

A Survey on Utilization of Agricultural Pesticides in Selected Palestinian Districts

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1. Introduction

The problem of agricultural pesticide utilization in the Arab countries is not only an issue of uncontrolled use, but it is also a problem pertaining to the handling, misuse and disposal of unwanted pesticides. This is exacerbated by undeveloped national laws and regulations in regards to potential fate and residuals impacts of pesticides on groundwater, food safety and public health. Extensive use of pesticides with residual contents exceeding the maximum residue limits on produce, urged many European countries to ban certain agricultural exports from several Arab countries (Bashour, 2008). Indeed, the sale and handling of pesticides are not regulated and there is no control over the use of pesticides, where accredited labs for pesticide residue analysis are scarce in many Arab countries (Safi et al., 1993; UNEP, 2003; De Waal and Robert, 2005). Palestine, like other Arab countries, the uncontrolled use, handling and misuse of pesticides caused an increase in types and numbers of pesticides, exacerbated by shortage of reliable data and knowledge gap on quantities utilized alerted the scientific community and the public about the health hazards of pesticides and their indiscriminate use (ARIJ, 1995; Richter and Safi, 1997; Samhan, 2008). Most of agricultural land in the Palestinian National Authority (PNA) is used to grow vegetables, orchards and dry land crops for food production. The latter consumes huge quantities of water and pesticides, with more people working intensively. In the PNA, people work on small plots in family owned small greenhouses, and large orchards, where agriculture employs about 30% of the 5 million PNA population (ARIJ, 1995).

Agricultural pesticides are commonly used to maintain and increase crop yields, while public health pesticides are applied to prevent vector-borne diseases, where both types are also applied in homes and gardens. Recent review on pesticides by Bjørling-Poulsen et al., (2008) indicated that laboratory experimental studies using model compounds suggest that many pesticides currently used in Europe (including organophosphates, carbamates, pyrethroids, ethylenebisdithiocarbamates, and chlorophenoxy herbicides) can cause neuro-developmental toxicity in humans and laboratory animals. Adverse effects on brain development can be severe and irreversible, while in other cases, increased levels of pesticides residues in mothers milk in Amman area, Jordan (Alawi et al., 1995).

In the West Bank and Gaza strip, the excessive uncontrolled use of chemicals (e.g. DDT, lindane, a-benzene hexachloride, organochlorine, and organophosphate) for pest control and plant disease abatement has been a major issue of land based food production (ARIJ, 1995). Increased agricultural productivity in the West Bank (WB) and Gaza strip (GS) has been achieved through intensified use of arable land with massive application of a variety of pesticides and fertilizers. The unsustainable pesticides use lead too many speculations as to increased breast cancer in Gaza

strip, contamination of cow's milk, where tractors and backpack sprayers are the current methods still used to apply pesticides to orchards and greenhouses in the PNA territories (Safi et al., 1993; Richter and Safi, 1997, Safi, 2002). However, little documented information on current practices of pesticides application pertaining to quantities and qualities, types and sales and actual application rates.

The fate and impact of pesticides application in the PNA is likely to remain unknown in the public and farmer eye, while the scientific community available is not experienced in predicting the relevant studies due to lack of expertise, financial resources and technical tools. To this end, lack of a national regulation on pesticide use, prohibition of pesticides placing on the market and use of plant protection products containing certain active substances are outstanding environmental issues (WHO, 1993; UNEP, 2003; Bjørling-Poulsen et al., 2008). No official information is available on anecdotal reports of the sale of restricted pesticides by Israel to the PNA and other anecdotal reports that Israeli farmers buy back cut-rate pesticides sold to PNA distributors (Richter and Safi, 1997, UNEP, 2003). Thus, developing a "pesticides regulation" that guarantees a sustainable use of harmful substances with obligation to keep records and to carry out controls with simplified procedures for low risk substances and products is an urgent national responsibility.

2. Materials and Methods

The main purpose of conducting the national pesticides survey (NPS) is to evaluate pesticides rationally used in a sustainable manner in terms of quantities and qualities, in order to assist the policy/decision makers to best manage and control the pesticides usage through developing rules, regulations and legislation. Three PNA districts; Jericho, Jenin and Gaza as pilot areas are targeted. A detailed literature survey as to pesticides regulations, applications in agriculture and public health sector (insecticides) was conducted. The literature survey revealed lack of published scientific data with few unpublished reports from national authorities. The only scientific literature is published on pesticides use in agricultural sector in Gaza strip, no free access to data published except only to one refereed article published by Safi, (2002) and Yassin et al., (2002). The knowledge, attitude, practice, and toxicity symptoms related to pesticide use in the Gaza Strip were described via a questionnaire distributed on farm workers.

3. Results and discussion

3.1 Local literature survey and Pesticides registration and use in the West Bank governorates
According to publication made by the Israeli Ministry of Agriculture (2007) about 1019 registered pesticides in Israel. For organic farming about 154 chemical substance are in use including pesticides, and pheromones and insect attractants. In 2004, the Palestinian side applied about 464 active substance (more than 900 pesticides). In cooperation with Adam Smith, UK, the Palestinian National Committee identified in 2007 only 242 active ingredients that are adequate for use and permitted for application in the agricultural and public health sectors.

The national scientific committee on pesticides control established in 1999, was reactivated with new members only from the West Bank in 2007 due to political instability in Gaza strip. A Palestinian regulation on pesticides registration is finalized for approval by the national cabinet. Analyzing the annual pesticides applications in agricultural farms within the northern districts of the West Bank revealed that a drastic reduction in the quantities used for all pesticides types. It is estimated that only 770 tons of pesticides were applied in agricultural sector in Palestine compared with 979 tons of pesticides utilized during the year 2006 (Ministry of Agriculture records, 2008). Figure 1 shows the amounts of pesticides used in 1996, those for the

year 2007, less than 30% of insecticides, around 53% of fungicides, 64% of herbicides, 20% soil disinfecting agents (MoA, 2008).

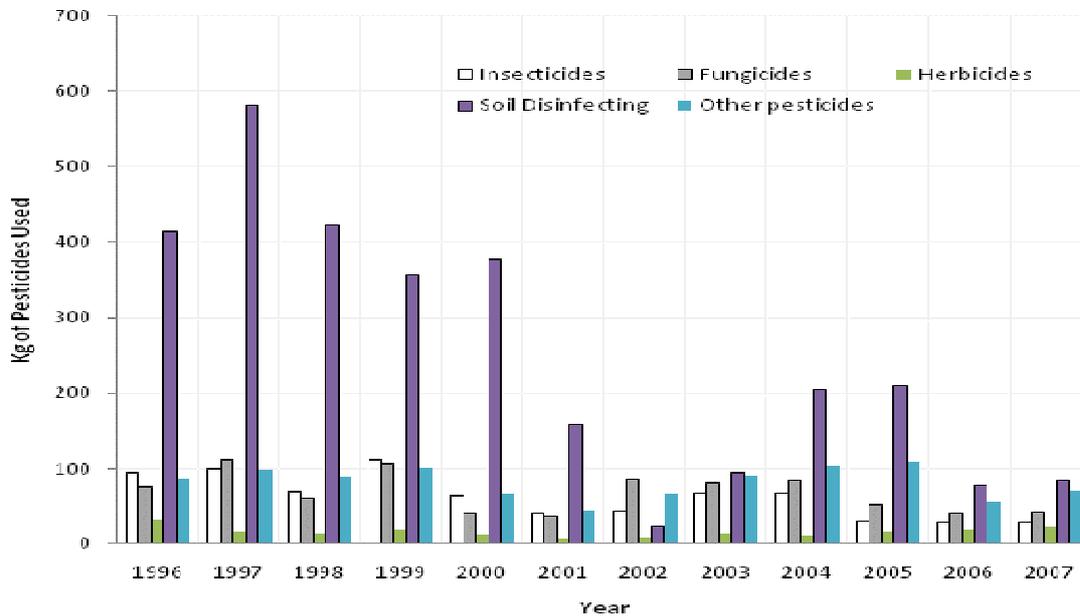


Fig. 1: Estimated annual pesticides quantities (kg) for the northern West Bank Districts

The data presented in Fig. 1 shows a sharp decrease (65%) in the annual quantities of the main agricultural pesticides (insecticides, fungicides, and herbicides) including soil disinfecting chemicals and other types of pesticides between year 2007 and those utilized during the year 1996 in the northern West Bank districts.

3.1.1 Pesticides application in Gaza Strip Governorates

During an epidemiological study conducted by Yassin et al., (2002) over 10 years (1990-1999), they reported that farmers applied several banned and potential hazardous pesticides despite known pesticides carcinogenicity, genotoxicity and cytotoxicity. Total recorded hospital cancers cases in men (2277) and women (2458) revealed a strong relationship between extensive pesticides exposure and the recorded. The adverse public health impacts caused by the misuse of pesticides is well-known, especially under uncontrolled pesticides usage in Gaza Governorates, that ranged from 216.9 to 393.3 t from 1990 to 1999, respectively, as indicated by Yassin et al., 2002. Regarding toxicity symptoms associated with pesticides, results published by Safi (2002) showed that common self reported toxicity symptoms among farm workers were burning sensation in the eyes/face, dizziness, cold/breathlessness/chest pain, itching/skin irritation, and headache. He called for urgent prevention, intervention, and protection from the Ministry of Health and other non-governmental organizations.

Palestine, as many other developing countries, lack of regular pesticides analysis and control in groundwater makes it difficult to unite efforts of all information and examine their relation to the soil under local conditions. It is recorded that more than 1000 tons of pesticides used in Gaza Strip resulted from the application of 75 different kind of pesticides, 19 of which type of internationally prohibited (Safi, 2002). For comparison, Table 1 lists the amounts of pesticides applied during the years 2004 until 2006.

Table 1. Importable Quantities of Pesticides in Gaza Strip (2004 – 2006)

Materials	Quantity (Ton), 2004	Quantity (Ton), 2005	Quantity (Ton), 2006
Insecticides	95	42	38.5
Fungicides	120	74	55
Herbicides	12.5	20	24.9
Methyl Bromide	293	300	111
Hormones	4.5	300	8
Attractive Materials	50	-	17
Nematicides	33	14	-
Others	3.8	1	-

Source: Ministry of Agriculture, 2006.

The fate and impact of pesticides application in the PNA is likely to remain unknown in the public and farmer eye, while the scientific community available is not experienced in predicting the relevant studies due to lack of expertise, financial resources and technical tools. Afifi (1994) indicated that the arrival of any of these pesticides to the underground water is closely linked to several factors; among of which are soil type and chemical composition, physical and chemical characteristics of contaminated pesticides; biological activity of the micro-organisms in the soil.

Adsorption is one of the most important factors that affects fate of pesticide in soils and determines their distribution in the soil/water environment (Kah and Brown, 2007). Concern about the environmental impact of repeated pesticide use has prompted research into the environmental fate of these agents, which can emigrate from treated fields to air, soil and water bodies (Arias-Estevez et al., 2008; Mirbagheri and Hashemi, 2009). The following points which play an important role in the movement of pesticides:

- The more biological activity of the soil the more opportunity to demolish the substances, and access to the groundwater will be decreased.
- In winter, with an increase rate of rainfall and temperature drop below the biological activity of micro-organisms and a greater chance laundering of these substances into the groundwater.
- pH deviation from a point affects the activity of micro-organisms and thus reduce the chances of demolition.

Recent published results on pesticides impact on ecosystem and soil microflora can be found in Aly and Schröder (2008). In Palestine, one can raise a major questions; what are the potential environmental impacts of herbicides used in both irrigated agricultural farms and rain-fed olive groves are unknown, and warrant further investigations.

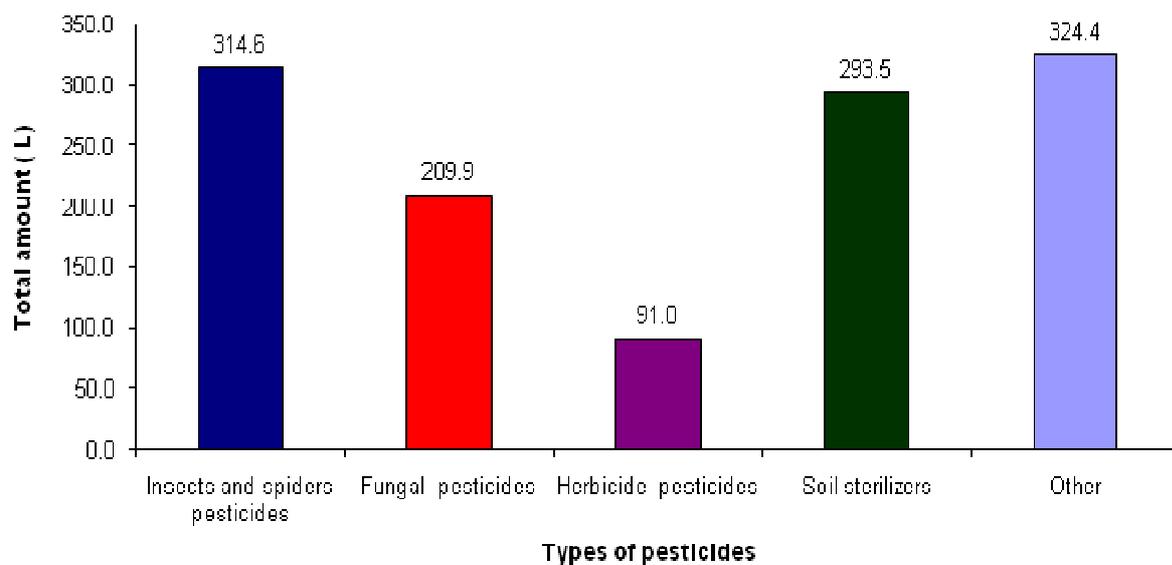
3.2 Results of pesticides survey in selected Palestinian districts

3.2.1.1 Types and quantities of agricultural pesticides used in the West Bank districts

Depending on crops patterns, the results of the questionnaires revealed variations in the types of agricultural pesticides types used in Jenin, and Jericho districts, these were about 90, and 72 types of pesticides that are commonly used, respectively. The total area of agricultural farms (open and closed type) in the West Bank districts under study is about 5608 donums, which makes about 5.6% of total irrigated land with vegetables. Most cultivated crops are vegetables (tomato and cucumber).

The total quantity of pesticides including soil sterilizers and other chemicals applied in the West Bank districts was given by the respondents as 1233.4 L (0.22 L/donum). Figure 2 depicts the insecticides with the highest percentage (25.5%) compared with fungicides and herbicides, 17.8% and 7.4%, respectively. It is noteworthy mentioning that soil sterilizers and others types of chemicals are used with 23.8% and 26.3%, respectively.

Fig. 2: Types and total amount of various pesticides applied in West Bank districts



The Palestinian Central Bureau for Statistics (PCBS, 2007/2008) published recent data for the West Bank on the total irrigated agricultural land area of 100,781 donums (open and closed), cultivated with vegetables. Knowing the specific pesticides application of 0.18 L/donum (without soil fertilizers) would yield about 18.1 tons as total pesticides used in irrigated land cultivated with vegetables. Comparing published data on pesticides by Applied Research Institute Jerusalem (ARIJ, 1995), our results indicated a reduction in pesticides application rates in agricultural sector, presumably as a result of IPM introduction, recently promoted by the MoA. Further detailed analysis of the results obtained for the individual districts on quantities of various pesticides including graphics can be found elsewhere (Al-Sa'ed, 2008).

3.2.2 Types and quantities of agricultural pesticides used in Gaza strip districts

The data obtained from the questionnaires revealed about 68 types of pesticides that are commonly used in agricultural sector in Gaza strip. The total area of agricultural farms (open and closed type) is about 506 donums, which is around 1% of total irrigated land with vegetables. Most cultivated crops are vegetables (tomato, cucumber and strawberry).

Major findings on pesticides survey in Gaza strip are listed below:

1. Vertimic is found to be the common pesticide, which is intensively used in the two target areas. The common pesticides used in the two target areas are shown in Table 2.

Table 2: Commonly used pesticides in Gaza open and closed agricultural fields

Open Field agriculture (Strawberry) and active ingredient	Intensive Agriculture (Greenhouses) and active ingredient
Vertemic (Abamectin)	Vertemic (Abamectin)
Match	Eviscet (Thiocyclam hydrogen Oxalate
Rovral 50	Smash (Fenproathrin)
Strobi	Tamaron (Methamidophos)
Ronstar (Oxadiazone)	Ofir (Penconazole)

- The initial results showed that pesticide usage is greater in areas of intensive and high value crop cultivation. More pesticides are used for crops grown under plastic than for those grown in open irrigation systems.
- The survey reveals widespread problems in both usage and disposal of pesticides. Most of the labels hold Hebrew language that most of the farmers don't read. A relatively limited number of farmers in Gaza Strip said that they read and followed advice given in agricultural publications. Most of the farmers interviewed mainly depend on their own knowledge and experience at the application of pesticides.
- The initial results showed that the farmers rarely committed with the recommended doses of the pesticides. Most of the interviewed farmers seldom followed the instructions of safety period, though some of them know the danger of harvesting the crops earlier.
- No cases of sand fly (leishmaniasis) observed in Gaza.
- Based on the data collected and analysis we can find the total annual tonnage utilized in agricultural purposes in Gaza Strip ranges from 500-700 ton/year, which lead to an annual average of 3.84 kg/donum of pesticide used in the target areas.
- Despite the high risk and frequency of exposure, farmers did not wear proper personal protection like gloves, cloth face and boots while working with pesticides.

The size of the agricultural land in Gaza strip is given by 506 donum, where the total pesticides applied during the agricultural season is about 1942.2 liters (3.84 L per donum).

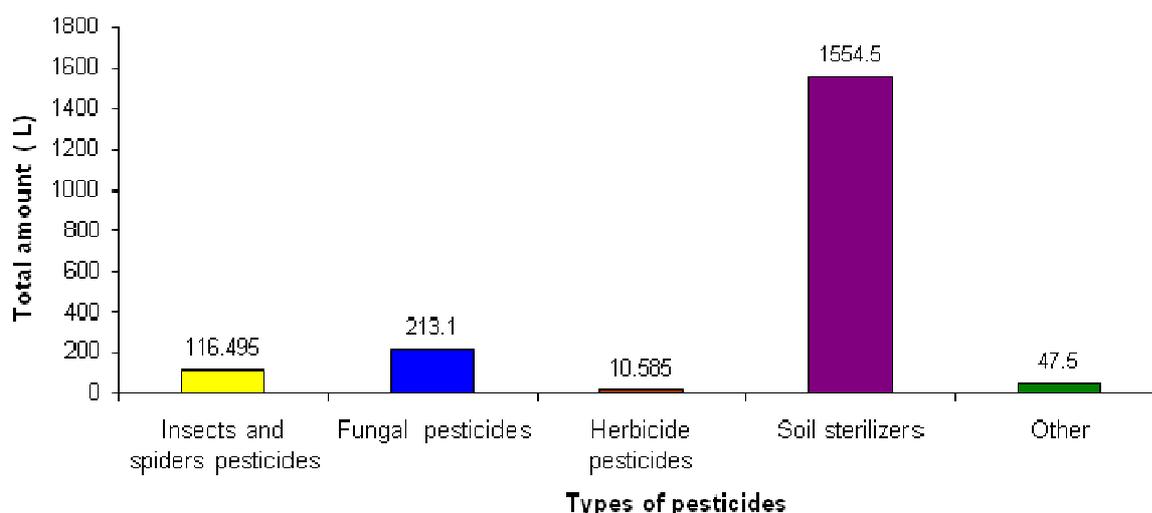


Fig. 3: Types and total amount of various pesticides applied in Gaza strip

Figure 3 shows the total amount of pesticides including soil sterilizers and other chemical substances applied in agricultural sector (L) during the agricultural season for 2008. Among the total quantity, the percentage of soil sterilizers as a chemical substance is the highest (80.04%) compared with insecticides, fungicides, herbicides and others (6.0%, 10.97%, and 0.55%, 2.45% respectively). However considering only the pesticides applied without soil fertilizers would give a specific value of 0.77 L/donum. Similarly, taking the recent data published by the PCBS (2007/2008) on total irrigated land cultivated with vegetables in Gaza strip (50,292 donums; open and closed areas) revealed a total pesticides quantity of about 38.7 kg/donum. This amount is higher (68%) than the total annual pesticides applied on vegetables cultivated land in the West Bank, despite that the total irrigated land in Gaza strip is only 33.3% of the total vegetables cultivated irrigated land in Palestine.

3.2.3 Attitude and awareness of farmers towards pesticides hazards

The questionnaires distributed on different groups of farmers in rural and urban areas within Jenin, Tubas and Gaza Strip districts were collected and statically analyzed. Table 3 summarizes the answers given by the respondents on various raised questions.

It is obvious from the data listed in Table 3 that more than 25% of respondents are neutral in opinion, most likely unaware of negative effects of pesticides on biodiversity (birds, bees, soil ecosystem). However, more than 80% of replies were unaware of potential impacts on groundwater and air pollution. This is reflected on the urgent needs to conduct effective training programs on environmental hazards that can result from excessive or uncontrolled use of pesticides. Pesticides, when applied at recommended doses, revealed in an experimental study conducted by Andersch and Anderson (1991) that, 31 pesticides (15 insecticides, 10 fungicides, and 6 herbicides) had no long term (greater than 90 day) influence on soil nitrogen mineralization. However, in the absence of national regulations on sustainable use of pesticides, excessive use of pesticides might lead to detectable concentrations in women milk and enter groundwater and surface water (Alawi *et al.*, 1992; Alawi *et al.*, 1995; Albanis *et al.*, 1995).

Table 3: Farmers attitude towards adverse impacts of pesticides use in agriculture

Items (sample size 109 questionnaires)	Completely Agree Number (%)	Agree Number (%)	Neutral Number (%)	Disagree Number (%)	Totally Disagree Number (%)
The wrong use of pesticides could lead to the human death	19 (17.4)	73 (67)	11 (10.1)	4 (3.7)	2 (1.8)
The wrong use of pesticides could lead to damage human health	29 (26.6)	54 (94.5)	11 (10.1)	12 (11)	3 (2.8)
The wrong use of pesticides could lead to damage animal health	29 (26.6)	60 (55)	6 (5.5)	11 (10.1)	3 (2.8)
The use of pesticides contributes to the elimination of beneficial organisms in the soil and nature	17 (15.6)	38 (34.9)	26 (23.9)	21 (19.3)	7 (6.4)
The use of pesticides kills the bees	20 (18.3)	43 (39.4)	24 (22)	20 (18.3)	2 (1.8)
the use of pesticides kills the birds	17 (15.6)	48 (44)	23 (21.1)	20 (18.3)	1 (0.9)
The pesticides contribute to pollution and reduce soil fertility	18 (16.5)	43 (39.4)	31 (28.4)	14 (12.8)	3 (2.8)
The use of pesticides leads to burn or distorted the plants	11 (10.1)	36 (33)	43 (39.4)	15 (13.8)	4 (3.7)
The use of pesticides causes air pollution by toxic compounds	17 (15.6)	61 (56)	18 (16.5)	8 (7.3)	5 (4.6)
The use of pesticides leads to damage ozone	7 (6.4)	16 (14.7)	4 (3.7)	7 (6.4)	75 (68.8)
The use of pesticides leads to groundwater pollution	11 (10.1)	12 (11)	4 (3.7)	7 (6.4)	75 (68.8)

Major concern is that about 86.3% of respondents cannot read instructions made on pesticides labels, as most of them are either in Hebrew or English, so they rely on dose amount and calibration on their own experience (95.4%).

4. Conclusions and recommendations

The current study has provided a quantitative synthesis of accessible information with regard to estimating pesticides utilization and awareness of farm workers and public health inspectors on the potential risk of misuse. The MoH and MoA require strong management to control hazardous and toxic pesticides in public health and agricultural sectors. Relevant authorities, Palestinian Water Authority and Environmental Quality Authority must improve sanitation and solid waste services to minimize water pollution to domestic and agricultural wells (groundwater) by pesticide toxicants. The majority of respondents replied aware of hazardous impacts of pesticides, however, gave unjustified arguments as to applying safety measures usage, storage or disposal of used pesticides bottles or obsolete residues. It is necessary for the farmers to use a pesticide with low water solubility instead of pesticides with high solubility, and agricultural farm schools in respective districts should help farmers by providing adequate information. Chemical decomposition and microbial biodegradation in the drainage channels of paddy fields must be strengthened by increasing the aquatic purification capacity, which can be done by extending the residence time by placing barriers and other obstacles on the river bed, for example, in a zigzag fashion on both sides of the river. Cement or brick blocks are examples of appropriate obstacles. Advance analyses of surface water, groundwater, rivers, and coastal water by water authorities are strongly and continuously recommended.

Technical guidelines on pesticide storage, stock control, disposal of both bulk and small quantities of unwanted and obsolete pesticides with technical provision. Control and monitoring of pesticides usage, evaluation of pesticides residues, pollution assessment of soil, produce and aquatic environment are urgent activities to minimize adverse pesticides impacts. Flux quantification of agricultural pesticides from land-to-sea (Gaza strip) and land-to-groundwater (West Bank and Gaza strip), among other allochthonous organic substances, through urban and rural agricultural practices aids in identifying, controlling and managing water-quality problems in both surface and groundwater bodies as well as protects soil and public health from degradation and potential hazards, respectively. As groundwater protection in Palestine is a relatively new environmental field, it still lacks a well developed legal national body, established institutions, and local administrative policies and procedures. Despite few governmental efforts, still laws, institutions, and policies have to be developed at the local taking into account the regional experience and political commitments with neighboring countries.

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