormone(s),	

Pesticide name	Use type	Chem. class	Human Health		Environment		
			Toxicity information	Effect	Ecotoxicity		Characteristics
					Organism	Effect	
				cases ofacute intoxication		Morphology, Mortality, Physiology, Population, Reproduction	and within leaves decline rapidly with half-lives of the order of a few hours; complete loss of the methyl parathion occurs within about 6-7 days. -Microorganisms capable of degrading the compound in different habitats and circumstances -Methyl parathion is a non-selective insecticide that kills beneficial species as readily as pests. -It is not bioconcentrated and is not transferred through food-chains and is degraded rapidly by many microorganisms and other forms of wildlife
					Insects	Accumulation, Behavior, Histology, Intoxication, Mortality, Population	
					Molluscs	Biochemistry, Enzyme(s), Growth, Histology, Mortality, Physiology, Population	
					Zooplankton	Behavior, Ecosystem Process, Enzyme(s), Feeding Behavior, Growth, Intoxication, Mortality, No Effect Coded, Population, Reproduction	
Chlorophos	InsectIcIde	Organophosphorus	-Carcinogen -Colinesterase inhibitor	- Muscle twitching, weakness, tremor, incoordination -Severe cases: seizures, incontinence, respiratory depression, loss of consciousness	Amphibians	Growth, Mortality	-It has high water solubility -Trichlorfon is a moderately toxic organophosphorus ester insecticide
					Crustaceans	Behavior, Mortality, Population	
					Fish	Accumulation, Behavior, Biochemistry, Cell(s), Enzyme(s), Genetics, Growth, Histology, Intoxication, Morphology, Mortality, Physiology, Population, Reproduction	
					Insects	Behavior, Histology, Intoxication, Mortality, Population	
					Molluscs	Accumulation, Behavior, Growth, Histology, Mortality	
					Zooplankton	Accumulation, Intoxication, Mortality, Population	
DImethoate	IncectIcIde	Organophosphorus	-Possible carcinogen -Colinesterase inhibitor -Reproductive toxin	- Headache, dizziness, nausea, vomiting, abdominal cramps, diarrhea - Respiratory	Amphibians	Development, Growth, Mortality, Physiology	-Also use as fly control - Dimethoate does not persist in the environment - Hydrolytic degradation is rapid - Degradation in soil is
					Crustaceans	Avoidance, Enzyme(s), Mortality, Physiology, Population	
					Fish	Accumulation, Behavior, Biochemistry, Enzyme(s), Feeding Behavior, Growth, Histology, Intoxication, Morphology, Mortality, Physiology, Reproduction	

Pesticide name	Use type	Chem. class	Human Health: Toxicity information	Human Health: Effect	Environment: Ecotoxicity: Organism	Environment: Ecotoxicity: Effect	Environment: Characteristics
				depression, tightness in chest, wheezing, productive cough, fluid in lungs	Insects	Behavior, Development, Mortality, Population	dependent on the type of soil, temperature, moisture, and pH level - The toxicity of dimethoate for aquatic organisms and birds is moderate to high -It is more toxic for honey bees.
					Molluscs	Accumulation, Behavior, Biochemistry, Enzyme(s), Growth, Intoxication, Mortality, Physiology, Reproduction	
					Zooplankton	Accumulation, Behavior, Growth, Intoxication, Mortality, Population, Reproduction	
ConfIdor Imidacloprid	Insecticide	Chloro-nicotinyl	No information available	-The substance may cause effect on nervous system - Skin and eye irritation. - Fatigue, twitching, cramps, and muscle weakness including the muscles necessary for breathing	-	No information available	-Potential ground water contaminant -This substance may be hazardous in the environment; special attention should be given to birds, crustacea, fish and honey bees
Dursban ChlorpyrIfos	InsectIcIde NematIcIde	Organophosphorus	-Colinesterase inhibitor -Suspected endocrine disruptor	-The substance may cause effects on the nervous system, resulting in convulsions, respiratory failure	Amphibians	Behavior, Mortality	- The substance may cause long-term effects in the aquatic environment
					Crustaceans	Accumulation, Behavior, Biochemistry, Enzyme(s), Genetics, Intoxication, Mortality, No Effect Coded, Physiology, Population	
					Fish	Accumulation, Avoidance, Behavior, Biochemistry, Cell(s), Enzyme(s), Feeding Behavior, Growth, Histology, Mortality, Physiology, Population, Reproduction	
					Insects	Accumulation, Behavior, Development, Enzyme(s), Intoxication, Mortality, No Effect Coded, Physiology, Population	
					Molluscs	Accumulation, Behavior, Growth, Intoxication, Morphology, Mortality, Population	
					Zooplankton	Accumulation, Avoidance, Behavior, Cell(s),	

Pesticide name	Use type	Chem. class	Human Health		Environment		
			Toxicity information	Effect	Ecotoxicity		Characteristics
					Organism	Effect	
						Development, Enzyme(s), Feeding Behavior, Growth, Intoxication, Mortality, No Effect Coded, Population, Reproduction	
A c t a r a Thiamethoxam	**F u n g I c I d e I n s e c t I c I d e**	**Second generation of neonicotinoid**	-Carcinogen	Symptoms: -Causes mild eye and skin irritation		No information available	-thiamethoxam relies less on soil moisture than organophosphate and carbamate granules and even other neonicotinoid seed treatments -thiamethoxam is not too tightly bound to soil organic particles making it available for uptake by the plant.
							-posed no risk of accumulation even after repeated use.

(Source: PAN, 2005; Syngenta, 2005)