

Knowledge and Practice of Pesticides use among Small Holder farmers in Zambia

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Abstract— Pesticides are essential for the control of infestation of disease, insect pests and weeds on different crops. Due to wide usage of synthetic pesticides which may lead to increased exposure and associated environmental and health risks among small-holder farmers in Zambia, a study was undertaken to understand how knowledgeable farmers are on pesticide use and practices. A total of 418 small scale farmers were randomly sampled from Mkushi, Mpongwe, Luangwa, Mbala, Solwezi, Chipata and Kalomo Districts of Zambia. Data pertaining to types of pesticides use, handling, storage and disposal was solicited using structured questionnaires. The data collected was analyzed using SPSS. Findings revealed that of the sampled farmers 43%, 30%, 25% and 17% used Glyphosate, Dicamba, Paraquat and Atrazine respectively as herbicides in Maize. 21% and 14% used Cypermethrine and Monocrotophos respectively as insecticides in both Maize and Soybean. 81% of the sampled farmers used empty containers for either storing drinking water or salt while only 15% wore protective clothing when applying pesticides. Pesticide mishandling occurred regardless of the amount of experience a farmer had using pesticides. 68% of the sampled farmers had never received any formal basic training in pesticide use, hence a clear knowledge gap. The fact that receipt of basic training was the main predictor of a farmers' level of knowledge on pesticide use, a farmer who had received basic training in appropriate chemical pesticides use, as opposed to one who had not, had a better chance of using chemical pesticides safely and in the right quantities.

Keywords— Pesticides, Agriculture, Knowledge, Practices, Farmers.

I. INTRODUCTION

Agriculture plays an important role in the economy of Zambia. The sector generates approximately 10 percent of the Gross Domestic Product (GDP) and provide livelihoods for more than 70 percent of the population (SNAP, 2016). Commercialization of agriculture is central in accelerating economic growth and poverty reduction whose economy is overwhelmingly rural and agrarian. Zambia's climate is ideal for growing a range of crops including maize, soybean and common beans. Among the abiotic constraints in the production of these crops are infestation of weeds, insects and disease pathogens, and therefore basic agronomic practices entail heavy use of pesticides such as chemical insecticides, herbicides and fungicides to ensure food security.

According to Food and Agriculture Organization (FAO, 2002), a pesticide means any substance or mixture of substances intended for preventing, destroying or

controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals causing harm during or otherwise interfering with the production, processing, storage, transport or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs, or substances which may be administered to animals for the control of insects, arachnids or other pests in or on their bodies. The term includes substances intended for use as a plant growth regulator, defoliant, desiccant or agent for thinning fruit or preventing the premature fall of fruit, and substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport. Pesticides are widely used in agricultural production to prevent or control pests, diseases, weeds, and other plant pathogens in an effort to reduce or eliminate yield losses and maintain high product quality (Damalas, C. A. and Eleftherohorinos, I. G., 2011). By virtue of their widespread use, pesticides have become a

major group of environmental contaminants. When used inappropriately, pesticides contaminate the environment and accumulate in the food chain thereby posing risks to human health (Blasco et al, 2003; Leong et al, 2007; Pesticide Action Network, 2001).Richter, 2002 further stresses that annually there are dozens of million cases of pesticide poisonings worldwide

For this reason, proper use of pesticides such as application, handling, storage and disposal is cardinal in ensuring good results for crop protection and quality improvement, labour saving and achievement of substantial economic benefit in agriculture. Several studies have been conducted on the use of pesticides in cotton and vegetables, very few if any on cereals and legumes have been documented in Zambia.This study was therefore aimed at understanding the knowledge and practices of small holder farmers as regards the use of chemical pesticides in legume and cereal cropping systems in Zambia.

II. MATERIALS AND METHODS

A total of 418 small scale farmers were randomly sampled from seven districts in seven provinces of Zambia in a

survey conducted in 2015 (Figure 1). The Districts selected were purposively sampled based on agriculture patterns in relation to cultivation of cereal (maize) and legume (common beans and soy beans) based crops as well as on a fair representation of all the agro ecological zones in Zambia. The regions were sampled by choosing a representative district and within the District agricultural blocks were chosen. Within a particular farming block, camps were purposively selected for questionnaire distribution. Analysis on some pertinent questions designed in the questionnaire was done using the SPSS statistical package version 21.0.0.To determine the relationship between variables Spearman's rank correlation was used before conducting logistic regression since all the variables were categorical with the exception of one that is total cultivated land. Chemical pesticide use; years of farming at your own household; total cultivated land and; whether a respondent received basic training on the handling and application of pesticides were the variables included in the regression model.

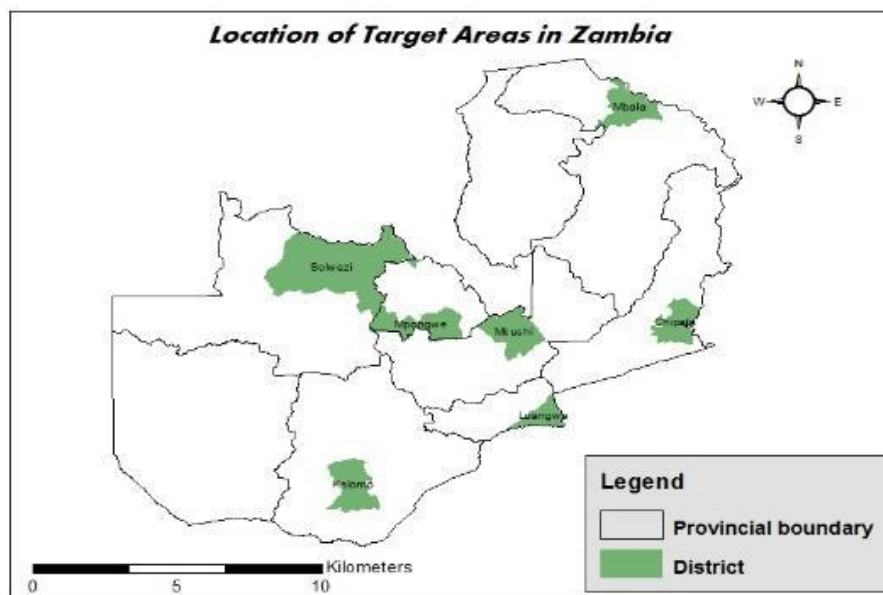


Fig.1: Location of surveyed districts

III. RESULTS

A total of 162 synthetic pesticides trade names belonging to 52 active ingredients when grouped were being used by the small holder farmers in the surveyed areas. Chipata District had the highest number of farmers (60%) that had used

pesticide for over 10 years while Kalomo, Lungwa, Solwezi and Mbala Districts had the highest (80%) number of farmers who had used pesticides for less than three years.

Commonly used pesticides

The study revealed that as much as small holder farmers use other types of chemical pesticides, more than 40 percent use *glyphosate* as an active ingredient which is also traded as cycat, round up, glyphona, glyphocure, wound out, Buccaneer, Muscle up, eraser, extreme, ranger Pro and Buzza. 32 percent reported having used *Dicamba* trading as stella star while 25 percent had used paraquat trading as

paraquat, parachute and gramoxone. Other common chemical pesticides are *cypermethrine*; *atrazinetrading* as atrazine, bullet and atraforce; a combination of atrazine and cyanazine trading as afristik, cropservice, maize weed killer and ATS blazing; *Monocrotophos*; Acetochlor trading as Acetachlor and Acetacure; *Lambda Cyhalothrin* trading as Karate, lambdacure and lambda; and *Quizalofop-P-ethyl* trading as pantera and panther.

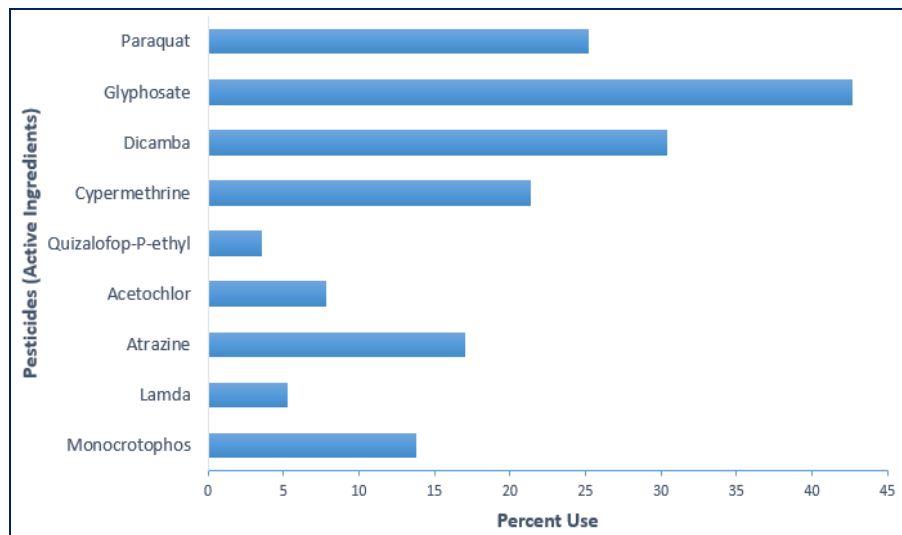


Fig.2: Commonly used pesticides in the target districts

Practice with Pesticides Use

The survey revealed (Figure 3) that 59 percent of the people kept the pesticides to be re used later, 20 percent threw them away, 5 percent gave them away while only a percentage sold to other famers. Eighty-one percent of the respondents said they used empty containers for either storing drinking water or storing salt, 12 percent used the containers for buying diesel while 6.1 percent either sold or buried the containers. There was no significant relationship between the farmers practice on leftover practice and level of education at $p=0.005$.

The study further revealed that 80.1 percent of the farmers bought pesticides that were well labeled with the majority of the farmers being from Solwezi and Chipata Districts. Only 15 percent of the farmers used full protective clothing when applying pesticides. The remaining 85 percent either

wore gumboots or did not wear any form of protective clothing. The study revealed that the 15 percent that had used full protective clothing had either attained secondary or tertiary education. Hence, there was a positive correlation between level of education and the practice of wearing protective clothing.

The study also revealed that 96 percent of the small holder farmers responded in affirmative that pregnant, lactating or nursing women did not handle chemical pesticides. Ten percent of the farmers ever experienced an accident associated with the use and handling of pesticides. Of these, the most commonly experienced symptoms were skin irritation, dizziness, headache and difficulty in breathing. To remedy these symptoms most farmers drank milk and took a bath.

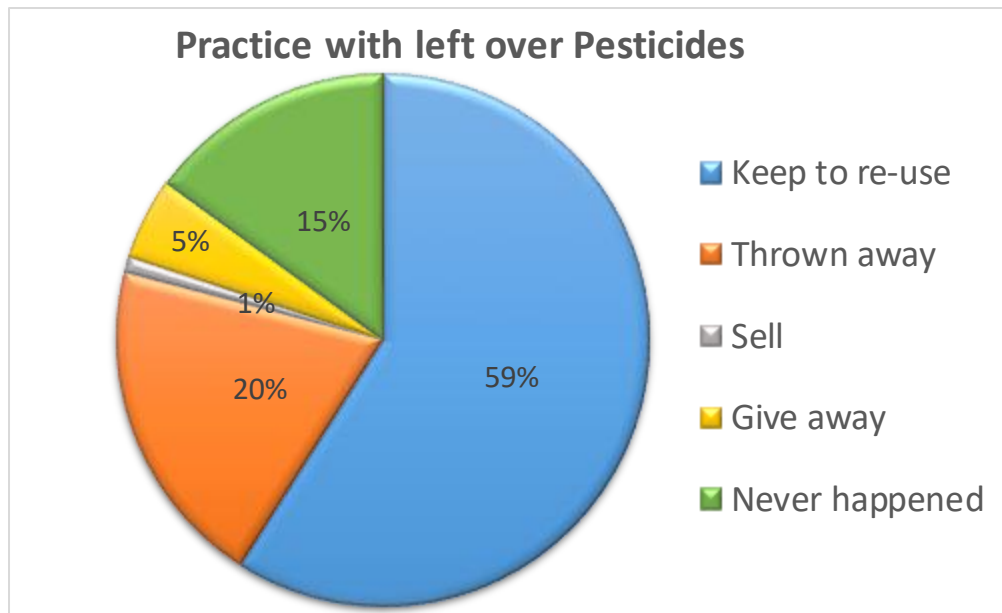


Fig.3: Usual practice with left over pesticides

Application rates

Solwezi had the highest average application rates per hectare for *glyphosate* while farmers in Luangwa and Mbala Districts had average application rates standing at 0.39 and 0.45 litres per hectare respectively (Figure 4).

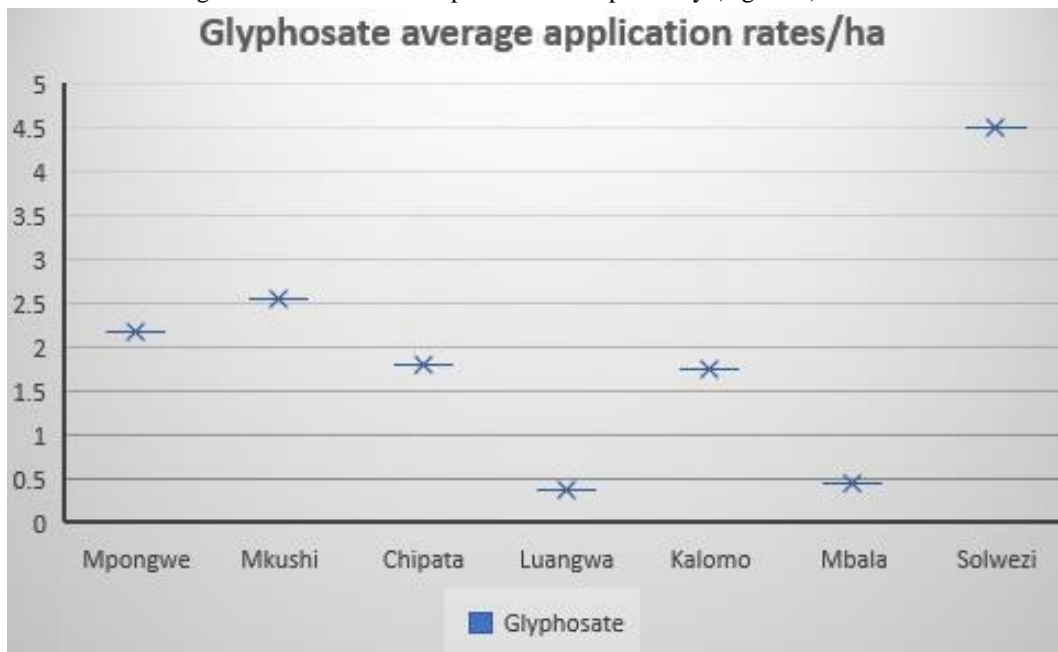


Fig.4: Average application rate for *Glyphosate* per hectare

The study further revealed that farmers in Mkushi, Kalomo and Solwezi districts applied *Dicamba* at an average rate of 2.38, 2.68 and 0.6 litres per hectare respectively

Training

Sixty-eight percent had never received any formal training in pesticide use and/or handling. Luangwa, Kalomo and Mbala Districts had the highest number of farmers who had never received any form of training in pesticides use (Figure 5). The study revealed that there was a positive correlation between having received any form of training in pesticide use and handling and the district where the respondent came from.

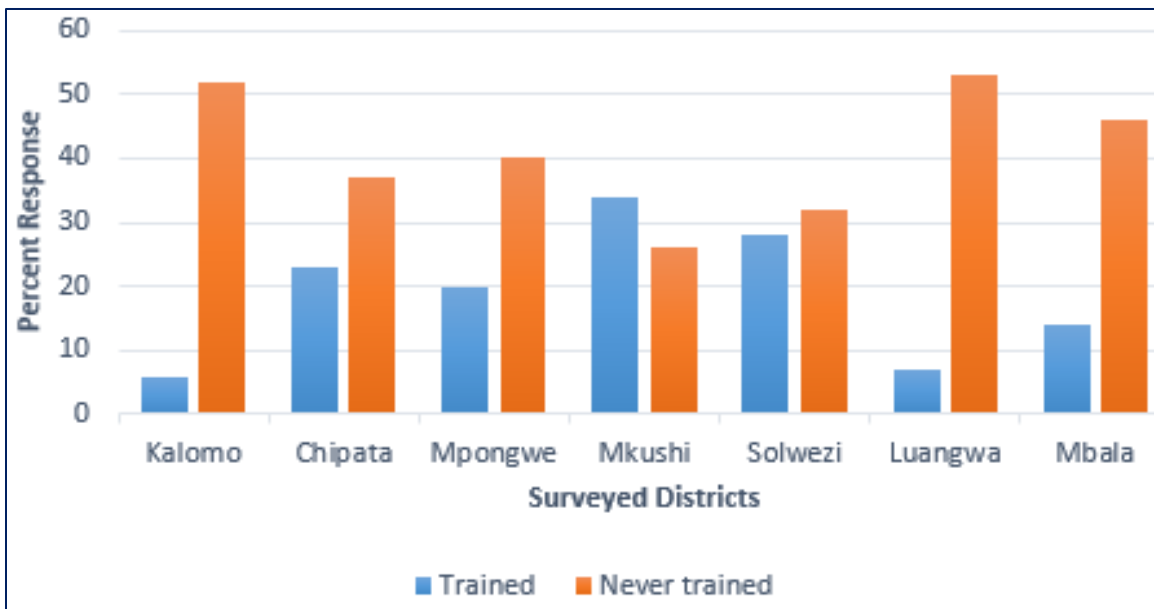


Fig.5: Training in pesticide use and handling per District

Alternative ways of Pest Control

The study further revealed that 46.9 percent of the farmers used crop rotation while 42.6 percent also practiced mechanical techniques (in the case of weeding) of pest management as alternative ways of controlling pests in cereal legume cropping systems. Only 1 percent had used washing powder as alternative way of pest control (Figure 6).

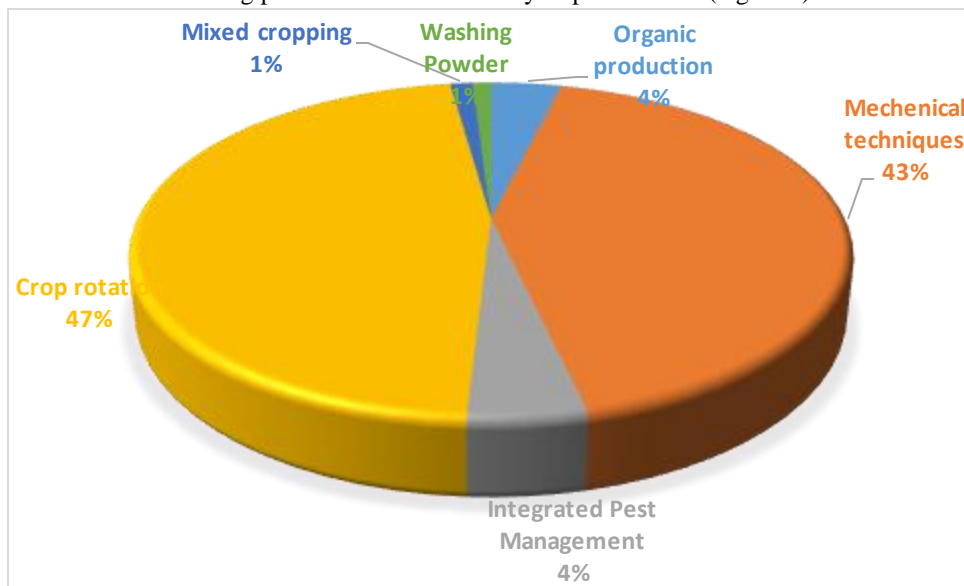


Fig.6: Other ways small holder farmers control pests

A regression analysis of the study further showed that there was a significant positive correlation at $p=0.05$ between respondents' use of chemical pesticides and level of education. The same observation was made with regards chemical pesticide use and total cultivated land, and; whether a respondent received basic training on the safe handling and application of pesticides or not. The Logistic regression further showed a Nagelkerke R Square value of 0.253. The model was given by the equation below.

$$\text{Logit (p)} = 2.645 - 0.792X_1 - 0.770X_2 - 0.136X_3 - 2.027X_4 + 0.037X_5$$

Where; X_1 = primary education level, X_2 = Secondary education, X_3 = Tertiary education level, X_4 = Received basic training, X_5 = Total Cultivated land

IV. DISCUSSION

The results of this study show that *glyphosate*, followed by *Dicamba*, *paraquat* and *Atrazine* respectively are widely used by small holder farmers as herbicides in Maize while *cypermethrine* and *Monocrotophos* are used as insecticides in both Maize and Soybean. *Phorate* was predominately used as a fungicide in common bean growing areas. Use of such pesticides is seen as a way of reducing yield losses in the light of prevalent pest and disease occurrences and, as a way of dealing with labour constraints.

It is evident from this study that farmer's application rates are more than the manufacturers recommended rates, while in other cases farmers application rates were below the recommended rates as seen by the average application rates being used by farmers for *Dicamba* and *glyphosate* in the districts where the study shows high use of such chemicals. Only farmers in Mpongwe and Mkushi Districts applied *glyphosate* within the recommended range of 2 to 4 litres per hectare. The observed over application and under application may defeat the purpose for which pesticides are being used that is to increase crop productivity. Over application may result in pesticides resistance and accumulation of pesticide residues in soil and in crops over time.

Moreover, there is a knowledge gap on the use of synthetic/chemical pesticides as majority of the farmers do not know how to use and handle them. Despite having used pesticides for less than 3 years, a considerable number of farmers in Solwezi District have been trained in pesticide use. This can be attributed to the intervention of the mines in fostering sustainable agriculture where farmers are given farming inputs and are trained on conservation agriculture practices in selected camps. A considerable number of

farmers have also been trained in Mkushi district owing to the heavy presence of Conservation Farming Unit. Despite the vigorous increase of small holder farmers using pesticides in the recent past, Luangwa, Kalomo and Mbala still lag behind on the population of farmers that have been trained and sensitized on safe pesticide use.

Majority of farmers use crop rotation as an alternative pest control method, which may be attributed to the vigorous promotion of Conservation Agriculture that have been carried out in Zambia in the recent past. Mechanical weed control especially using hand hoes also still remains common among small holder farmers due to the high cost of procuring pesticides later on the equipment that is used when applying them. Some farmers perceive pesticides as dangerous to human health and the soil, hence the reluctance in using them. This also explains why majority of farmers do not involve pregnant or lactating women in pesticide use and handling.

The fact that receipt of basic training in handling of chemical pesticides by farmers was the main predictor of a farmers' chemical pesticide use. A person who had received basic training in handling and applying of chemical pesticides, as opposed to one who had not, had a better chance of using chemical pesticides safely and in the right quantities. This is in line with existing evidence from studies conducted from regions within several Sub-Saharan African (SSA) countries where pesticide use suggests that farmers' knowledge of personal safety when applying pesticides is low (Mekonnen and Agonafir 2002; Ngowi et al. 2007) and also that farmers were unable to correctly order pesticides by their toxicity levels (Maumbe and Swinton 2003).

Therefore, with vigorous training, advocacy and sensitization on the safe use and the benefits, negative perceptions can be overcome with time. Conducting training in pesticide handling would increase safe use of chemical pesticides by about 25 percent going by the Nagelkerke R value, even though there could be other factors other than the ones included in the model influencing safe pesticide use. Therefore, measures to foster the judicious use of pesticides by small holder farmers should therefore be recommended to control weeds, pests and diseases, and increase crop productivity. Farmers using washing powder as a means of pest control is in itself an interesting finding which guarantees further investigations and studies.

While pesticides such as insecticides, fungicides and herbicides are promoted as inputs that eliminate yield

losses, maintain high quality of products and prevent other undesirable effects that may be caused by the pest, they can be detrimental to human health if inappropriately used as evidenced by the commonly experienced symptoms of intoxication which include dizziness, headaches and breathing problems among others.

V. CONCLUSIONS AND RECOMMENDATIONS

It is evident from the study that knowledge on safe use of pesticides among small holder farmers in most parts of Zambia is inadequate as farmers are not sufficiently trained on safe handling, use and storage pesticides later on disposal of empty pesticide containers.

Sustainable use of chemical/synthetic pesticides remains a challenge among small holder farmers in Zambia going by the practices farmers employ when using pesticides. Moreover, health and environmental problems cannot be isolated from economic concerns due to the fact that incorrect pesticide use results not merely in actual yield losses but also in health risks and environmental contamination.

Based on the findings of the study, it is recommended that vigorous training of small holder farmers be undertaken on safe and appropriate use of chemical pesticides. This training should be accompanied by promotional programmes through electronic and print media. In this regard, a country wide strategy on wide dissemination of chemical pesticide safe use for small holder farmers is inevitable for enhanced sustainability in the agricultural sector.

ACKNOWLEDGEMENTS

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