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FARMERS' KNOWLEDGE AND ATTITUDES ON PESTICIDE USAGE IN VEGETABLE CULTIVATION IN SRI LANKA

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ABSTRACT

A farmer survey was conducted in four major vegetable growing districts*; Badulla, Kandy, Matale* and *Nuwara Eliya* to identify the sensitivity of vegetable growers on the impacts of synthetic pesticides used in vegetable cultivation and the problems faced by them in maintaining pest- and disease- free crops for maximum economic benefits. The key factors involved in farmers' decision making in selecting pesticides were the product quality, farmer experience, availability and reputation than the price, product novelty and influence of the dealer and the peers. More farmers indicated that some *Organophosphates, Carbamates, Pyrethroids* and fungicides are more effective in controlling insect pests and diseases. A majority of farmers reported that the new-hybrids which are sensitive to insect pests and diseases as a drawback in minimizing agrochemical usage. The survey revealed that the product quality, farmers' experience, availability of the product, company reputation, income, and price are influenced for decision making. Hence suggested cohesive research and development programs to develop non-pesticide dependant crop management practices; efficient pesticide application techniques that help minimize to pesticide requirement; establishment of surveillance system and implementing policies to regular monitoring of pesticide residues in vegetables. We emphasize that excessive use of pesticides is an economical and behavioural "lock in' aspect that require multi-dimensional approach to find a solution to this issue.

***Key words*:** Farmer Perception, Pesticide Usage, Vegetable Farmers

INTRODUCTION

Many attempts have been made in recent years in Sri Lanka to study the pesticide use practices in vegetable cultivation, especially in the up - and mid- country in order to provide *status quo* of the issue and to develop guidelines to minimize pesticide use (Chandrasekara *et al*. 1985; De Silva 2003; Selvarajah and Thiruchelvam 2007; Sumith 2009; Marasinghe *et al* 2011; Chaminda *et al.* 2012; Sumith and Munkittrick 2011, Sutharshan *et al*. 2014; Padmajani *et al*. 2014; Pathirana *et al*. 2015; Marasinghe *et al.* 2017). These investigations were aimed mainly to determine the profile and frequency of pesticides used and the application techniques followed. However, no efforts have been made to determine the underline forces that make farmers to adhere to pesticide-based pest management methods and to understand the knowledge and technology gaps that need to be fulfilled to empower farmers to shift towards a new pest management system with least pesticide-dependence (Sinek 2009).

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This study was conducted to identify;

Major pests such as insects, mites, nematodes, pathogens and weeds in vegetables grown in *Nuwara Eliya, Badulla, Kandy* and *Matale* districts as recorded by farmers and the management methods followed by them to control these pests.

The pesticides commonly used in vegetable cultivation to help design methods to minimize resistance development in insect pests and pathogens to pesticides and to minimize over use of pesticides

Farmers' knowledge gaps on; the decision making on pest management; toxic levels of pesticides, correct selection of pesticides, safe application methods to mitigate residue levels in harvests, non-pesticidal methods available for pest management, economic advantages of toxic-residue free vegetables

METHODOLOGY

Survey areas: The survey was conducted among 160 leading farmers randomly selected from major vegetable producing districts of *Badulla* (32), *Kandy* (30), *Matale* (25) and *Nuwara Eliya* (73) in Sri Lanka.

Survey instrument: The survey was designed to determine the socio-demographic profile of vegetable farmers in the selected districts, record the agronomic and pest management practices followed during the main season of 2016/ 2017 and to obtain detailed information about farmers' knowledge and attitudes on decision making on insect pest and disease management.

The questionnaire used by the IPMNet in Asian countries was adopted as the base document in preparing the survey instrument (Heong *et al*., 1994). The modified questionnaire was pretested with leading farmers in Nuwara Eliya and modifications were made accordingly.

Survey procedure: To ensure consistency in responses, the enumerators followed a uniform questioning and recording procedure. Follow-up discussions helped share experiences and make necessary adjustments to the survey procedure. Farmers were interviewed within a period of 10 weeks (February-April 2017) to enable them to recall the activities undertaken in the previous season more accurately.

Statistical analysis: Descriptive statistical analytical procedures with the Pearson product movement correlation test were applied to analyse the data as indicated under results and discussion.

RESULTS AND DISCUSSION

This part shows the overview of vegetable cultivations in *Badulla, Kandy, Matale* and *Nuwara Eliya* Districts. We observed that the majority of the vegetable farmers were middle aged, studied up to General Certificate of Education (Ordinary Level) and the average monthly income level of Rupees 31,000/ – 40,000/ (Table 1).

Table 1. General features of responding farmers (nearest whole number)

Feature	Category	Percentage
Age (Yrs)	< 30	10
	31-40	35
	41-50	25
	51- 60	20
	> 61	10
Education	None	8
	Primary	44
	Secondary	48
Experience (Yrs)	<10	29
	10-20	34
	>20	37
Income/ Monthly (Rupees)	20,000 - 30,000	15
	31,000 – 40,000	50
	41,000 – 50,000	25
	>50,000	10

A negative significant correlation (r=-0.2) was observed between the level of income and the age of the farmer. There were no significant correlations among the income versus education and the experience. These observations indicated any new-developments should first be introduced to young farmers for productive outputs.

Vegetables cultivated by the farmers are discussed as general features of vegetable cultivation. Vegetables cultivated by the farmers included mainly, Bean, Cabbage, Capsicum, Cucurbits, Leeks, Long Bean, Tomato and Potato and found that they were aware of the major pests, diseases and symptoms of nutrient deficiencies and the recommendations to overcome these problems (Table 2 and 3). This is more obvious by the fact that some farmers use local names to identify pests and diseases.

An attempt was made to identify the factors involved in farmers' pest management decisions. All farmers acknowledged that vegetables are sensitive for insect and disease infes-

Table 2. Major vegetables grown by the farmers interviewed in Nuwara Eliya, Badulla and Kandy and Matale districts

District	*Vegetables Grown by the farmers interviewed*
Nuwara Eliya	Bean, Cabbage, Carrots, Leeks, Potato
Badulla	Bean, Capsicum, Leeks, Long bean, Potato, Tomato
Kandy	Bean, Cucurbits, Cabbage, Tomato
Matale	Bean, Cabbage, Cucumber, Okra, Tomato

Table 3. Major pest, disease and weed problems reported by farmers in *Nuwara Eliya, Badulla, Kandy* and *Matale* districts

Crop	*Pests*
Beans	Bean Fly, Sucking Pests (Aphids, Thrips, White Flies), Leaf Miner, Pod Borer
Cabbage	Leaf Eating Caterpillars, Soil Pests (Ants and Grubs)
Carrots	Maggots
Capsicum	Leaf Curl Complex, Pod Borer
Cucumber	Melon Fly, beetles, white flies
Leeks	Root eating maggots.
Okra	Shoot and Pod Borer, Leaf hoppers, Leaf Miners, White Flies,
Tomato	Fruit Borer, Sucking Pests (Aphids, Thrips, White Flies)
Potato	Tuber Moth, Mites, Sucking Pests (Aphids, Thrips, White Flies)

Crop	*Diseases*
Beans	Leaf spot, Rust, Anthracnose
Cabbage	Ring Spot,
Carrot	Alternaria Blight
Capsicum	Foot Rot, Anthracnose, Blossom Blight, Powdery Mildew, Phytophthora Blight
Cucumber	Powdery Mildew, Downy Mildew, Virus,
Leeks	Purple Bloch
Okra	Powdery Mildew,
Tomato	Damping Off, Blight, Powdery Mildew, Anthracnose, Wilt, Mosaic Virus, Curl Top Virus, Nematode
Potato	Damping Off, Foot Rot, Root Rot, Downy Mildew/ Powdery Mildew/ early Blight/ Late Blight

tations, and hence maintaining healthy crops have been a challenging task that requires continuous vigilance and precautions to prevent further spreading and destroying the crop. This is recognized as one of the reasons that compelled farmers to use pesticides whenever they observe insect or disease damage. In addition, the cost of pesticides as compared to total cost of production in vegetables has been estimated to be around 10-14% (DOA 2014/15) (Table 4). Hence, farmers assume that the return on investment to pesticides is greater and make them over dependant on pesticides to protect the crop for higher productivity. Therefore it is recognized as essential to re-design training modules and demonstrations to change the farmers' pest management decision making towards a more

Table 4. Cost of pest and disease control of some vegetables as a percentage of the total cost of production (excerpt from DOA 2014/15 and DOA 2016)

crop	***Total cost of production SLR/ha***	***Pest and disease control SLR/ha***	**Cost as a percentage**
Cabbage	453,182	45,500	10
Carrot	376,125	40,072	10.6
Potato	733,182	78,837	10.7
Tomato	858,357	44,395	05.2
Leeks	537,670	31,300	05.8

Table 5a. Commonly used insecticides used for the control of vegetable insect pests (recorded > 25% farmers) in *Nuwara Eliya, Badulla,* and *Matale* districts (values given to the closest number divided by 5)

Mode of Action Group		***Common Name of Insecticides***	***Farmers reported using the indicated pesticide (%)****
1A	Carbamates	Carbosulfan	85
1B	OrganoPhospate	Diazinon, Profenofos	40, 75
2A	Phenyl Pyrozele	Fipronil	30
3A	Pyretroids	beta-Cyfluthrin	15
4A	NeoNicotinoids	Acetamiprid, Thiamethoxam, Imidacloprid	45 65 75
5	Spinosyns	Spinosad	90
6	Avermectins	Abamectin, Emamectin Benzoate	100 65
10	Mite Growth Regulators	Hexythiazox	40
14	Nereistoxin Analogues	Thiocyclam	75
28	Diamides	Chlorantraniliprole, Flubendiamide Virtako (4A + 28)	65 20 80
UN	Unknown mode of actions	Neem	15

sustainable and realistic path (Wilson and Tisdel 2001; Norton 1996).

This section shows the popular pesticides used in vegetable cultivation in the study area. Vegetable farmers apply more fungicides than insecticides especially in *Nuwara Eliya* and *Badulla* districts. It was observed that the farmers do not record their inputs in crop management, which is a drawback in reviewing possible improvements. Hence empty containers in the field were used as a guide to record some products used by farmers (Table 5). Apart from synthetic pesticides, only a few (10%) were found to use neem extracts regularly for the control of caterpillar pests of cabbage.

Furthermore, more than 85% farmers found to use *organophosphate, carbamates* and *pyrethroids* (Table 5) and old fungicides that they say were more effective in controlling the pest and disease problems. Therefore, majority of respondents suggested that these compounds

Table 5b. Commonly used fungicides used for the control of vegetable diseases (recorded > 25% farmers) in *Nuwara Eliya, Badulla,* and *Matale* districts (values given to the closest number divided by 5)

Mode of Action Group		***Common Name of Fungicides***	***Farmers reported using the indicated pesticide (%)****
B1	Methyl Benzimidazole Caramates	Carbendazim, Thiophanate -methyl	55 85
B4:	Phenylurease	Pencycuron	50
C2	Succinate Dehydrogenase Inhibitors	Flutolanil	75
C3	Quinone Outside Inhibitors	Pyraclostrobim	85
F2	Thiolates	Edifenphos, Isoprothiolane	40 55
F4	Carbamates	Propamocarb	
G1	DEemethylation Inhibitos	Bitertanol, Difenoconazole, Epoxiconazole, fenbuconazole, Hexaconazole, Propiconazole, Tebuconazole	70 65 55 40 80 45 75
I1	Melanine biosynthesis inhibitors	Fthalide, Tricyclazole	50
Multi-site 1	Inorganic,	Copper, Sulphur	50
Multi-site M3	Dithio Carbamates	Thiram, Mancozeb, Metiram, Propineb. Maneb	85. 90, 65, 80. 65
Multi-site M4	Phthalimides	Captan, Folpet	50, 75
Multi site M5	Chlorothaonils	Chlorothalonil	80

should not be withdrawn without considering the negative impact that may cause to the vegetable cultivation due to withdrawal of the same. However, social economic, environmental, health, and marketing issues need to be considered in this regard though these are more effective pesticide.

Table 6. Factors influence farmers' selection of pesticides *

	Factor	*Average Rank*
1	Quality/ efficiency of control	5
2	Experience	3.2
3	Availability	2.7
4	Company Reputation	2.6
5	Income	2.1
6	Price	1.1
7	Novelty of the product –new compounds	0.9
8	Packaging Style	-1
9	Rules and Regulations	-0.2
10	Transport Distance	-1.0
11	Dealer Influence	-1.1
12	Promotions	-2
13	Beliefs and Attitudes	-2.5
14	Purchase on Credit	-3.1

Wilcoxon signed Rank test was employed to identify the factors influencing farmers' selection of pesticides. The test revealed that product quality, farmers' experience, availability of the product, company reputation, income, and price were the main determinants that influence the purchasing decision (Table 6). Therefore, efforts need to be given to provide framers with their most preferred pesticides, selected on the basis of control efficiency, resistance management (IRAC 2017; FRAC 2017).

There are large number of empirical evidence regarding farmers' knowledge on pesticides and safe handling procedures. This study too made an attempt to recognize the safe handling procedures of the plant protection chemicals. All the criteria evaluated for farmers' knowledge found to be weak requiring greater attention to improve safe application procedures (Table 7).

Table 7. Ranking of farmers' knowledge on pesticides and safety

Criteria	*Rank*				
	Very Weak	*Poor*	*Moderate*	*High*	*Very High*
Colour band	X				
Toxicity levels	X				
PHI	X				
Recommended dose		X			
Banned Pesticides		X			
Safe handling			X		
Proper Application		X			
Safe Disposal		X			
Protective Cloths		X			
Harmful Effects				X	

Table 8. Correlation between adoption level of safety methods and demographical factors.

		Education	*Income*	*Experience*
Application of Safe Methods while Applying pesticides	Pearson Correlation	0.280*	0.129	- 0.325*
	Sig.(2-tailed)	.030	0.325	0.011

We observed a positive significant correlation between level of education and application of safety methods and not the level of experience (Table 8).

It was observed that need for paradigm shifts in insect pest and disease management in vegetables because it is highly debatable and sensitive issue at present scenario. Many stockholders such as farmers, consumers, researchers, input suppliers and policy makers at present are debating on how balancing issues of the farmers, human health and environmental issues. In traditional forms of vegetable cultivation, adaptation to pests had been achieved by naturally selected cultivation practices and resistant varieties. However, the need for increased vegetable production has led to the adoption of more intensive cultivation practices which have led to increases in insect pest and disease attack and a greater reliance on pesticides as the major form of control. While breakthroughs in novel methods of control are possible, what their immediate impact might uncertain and certainly unproven. Hence, at present, there is far more potential to improve pest management by fully utilizing the control methods and practices currently available (Norton, 1996). What is required is a better understanding of farmers' problems that will enable key constraints to be reduced and more appropriate control strategies to be designed (Bentley and Andrews 1996; Moore 1997).

Farmers' needs for higher and profitable production of 'safer foods" to consumers and guidelines to curtail exposure levels of toxic chemicals are summarized below on the base on the farmers' suggestions and findings of the present study.

1. **Permanent Farmer Clinics and Demonstration Farms:** Based on the discussions, we have had with farmers, the following training needs were identified; Regular farmer clinics, permanent demonstrations farms on Good Agriculture Practices to enable farmers visit when necessary,
2. **Digital information system**: Digital information on field problems and timely control methods through smart phones or normal phones for farmers to update their knowledge and competence in solving problems.
3. **Resistance Management in pests to pesticides**: It appeared that the profile of pesticide available for resistance management is insufficient and unbalanced. It was further observed that withdrawing of effective insecticides will negatively influence the vegetable production as farmers will have to depend on regular application of insecticides that are less effective. Farmers appreciated the colour charts developed by IRAC (2017) and FRAC (2017) to help choose alternate pesticides for the control of pests and diseases in view of managing resistance development in pests and pathogens.
4. **Training on Safe Pesticide Applications:** Training on safe pesticide applying techniques and introduction of efficient sprayers to help obtain better control of pests and diseases and minimize the need for regular pesticide applications.
5. **New Crop Varieties:** A majority of farmers (60%) reported that the fertilizer responsive, newly introduced short-duration hybrids which are sensitive to pests and diseases as one of the drawbacks in minimizing agrochemical usage. Furthermore, insisted thorough knowledge on the varieties before introducing for cultivation.
6. **Establishment of surveillance system**: Proposed to establish a simple pest and disease surveillance system at village level to help farmers decide pesticide application schedule.
7. **Non-synthetic Chemical Based Pest and Disease Management Methods:** Farmers' adoption to non-pesticide methods was very low because majority of them (82%) were not aware of non-pesticide methods for pest and disease management except neem extract. Hence, further research on alternate pest management methods, in-

cluding resistant varieties, botanicals, natural enemies, pheromones, ecosystem engineering tools is suggested. These methods need to be transferred to farmers for adoption.

8. **Establish farmer organizations with storage facilities:** One of the suggestions proposed by farmers to minimize pesticide use was to establish common storage facilities at village/ community level for them to harvest the crops at early stages and store before marketing to obtain maximum economic benefits.
9. **Monitoring pesticide residues:** Implementing policies to regular monitoring of pesticide residues in vegetables. It is assumed that this action would encourage farmers to use pesticides in a responsible manner.

CONCLUSION

A majority of farmers knew agrochemicals are harmful to environment and the health but unaware of the unacceptable levels of toxic chemicals present in their produce. Farmers demand for continuing education system to upgrade their knowledge on this issue. Further, non-availability of farmer acceptable, efficient, alternate non-pesticide based pest and disease control methods (i.e. botanicals, pheromones, bio-control agents, knowledge on companion crops, flowering weeds, ecosystem management methods) hinder minimizing pesticide use in vegetable cultivation.
There were few key factors which involved to purchasing decision of plant protection chemicals. The key factors involved in farmers' decision making in selecting pesticides were product quality, farmers' experience, availability of the product, company reputation, income, and price. A majority of farmers indicated that some *Organophosphates*, *Carbamates*, and fungicides are more effective for to control insect pests and diseases under outbreak situations.

It can be suggested that community level surveillance system to make farmers aware on pests and diseases incidences, cooperative cold storage facility to timely harvest and store excess production in this regard. Further, it is significant for implementing policies to regular monitoring of pesticide residues in vegetables.

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