

Pesticide Residues in Soil and Groundwater in Tobacco Farms of Ilocos Sur, Philippines: Basis for Ecological Program and Advocacy

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Abstract: Pesticides in agricultural production have serious impact on environmental quality and human health. This study assessed the level of pesticide residues in the soil and groundwater in tobacco farms of Ilocos Sur, Philippines. Descriptive method was used where data were gathered using a questionnaire. Collections of soil and groundwater samples were done to determine organophosphates, organochlorines, pyrethroids and other pesticide residues which would validate the responses of the tobacco farmers. Results showed that tobacco farmers used nonergonomic personal protective equipment during pesticide application that increased their exposure. Pesticides were stored at home which might have exposed children and adults to hazardous risks. Empty pesticide containers and other packaging materials were buried and burned that might have contributed to groundwater contamination and pollution. No pesticide residue was detected in the soil in tobacco farms during the wet season in upland and lowland sampling areas. However, significant concentration of chlorpyrifos was reported during the dry season. Pesticide residue in groundwater was not detected.

Keywords: Groundwater, Pesticide Residues, Soil

I. INTRODUCTION

Pesticides are known to be man's panacea towards optimum agricultural production. It has played an important role in the success of modern farming. The World Health Organization (WHO) estimates that developing countries consume about 20% of the pesticide production worldwide. In Southeast Asia, where agriculture is the principal economic activity, pesticides are an essential ingredient. The use of pesticides has helped considerably downgrade crop damage and to get better produce of the crops. On the other hand, their unfavourable effects in the form of environmental degradation and impacts on human health have also been well established. The foremost issue of pesticides misuse commences at the local area where it causes severe damage to land/soil, water, farmer's/worker's health and the environment as a whole including pollution of the atmosphere that is reflected globally from region to region and continent to continent (Huber et al., 2000; Kidd et al., 2001; Ntow, 2001; Cerejeira et al., 2003). This is supported by Lamers & Nguyen (2011) that the nature of pesticides used in crop production along with inadequate management of pesticide use, presents an environmental risk for ecosystems.

A study by Bouman et al. (2002) found residues of dangerous pesticides in the artesian wells around agriculture areas in Manguang in Batac, Ilocos Norte and in other locations in Laguna and Nueva Ecija (Luzon Island). Recently, researchers at the Benguet State University found pesticide residues of organophosphates, organochlorines and pyrethroids in soil and

vegetables grown in the Benguet municipality (Reyes et al., 2007).

Likewise, Del Prado Lu (2010) noted that pesticide residues were found in soil and water samples in the farming areas of Benguet. She also noted that endosulfan, which is restricted in the Philippines and banned in other countries, was found to be the most prevalent pesticide used (17.7%) and the second highest in concentration (0.015 mg/kg) in soil samples. In addition, it has been noted by Cerejeira et al. (2003) that pesticides also exacerbate environmental pollution, biodiversity losses and worsening of natural habitats. There have also been documented instances of pest resurgence, development of resistance to pesticides, secondary pest outbreak and devastation of non-target species. Despite the fact that pesticides are also used in other sectors, agriculture is being perceived as the most critical cradle of undesirable effects (Sattler et al., 2007).

Tobacco farming is one of the most important commodities in rural areas of North Luzon. Ilocos Sur is the country's largest Virginia tobacco producing province providing the bulk of raw materials for cigarette making factories. It has a total land area of 257,965 hectares composed of 34 municipalities of which 29 municipalities are tobacco growing areas.

Tobacco as a crop is an exportable commodity which requires intensive use of pesticides that impregnates residues to the different natural sinks. Monitoring the presence of pesticides in different environmental compartments has proved to be a useful tool to quantify the amount of pesticides entering the environment and to assess ambient levels for the evaluation of trends and potential problems (Muir et al., 2004; Donald et al., 2005). Although numerous local and national monitoring studies have been conducted around the world and provided nationwide patterns of pesticide presence and distribution (Roberts et al., 1998; Andreu and Pico, 2004), there are still a number of gaps in the information regarding pesticides.

This study aimed to assess the level of pesticide residues in the soil and groundwater on a temporal and spatial scales in tobacco farms of Ilocos Sur, described the socio-economic and farm profiles of tobacco farmers, source of groundwater and type of soil, and identified the current farm cultural practices. The results shall be the basis for the development of a training design for ecological program and advocacy in the local communities.

II. METHODOLOGY

A. Research Design

This study utilized the descriptive method of research specifically the survey type. It describes, explains and interprets conditions relating to the profile of farmer-respondents, their

farm characteristics and farm cultural practices in tobacco cultivation. In the survey method, respondents answered questions administered through the use of a questionnaire and complemented with personal interviews. Further, to substantiate the perception and or responses of the farmer-respondents on the level of pesticide residues in the soil and groundwater, collection of soil and groundwater samples was conducted from the eight sampling sites identified.

B. Sources of Data

Sampling sites in the tobacco production areas were selected based on geographic proximity of barangays with higher population densities (assumed to have higher pesticide usage), where flue-cured tobacco are traditionally planted and the relative time engaged in tobacco production. The sites of the study were in Sta Maria, Candon (lowland), Salcedo and San Emilio towns (upland). Two barangays within each of the four municipalities were selected from which one sample was collected per barangay. Eight soil and groundwater samples each for wet and dry seasons were collected for a total of 32 samples.

III. RESULTS AND DISCUSSION

A. Profile of Tobacco Farmer-Respondents

Age. Data shows that 29.3% of the respondents belonged to age bracket ranged between 41 to 50 years, 1.4% belonged to age group of 20 years and below and 1.7 % constituted 71 years and above. The mean age of 44.10 indicates that the farmers at 41 to 50 years were at their productive age and can actively perform farming activities. It was emphasized in the findings of Habib et al. (2014) that age group of 41-50 showed more interest in cash crop cultivation such as tobacco and sugarcane. It could also be noted from the results that there were still farmers with ages 71 and above (1.8%). The reason behind the involvement of a small proportion of age group of 71 years and above in tobacco cultivation may be similar to the one documented by Kalamata (2006) who reported that advancement in age above 64 years reduces body strength to engage in labor intensive farming activities like tobacco farming leading to retirement from active physical works.

Gender. As gleaned from the table, male (84.5%) posted the highest percentages compared to their counterparts (15.5%) female. This reflects that men are considered to be in charge of providing for the needs of his family. This is also expected given the nature of tobacco production which demands energy. However, the responsibility of women in agricultural production should not be discredited as merely reciprocation to that of men, or a provision of support system. The noteworthy involvement of women in farming has also been noted in the study of McCoy et al. (2002), wherein women do not only partake in the time-honored roles, they also work with their husbands in farming. These farm operations prompt women to health hazards that result in illness, injury or even death (Meeker et al., 2002).

Educational Attainment. Data revealed that nearly one-half of the farmers were able to finish high school (40.3%); while only about 27.6% reached high school level, 12.1% were elementary graduate, 10.0% reached college level, 5.2% underwent vocational studies while about 2.1% reached elementary level. Exposure to education according to Otunaiya & Akinleye (2008) will intensify farmer's capacity to acquire process and utilize information applicable to the adoption of

improved agricultural technologies. Also, Ballara (1991) added that education helps people obtain knowledge, become sensible users of natural resources and sustained protection of the environment. The author likewise mentioned that it expedites a transformation in attitude thus resulting to increased production. The findings further indicated that most of the farmers were educated which might have led to their ability to properly read and understand the instructions related to pesticide usage.

Monthly Income. More than half (63.4%) of the farmer-respondents had monthly income ranging from 2,000 pesos and below while only 1% had monthly income of 10,001 pesos and above. The result is consistent with the latest figures from the Philippine Statistics Authority (PSA, 2015) that the poverty incidence among fishermen is 39.2 percent, and among farmers, 38.3 percent. Most Ilocos farmers resort to contract-growing--borrowing capital from lenders in order to plant tobacco. Part of this agreement is for the farmers to sell their produce only to their lenders, often at lower prices. In addition, contract farming thus permits tobacco companies and or manufacturers to control species variety, volume and production costs, and creates asymmetric bargaining powers between tobacco firms and farmers (Almeida, 2005, Vargas & Campos, 2005). Studies demonstrate that contract farming exasperate a cycle of indebtedness for farmers who find themselves owing companies substantial amount of money for payments advanced as agricultural inputs annually (Almeida, 2005, Akhter et al., 2008, Vargas & Campos, 2005, Nguyen et al., 2009), thus aggravating the cyclical nature of poverty.

Household Size. Data revealed that majority (70.0%) of the farmers had 4 to 6 persons per household while 1.0% constituted 10 and above family members. It indicates that the farmers had ideal family size where children are considered as assets.

Source of Water for Domestic Use. The source of water for domestic use by the greatest number (63.4%) of respondents was groundwater while 36.6% pointed out coming from spring.

Farming Experience. Most (23.8%) of the farmers have been farming for 26-30 years while 4.8% have 21 to 25 farming experience. Older farmers have been observed to have higher productivity than younger farmers. For example, Ajani (2000), Ajibefun and Abdulkadri (1999, 2004), Ajibefun et al. (2006), and Idjesa (2007) observed that productivity in the forest and savannah agro-ecological zones of Nigeria was positively associated with more experience in farming.

Table 1: Socio-Economic Profile of Respondents

Socio Economic Profile	N	%
Age		
20 and below	4	1.4
21 – 30	37	12.8
31 – 40	72	24.8
41 – 50	85	29.3
51 – 60	68	23.4
61 – 70	19	6.6

Socio Economic Profile	N	%
Total	290	100.0
Gender		
Female	45	15.5
Male	245	84.5
Total	290	100.0
Highest Educational Attainment		
Elem level	6	2.1
Elem graduate	35	12.1
HS level	80	27.6
HS graduate	117	40.3
Vocational	15	5.2
Socio Economic Profile	N	%
College level	29	10.0
College graduate	8	2.8
Total	290	100.0
Monthly Income		
2000 and below	184	63.4
2001 - 4000	28	9.7
4001 - 6000	17	5.9
6001 - 9000	14	4.8
8001 – 10000	44	15.2
10001 and above	3	1.0
Total	290	100.0
Household Size		
1 – 3	33	11.4
4 – 6	203	70.0
7 – 9	51	17.6
10 and above	3	1.0
Total	290	100.0
Source of Water for Domestic Use		
Spring	106	36.6
Groundwater	184	63.4
Total	290	100.0
Farming Experience		
5 and below	39	13.4
6 – 10	57	19.7
11 – 15	50	17.2
16 – 20	61	21.0
21 – 25	14	4.8
26 – 30	69	23.8
Total	290	100.0
Number of Years in		

Socio Economic Profile	N	%
Tobacco Farming		
5 and below	50	17.3
6 – 10	86	29.8
11 - 15	36	12.5
16 – 20	61	21.1
21 – 25	14	4.8
26 – 30	42	14.5
Total	290	100.0

B. Farm Characteristics

Farm Size. Less than one-half (41%) of the farmers cultivated pieces of land ranging between 0.5 hectare and below while 10.7 % had farm size between 1.10 to 1.25 hectares. The data suggest that most of the tobacco farmer-respondents were small scale farmers and the land they tilled was used as a source of livelihood in subsistence farming.

Distance of House to Farm. Almost half (48.3%) of the respondents had farms located between 0.5 kilometers or less while 3.8% had farms located between 1.10 to 1.25 kilometers. It is inferred that these farms are closely located near settlement areas, thus, are affected by spray drift during pesticide application. Notably, previous research implied that the quantity of drift and the space pesticides travel are influenced by the application method, meteorological conditions, topography, characteristics of the crop or area being sprayed, and decisions made by applicators (US EPA, 2009)

Cropping Pattern. Results revealed that almost all (98.6%) of the respondents practiced the cropping pattern of planting rice and tobacco over rice, vegetable, corn (1.4%).

Farm Type. Majority of the respondents disclosed that their farms were owned (65.9%) while 34.1% were rented or leased. This result reflects that farm land are an important endowment to younger members of the family who will continue the age old tradition of crop production like planting of rice and tobacco and other commodity (food and non- food/fiber) in the study area.

Sources of Information on Pesticides. Almost all of the farmer-respondents declared that information regarding pesticides are provided by radio/audio as well as television, (99.7%) and (97.2%) respectively. This is consistent with the findings of Ekbia & Evans, 2009, Ommani & Chizari, 2008 that television, internet and radio have the facility to transfer related and timely information that help farmers to make decisions to use resources in the most productive and profitable way.

Table 2: Farm Characteristics

Farm Characteristics	N	%
Farm Size		
0.5 and below	119	41.0

Farm Characteristics	N	%
0.51 – 0.75	105	36.2
1.10 – 1.25	31	10.7
1.51 – 1.75	35	12.1
Total	290	100.0
Distance of House to Farm (km)		
0.5 and below	140	48.3
0.51 – 0.75	79	27.2
1.10 – 1.25	11	3.8
1.51 – 1.75	60	20.7
Total	290	100.0
Cropping Pattern		
Rice-tobacco	286	98.6
Rice-vegetable-corn	4	1.4
Total	290	100.0
Farm Type		
Owned	191	65.9
Rented/Lease	99	34.1
Total	290	100.0
Sources of Information on Pesticides		
Audio/Radio	289	99.7
Television	282	97.2
Newspaper	262	90.3
Posters	259	89.3
Leaflets	261	90.0
Booklets	261	90.0
Demonstration	268	92.4
Farmers' Training	260	89.7
Field days	257	88.6
Agricultural technician	269	92.8
Pesticide dealer	259	89.3
NGO worker	248	85.5

Type of Pump Well. The highest number of pump wells falls in the category of Type II (55.2%), in which the delivery of deep well water to the end user is from the groundwater to the pipe or tube, then to electric water pump to concrete water tank then to the faucet.

Table 3: Source of Groundwater Characteristics

Source of Groundwater Characteristics	N	%
Year Constructed		
1950s	2	.7
1960s	9	3.1
1970s	8	2.8
1980s	19	6.6
1990s	40	13.8
2000s	52	17.9
2010s	6	2.1
Total	136	46.9
Materials Used		
GI pipe/tube	260	89.7
Concrete culvert	10	3.4
Brick culverts	20	6.9
Total	290	100.0
Utilization Type		
Domestic	229	79
Irrigation	61	21
Total	290	100.0
Type of Pump Well		
Type I	128	44.1
Type II	160	55.2
Type III	2	0.7
Total	290	100.0

C. Source of Groundwater Characteristics

Year Constructed. Data showed that the highest number of the pump well was constructed in 2000s (17.9%) and least in 1950's (0.7%).

Materials Used. GI pipes/tubes appeared to be the most conventionally used material (89.7%) while 6.9 % and 3.4 % accounted for brick and concrete culverts, respectively. According to Walshauser (2013), galvanized iron pipes and tubes are more desirable in many situations. He mentioned that GI pipes/tubes entail low initial cost, can last more than 50 years in many rural areas, and more than 25 years in severely exposed urban and coastal environments, hence their long life, low maintenance costs and toughness.

Utilization Type. The groundwater withdrawn from pump well is generally utilized for domestic purposes (79%) while 21% is intended for irrigation.

D. Type of Soil

Table 4: Type of Soil

Type of Soil	N	%
Silty	5	1.7
Clayey	87	30.0
Loamy	181	62.4
Sandy	17	5.9
Total	290	100.0

Type of Soil. Most of the areas had a soil type belonging to the loamy category (62.4%), 30.0 % was clayey, 5.9% was classified sandy while 1.7% was silty. Accordingly, these types

categorize the soils of the province, depending upon their topographic positions, namely: a) soils of plain, b) soils of intermediate uplands, and c) soils of the mountains. The soils of the plains are represented by the Bantog Clay Loam, San Miguel Silt Loam, Umingan Sandy Loam and two miscellaneous types; the beach sand and the river wash. (Province of Ilocos Sur, Natural Resource Management Plan, 2014)

E. Farm Cultural Practices

Pesticide Usage. Most of the farmer-respondents used different pesticides that vary in terms of use and toxicity. Pesticides in tobacco farming is used as insecticide, fungicide and herbicide. Toxicity category ranges from category I as extremely hazardous; II as moderately hazardous, and III as slightly hazardous. According to Wesseling et al. (1997), pesticides that are strongly banned or restricted due to its deadly effect tend to have the lowest cost in the market. Moreover, laxity in the implementation of laws against application of dangerous pesticides in the Philippines is another reason why farmers can easily use hazardous chemicals despite knowledge on its potential risks to health (Rola & Pingali, 1993).

Spraying Time. Farmers' spraying time was usually in the morning (26.21%) than in the afternoon (15.86%) when the temperature is usually cooler and the relative humidity is typically higher. According to Deveau (2011), wind velocity and direction, temperature variation and relative humidity are the key environmental conditions that affect spray drift.

Frequency of Spraying. Farmer-respondents applied pesticides once a week (23.45%) and twice a week (2.07%) depending on the occurrence of pests and diseases.

Rate/Amount of Pesticides Used. One-fourth of the respondents (25) applied pesticides in the farm at a range of 30-49 ml (8.62%) while nearly one-fourth (23) used 50-99 ml (7.93%). The quantity of application varied between tobacco farmers because of the different geographical location, the sizes of their farm and other physical and meteorological factors. On the other hand, some of the respondents did not indicate (no response) on the frequency of pesticide application and rate or amount of pesticide per application.

Method of Application. All (100%) of the farmer-respondents indicated that they were using manual backpack sprayer. Based from the interview with some of the farmers, the lack of capital was the main reason for farmer's inability to buy required equipment such as motorized or power sprayer. Most farmers owned and made use of a knapsack sprayer, however the utilization of this type of sprayer is in itself presents some hazard to the user. According to Ntow et al. (2006), the use of said sprayer is prone to leakage, especially as the spray equipment ages. Matthews et al. (2008) recognized causes of leakage from the knapsack and highlighted the necessity to provide high quality equipment at an affordable cost that will last in hot and humid tropical environments.

Use of Personal Protective Equipment. The use of personal protective equipment while applying pesticides was only practiced sometimes (AWM=3.1867) despite the risk and frequency of exposure. However, it could be noted that wearing of long sleeve shirt was always practiced as reflected by the mean of 4.80. Oftentimes they wore wide brimmed hat (M=4.32), gloves (M=3.78), safety shoes (M=3.77) and mask

(M=3.58). Sometimes, they wore respirator (M=2.54) and safety glasses (M=3.28), and there were farmers who seldom did not wear protective equipment (M=1.51). The low capital outlay on protective clothing during pesticide handling and application could be explained by insufficient knowledge on pesticide toxicity plus the high levels of poverty which make farmers incapable to acquire them. The high costs of personal protective equipment are also deterrent in prioritizing their personal safety (Sam et al., 2008; Salameh et al., 2004; Oluwole & Cheke, 2009). Similar results were reported from the study conducted by Dogra et al. (1998), Recena, Caldas, Pires, and Pontes (2006), and Atreya (2007). The result also confirms the findings of Clarke, Levy, Spurgeon and Calvert (1997) that in the tropical countries, the habit or practice of using PPE was poorly tolerated because of discomfort associated with hot and humid conditions and its high price. However, even when PPE was used, their protective function was inadequate in this study. Also, the fact that farmers who accounted use of respirators as protection were, based on observation, mostly using disposable dust masks, which are not efficient protection when spraying toxic pesticides, may illogically escalate risk because the users confusedly believed they are protected and so may not follow other safety precautions. However, it is essential to acknowledge that PPE too often becomes temporary panacea for more important and sustainable safety measures, coherent with good occupational health and safety practices. For example, Integrated Pest Management (IPM), safer application methods and lesser use of toxic chemicals or mechanical and biological barriers to pests are important ways to reduce reliance on, and, hence, human exposure to pesticides in agriculture. Further, it is important to recognize that PPE usage should be a must for safer practices in general. Farmers who are mindful in using PPE may have a better tendency to practice healthier hygiene when handling pesticides.

Storage of Pesticides. On how pesticides are stored, farmer-respondents kept the pesticides at home (M=3.49), a practice which may expose children and adults to hazardous risks. Some of the respondents sometimes store their chemical pesticides in specific store room/room stack (M=3.39), in farm sites (M=2.74) and in some situation, pesticides are bought and used immediately (M=3.01). The respondents divulged that they seldom stored their chemical inputs in animal house (M=2.42). The findings corroborate the study of Tijani (2006) that farmers stored pesticides in places other than designated area for this purpose, exposing users and non-users, especially children to hazards. Stored pesticides may expire and no longer suitable for use. Farmers are encouraged to keep a record or inventory of the pesticides they are using to easily determine their shelf life and proper disposal.

Handling and Application. Farmers adopted safe pesticide handling and application practices such as washing hands after pesticide application (M=4.69), taking a bath after pesticide application (M=4.57), reading information written on pesticide packages (M=4.53), keeping away from recently sprayed areas (M=4.40) and avoiding spraying against the wind direction (M=4.47). As per observation, majority of the tobacco farmer-respondents reentered a sprayed field within 24 hours. Proximity to farms can also be a risk factor for pesticide poisoning. According to British Columbia (2010), pesticides can also move into other areas away from sites of application such as water bodies through runoff, soil through adsorption and leaching and

air through spray drift. In the area of investigation, it was observed that houses were adjacent to tobacco farms and thus may predispose household members to pesticide residue that remains in the environment. People in these areas should be appropriately notified about the risk and given adequate knowledge about the quality of the ambient air, surface water and soil and effective measures for protecting their health.

Disposal of Empty Containers, Bottles and Other Packaging Materials. Farmers sometimes practiced proper disposal of empty containers, bottles and other packaging material. It was pointed out that it was through burying ($M=3.36$), burning ($M=2.86$), and washing and reusing at home ($M=1.99$). It can be inferred that these are unsafe practices and has been described as a foremost concern in a number of studies (Recena et al., 2006, Avory, 1994 & London, 1994). Sawalha et al. (2010) indicated that improper dumping of empty pesticide containers such as discarding these into immediate surroundings, into local waste bins, or even burying and reusing it at home can render danger to the environment and the general public. In addition, burning empty pesticide containers in open fires or burying empty containers should not be used as a method of management and disposal of empty pesticide containers. These customary practices are probably perilous to human health and the environment and should be discouraged and appropriate management promoted. Safe burial requires adequate knowledge of local hydrology as well as of the chemical behavior of pesticides. Open burning of hazardous wastes that emit poisonous and toxic fumes is prohibited under the Philippine Clean Air Act of 1999. Also, the improper disposal of empty pesticide bottles and indiscriminate washing of sprayers pose a direct hazard to soil and water. Safe disposal should become part of the solid waste management program of the barangay through the local government units (LGUs) pursuant to RA 9003, otherwise known as the Ecological Solid Waste Management Act of 2000.

F. Level of Pesticide Residue in the Soil and Groundwater in Tobacco Farms on Temporal and Spatial Scales

Pesticide residues detected in the soil and groundwater were below the limit of quantification ($<LOQ$) during the wet season in upland and lowland sampling sites. It has been documented that the months of July to October every year, the Southwest monsoon (habagat) brings in extreme rainfall. During heavy precipitation, the soil works as a filter buffer and has a degradation potential for pesticides having the property storage of pollutant, owing to the presence of organic carbon (Burael and Bassmann, 2005). This is supported by the findings of Abong'O et al. (2015) that leaching of pesticide residue is higher during the wet season than the dry period. This is obviously due to the higher flow of water during the wet season. Similarly, pesticide residue detected was less than the quantification limit in the groundwater ($<LOQ$) during the dry season. This can be attributed to the ecological role that the soil plays in determining the chemicals leachability to the groundwater, and soil organic content on pesticide persistence. According to Andreu and Pico (2004), pesticide residues with high soil-sorption constant (K_{oc}) has low leaching potential. In this study, pesticide residues detected in the soil during the dry season in upland and lowland areas included chlorpyrifos, characterized with low polar characteristics (Andreu & Pico, 2004) and the compounds

movement is therefore limited throughout the soil profile such that there is less potential for groundwater contamination.

However, in Figure 1, it illustrates that the concentration of chlorpyrifos in the soil was significantly high at 1,256.61 mg/kg in lowland and 4.20 mg/kg in upland during the dry season. Chlorpyrifos was used as a systemic insecticide on farms to kill worms and other pests. Moreover, the behaviors of chlorpyrifos in soil were studied intensely due to its long persistence in soil environments and harmful impacts upon organisms (e.g., Racke et al., 1998; Yucel et al., 1999; Singh et al., 2003; Ngan et al., 2005; Fang et al., 2006; Vischetti et al., 2007; Fang et al., 2008; Vejares et al., 2010). In trace amounts, chlorpyrifos has been reported to cause neurological disorders such as attention deficit hyperactivity disorder and a developmental disorder both in fetuses and children (Rauh, 2006). In addition, Lu (2010) cited that, in the Philippines, chlorpyrifos residues found in the soil samples in Benguet were concomitant with muscle fasciculation experienced among local farmers.

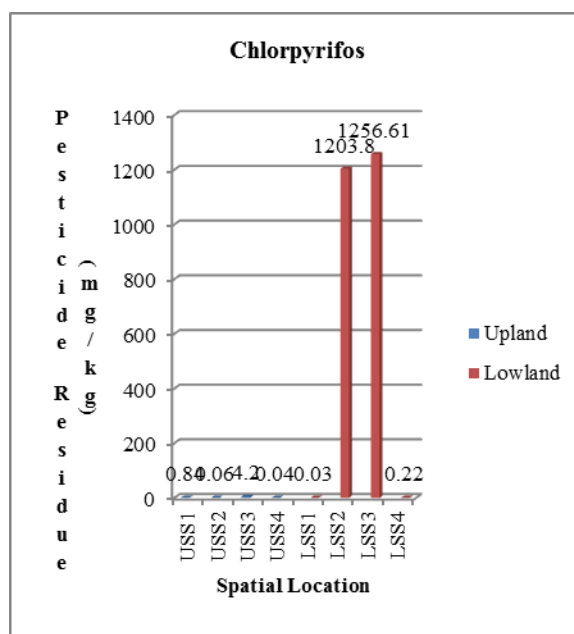


Figure 1: Level of Pesticide Residues in Soil on a Temporal (dry) and Spatial Basis

An ecological program/advocacy was designed by the researcher to intensify the level of awareness and practices on proper pesticide handling, application and disposal of pesticide packages/containers by tobacco farmers and disseminate the environmental and health effects of the same.

CONCLUSION

Farmer-respondents socio economic and farm profiles reflect the extent of agricultural productivity in maximizing outputs and/or to produce higher yields. This involves the use of pesticides to protect the tobacco crop from pests and diseases. A viable source of groundwater and healthy soils also plays a crucial role.

Farm cultural practices of tobacco farmers varied in terms of pesticide usage, use of PPE, storage of pesticides, handling and application and disposal of empty containers and other packaging materials. The level of pesticide residues detected in the soil specifically chlorpyrifos differed during the

dry season in upland and lowland areas. However, pesticide residues was below the limit of quantification (<LOQ) in the soil during the wet season and in the groundwater samples for both dry and wet periods in the various sampling sites.

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