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Synthetic pesticides use and Soil Biodiversity Conservation in Budondo Sub County, Jinja District

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ABSTRACT

Progressive famers in Budondo continue to use a variety of pesticides to optimize crop production. This has been a key feature in agriculture intensification. However, their continuous application has resulted into soil pollution, threatening processes driven by soil microorganisms and, thereby, affecting soil fertility and quality. A study of 340 households in Budondo Sub-County farming community, Jinja District revealed that pests destroyed their crops and caused significant yield losses. This was manifested in their score of responses viz. strongly agreed (1175) and strongly agreed (1075) respectively. Farmers demonstrated knowledge of soil macro fauna (96.2%), however, they claimed that termites and earthworms were pests (45.6%) because they ate and reduced their crop yield (86.8%) and constructed ant hills which were laborious to dig (60.3%). Farmers therefore sprayed their gardens with inorganic pesticides (81.8%) in order to eliminate pests quickly (86.5%). They also poisoned termites and earthworms with synthetic chemicals (77.9%) disregarding their long term economic benefits of decomposing organic matter and nutrient recycling among others. The researcher therefore recommended the government of Uganda to make and adopt a policy and action plan on pest management for sustainable soil biodiversity conservation. Farmers in Budondo be sensitized and trained about dangers of pesticide use how to mix plant extracts to form organic pesticides if any conservation measures were to be attained.

Key words: Soil, biodiversity, conservation, synthetic, inorganic, pesticides, households.

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INTRODUCTION

Since before 2000 BC, humans have utilized synthetic pesticides to protect their crops against pests and this has increased dramatically over the past 60 years (Isenring, 2010). Pesticides classified as biocides are inorganic substances or mixture of substances intended for preventing, seducing, destroying, or mitigating any pest (Nations, 2003). They include: Insecticides which kill insect pest, herbicides kill weeds, fungicides kill fungi, nematicides kill nematodes and termiticides kill termites (Manual, 2013).

Progressive famers in Budondo use a variety of pesticides to optimize crop production. This has been a key feature in agriculture intensification. However, their continuous application may result in soil pollution, threatening processes driven by soil microorganisms and, thereby, affecting soil fertility (Eisenhauer et al., 2009).
Concerns have developed over the long-term sustainability and environmental consequences of the intensification of agricultural systems. It is now clear that pesticides can have negative local consequences, such as lower soil fertility, and reduced biodiversity (Matson, 2009). They contaminate soil, air, ground and surface water, as well as the plants and animals that come into contact with these contaminated sources along their hundreds of miles journey from the original source

Soil biodiversity reflects the variability among living organisms in the soil - ranging from the myriad of invisible microbes, bacteria and fungi to the more familiar macro-fauna such as earthworms and termites. Soil organisms act as the primary driving agents of nutrient cycling, regulating the dynamics of soil organic matter, modifying soil physical structure and water regimes there by creating habitats for other soil organisms and plant roots, enhancing the amount and efficiency of nutrient acquisition by the vegetation, and enhancing plant health (Ayuke, 2010). Soil fauna and their biodiversity have also been widely used as bio-indicators of soil quality (Paoletti, 1999).

Farmers in Budondo Sub County use herbicides and pesticides, because they are cheap and very effective to control weeds. They also help kill viruses, bacteria, fungi, and other organisms that attack plants and cause them not to grow weakly. The synthetic pesticides used are a major factor affecting this soil biological diversity; along with habitat loss and climate change (Mal et al., 2009). They can have toxic effects in the short term in directly exposed organisms, or long-term effects by causing changes in habitat and the food chain (Isenring, 2010). Herbicides decrease organic matter inputs from weeds but also have a direct impact on non-target soil biota. Pesticides can save farmers' money by preventing crop losses to insects and other pests (Kellogg, Nehring, Grube, Goss, & Plotkin, 2000) but damage the longer lived organisms such as earthworms in the long run (Seymour, 2004). The feeding activity of soil organisms was higher in soil from organic gardens than from conventionally treated sites (Isenring, 2010). The number of earthworms was up to three times higher in organic compared to conventional plots, and growth of symbiotic mycorrhizae was 40% higher in organic compared to conventional systems and the length of plant roots colonized (Bengtsson, Ahnström, & Weibull, 2005; Isenring, 2010).

The destruction of biodiversity by agriculture creates a vicious cycle that actually undermines agriculture, because wild species are often essential to agricultural productivity (Atina, 2007). Pests can develop a resistance to the pesticide, necessitating a new pesticide. Alternatively a greater dose of the pesticide can be used to counteract the resistance, although this will cause a worsening of the ambient pollution problem.
The researchers' specific objectives to this study were:

- To establish why synthetic pesticides are used by farmers in Budondo Sub county
- To assess the effect of synthetic pesticides on soil macro fauna conservation in Budondo Sub county
- To establish ways through which soil biodiversity conservation can be enhanced in Budondo Sub county

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Description of study area: Budondo is one of the 12 sub counties (6 rural and 6 urban) in Jinja District in Busoga region and in Uganda. It has five (5) parishes and a total of thirty eight (38) villages. It is located in Kagoma County along River Nile west of Jinja Town. It is about 10 Km from Jinja town. Budondo Sub county community has a total population of 45,035 male and female who live in 8502 households. The average household is 5.3 with an average land holding of 1.5 acre per household (Statistics, 2005).

MATERIALS AND METHODS

This was a case study conducted through a descriptive survey research design. It was concerned with establishing the relationship between synthetic pesticide use and conservation of soil biodiversity in Budondo Sub County, Jinja District.

Descriptive approach was used in order to gather information about the present existing condition and utilize observations in the study (Creswell, 2003). The research study partially based its findings through both quantitative research methods in order to permit a flexible and iterative approach. It also employed qualitative research method in order to find and build theories that would explain the relationship of one variable with another variable through qualitative elements in research (Atomica, 2010). A total of 340 respondents were randomly determined using a probabilistic sampling design specifically simple random sampling from 8502 household in Budondo Sub County chosen in line with Strydom and De Vos sample determination table (De Vos & Strydom, 1998).

Researchers used both administered questionnaire, interviews, observations and documentary analysis as the main tools for collecting data. They were concerned with views, perceptions, opinions, attitudes and behaviours of the respondents (Otieno, Buyinza, Kapiyo, & Oindo, 2013). Questionnaires were administered by the interviewer especially where concepts were difficult to interpret by farmer respondents. The data obtained through a questionnaire was similar to that obtained through an interview because of the open ended questions (Burns & Grove, 1993). Descriptive statistics for the survey items was summarized in the text and reported in tabular and chart forms. Frequencies analyses were conducted to identify valid percent for responses to all the questions in the survey.

RESULTS AND DISCUSSIONS

Socio- demographic characteristics of respondents

The socio-demographic characteristics of respondents were tabulated from questionnaires describing bio-data, education background and occupation of respondents in the five parishes of Budondo Sub-County (Table 1).
The mean age of 37.6 of household respondents authenticated the responses given the Ugandan age of consent of 18 years. This supports Segura who suggested that the youth emigrate from their farming communities and perhaps are less motivated to carry out farming (Segura, Barrera, & Morales, 2004). It also implies that pest management was carried out by the mature farmers who had knowledge and made farming decisions on the choice of farm inputs used (Lutap & Atis, 2013).

More than a half of respondents were female (57%) indicating gender sensitivity and farming dominance by female. Over a half of respondents were married (58.5%) and had over six dependants (57.4%) (Table 1). This indicates that the most of households practiced farming to produce food to survive their household members and generate income to help them fulfill their needs and responsibilities (Mal et al., 2009).

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Over three quarters of household respondents (79.7%) attended formal education. This shows that they had the capacity to be sensitized about pest management practices and implement them effectively. The major economic activity in rural communities was farming (Mal et al., 2009).
This is manifested by the majority of household respondents (88.2%) whose occupation was farming with over 5 years' experience (70.5%) (Table 1). The respondents (an average of 20%) were randomly selected from each of the five parishes that constitute Budondo Sub-County. This intended to ensure an equal representation of the study area.

Table 1: Socio-demographic Characteristics of Respondents in Budondo Sub-County (N=340)

Characteristics	Frequency	Percentage
Age		
10-19	27	7.9
20-29	77	22.6
30-39	83	24
40-49	88	25.9
50-59	34	10.0
≥ 60	31	9.1
Mean	37.6	-
Sex		
Male	154	45.3
Female	186	57
Marital status		
Single	62	18.2
Married	199	58.5
Divorced	9	2.6
Widowed	51	15
Separated	19	5.6
Dependants		
1-5	145	42.6
6-10	140	41.2
11-15	40	11.8
≥ 16	15	4
Highest education level		
Primary	151	44
O' level	88	25.9
A' level	20	5.9
College/ University	12	3.5
Never to school	69	20.3
Occupation		
Farming	300	88.2
Trading	34	10
Civil servant	6	1.8
Working experience		
1-2 years	48	11
3-4 years	61	17.9
5-6 years	46	13.5
≥ 7 years	185	54
Parish		
Ivunamba	83	24
Namizi	73	21.5
Kibibi	74	21.8
Buwaji	63	18.5
Nawangoma	47	13.8

From table 1, farming was the major occupation (88.2%) for the mature (mean age= 37.6) and married (58.5%) in Budondo Sub County. It was practiced to provide a source of food for survival and to sustain their families given a large number of household dependents of six and above. All the respondents were from parishes of Budondo Sub County and therefore were key stakeholders of the study.

Inorganic pest management practices and peasantry

Table 2: Crops Grown in Budondo Sub-County (N=340)

Crops	Yes (%)	No (%)
Vegetables		
Cabbage	229 (67.4)	111 (32.6)
Carrots	138 (40.6)	202 (59.4)
Tomatoes	253 (74)	87 (25.6)
Onions	132 (38.8)	208 (61.2)
Pumpkins	171 (50.3)	169 (49.7)
Ginger	92 (27.1)	248 (72.9)
Greens	296 (87.1)	44 (12.9)
Other vegetables	23 (6.8)	317 (93.2)
Cereals		
Maize	332 (97.6)	8 (2.4)
Rice,	124 (36.5)	216 (63.5)
Millet	83 (24)	257 (75.6)
Sorghum	25 (7.4)	315 (92.6)
Other cereals	0 (0.0)	340 (100)
Root tubers		
Cassava	291 (85.6)	49 (14)
Sweet potatoes	319 (93.8)	21 (6.2)
Yams	264 (77.6)	76 (22.4)
Other root tubers	8 (2.4)	332 (97.6)

Fruits		
Banana	317 (93.2)	23 (6.8)
Pawpaw	215 (63.2)	125 (36.8)
Oranges	135 (39.7)	205 (60.3)
Jack fruit	287 (84)	53 (15.6)
Mangoes	251 (73.8)	89 (26.2)
Passion fruits	175 (51.5)	165 (48.5)
Pineapples	48 (11)	292 (85.9)
Other fruits	16 (7)	324 (95.3)
Legumes		
Ground nuts	304 (89.4)	36 (10.6)
Beans	329 (96.8)	11 (3.2)
Soya	259 (76.2)	81 (23.8)
Peas	36 (10.6)	304 (89.4)
Other legumes	19 (5.6)	321 (94)

Over a half of respondents grew most of vegetables i.e. Cabbage (67.4%), Tomatoes (74%), Pumpkins (50.3%) and greens like dodo, sukuma etc. (87.1%) (Table 2). This was due to Budondo's conducive ecology for vegetable growing enhanced by her location near River Nile and proximity to Jinja town. Respondents revealed that Ginger farming (27.1%) had just been introduced in the area whereas Onions (38.8%) and Carrots (40.6%) were progressing due to increasing demand in and neighboring markets (Table 2). This was in line with Pophiwa who urged that there was a growing demand for food globally most especially organically produced (Pophiwa, 2012).

Maize was the dominant cereal crop grown in Budondo Sub-County as agreed by (97.6%) (Table 2). This was because maize is the traditional food and cash crop in the study area and promotes food security. There was also a high demand of maize by schools, prisons and neighborhood countries. Rice growing was represented by (36.5%), millet (24%) and Sorghum 7.4% possibly due to their unfavourable ecological environment in the study area. More than three quarters of respondents agreed that cassava (85.6%), sweet potatoes (93.8%) and yams (77.6%) were grown by the majority households. This indicated that farmers in Budondo value the traditional staple foods.

Most households grow banana (93.2%), jack fruit (84%), mangoes (73.8%), pawpaw (63.2%) and passion fruits (51.5%) (Table 2). This was possibly due to high demand of fruits by urban dwellers around the study area. However, orange growing (39.7%) was still low while pineapple growing (11%) was left to isolated farmers possibly due to little awareness about their growing methods. Most of respondents agreed that legumes grown were beans (96.8%) followed by ground nuts (89.4%), and soya (76.2%). This is because they were consumed in different forms. Peas (10.6%) are grown by isolated farmers (Table 2) possibly due to little awareness about the value and growing methods of it.

It was found out that (85.9%) of household respondents were aware of pests (Table 3), very few could identify aphids (15.6%), whiteflies (7.6%), mealy bugs (10.6%), cut worms (15%), stem borers (25.9%), hoppers and locusts (22.9%), african boll worm (7.1%), african army worm (7.1), thrips (10.9%), leaf minors (17.6%) and white grabs (12.4%). Little knowledge about pests implies that farmers were unable to establish the growing habits and behaviours of the pests. This probably limited farmers' ability to choose the appropriate method of control and possibly adapt to pesticides as the only solution. This contradicts the IPM approach which relies on knowledge and experience. To minimize losses to pests, farmers should have awareness about the types of pests which attack crops as well as their biology which is not the case in Budondo (Lutap & Atis, 2013)

Table 3: Knowledge about Pests in Budondo Sub-County (N=340)

Variables	Yes (%)	No (%)
Are you aware of pests	292 (85.9)	48 (11)
Pests		
Aphids	53 (15.6)	287 (84)
White flies	26 (7.6)	314 (92.4)
Mealy bugs	36 (10.6)	304 (89.4)
Termites	155 (45.6)	185 (54)
Cut worms	51 (15.0)	289 (85.0)

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Stem borers	88 (25.9)	252 (71)
Hoppers and locusts	78 (22.9)	262 (77.1)
African boll worm	24 (7.1)	316 (92.9)
African army worm	24 (7.1)	316 (92.9)
Thrips	37 (10.9)	303 (89.1)
Leaf miners	60 (17.6)	280 (82.4)
White grabs	42 (12.4)	298 (87.6)
Others	182 (53.5)	158 (46.5)
Pest management practice		
Spray them using pesticides	278 (81.8)	62 (18.2)
Pick them by hands	48 (11)	292 (85.9)
Weed crops to prevent pests	113 (33.2)	227 (66.8)
Crop rotation	142 (41.8)	198 (58.2)
Intercropping	110 (32.4)	230 (67.6)
Spray using a mixture of any of urine, red pepper, neem, onions etc.	103 (30.3)	237 (69.7)
Use ash mixed with pepper and urine	112 (32.9)	228 (67.1)
Leave them	38 (11.2)	302 (88.8)
Any other	10 (2.9)	330 (97.1)

Almost a half of respondents identified termites (45.6%) as pests. This indicates that some of the farmers in Budondo Sub County knew little about other functions of termites. Most farmers in Budondo knew pests by local names (53.5%), others saw pests' symptoms on their crops while others saw them physically but were not aware of their names. This indicated that pests were common in the study area. Table 3 also portrays that spraying with pesticides (81.8%) is the common method used towards managing pests in Budondo Sub-County.This justifies that crops in Budondo Sub-County were largely affected by pests and farmers try to prevent crop losses to insects and other pests by spraying with pesticides as highlighted by Seymour (2004).

As discussed by Lutap and Atis (2013) about organic methods of controlling pests, less than a half of households agreed that farming practices reduce on pest infestation for example picking pests by protected hands (11%), weeding crops to prevent pests (33.2%), rotating crops (41.8%), intercropping (32.4%), spraying with a mixture of any of urine, red pepper, neem or onions (30.3%), using a mixture of pepper and urine (32.9%) while others left them (11.2%) (Table 3). This little awareness could perhaps be due to little exposure to organic pest control measures (Sebastian, Joshi, Gergon, Catudan, & Desamero, 2003)

Table 4 shows that over a half of household respondents in Budondo Sub-County were aware of chemicals used to kill pests (67.1%). This was supported by farming households (81.8%) who sprayed their crops with pesticides (Table 4).

Apart from dimethoate (42.6%) and cypermenthrine (46.2%) insecticides, where almost a half of household respondents were aware of, the rest of chemicals were far less known as manifested by less than (10%) of respondents who were in agreement to their use (Table 4). This meant that respondents used chemicals without their proper knowledge. This could increase problems associated with over or under dosage.

Over three quarters of household respondents agreed that the common source of pesticides was shops in their villages (76.2%) whereas less than a half, sourced the pesticides elsewhere, in their Parish (39.4%), Sub-County (28.8%), Jinja town (30.9%), agriculture officer (6.8%) etc. (Table 4).This implied that the pesticides were easily available and accessible to farmers which increased the risk of spraying with pesticides

Table 4 clearly shows that the majority of household respondents used inorganic pesticides because according to respondents, they quickly eliminated pests (86.5%), killed weeds (43.8%), killed termites (57.6%), increased crop yield (42.4%), made crops healthy (30.9%) while others claimed that they were easier to use and were effective (50.3%).

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Table 4: Inorganic Pesticide Use in Budondo Sub-County (N=340)

Variables	Yes (%)	No (%)
Are you aware of chemicals used to kill pests	228(67.1)	112 (32.9)
Inorganic pesticides		
Dimethoate (Tufgor) insecticide	145 (42.6)	195 (57.4)
Malathion insecticide	28 (8.2)	312 (91.8)
Cypermenthrine insecticide	157 (46.2)	183 (53.8)
Imax insecticide	23 (6.8)	317 (93.2)
Caboferadine	19 (5.6)	321 (94)
Mancozeb fungicide	15 (4)	325 (95.6)
Glyphosate herbicide	7 (2.1)	333 (97.9)
2,4 D herbicide	19 (5.6)	321 (94)
Atrazine herbicide	13 (3.8)	327 (96.2)
Paraquat herbicide	9 (2.6)	331 (97.4)
Other chemical	67 (19.7)	273 (80.3)
Source of pesticides		
Shops in the village	259 (76.2)	81 (23.8)
Shops in the parish	134 (39.4)	206 (60.6)
Shops in the sub county	98 (28.8)	242 (71.2)
Jinja town	105 (30.9)	235 (69.1)
From an agriculture officer	23 (6.8)	317 (93.2)
Make their own chemical from plant extracts	28 (8.2)	312 (91.8)
Any other source of chemical	2 (0.6)	338 (99.4)
Reasons for use of inorganic pesticides		
Eliminate pests quickly	294 (86.5)	46 (13.5)
Kill weeds	149 (43.8)	191 (56.2)
Kill termites	196 (57.6)	144 (42.4)
It is easier and effective to spray crops with pesticides	171 (50.3)	169 (49.7)
Increased yield with the use of pesticides	144 (42.4)	196 (57.6)
Pesticides make crops healthy	105 (30.9)	235 (69.1)
Any other	13 (3.8)	327 (96.2)
Are you trained about the use of pesticides?	128 (37.6)	212 (62.4)
Trainer about the use of inorganic pesticides		
District agriculture officer	26 (7.6)	314 (92.4)
Drug shop owners where pesticides are sold	71 (20.9)	269 (79.1)
NAADS staff	43 (12.6)	297 (87.4)
NGO	28 (8.2)	312 (91.8)
Fellow farmers	52 (15.3)	288 (87)
Other trainer	4 (1.2)	336 (98.8)

This was in support of Kellogg et al (2000) who suggested that pesticides save money by preventing crop losses due to pests and clearly explained why pesticide use was rampant in Budondo. Though about a third of household respondents (37.6%) claimed to have been trained about the use of inorganic pesticide use, there was very little awareness about the names of pesticides and their mode of application (Table 4)

The knowledge of households about the effects of pests and the use of pesticides to manage pests was tested using a 5 score point Likert scale as shown in Table 5.
As manifested in the respondents' scores of response, the people of Budondo Sub County strongly agreed that pests attacked their crops (1175) and caused significant yield loss (1075). They also agreed that pesticides and herbicides killed every insect pest and weed they came across (608).This could perhaps be the reason why they sprayed with pesticides as Kellogg et al (2000) puts. They agreed that the skin itches with use of pesticides (492) but were not sure whether pesticides kill bees (471), wasps (492), earthworms (477) and ants (435) as shown on Table 5. This implied that households in Budondo Sub-County used inorganic pesticides to minimize crop losses by pests with little knowledge of their negative effects on other non-target beneficial organisms.

Table 5: Likert Scale for the Effect of Pests in Budondo Sub-County (N=340)

Variables	Strongly agree (x5)	Agree (x4)	Not sure (x3)	Disagree (x2)	Strongly disagree (x1)
Pests attack crops	235 (1175)	99 (396)	6 (18)	0 (0)	0(0)
Pests cause significant yield loss	215 (1075)	112 (448)	13 (39)	0 (0)	0(0)
Pesticides and herbicides kill every insect	38 (190)	152 (608)	109 (327)	30 (60)	11 (11)

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pest and weed they come across					
Pesticides kill bees,	12 (60)	74 (296)	157 (471)	60 (120)	37 (37)
Pesticides kill wasps	10 (50)	72 (288)	164 (492)	60 (120)	34 (34)
Pesticides kill earth worms	16 (80)	69 (276)	159 (477)	61 (122)	35 (35)
Pesticides kill ants	34 (170)	88 (352)	145 (435)	49 (98)	24 (24)
Skin itches when use pesticides	97 (485)	123 (492)	92 (276)	22 (44)	6 (6)

Effects of inorganic pest management practices on soil macro fauna

Almost all the household respondents in Budondo Sub-County were aware and had seen soil living organisms (96.2%).

The knowledge of households about the effects of inorganic pesticides on soil macro fauna was tested using a 5 score point Likert scale as shown in Table 7.

As manifested in the scores of response, farmer respondents in Budondo Sub County agreed that herbicides decrease organic matter from weed (355 for strongly agree) and (520 for agree). This meant that herbicides once sprayed, not only cleared weed but also killed macro fauna that lived in and under weeds as stressed by Seymour (2004).

They were not sure whether once pesticides and herbicides were sprayed on crops, would further kill termites and termites (429). This indicated little awareness about the effects of inorganic pesticides on soil biodiversity. It also indicated that farmers sprayed crops with chemical pesticides that they had little knowledge about.

Table 7: Likert Scale for the Effect of Inorganic Pesticides on Soil Macro Fauna in Budondo Sub-County (N=340)

Statement	Strongly agree (x5)	Agree (x4)	Not sure (x3)	Disagree (x2)	Strongly disagree (x1)
Herbicides decrease organic matter from weeds	71 (355)	130 (520)	124 (372)	11 (22)	4 (4)
Pesticides and herbicides once sprayed on crops will further kill termites and earthworms	48 (240)	104 (416)	143 (429)	32 (64)	13 (13)

CONCLUSION

The pests have reportedly attacked farmers' crops and caused significant losses in Budondo Sub County. Soil macro fauna especially termites and earthworms have also been reported as pests by respondents there by disregarding their long term economic benefits of decomposing organic matter and nutrient recycling among others. Due to this pest problem farmers have resorted to use of inorganic pesticides as claimed by respondent (86.5%) because, they are easier to use and effective in eliminating pests.

RECOMMENDATIONS

Based on findings, it is recommended that the Government of Uganda should make and adopt a policy and action plan on pest management for sustainable soil biodiversity conservation. Farmers in Budondo should be sensitized about dangers of pesticide use in order to increase their knowledge. Organic pesticides should best alternate inorganic pesticide in the integrated pest management model when a level is determined to cause significant injury to the crop.

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