Application of Integrated Pest Management (IPM) in Vegetable Cultivation: Past Experiences and Suggestions for Promotion

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FOREWORD

Vegetable sub sector is an important component in the Agricultural sector in Sri Lanka. Sri Lanka being a tropical country has variability in terms of climatic conditions, a factor that has permitted the growth of a wide range of vegetable crops in different parts of the country. The vegetable sector has been using a large amount of agrochemicals annually. Evidence of the past studies shows that, overuse and misuse of chemical pesticides has widely been reported in this sector. It has also identified that, application of pest controlling approaches which use a lesser amount of chemical pesticides such as Integrated Pest Management (IPM), has not been well adopted by vegetable growing farmers in the country.

In a period in which a lot of discussions are being held regarding the negative impacts of the heavy use of synthetic chemicals in crop cultivation on the environment and human health, it is crucial to understand the factors affecting the poor adoption of environmentally sound and safer techniques of pest management such as IPM.

The present study has attempted to identify the factors affecting low adoption of IPM in the vegetable cultivation and to suggest strategies for promoting IPM in vegetable sector. Thus, study is timely and contains useful recommendations which could support in future efforts of promoting IPM in the vegetable sector in Sri Lanka.

E. M. Abhayaratne
Director

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EXECUTIVE SUMMARY

Vegetable production is one of the important agri-business ventures in Sri Lanka where the problem of overuse and misuse of chemical pesticides in the system has widely been reported. Understanding the negative consequences has resulted in developing an interest about safer and environmental friendly pest and disease control methods in food crop production. Consequently, techniques such as Integrated Pest Management (IPM) have drawn significant attention around the world.

Apart from the FAO funded 'IPM promotion programmes for paddy' conducted in late 1980s, there were a very few efforts taken for promoting IPM for the vegetable sector in Sri Lanka. Nevertheless, farmers have not exhibited much interest to follow IPM or other non-chemical pest controlling methods in vegetable farming. On the other hand, reasons of lower usage of IPM; possibility and strategies to promote IPM concept/technique in the vegetable sector have not been either identified or recorded. Therefore, narrowing down of the information gap by documenting the current status and understanding the lessons of past experiences are important moves for future vegetable IPM interventions. The main objective of the study was to find out the factors that influenced low adoption of IPM in vegetable cultivation and to draw recommendations to promote the use of IPM in vegetable cultivation.

The study focused on the districts of Kurunegala, Anuradhapura, Nuwara Eliya and Badulla from where primary data was collected from 292 farmers in a survey. Nine principles underlying IPM concept: destruction of crop residues, crop rotation, protection of natural enemies, soil treatment, proper chemical fertilizer management, non chemical weed management, non chemical pest management, using traps and baits and mixed cropping, were considered for adoption level analysis. In addition, nine socio-economic variables were tested for their influence on IPM adoption via regression analysis.

The findings indicate that, a majority of vegetable farmers in the area were able to acquire at least half of the total household income from vegetable farming. Failure of extension services in serving farmers properly in providing pest management information (due to various constraints) was confirmed in instances where some farmers have resorted to the advice of sales agents and other informal sources when making decisions pertaining to pest management.

Farmers had been used to apply chemical pesticides before the pests and diseases appear in the field or as a routine practice. The 'economic threshold level concept' which is the base of IPM concept was known by a few. However, recommended dosage was followed by the majority. Although farmers were aware of the negative impacts, using cocktails of agrochemicals continued.

The level of adoption of IPM techniques among vegetable farmers is not at a satisfactory level. Only the principles which had been known for a long time and

subjected to frequent discussion in the community and media had better been adopted by the farmers in areas where recently developed concepts were hardly followed. Despite the adoption level, understanding of farmers regarding IPM principles were not at a satisfactory level. It reflects the knowledge gap and the need for awareness or training on IPM.

Knowledge of farmers on IPM has positively influenced the level of adoption which indicates the possibility of increasing the adoption level via awareness and training in future interventions. Proportionate income has a negative influence on IPM adoption as farmers' dependency on income from vegetables has increased; they try to minimize the risk factor associated with the techniques such as IPM which allows crop damage to a certain extent during the process of pest management.

In addition, findings hint that, gaps in the existing policy and institutional set up, poor attitudes of farmers and officers on IPM, insufficient human resources in the current extension system and their capacity lags, and complicated practices involved in IPM technology were the major factors behind the low level of adoption of IPM in the vegetable sector.

The study recommends IPM as one of the priority policies of the extension programme at the national level by initiating measures to promote by allocating sufficient resources and building capacities of the officers. Filling the knowledge and attitudinal gaps of farmers and extension officers towards IPM, tailor-made IPM training program for trainers and the extension officers and community awareness to purchase 'pesticide free vegetable products' are the remedies. Establishment of 'participatory vegetable IPM trials' and developing simplified IPM packages for major pest and diseases also need to be done to popularize IPM among farmers. Advocacy on policy issues across the country and making the agencies and policymakers to internalize the subject in the routine programmes is essential for effective promotion of IPM.

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CHAPTER ONE

Introduction

1.1 Background of the Study

Vegetable production can be identified as one of the important agri-business ventures in Sri Lanka. Sri Lanka being a tropical country, crop cultivations are prone to various pests and diseases. Especially in vegetable cultivation, due to the perishable nature of the harvest and its high cash earning potential, farmers are highly keen to control pests and diseases in vegetable cultivation, in order to obtain a higher and quality yield.

According to the past research findings, vegetable farmers in Sri Lanka mostly rely on chemical methods over the non-chemical or traditional pest controlling methods to control pest and disease damages effectively and efficiently (Ministry of Economic Development and the World Bank, 2013). This has forced the vegetable sector to consume a significant amount of chemical pesticides in Sri Lanka and the amount is in a growing trend in the recent years (Piyasena, 2009).

Overuse and misuse of chemical pesticides in the conventional vegetable production system has also been reported. Bandara and Sivayoganathan (1996) have emphasized that, due to farmers being reliant on chemical pesticide than non-chemical methods, many negative consequences have emerged such as, development of pest resistance, resurgence of pest populations, emergence of secondary pests, hazards to human and other beneficial organisms. In addition, as farmers tend to use chemical pesticides extensively, the amount of money spent on pest control has been increasing continuously. The problem has not only resulted in a number of environmental and health issues, but also in an increased cost of production.

There is a growing concern on developing much safer and environmental friendly pest and disease control methods in food crop production following the increasing awareness on the effects of pesticide residues in foods and environment, and the health hazards created by overuse and misuse of chemical pesticides.

Integrated Pest Management (IPM) has been identified as a method that can be used in pest and disease management in crop cultivation. Series of definitions are available in the literature for describing what IPM is? According to the Bajwa and Kogan (2002) – IPM can be understand as, using of the best possible combination of methods to reduce and maintain pest populations below a level that would cause economic damage. IPM is based on a principle of optimum rather than maximum pest control. It also allows sustainable agricultural production with minimal negative effects on the producer, consumer, the agro-system, and the environment in general.

There are evidence to show the effectiveness of IPM in crop production in many parts of the world. In addition, the use of IPM in vegetable cultivation has given positive results in many countries including Bangladesh (Richb, 2013); Uganda (Steed, 2013): and India (Krishnamoorthy and Kumar, 2004). These countries have used the IPM concept very effectively in the vegetable pest management, producing a number of benefits over the conventional pest control practices. IPM is well known for its ability to cut down the cost of cultivation by means of reducing the amount of pesticides used.

IPM started in Sri Lanka as early as 1984 with the support of FAO mainly targeting paddy cultivation. Since then, it was supported by various programmes and projects. The Department of Agriculture, the Mahaweli Authority of Sri Lanka, Provincial Agriculture Departments, and various national and international NGOs such as Sarvodaya, CARE and Sri Lanka Red Cross have provided their support on IPM by conducting training programmes on IPM , but, focusing mainly on paddy. However, a few efforts were also made to promote the concept among vegetable farmers as well. For example, FAO project itself had formed a few vegetable IPM farmer groups (mainly in wet zone area). Apart from that, the Plant Protection Unit of the Department of Agriculture has been conducting training on IPM for farmers in the North Western Province, Eastern Province, Western Province and Southern Province, especially on the request of Provincial Extension Services.

With regard to Sri Lankan experience, Piyasena (2009) has shown that, 50% or more reduction of pesticide application could be achieved through IPM in Chili cultivation based on the results of farm level trials conducted by the Department of Agriculture with the funding assistance of FAO. In addition, Araiyadasa, *et al.* (2005) have found that, application of IPM in cabbage cultivation had reduced the cost of pest control by 80% while increasing the overall profit margin by 20% compared to conventional fields.

1.2 Significance of the Study

Sri Lanka is at a crossroads in addressing both overuse of pesticides and the higher cost of production in vegetable cultivation. The government has shown its commitment in this issue by identifying/inserting 'vegetable IPM promotions' as a critical action in the National Agricultural Policy documents as stated in the National Agricultural Policy, (2003).

However, despite the emerging issues of overuse and misuse of agro chemicals, farmers are not exhibiting much interest to move away from conventional practices of pest and disease management which they have been used to. In spite of farmers' knowledge on the availability of non-chemical methods used to control pests and the benefits achieved by using such methods those methods are neither popular nor often practiced by vegetable farmers in the country.

There is a lack of empirical evidence on the reasons of lower usage of IPM or non-chemical pest controlling methods by the vegetable farmers. In addition, information regarding the possibility and appropriate strategies suitable for promoting IPM concept/technique towards vegetable sector is vital to arrange necessary institutional support and policy directives in the future.

Therefore, documentation of the current status and lessons of past experience regarding IPM adoption in the vegetable sector is a critical need. Furthermore, identification of drawbacks and the possible ways to overcome the prevailing drawbacks is vital in planning future programmes related to vegetable IPM.

This study was conducted to narrow the information gap in the IPM adoption in vegetable cultivation and to suggest appropriate strategies for promoting IPM in vegetable cultivation.

1.3 Objectives of the Study

Principal objective:
The overall objective was to find out the factors influencing low adoption of IPM in vegetable cultivation and to propose recommendations to promote the use of IPM in vegetable cultivation

Specific objectives:

1. To document the lessons of experiences in using IPM
2. To determine the current status of the use of IPM by vegetable farmers
3. To examine the socio-economic factors influencing the adoption of IPM practices in vegetable cultivation
4. To find out problems in practising IPM in vegetable cultivation and propose strategies to promote

CHAPTER TWO

Methodology

2.1 Study Locations and Sample Size

The study was conducted in year 2013 and field data collection was conducted during the 2013 *Yala* season. The study sample was drawn using the *multistage sampling technique*. At the first stage, four districts which have the highest extent of vegetable cultivation were purposively selected for the study to represent up country and low country vegetables. The districts of Kurunegala and Anuradhapura were selected to represent low country vegetables, while Nuwara Eliya and Badulla were selected for up country vegetables.

In the second stage, two Agrarian Development Centers (ADC) were purposively selected from each district, based on the highest extent of vegetables grown in the area. In the third stage, three Grama Niladhari Divisions (GND) were randomly selected from each ADC. At the last stage, around 12 vegetable growing farmers were randomly selected from each GND. Accordingly, 292 farmers were interviewed for the survey. Table 2.1 shows the distribution of the sample among the study sites.

2.2 Data Collection Methods and Tools

The study employed multiple methods to collect primary and secondary data required for analysis. The major data collection methods used, are as follows:

I. Review of Literature

A comprehensive review of published and unpublished information was undertaken to explore the work done in the field and the experience of using IPM in vegetable cultivation in different countries. With the help of empirical studies, a questionnaire for the primary data collection was developed. Further, secondary information was used to develop guides for key informant interviews.

II. Key Informant Interview

Key informant interviews were conducted with; (i) officials involved in training and extension in the study areas (ii) policy-makers involved in decision making related to agricultural extension (iii) trainers, researchers and academics in the field of IPM, using a guided questionnaire.

Information regarding the influence of institutional setup on vegetable IPM promotion, effectiveness of different extension channels used in IPM training and strategies to promote IPM in vegetable cultivation was gathered via key informant interviews.

Table 2.1: Sample Distribution

Vegetable group	District	Agrarian Development Center	Grama Niladhari Division	Sample Size
Low country Vegetables	Kurunegala	Madahapola	Halmilla wewa	12
			Immihamine gama	12
			Angulgamuwa	12
		Melsiripura	Polkatuwa	12
			Neerammulla	12
			Meddeketiya	12
	Anuradhapura	Thambuththegama	Thispanepura	12
			Makulewa	12
			Thammannawa	12
		Galenbindunuwewa	Ulpath gama	12
			Aluthdiulwewa	12
			Koka wewa	12
Up country vegetables	Nuwara Eliya	Nuwara Eliya	Pattipola	12
			Sandathenna	12
			Bulu ela	12
		Rikillagaskada	Dimbulkumbura	12
			Udalumada	14
			Alawaththegama	12
	Badulla	Diyathalawa	Kahagolla	12
			Haputhalegama	14
			Aluthwela	12
		Bandarawela	Ambegoda	12
			Ambadande gama	12
			Konthe hela	12
Total				**292**

Source: Authors' Survey Data, 2013

III. Sample Survey

A sample survey was conducted using the pre-tested questionnaire. Trained investigators were employed for field survey under the supervision of the research team. The questionnaire was designed to obtain socio-economic information of respondents, degree of adoption of IPM methods, knowledge/understanding about IPM principles, constraints faced by farmers in practising IPM methods and, suggestions to overcome those barriers.

2.3 Data Analysis

Descriptive and quantitative statistics were employed in the analysis of data. Socio-demographic characters were analyzed using descriptive statistics where, factors influencing the adoption of IPM principles were identified by a multiple regression analysis. SPSS 20 statistical package was used for analysis.

2.3.1 Selection of IPM Principles

Based on empirical evidence and expert consultation, nine basic principles underlying IPM were considered in the primary data collection. The selection of the practices (in relation to the principle) was based on; being common for IPM package for any vegetable crop and; being essentially required (must include) in an IPM package (for any crop). The selection of the practices was supported by Weligamage, (2011); Singh*, et.al,* (2008); Krishnamurthi and Veerabhandraiah (1999).

Selected principles are follows.

i. Immediate destruction of crop residues (after the harvesting) and infected crop stands
ii. Crop rotation with different crop families between consecutive cropping seasons
iii. Protection and promoting naturally existing enemies of pests
iv. Conducting soil treatments prior to the new cultivation
v. Following the recommended dose in applying chemical fertilizer
vi. Use of non chemical weed management techniques
vii. Using physical pest control methods for pest and disease management
viii. Use of traps and baits to control pests
ix. Mixed cropping with different crop families

In addition to above mentioned principles, 'pattern of using chemical pesticides' was also tested for assessing the knowledge and understanding of farmers' related to pest management.

2.3.2 Ranking IPM Principles Based on Adoption Level

Pattern of applying IPM principles by farmers was categorized into five categories.

(i) Full application of IPM (*i.e.* applying for every crop in every season);

Application with modifications;

(ii) Applying in every season, but for selected crops
(iii) Applying for all crops, but not in every season
(iv) Applying for selected crops and not in every season
(v) Non application of IPM (*i.e.* not applying for any crop in any season)

IPM principles were ranked (for usage) based on the percentage of farmers who follow the specific principle together with the pattern of applying.

2.3.3 Factors Determining the Adoption of IPM Principles

The socio-economic factors that could influence the level of Adoption of IPM principles were indentified through regression analysis. Nine socio-economic factors which were already confirmed by past empirical studies having an effect on adoption were selected for the study as described in table 2.2.

Table 2.2: Description of Research Variables

Variables	Measurement	Units
Dependent variable		
Total adoption score (TAS)	Score for level of IPM Adoption by farmers	Number
Explanatory variables		
1. Age	Farmers' age	Years
2. Educational level	Number of Years of schooling	Years
3. Size of household labour	Number of household labour support for farming	Number
4. Experience in farming	Farmers' experience in vegetable farming	Years
5. Proportionate Income from vegetable production	Proportion of income from vegetable cultivation to the total household income	%
6. Extension contacts	Number of visits to/by the extension officer per season	Number
7. Knowledge score	Score for farmers' knowledge on benefits of using IPM and the method of applying each principle	Number
8. Source of information	Channels of information on pest management	Formal source=1 Informal source=2
9. Social contacts in farming	Involvement in farm groups	Yes=1, No=2

2.3.3.1 Development of the Total Adoption Score (Dependent Variable)

Total Adoption Score (TAS), the dependent variable was developed based on the level of adoption by each farmer towards IPM. The Level of adoption of IPM principles by farmers was assessed by giving the weighted score according to the pattern of applying of each IPM principle, for each farmer. Scores were allocated as indicated in table 2.3.

Table 2.3: Allocation of Scores According to the Pattern of Applying

Pattern of Applying	Score
(a) Fully applying	5
(b) Applying with modifications; i. Applying in every season, but for selected crops ii. Applying for all crops, but not in every season iii. Applying for selected crops and not in every season	 3 3 2
(c) Not applying	0

By adding the scores obtained for all nine principles, total adoption score (TAS), the dependent variable was calculated for each farmer.

2.3.3.2 Understanding of Farmers on IPM Principles (Developing the Knowledge Score)

The knowledge score (TKS) was developed giving weighted scores to the answers provided by farmers for all ten selected principles in relation to,

a) Understanding of farmers on advantages of or reasons for adopting a particular practice;
b) Awareness/knowledge of farmers' about the method/process of conducting each technique/principle compared to the accurate process ;
c) Permissibility for any deviations from the accurate process

Weights for each response provided by farmers were decided by comparing against the appropriate practice according to the situation. Appropriate practice was the way which is relative to the concept of 'managing pests at a minimum environment and financial cost'.

Allocation of weighted scores was done as follows:

a) Understanding the advantages of adopting a particular practice;
   i. Each correct answer was given +3 marks,
   ii. When there was more than one correct answer, marks were added together,
   iii. No marks were given for incorrect answers,
b) Awareness/knowledge of farmers' about the method/process of conducting each technique/principle;
   i. Knowing the accurate process +3 marks were given,
   ii. No marks were given for inaccurate process,
   iii. Processes which could negatively influence the concept of IPM were given -3 marks,
c) Permissibility for any deviations from the accurate process
   i. If the deviation was not due to the lack of understanding about the principle and, it could not affect the results of the IPM concept, +2 marks were given

ii. If the deviation was due to the lack of understanding, but least likely to affect the results of IPM concept -2 marks were given
iii. If the deviation was not due to the lack of understanding about the principle but ,the deviation could affect the results of the IPM concept, -3 marks were given
iv. If the deviation was due to the lack of understanding about the principle and, it could affect the results of the IPM concept, -5 marks were given

Total knowledge score of a farmer was calculated by adding all the marks (weighted scores) obtained by a farmer for each principle.

2.3.3.3 Analytical Tools

Gathered data was analyzed through SPSS 20 statistical package. Descriptive analysis, correlation/association analysis and regression analysis were used.

Geographical/location wise variation/relationship of various socio-economic parameters was tested by chi-square analysis.

The dependent variable, TAS being an integer, is continuous and normally distributed; stepwise multiple regression was employed to figure out the significant independent variables to the level of adoption of IPM.

2.3.4 Identification of Major Problems for Adopting IPM or Non-chemical Pest Controlling Methods and Suggestions

Farmers' view on major barriers for non adoption/non application of IPM technique in vegetable cultivation was recorded through field survey. Farmers' responses could be either based on their experience or belief. In the situations where farmers were not aware about the IPM concept, farmers were asked on problems they faced in adopting non-chemical pest management methods in vegetable cultivation in general, instead of broader concept of the IPM technique.

The percentage of farmers responded to each barrier was calculated. The major barriers experienced by the farmers in adopting IPM techniques/nonchemical pesticide methods were ranked based on the percentage values.

Similarly, information on suggestions of farmers to overcome the barriers which they experienced in adopting IPM technique (or non-chemical pest controlling methods in general) was collected. By following the similar method which used in identification of barriers, suggestions for promoting IPM in vegetable cultivation were also identified.

In addition to that, the perceptions of extension officers on barriers prevailing in IPM adoption and their suggestions were also gathered through key informant interviews.

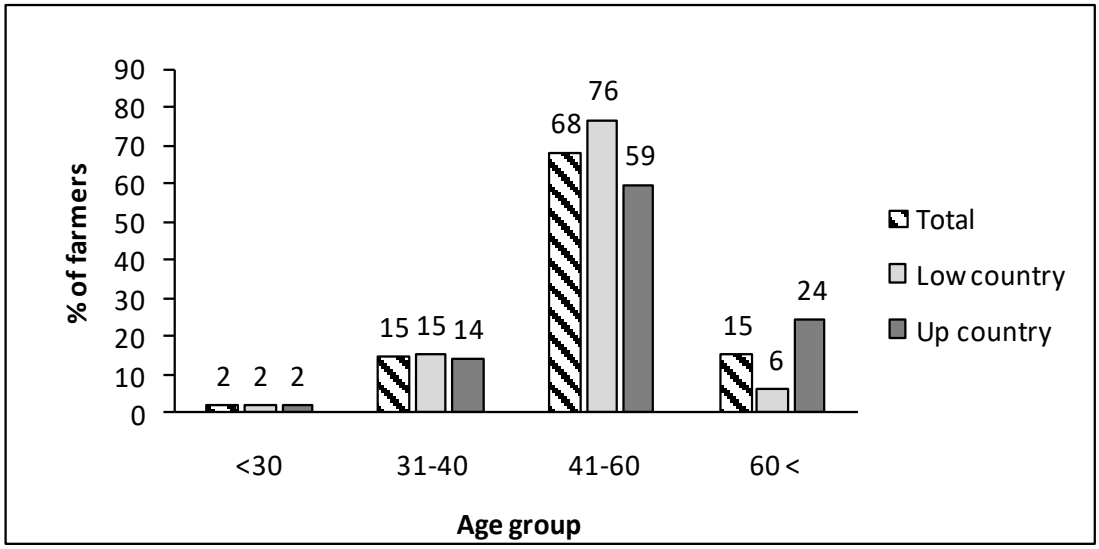
CHAPTER THREE

Demographic Characteristics of Farmers and Awareness Related to Pest Management Methods

3.1 Demographic Characters

3.1.1 Age Distribution

According to the findings, the majority of the respondents (73%) were between 31-60 years of age while only two percent of the total sample was below the age of 30 years (figure 3.1). It confirmed that there is less involvement of youth in vegetable farming as in other agriculture related occupations. These findings reveal that the youth have not been attracted to vegetable farming, though it is a comparatively high income earning agribusiness compared to paddy farming. These findings are in line with Krishnal, *et.al* (2007) where, the majority of those recorded as farmers were above 36 years of age.



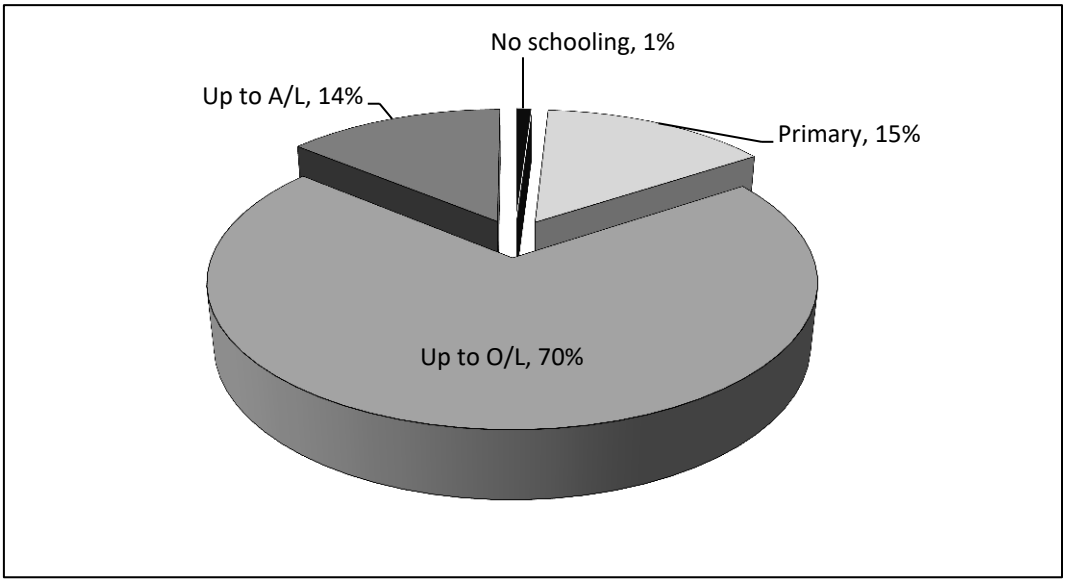
Authors' Survey Data, 2013

Figure 3.1: Percentage Distribution of Respondents According to the Age

With regard to the spatial variation, the number of farmers below 40 years of age, were same in both up country and low country areas. But, a difference was observed in other two groups where a percentage of farmers in the group of 41-60 years were higher in low country areas compared to up country areas. On the other hand, the percentage of farmers above 60 years was higher in up country areas. The Reason for this could be the nature of large scale fields/operations in low country areas that limited the engagement of elderly farmers in agricultural operations. On the contrary, up country areas, predominant with medium and small scale fields may have permitted elderly farmers too in the business for a longer period.

3.1.2 Education Levels

As indicated in figure 3.2, 70 percent of farmers in the study areas have studied up to GCE Ordinary Level while 14 percent of the sample had studied up to GCE Advanced Level. Only one percent of them have never had formal education. However, the situation of different sample locations with respect to the education level of farmers was more or less equal to the average values. According to these results, a total of 84 percent from the sample have been educated beyond the primary level which indicates the ability of understanding and following a concept like IPM correctly.



Source: Authors' Survey Data, 2013

Figure 3.2: Percentage Distribution of Respondents According to Education

3.1.3 Income Sources

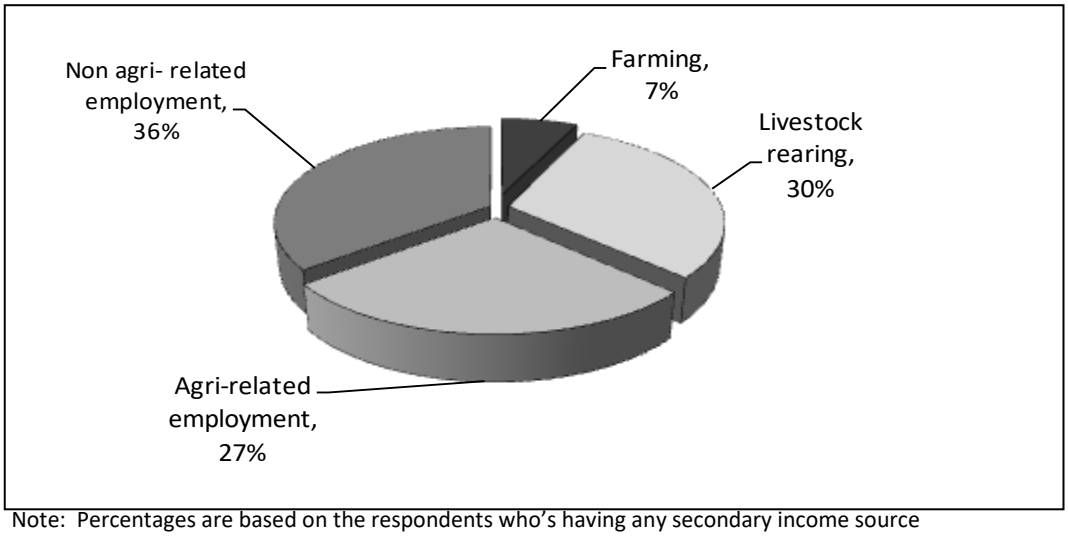
The survey results revealed that, 98 percent of farmers were engaged in farming as their primary income earning activity. Of those, 25% had some kind of a secondary income earning activity apart from the primary income source. (It indicates that; majority of the respondents (75%) entirely depended on farming as the sole income source as shown in table 3.1).

Table 3.1: Percentage Distribution of Respondents according to the Employment

Type of employment	Primary Employment		Secondary Employment	
	Number	%	Number	%
Farming	287	98.3	5	1.7
Livestock rearing	-	-	22	7.5
Agro-based self employment	1	0.3	16	5.5
Agricultural labour	1	0.3	5	1.7
Non agri-related self employment	-	-	16	5.5
Non agricultural labour	-	-	1	0.3
Public/Private sector employment	2	0.3	6	2.1
Skilled Labour	1	0.3	2	0.7
Total	292	100.0	73	25.0

Source: Authors' Survey Data, 2013

Figure 3.3 shows the variation of the types of secondary income earning activities which farmers were engaged in. Only 36 percent of farmers (of the farmers having any kind of secondary employment) were engaged in non-agriculture related employment as the secondary employment. (That also shown the dependency of respondents on farming or agriculture related income earning activities)



Note: Percentages are based on the respondents who's having any secondary income source
Source: Authors' Survey Data, 2013

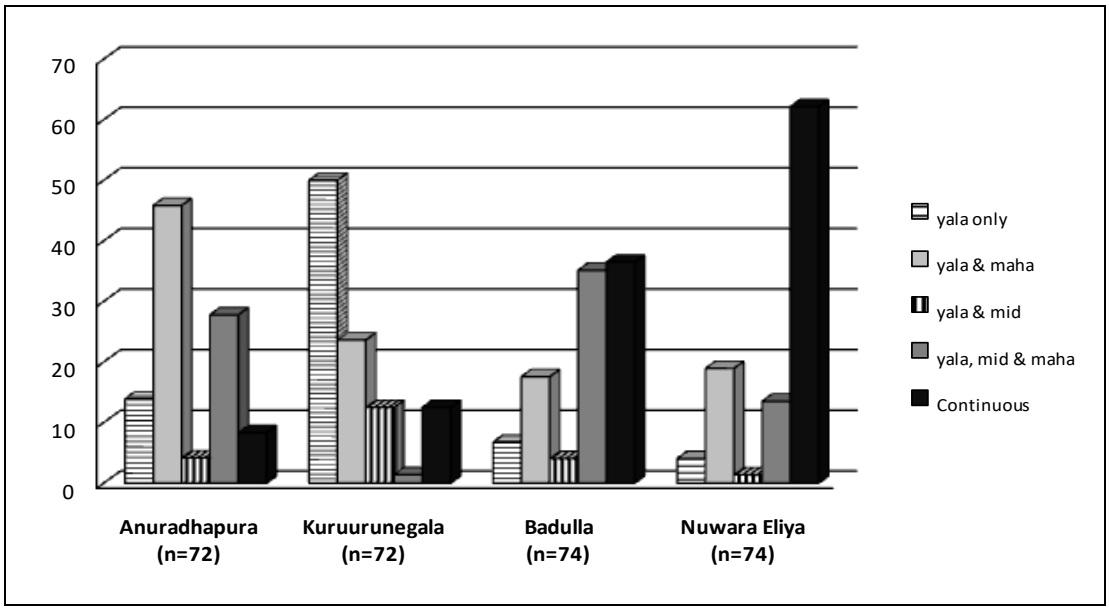
Figure 3.3: Percentage Distribution of Respondents According to the Secondary Income Sources

3.1.4 Cropping Pattern

There were clear differences in cropping pattern of study locations. As shown in figure 3.4, in Anuradhapura and Kurunegala districts, vegetable cultivation was done according to the cropping season. In Anuradhapura, the majority (74%) of the farmers had cultivated vegetables both in the *yala* and *maha* seasons. Being a major irrigated paddy growing area and the availability of water in both seasons has led to this situation.

On the other hand, in Kurunegala, 50 percent of farmers had cultivated only in the *yala* season and another 13 percent cultivated vegetables in *yala* and mid seasons. As the water regime of the Kurunegala district is primarily rain-fed and minor irrigation based, farmers cultivate paddy in the *maha* season and vegetables with the remaining water in the *yala* and mid seasons.

However, vegetables were cultivated in all three seasons i.e. *yala, maha* and mid or as continuous cultivation irrespective of seasons, in Badulla and Nuwara Eliya districts. The majority of farmers (71% and 76% in Badulla district and Nuwara Eliya respectively) were cultivating vegetables either during the three seasons or continuously. Favorable climatic conditions and the high income generation potential of up country vegetables have prompted farmers to grow vegetables throughout the year without a fallow period.



Source: Authors' Survey Data, 2013

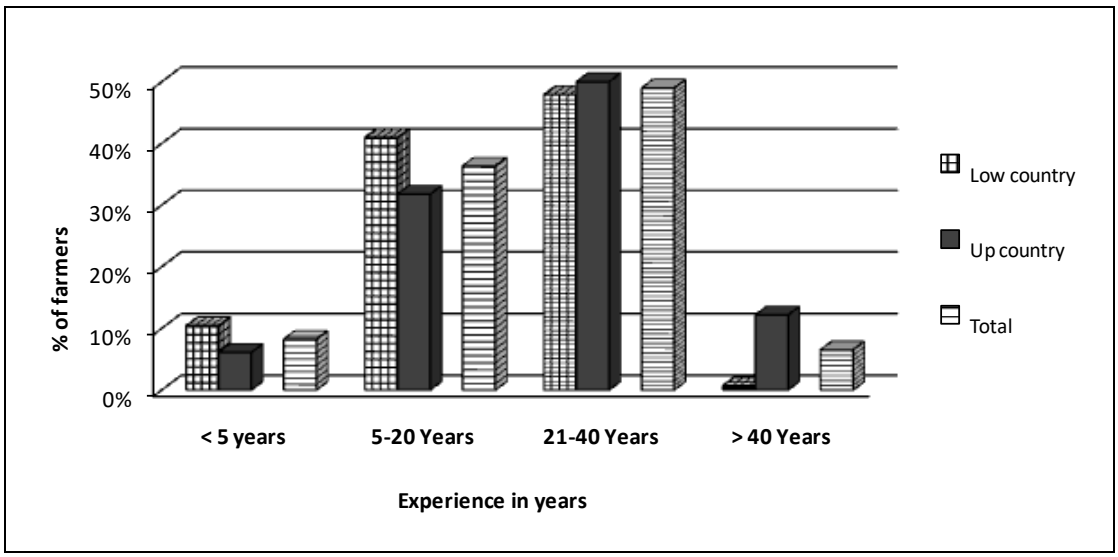
Figure 3.4: Percentage Distribution of Respondents According to the Pattern of Vegetable Growing

3.1.5 Experience in Vegetable Farming

According to the study findings, the majority of the farmers (in the total sample) were practising vegetable farming for more than five years. As showed in figure 3.5, 49 percent of farmers had 20-40 years of experience and another 36 percent had 5-20 years of experience in vegetable farming. It was expressed that, farmers' experience is sufficient to understand and apply a technique such as IPM, successfully in the vegetable cultivation.

However, a difference was shown in farmers' experience in two regions. In low country areas the percentage of farmers having experience less than 20 years was higher than in up country areas. In contrast, the percentage of farmers having

experience over 40 years was higher in up country areas than in low country areas. This pattern of having elderly farmers in the business in up country areas was also visible from the analysis of farmers' age, which had led to more experience in the field.



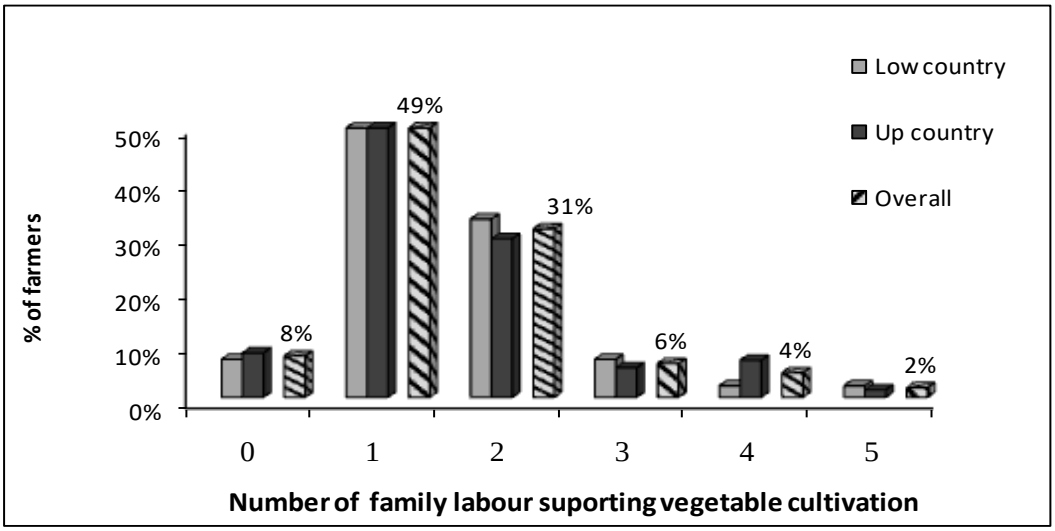
Source: Authors' Survey Data, 2013

Figure 3.5: Percentage Distribution of Respondents According to the Experience in Vegetable Farming

3.1.6 Availability of Family Labour for Vegetable Farming

As shown in the figure 3.6, availability of household labour (in addition to the main farmer) was limited to one to two members for around 80 percent of the total sample. However, eight percent of the farmers have not received any support from their family members for vegetable farming. The findings indicate that, the availability of household labour for farming activities is limited.

Furthermore, the condition with respect to engagement of family labour in vegetable cultivation is similar in the two main vegetable growing regions.

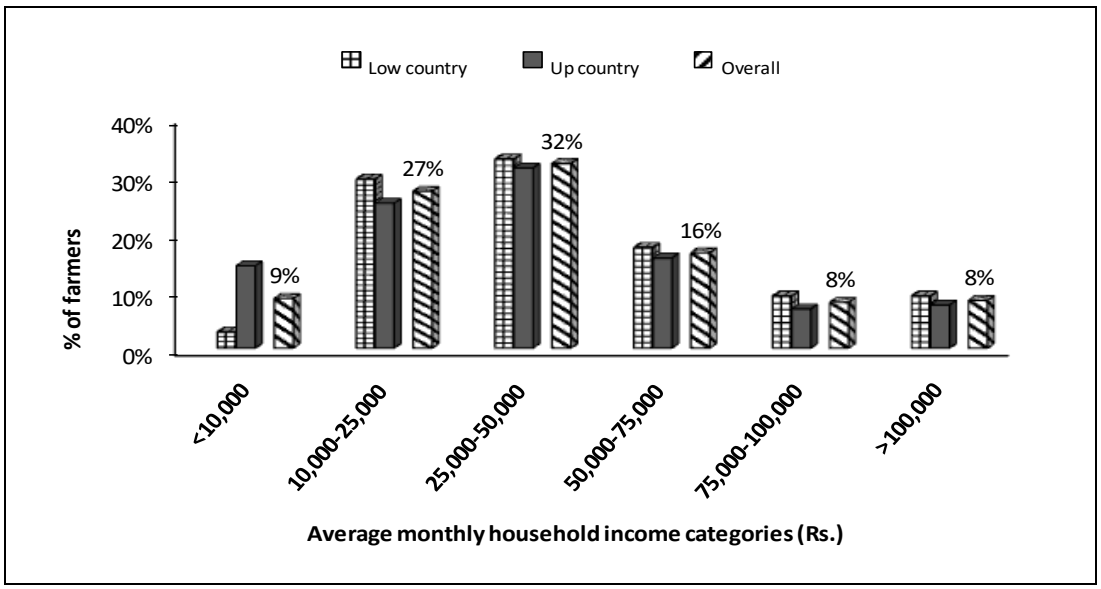


Source: Authors' Survey Data, 2013

Figure 3.6: Percentage Distribution of Respondents According to the Usage of Family Labour in Vegetable Cultivation

3.1.7 Income Distribution of Farmers

Farmers were inquired about the average household income and the average income earned from vegetable cultivation. As shown in Figure 3.7, average monthly income of majority (59%) of households was between Rs. 10,000 to 50,000 and 32 percent of households had an average monthly income of over Rs. 50,000. However about nine percent of households had only less than Rs.10,000 of an average income per month.



Source: Authors' Survey Data, 2013

Figure 3.7: Percentage Distribution of Respondents According to the Average Monthly Household Income

Mean total household income per month was 44,529 LKR for the total sample whereas, those values were 46,461 LKR and 42,597 LKR for low country and up country areas respectively. Slightly higher mean income value in low country region could be due to the higher contribution to the income by paddy production in the low country region compared to the up country area.

Distribution of proportionate income of vegetable cultivation to the total family income of the respondents is shown in Table 3.2. Overall, 17 percent of households totally depended on vegetable cultivation as a source of income. There were 68 percent of households of which the proportionate income from vegetable was over 50 percent (i.e. 1/2) of the total household income. This indicates the reliance of the sample farmers on the vegetable cultivation as a source of household income.

With respect to the value of proportionate income in different locations, only 21 percent of farmers in the low country areas had the proportion of over 0.75 of income from vegetable farming out of the total household income, which indicates less dependency on vegetable farming. In contrast, more than 54 percent of farmers over 0.75 of their household income from vegetable farming in up country areas were more dependent on vegetable production as an income source for their households.

Table 3.2: Percentage Distribution of Respondents according to the Proportionate Income from Vegetable Cultivation to the Total Household Income

Income class / Sample area	Not answered	<=0.25	Between 0.25 to 0.5	Between 0.5 to 0.75	Between 0.75 to 0.99	1
Low country	2	11	28	39	17	4
Up country	2	6	15	22	24	31
Average of the total sample	2	8	21	30	21	17

Source: Authors' Survey Data, 2013

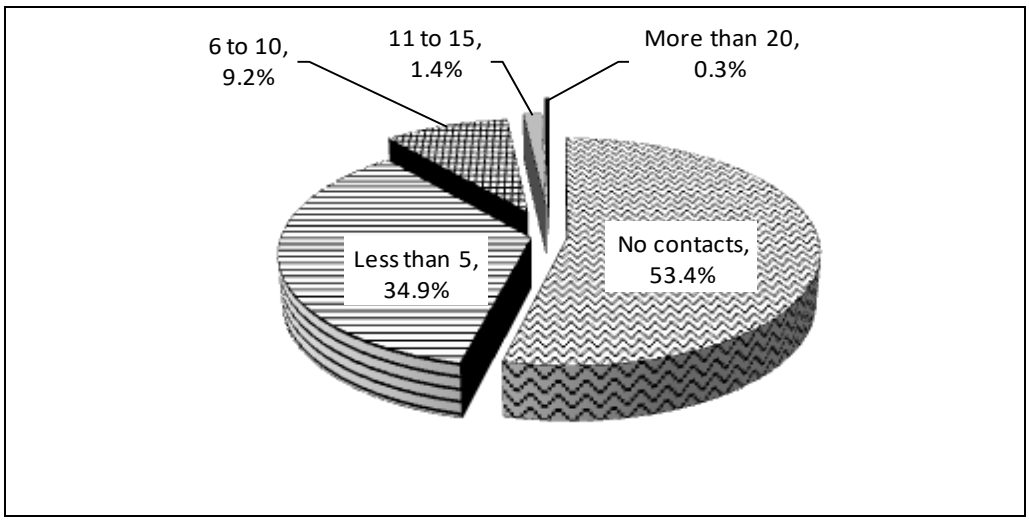
Therefore, value of proportionate income from vegetable farming between two major vegetable growing areas has shown a significant difference. This was also identified via chi-square test. According to the test results, X^2 (4, N=280) = 48.47, $p < 0.001$, null hypothesis was rejected, and thereby an association was present between the proportion of vegetable income and the vegetable growing area.

3.2 Exposure of Farmers to the Extension Service

Exposure to extension services by the farmers was estimated through collecting the responses of farmers on the frequencies of farmers' visits to the extension officer and visits of the extension officers' to the farmers' field. Then, total extension visits per season were calculated by adding up the above two types of visits. The study

results revealed a very low level of exposure to the extension service in all sample locations.

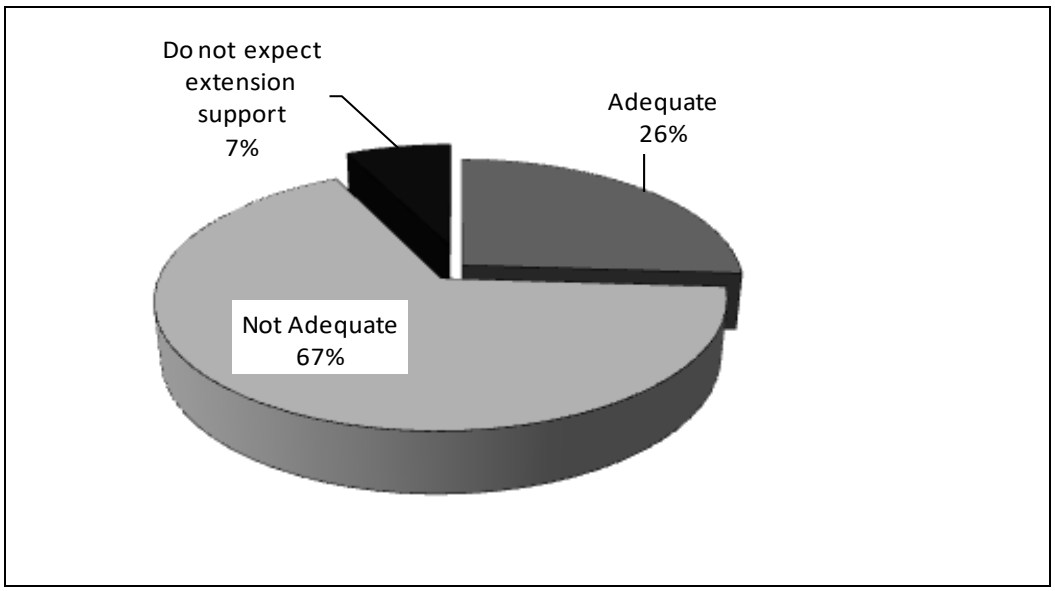
About 53 percent of the respondents had not had any contact with the extension staff during the cropping season/period. However, about 35 percent of the sample had 1 to 5 number of extension contacts and another 10 percent had 6 -10 contacts with the extension officer per cropping period at a given time (Figure 3.8).



Source: Authors' Survey Data, 2013

Figure 3.8: Distribution of Respondents According to the Number of Extension Contacts per Cropping Season

Farmers' views on the adequacy of current extension contacts to solve the practical problems in pest and disease management in vegetable cultivation were obtained. As shown in figure 3.9, about 67 percent of the farmers have responded that, the current extension contacts were not adequate and need to be increased while, 26 percent said it was adequate. However, seven percent of farmers did not expect the support of extension service for their cultivation, with respect to pest and disease management. According to respondents, the main reason for not using the support of the extension service was due to the attitude of trusting their own experience in pest and disease management. Further, respondents do not expect the support of extension service in terms of obtaining advice for pest and disease management in the future as well.



Source: Authors' Survey Data, 2013

Figure 3.9: Farmers' View on the Adequacy of Extension Contacts

3.3 Knowledge, Understanding and Behavior of Farmers on Using Chemical Pesticides

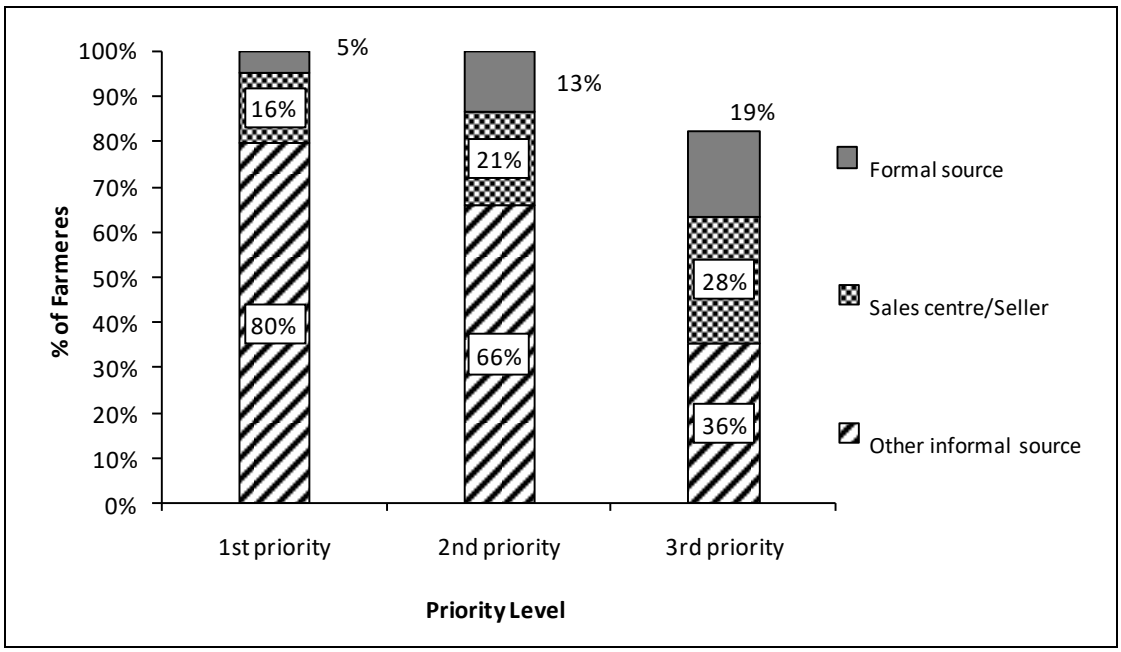
3.3.1 Source of Information for Selecting Chemical Pesticides

Farmers' preference on information source to make decisions on selecting pesticides for particular pests or disease incidence in vegetable cultivation was examined. All the sources mentioned by farmers were categorized into two groups namely, formal sources and informal sources. The reason for above categorization was formal sources could have a higher assurance for the accuracy of the information shared where as the uncertainty about the accuracy of information shared via informal sources could be higher compared to the formal sources. Accordingly, training programmes, information received from the extension officers, printed materials or electronic media programmes produced by research institutions, government departments or any other line agencies were considered as formal sources. Personal experience, inputs from neighboring farmers and advice/information received by agro-chemical sellers were considered as informal sources.

Results revealed that a large majority of respondents have trusted informal sources when deciding pesticides. As shown in figure 3.10, about 95, 87 and 81 percent of the farmers have used information from informal sources, as the first, second and third preference respectively. Results also show that, information from 'chemical seller' represents a significant value out of whole informal sources where its contribution was 16, 21 and 28 percent (out of the total amount of informal information contacts) when considering first, second and third preference of the information channels.

Although the frequency of using formal sources shows a slight increase in terms of the preference (from first to third preference), composition of 'chemical seller'

information source has increased with the preference (from first to third preference).



Note: The total of three preferred information sources has not produced 100%, as all the farmers have not responded for the third preferred source.

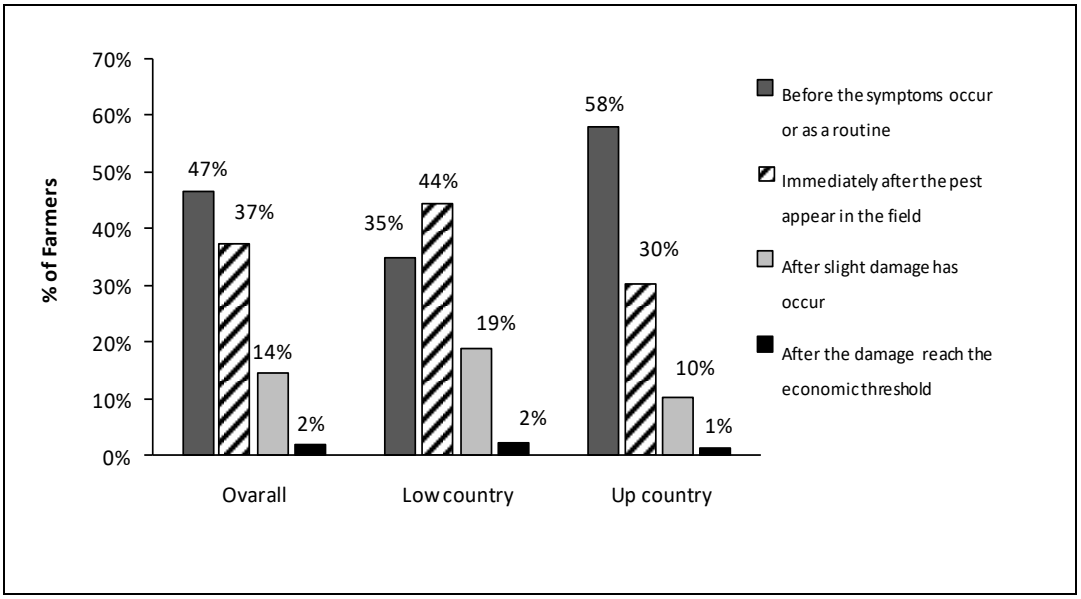
Source: Authors' Survey Data, 2013

Figure 3.10: Farmers' Preferred Source of Information for Pesticide Selection

3.3.2 Pattern of Using Chemical Pesticides in Vegetable Cultivation

The farmers were asked about the stage (with respect to the level of pest damage) which chemical pesticides being applied for their cultivations. With respect to the analysis of total sample area as a whole, 47 percent had applied chemical pesticides before the occurrence of pests in the field or as a routine practice based on their experience (Figure 3.11). Another 37 percent had applied chemicals immediately after observing the pests in the field. Both practices are not accepted in the conventional agriculture. Only two percent of farmers had followed the 'economic threshold level concept' in deciding the time/stage which, chemical pesticides should be applied in the event of pest or disease incidence.

Further, the pattern of chemical application has shown an association with the growing region. According to the results of chi-square test, X^2 (3, N=292) = 16.41, $p < 0.001$, null hypothesis was rejected and thereby indicated the presence of an association between the growing region and the pattern of chemical application in vegetable cultivation.



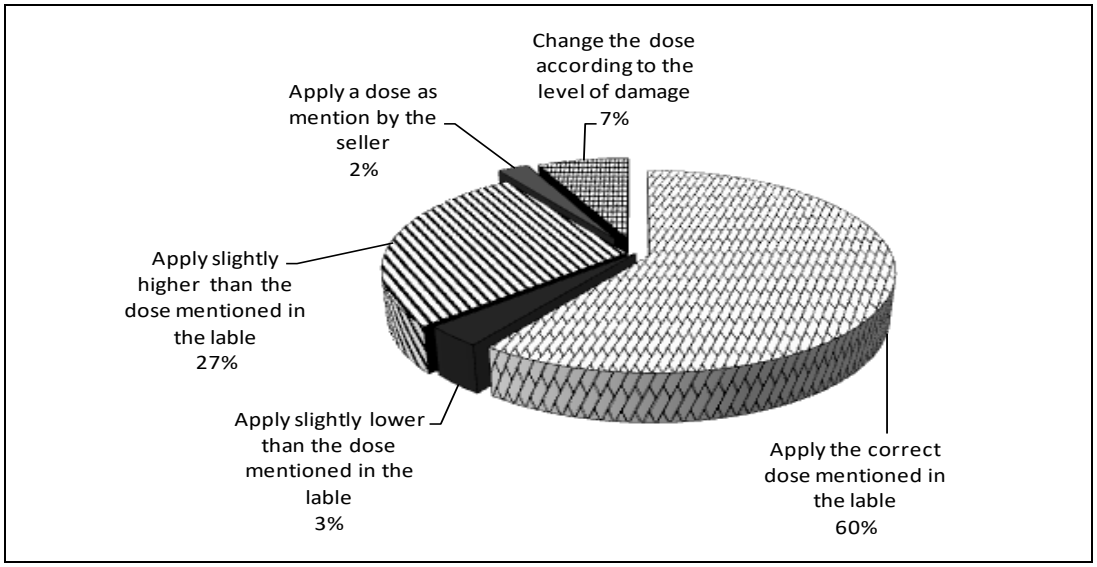
Source: Authors' Survey Data, 2013

Figure 3.11: Pattern of Chemical Application with Respect to the Level of Crop Damage

Applying chemicals 'prior to the occurrence of symptoms and/or as a routine practice' is greater in up country areas (58%) than in low country areas (37%). As the crops grown in up country areas are having higher possibility to be subject to pest damages due to the wet/moist atmospheric conditions, and the economic loss that could occur if pest damage happens is higher due to the high value nature of up country vegetables, up country farmers are trying to apply chemicals as early as possible to avoid pest damages prior to occurring them. But in contrast, low country situation is having a lesser possibility to cause larger economic loss compared to the up country situation and as a result, farmers could allow/wait more time for applying chemical pesticide in a pest incidence. Having a higher percentage of respondents who used to "apply chemicals after seeing the pest in the field or after a slight damage has occurred" in the low country area also confirms the above fact.

3.3.3 Farmers' Adherence to the Recommended Dosage in Using Chemical Pesticides

The farmers were inquired regarding the following of instructions on the recommended dosage in applying chemical pesticide in vegetable cultivation. As shown in figure 3.12, 60 percent of farmers followed the recommended dosage in applying any chemical. However, the rest of the farmers applied chemicals outside the recommended level. The majority (27%) had applied a higher dosage than the recommended level. Two percent of the total sample had used to follow the instructions given by the chemical sellers in deciding the dosage, despite the instructions provided in the label of the chemical container.



Source: Authors' Survey Data, 2013

Figure 3.12: Farmers' Adherence to the Use of Appropriate Pesticide Dosage

3.3.4 Farmers' Behavior of Using Mixture of Agro Chemicals

Farmers' behavior in applying chemical pesticides as a mixture and their awareness on mixing several agro chemicals together was investigated during the survey. As indicated in Table 3.3, 83 percent of the farmers were well aware that mixing of chemicals is inappropriate. However, out of the knowledgeable farmers, 33 percent mix several chemicals together in application. There were a total of 46 percent of the farmers (in both aware and non-aware groups), with the habit of applying cocktail mixtures. According to the respondents, some of the agro chemicals (especially growth regulators/hormones and vitamins) recommended (by manufactures) to be used by mixing with other chemicals in application where, such cases have misled farmers in terms of using mixed agro chemicals.

The respondents' lack of awareness on the correct application with respect to chemical mixing highlighted the requirement of conducting frequent awareness programmes on the adverse effects of mixing agro-chemicals.

Table 3.3: Farmers' Behavior of Mixing of Different Chemicals against Awareness on Negative Effects

Awareness on Negative Effects of Mixing / Pattern of Mixing	Aware that Mixing is Undesirable	Not Aware that Mixing is Undesirable	Total
Never mix chemicals together	147 (50%)	12 (4%)	159 (54%)
Mix chemicals arbitrarily	74 (25%)	35 (12%)	109 (37%)
Mix only the selected chemicals together*	22 (8%)	2 (1%)	24 (9%)
			292 (100%)

Note: *- 'Mix only fungicides with insecticides' but not any other chemicals;
Source: Authors' Survey Data, 2013

CHAPTER FOUR

Understanding IPM Principles and Determinants of their Adoption

4.1 Farmers' Awareness on Non Chemical Pest Management Methods

Farmers' knowledge and awareness about the ability of using non chemical pest controlling methods was tested in the survey. As indicated in table 4.1, the possibility of successful use of non chemical methods to mange pests and diseases in vegetable cultivation was known by 96 percent of farmers. However, the majority (75%) of farmers responded as they are not using non-chemical methods for controlling pests in vegetable cultivation. Reasons for not using non chemical pest control methods describe in chapter five.

Table 4.1: Awareness and the Usage of Non-Chemical Pest Control Methods

Usage / Awareness on non- chemical methods	Used	Not used	Total
Aware about such methods	63 (21%)	218 (75%)	281 (96%)
Not aware about such methods	11 (4%)		11 (4%)
			292 (100%)

Source: Authors' Survey Data, 2013

4.2 Awareness of Farmers on IPM Concept

Farmers' were tested for their familiarity with the IPM concept, during the survey. Among the respondents, 56 percent were not aware of IPM prior to the survey. Although, the remaining 44 percent of farmers had heard about the IPM earlier, only 21 percent (from the total sample) had some kind of understanding/knowledge about what IPM is, and what type of benefits it could provide (table 4.2). Farmers have acquired the knowledge of IPM through various sources.

Table 4.2: Awareness about and Knowledge on IPM Concept

Knowledge / Familiarity	Have some knowledge	No knowledge	Total
Heard about IPM	61 (21%)	67 (23%)	128 (44%)
Not heard about IPM	164 (56%)		164 (56%)
			292 (100%)

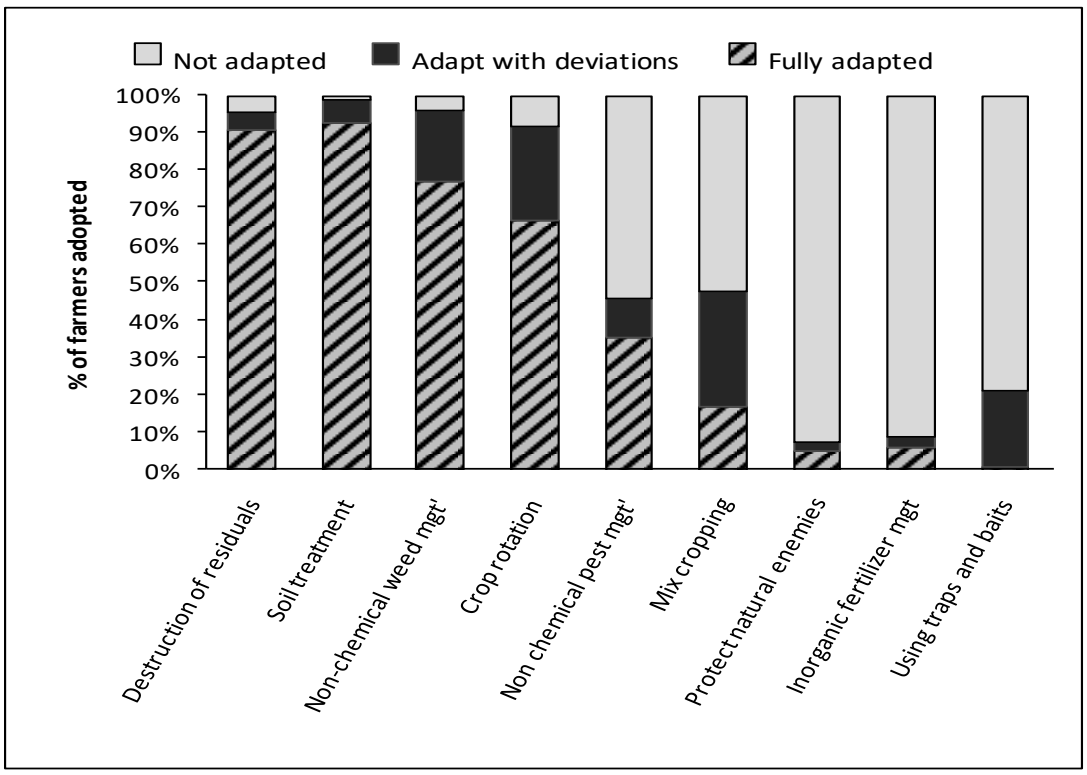
Source: Authors' Survey Data, 2013

4.3 Commonly Adopted IPM Practices by Vegetable Farmers

Nine selected principles underlying the IPM concept were considered for testing the level of adoption by sample farmers. Based on the farmers' responses, pattern of adoption for each principle was recorded and categorized against three patterns namely, '***not Adopted'*** (farmers not following at all); '***practiced with deviation***' (farmers practise only in selected crops or in some seasons); and '***fully adopted***' (farmers practice on every crop in every season).

As indicated in Figure 4.1, 'destruction of crop residues immediately after harvesting' and 'conducting soil treatments' (such as turning the soil/ploughing, adding organic fertilizer, soil sterilization) were fully adopted by 91% and 93% of farmers respectively. 'Conducting non-chemical weed management' and 'crop rotation' were next in common for adoption (77% and 66% respectively) among farmers. 'Non-chemical pest management' and 'mix cropping' were also fully adopted by some farmers but, 'protecting natural enemies of pests', 'using traps and baits' and 'correct management of inorganic fertilizer' were adopted by a very few farmers correctly and continuously.

Though, farmers follow the above practice in the cultivation, sometimes they do not possess a correct understanding on its possible impact on pest and disease controlling. As a result, they have not perceived it as a (non chemical) pest controlling method. In that sense, it can be considered as unintentional adoption of IPM principles by farmers.



Source: Authors' Survey Data, 2013

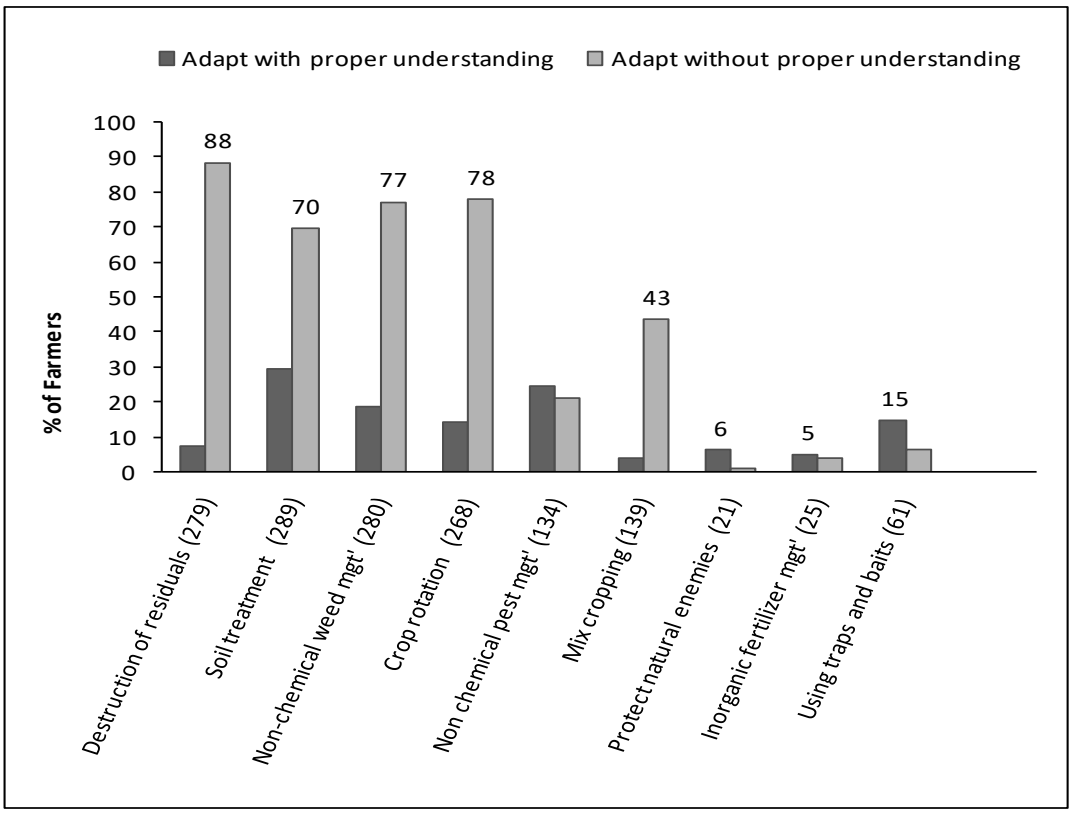
Figure 4.1: Pattern of Adoption for Each IPM Principle

4.4 Knowledge and Understanding of Farmers on IPM Principles

Together with nine selected IPM principles, the aspect of 'Minimum and delayed use of chemical pesticides at recommended dose' was used in determining farmers' knowledge and understanding of IPM concept.

Farmers' understanding on IPM principle was assessed during the survey by comparing farmer responses with the most appropriate justification in the given context. The advantages of adopting a particular practice; accuracy of the methodology adopted; and reasons for deviations from the accurate technique were considered in comparison, in order to decide the most appropriate justification.

According to the results as indicated in figure 4.2, majority of farmers had not had a good understanding of the principles of IPM. With respect to the principles of IPM such as, destruction of residuals, soil treatment, non-chemical weed management, crop rotation, and mixed cropping (which had a higher adoption level by farmers); about 88, 70, 77, 78 and 43 percent of the farmers followed those principles respectively 'without proper understanding' on the concept. However, about 25 and 15 percent of farmers were having a sound knowledge about using non-chemical pest management methods, and using traps and baits in pest management respectively.



Note: Figures in parenthesis (in axis label) denote the number of farmers who adopted the particular principle
Source: Authors' Survey Data, 2013

Figure 4.2: Understanding of Farmers' of IPM Principles (% of total sample)

According to the results, it is clear that, the concepts which are relatively novel to the farming community and subjected to frequent discussions, were better understood by farmers compared to the other concepts which were known to farmers for a long time and were not subjected to frequent discussions and thereby neglected in most of the time. For example, concepts such as using non-chemical pest management methods, protecting natural enemies in pest controlling and using traps and baits for pest controlling were subjected to frequent discussions in the community in the recent past (especially with the discussions regarding higher use of various chemicals in food crop productions) thereby, farmers had opportunity to acquire some knowledge recently on such techniques.

These findings indicate the importance of addressing the knowledge gaps and areas to be emphasized in future awareness programmes of IPM. It is clear that, the principles which were least understood by farmers, should be given priority and prominence in future IPM awareness and training interventions.

4.5 Factors Affecting the Level of IPM Adoption by Vegetable Farmers

In order to identify the relationship between the level of IPM adoption and selected socio-economic variables, '*stepwise multiple regression model*' was applied. The predictor variables tested in the model were;

Age (AG), Educational level (EDU), Family labour (FLAB), Experience in vegetable farming (EXP), Proportionate income from vegetable production (PROINC), Number of extension contacts (EXT), Knowledge score (KNSC), Source of information (INF) and Social contacts in farming (SOCON).

Out of the above nine variables, six variables namely Age (AG), Educational level (EDU), Experience in vegetable farming (EXP), Number of extension contacts (EXT), Source of information (INF) and Social contacts in farming (SOCON) were automatically removed during the process of stepwise regression as they did not show a significant level of interaction/effect with the dependent variable. Three predictor variables fitted the model with a significant level of interaction, namely, Knowledge score (KNSC), Proportionate income from vegetable production (PROINC) and Family labour (FLAB). A summary of the model information is shown in table 4.3.

Table 4.3: Results of the Empirical Model

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1712.966	3	570.989	29.952	.000
Residual	5490.253	288	19.063		
Total	7203.219	291			

* Model is significant at 1% significance level

Model	Un-standardized Coefficients	t	Sig.
Constant	16.479	12.217	.000
KNSC	0.132**	8.882	.000
PROINC	-3.092**	-3.327	.001
FLAB	-.563**	-2.197	.029

Note: Significant coefficients at 5% significance level are represented by a '**'.
$R^2 = 0.238$

Value of R^2=0.238, implies that variables in the model could explain 23% of the level of IPM adoption by vegetable farmers. However, R^2 value has a relatively lower value than required to provide a strong prediction.

According to the results of the regression analysis, the model equation can be written as follows:

ADSC=16.479+ 0.132 KNSC – 3.092 PROINC – 0.563 FLAB

Some of the previous studies prove that the training on IPM related aspects could create a significant impact on the adoption level. For example, knowledge, attitude and adoption of IPM between IPM trained and IPM non-trained groups have shown a significant difference as reported in Bandara and Sivayoganathan, (1999) and Krishnamurthi and Veerabhadraiah (1999). Further to that, a study conducted on paddy and cotton by Sing *et.al* (2008) also reported that, adoption of IPM was significantly higher among IPM trained farmers compared to non-trained farmers.
Despite the high significance of training component to the level of adoption, it was not possible to check the effect of 'farmers' exposure to IPM training' in the regression in this study, as the number of farmers received training on vegetable IPM (in all locations) was not adequate. The non inclusion of training component in the regression model also could be a reason to have a lower R^2 value in the fitted model.

As farmers were not conversant about vegetable IPM (no proper training on vegetable IPM has been received by them) unlike in most of the past studies, the research team had to apply an indirect method of identifying the level of adoption of IPM (by assessing the knowledge, awareness, and adoption of 'the principles which IPM is based on'). This strategy could also result a weaker relationship among predictor variables and the dependent variable. In other words, adoption was less explained by selected variables. In contrast, most of the past empirical studies were conducted in a situation where proper IPM programmes had been launched towards the farming community prior to the adoption level assessment study.

4.5.1 Farmers' Knowledge on IPM Principles

According to the results of the model, knowledge level of the farmer had positively influenced the level of IPM adoption with a coefficient of 0.132, which means, by increasing the farmers' knowledge score by 1 percent, the adoption will increase by 0.1 percent. It is understandable that, the increasing of knowledge on IPM will lead to understand the principles behind it, advantages of it, thereby develop positive attitudes towards following IPM techniques in their cultivations. This finding is consistent with Bandara and Sivayoganathan (1996) where IPM adoption was significantly related to farmers' knowledge on IPM.

4.5.2 Proportionate income from the Vegetable Cultivation to the Total Household Income

Proportion of the income generated through vegetable cultivation to the total family income has shown a negative relationship with the level of IPM adoption at 3.092 coefficient value. It implies that, 1 percent increase of the propionate income will result in 3 percent of decrease in the level of adoption (adoption score) of IPM. This could be explained together with the risk aversion behavior of farmers where, when the contribution of the income from vegetable production to the total household income increases, farmers tend to be secure that income without taking any intervention that could risk the production (thereby income). As founded in literature, most of such farmers prefer chemical pesticides for effective control of pest and diseases (to ensure quick and assured pest control), and do not opt to adopt other non-chemical methods such as IPM which allows some level of damage to the harvest. As a result, if a farmer is fully depends on vegetable production for his/her income, his/her adoption towards IPM is less.

4.5.3 Family Labour

Influence of family labour to the level of adoption was negative and was at coefficient of 0.563. According to the empirical studies (with proper training opportunities for IPM), most of the time there was a positive relationship. Negative relationships could be due to the marginal profit that could be obtained by using an additional family labour unit for vegetable cultivation is lower.

With a high level of IPM adoption, labour requirement become higher. But due to various other limitations in the production system, profit does not increase at the rate of labour increased, and as a result, it could create a net loss to the farmers. Consequently, they tend to move away from labour intensive methods such as IPM. Therefore, the relationship between IPM and labour could become negative.

CHAPTER FIVE

Problems in Adopting Non-Chemical Pest Control Methods and Probable Suggestions

5.1 Problems in Adopting Non-Chemical Pest Control Methods in Vegetable Cultivation: Farmers' View

Farmers' views on the problems that they faced in adopting 'non-chemical pest and disease controlling measures' in vegetable cultivation were collected and the problems were ranked according to the recorded frequency. According to the Table 5.1, leading problems that farmers face in adopting IPM are lack of knowledge and awareness on suitable non-chemical pest controlling methods/techniques, time consuming process to yield results, and high labour requirement. In addition, lack of trust about the efficiency of IPM techniques, difficulty in applying the technique to larger extents and high-risk associated with the method were also recorded in lesser frequency. Farmers were also concerned about the less effectiveness of applying IPM at individual farm level, inability to eradicate the pests, unavailability of non-chemical pesticides in the market, lack of advisory services to guide farmers to practise the techniques, difficulty in applying multiple cropping areas, convenience and quick effects of using chemical pesticides.

Table 5.1: Problems Faced by Farmers in Adopting IPM in Vegetable Farming

Problem	Recorded frequency from the total sample
Lack of knowledge on such techniques	175 (60%)
Time consuming nature	160 (55%)
High labour requirement	136 (47%)
Lack of trust in farmers on such methods	57 (20%)
Difficulty in applying at larger scale	55 (19%)
Higher risk associated in using such methods	45 (15%)
Less effective when practice as individually	19 (7%)
Absence of complete removal of pests	14 (5%)
Unavailability of 'non-chemical pesticide products' in the market	13 (4%)
Lack of advisory service to support practicing such methods	6 (2%)
Difficult to adopt in multi cropped situation	6 (2%)
Chemical pesticides are easy to use and efficient	6 (2%)

Note: Percentages exceed 100% as multiple responses were allowed
Source: Authors' Survey Data, 2013

Krishnal *et.al.*(2007), also reported similar problems in IPM adoption such as, lack of coordination among farmers, poor technical know-how, risk aversion and complexity of the IPM method.

The problems associated with the application of IPM or any other 'non-chemical pest control measures' were categorized under three major areas considering the nature of the problem:

a. Drawbacks related to the characteristics of the method i.e. *technical and economic aspects* of the method itself;
b. Drawbacks related to the characteristics of followers i.e. *attitudinal aspects* of followers;
c. Drawbacks related to the characteristics of the sender and channel i.e. *information dissemination and awareness*;

The problem of lesser adoption of non-chemical pesticide methods and/or IPM, as per the above analytical framework is graphically shown in figure 5.1.

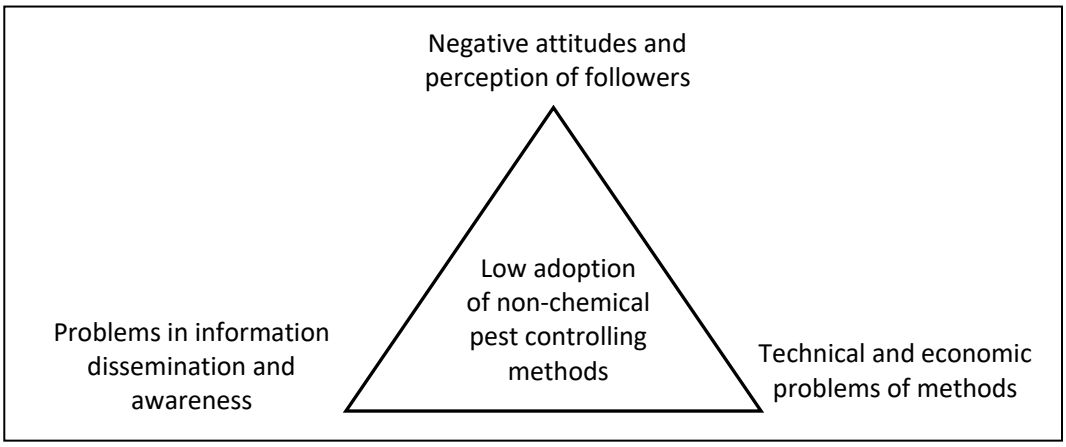


Figure 5.1: Problems in Adoption of Non Chemical Pest Controlling Methods

However, according to the cause of the problem, some of the problems expressed by the farmers could not be included into a single category. In a meaningful analysis those problems seems to be having multiple causes. Figure 5.2 graphically describes the inter-relationships of the causes of problems, with respect to the main category of the problem.

Since the problems pointed out by farmers flow from one to another as shown in figure 5.2, in practical situations those problems need to be understood from multiple perspectives to address them correctly in a strategic way to promote IPM for vegetable cultivation.

For example, 'lack of confidence of farmers on non-chemical pest controlling methods' is mainly due to an attitudinal problem of farmers i.e. either due to a bad experience or wrong beliefs. Therefore, appropriate strategies for changing farmers'

attitudes would help solve the problem. In contrast, 'easiness and effectiveness of using chemical pesticides' might be due to a combination of both inherent weaknesses in non-chemical methods, and negative attitudes of farmers. Therefore addressing the farmers' attitude alone will not be sufficient to solve the problem, rather methodical improvement of IPM technique should also be considered to overcome the barrier.

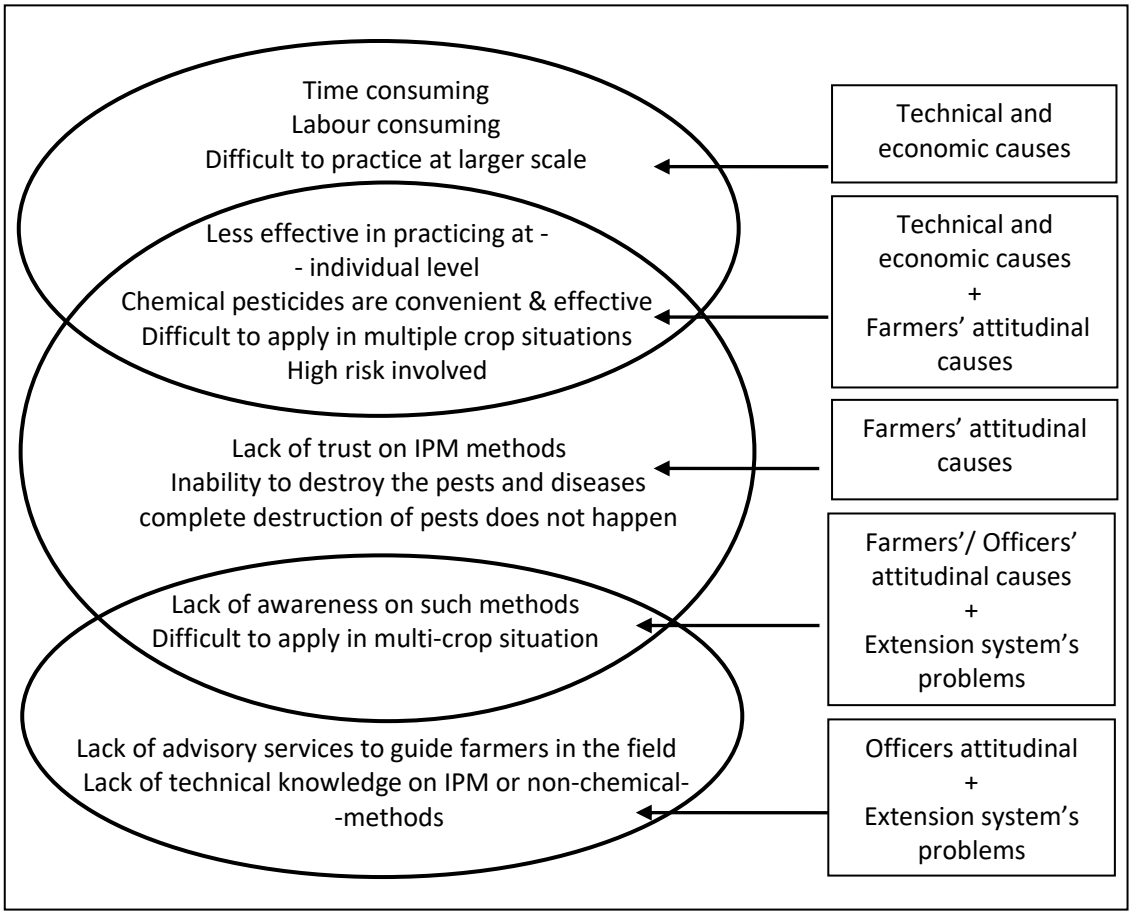


Figure 5.2: Relationship Among Causes of the Problems in Adopting Non-chemical Pest Controlling Methods

5.2 Problems Associated with the Adoption of IPM in Vegetable Cultivation: Officers' Perspective

Information on the prevailing problems in promoting IPM in vegetable cultivation in the perspective of the officers' working in the grass-root level extension service was collected through key informant interviews. Information elicited from the officers on the subject was categorized into five broader areas, based on the possible cause.

(a) Problems due to IPM not being incorporated in the national policies

Priority has not given to the vegetable IPM in national or provincial level agricultural extension planning. Although the extension programmes of some provinces (Uva, North Western and North Central) have scheduled some training programmes for 'paddy IPM' in their extension plans (for the year 2013), vegetable IPM promotions are not incorporated in their plans. Further, some of the IPM programmes (especially for the paddy sector) which had been planned at the beginning (in some sample locations) were not being able to conduct, as the priority had to be given to some other programmes of the central government (such as "Divineguma" programme related activities).

(b) Problems related to the poor institutional support and resource limitations

Promotion of IPM in vegetable cultivation was hindered due to the unavailability of financial support by the central government or provincial administration. Especially the provincial extension system has been struggling to acquire necessary resources for vegetable IPM training programmes in their areas. More often provincial extension staff has to seek assistance of resource persons from different other systems (ex. from universities and research institutes) in conducting these programmes in which the allocation of allowances for such hired resources had been difficult due to the shortage in funds. In addition to that, allocating funds for transport, training materials and subsistence or refreshments for participants have been a challenge in organizing training and promotions in IPM. As a result, efforts for IPM promotions and training were limited.

(c) Problems related to knowledge, skills and attitudes of the extension staff

(i) Extension staff had not been updated with the new IPM packages developed by the research staff
(ii) Majority of subject officers (SMOs) trained under FAO-paddy IPM programme has left or retired from the service and thereby, a lack of trained SMOs on the subject persists
(iii) The present SMOs do not have an opportunity to receive special training on IPM as done in the past FAO- paddy IPM programme
(iv) No comprehensive training had been received by Agricultural Instructors (AIs) or farmers (in all sample locations) on vegetable IPM, at least for the last five years of period
(v) Due to the lack of knowledge on vegetable IPM, AIs have not developed confidence on IPM techniques and their attitude towards promoting IPM in vegetable cultivation is usually negative
(vi) Some AIs are reluctant to conduct field level farmer training programmes without having any tangible benefits or incentives to be given to the farmers to motivate them

(d) Problems related to farmers' attitudes

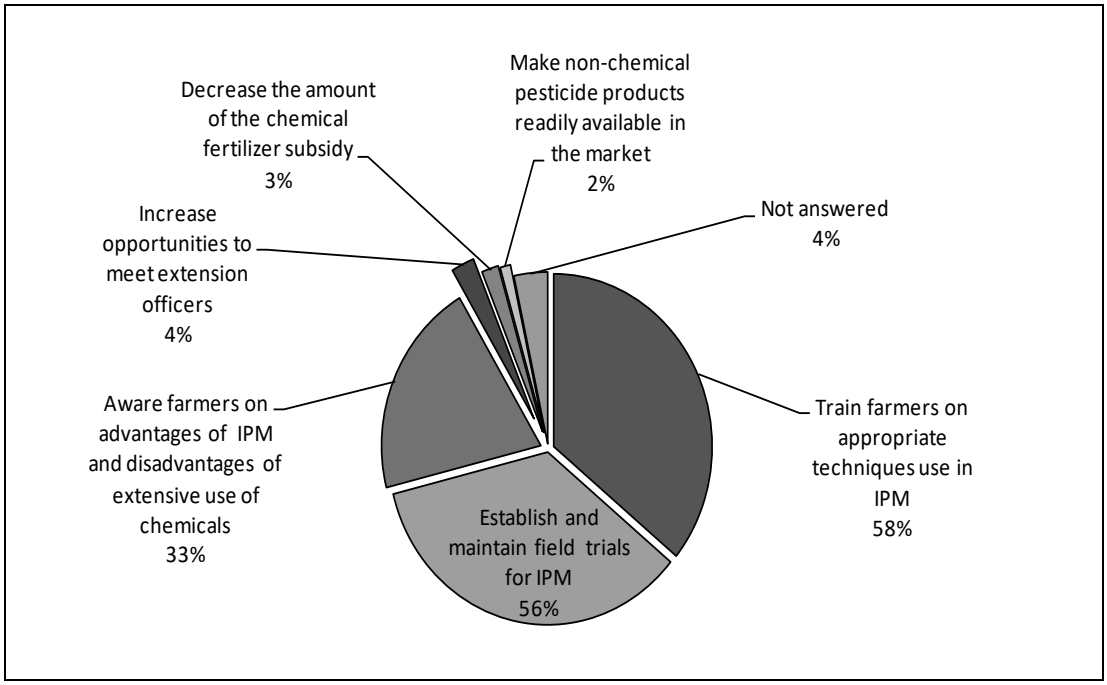
(i) Farmers tend to believe in their own experience and not keen to get advice from the extension staff
(ii) Farmers are not prepared/willing to take risks by experimenting new techniques in their fields especially, as vegetable crops stand for a short period and due to its higher value
(iii) Farmers do not prefer time consuming and labour intensive methods to control pests and diseases
(iv) As the consumer preference is for fresh produce which is free from pest and disease damage, farmers are less concerned over IPM techniques which allow some level of damage to the products. Instead they are using chemical pesticides intensively to ensure that products are completely free from pest and disease damages
(v) Farmers are not willing to spend their time on visiting the extension officer and some farmers think it as a waste of time

(e) Problems related to the characteristics of the IPM method

Developing IPM packages for vegetables is difficult (as there are many species, high crop variation, variation of seasons and location) compared to a single crop situation such as paddy. Some of the features such as timely cultivation and timely destruction of crop residuals collectively, are difficult to be promoted in the areas which have a year-round cultivation system (ex. Nuwara Eiya).

5.3 Farmers' Suggestions to Overcome the Problems Associated with Adoption of IPM

Farmers were inquired about their suggestions to popularize and promote IPM in vegetable cultivation. The possible strategies proposed were prioritized (Figure 5.3). According to the analysis, 58 percent of farmers were in need of proper training on IPM techniques; and 56 percent of farmers requested to establish farm level field trials or demonstrations of IPM in vegetable cultivation for learning and dissemination of IPM techniques on vegetable cultivation. Another 33 percent suggested to make both the farmers and the consumers aware about the health, environmental, social and economic aspects of using IPM over the extensive use of chemical pesticides in vegetable cultivation.



Note: The total may exceed 100 as respondents have provided multiple responses
Source: Authors' Survey Data, 2013

Figure 5.3: Farmers' Suggestions to Overcome Problems in Adopting IPM in Vegetable Farming

5.4 Officers' and Experts' Suggestions to promote IPM in vegetable cultivation

For the convenience of understanding, the opinions and suggestions provided by IPM experts and the relevant officers (who engage in IPM promotion and extension), to promote IPM in vegetable cultivation were categorised under three aspects based on the cause of the problem.

(a) Aspects related to the knowledge, awareness and attitudes of farmers and officers

   (i) Creating awareness and educating farmers regarding the benefits and the technical aspects of IPM method
   (ii) Change farmers' attitude towards the appropriate use of agro chemicals in pest management
   (iii) Change the attitude of officers towards promoting 'minimum chemical used' pest management methods
   (iv) Provide comprehensive training on IPM for all the officers engaged in extension activities

(b) Aspects related to facilitating the institutional support, and national level policy implications

(i) Ensure strong policy support at national level to promote IMP in vegetable cultivation
(ii) Activities on vegetable IPM promotion should be included as a priority work in the general extension plan
(iii) Formulate dedicated IPM programmes at provincial level with necessary financial and human resource allocations
(iv) Initiate vegetable IPM promotion as a separate programme and appoint responsible officer to undertake promotion at divisional level
(v) Promote composting programmes at farm level parallel to IPM promotions
(vi) Develop a system to certify the IPM products, enabling to market them separately with a high value
(vii) Regulate the sale of agro-chemicals by establishing a certification process for chemical sellers
(viii) Regulate overuse of chemicals by farmers through a system of selling pesticides for a prescription issued by an authorised person, endorsing only the required amount of pesticides from a certified shop
(ix) Develop APRAs as messengers between farmers and extension staff in IPM promotion activities
(x) Facilitate and increase the opportunities to interact and exchange ideas among researchers, experts, academics and extension staff on IPM

(c) Aspects related to the characteristics of the IPM technique

(i) Develop specific IPM packages for controlling major economic pest and disease in high value crops
(ii) Facilitate research towards developing effective non-chemical pest and disease management techniques (to invent new botanicals/ and bio agents)

5.5 Appropriate Strategies/Methods/Tools to Promote IPM in Vegetable Cultivation: based on Officers' Suggestions

i. Adopt field trials and demonstrations for IPM training/promotion programmes
ii. Initiate pilot programmes in selected locations of major vegetable growing areas and scale up with the experiences
iii. Promote 'Track approach/Yaya approach" programmes in the vegetable system to prepare farmers for cooperative working habit; initially in major vegetable growing areas as a pilot programme
iv. For farmer awareness programmes;
   - IPM message should be conveyed towards farmer via "quick awareness sessions" during various programmes conducted by different institutes/ officers operating at village level

- Use crop clinics as a vehicle of conveying the message of IPM
- Conduct propaganda campaigns using mass media

v. Provide certified prices for IPM products at the initial stage to motivate farmers

vi. Combine undergraduate and postgraduate research studies with field level IPM promotional and awareness activities (ex. action research)

CHAPTER SIX

Conclusion and Recommendations

6.1 Summary of the Major Findings

1. Age distribution
   Majority of the farmers (73%) engaged in vegetable farming were between 31-60 years of age and only two percent of the total sample were below the age of 30. The findings indicate the low involvement of youth in the vegetable farming, despite being recognized as a relatively high income earning agribusiness.

2. Education level
   About 70 percent of farmers had studied up to GCE Ordinary Level and another 14 percent had studied up to GCE Advanced Level. The proportion of farmers who have never had school education was only one percent. The level of education of the majority was adequate to understand a concept such as IPM correctly.

3. Income earning activities
   About 98 percent of the farmers were engaged in farming as their primary income earning activity and 75% of the farmers had no other alternative income source.

4. Cropping pattern
   Cropping pattern varies with the type of water regime. Farmers in the major irrigated areas of the Anuradhapura district cultivated vegetables in both *yala* and *maha* seasons while in rainfed minor irrigated areas of the Kurunegala district majority of the farmers perform vegetable farming only in the *yala* season and to a certain extent in both *yala* and mid seasons. However, the majority of the farmers in upcountry areas perform vegetable cultivation throughout the year.

5. Experience in vegetable farming
   Majority of farmers have been engaging in vegetable farming for more than five years and have gained sufficient experience to grasp a technique such as IPM successfully.

6. Availability of household labour for vegetable farming
   About 50 percent of the total farmers received the support of at least one family member (addition to the main farmer) for vegetable farming activities. Another 31 percent of farmers received the support of two family members.

7. Average monthly income
   Average monthly income of majority (59%) of households was between Rs. 10,000 to 50,000 and 32 percent of the farmers had an average monthly income of more than Rs. 50,000. However about one tenth of the total had received an average monthly income which was less than Rs.10,000.

8. Proportionate income from vegetable cultivation
   About 17 percent of households were totally dependent on vegetable production for their household income. Another 68 percent of households received 50% of the total household income from vegetable cultivation.

9. Availability of extension service
   Only 47 percent of the farmers had any contacts with the extension staff at field level. The number of contacts vary from 1-10 per cultivation season. About 67 percent of farmers were not satisfied with the adequacy of current extension contacts while 26 percent said it was satisfactory. Another seven percent of farmers did not expect the support of extension service for pest and disease management in vegetable cultivation.

10. Source of information for selecting chemical pesticides
    Informal source of information is the first, second and third preference in choosing pesticides for the 96, 87 and 67 percent of the farmers respectively. 'Sales center agents' was the prominent informal source.

11. Pattern of using chemical pesticides in vegetable cultivation
    About 47 percent of the farmers had applied chemical pesticides before pests or diseases appeared in the field or as the routine activity and 37 percent had applied chemicals immediately after detecting the pest or disease incidence in the field. Only two percent of the farmers followed the 'economic threshold level concept' in pesticide applications.

12. Following the recommended dose in chemical pesticide application
    The instructions on the recommended dosage of chemical pesticides were followed by 60 percent of the farmers and the rest of farmers have deviated (mostly towards higher dosage) from the recommendations.

13. Mixing different chemical pesticides together in the application
    About 83 percent of the farmers were aware of the disadvantageous of mixing different chemicals, but 33 percent of the knowledgeable farmers were in the habit of mixing several chemicals together in application. Out of the total farmers, 46 percent (both aware and non-aware farmers) had applied mixture of chemicals.

14. Awareness on non-chemical pest management methods
    Awareness on the effective use of non chemical methods for pest and disease management was with 96 percent of farmers but, about 75 percent of the

farmers had not used to practise any of the non-chemical methods in pest and disease management in vegetable cultivation.

15. Awareness on 'IPM concept' and the based on principles

About 56 percent of the farmers had not heard about the concept of IPM earlier. Although, 44 percent of farmers had heard about the IPM earlier, only 21 percent had a certain degree of understanding/knowledge about IPM.

Majority of farmers had not had a good understanding regarding the underlying principles of IPM. Even with respect to the practices which were highly adopted (such as destruction of residuals, crop rotation, soil treatment, non-chemical weed management, and mix cropping), at least 60 to 80 percent of farmers have not had proper understanding on its underlying principles.

16. Commonly adopted IPM practices

'Destruction of crop residues' , 'conducting soil treatments' 'conducting non-chemical weed management' and 'crop rotation' were adopted by 91% ,93%, 77% and 66% of the farmers respectively. 'Non-chemical pest management' and 'mix cropping' were adopted only by 35% and 17% of the farmers respectively. All these principles were mostly practised by the farmers without having any understanding on the concept of IPM. However, only a few farmers had adopted 'protecting natural enemies of pests', 'using traps and baits' and 'correct management of inorganic fertilizer', but a considerable proportion of them used the techniques with an understanding.

17. Factors influencing the level of IPM adoption

The level of IPM adoption was positively related to the knowledge of farmers on IPM. Proportionate income from vegetable cultivation and the extent of family labour had negatively influenced the IPM adoption.

Further, gaps in existing policy and institutional setup, poor attitudes of farmers and officers on IPM, weak extension system, complicatedness of IPM technology have also resulted in low level of IPM adoption in the vegetable sector.

6.2 Conclusions

1. Adoption of IPM techniques among vegetable farmers is not at a satisfactory level. Out of nine selected principles only four principles (well known among farmers for a long period) were adopted by more than 50% of farmers. All the other principles were less or poorly adopted.

2. There is a knowledge gap in terms of the principles of IPM and its application among farmers. Despite the level of adoption, understanding of farmers on the basics of IPM concept and its techniques was very poor. At the same time, lack of training opportunities and awareness of farmers on IPM was recorded and it could have directly resulted in the poor understanding on the basics of IPM.

3. Weaknesses in national level policies for IPM promotion, poor attitudes of farmers and extension officers, weaknesses in the extension system and institutional gaps are the constraints of promoting IPM among vegetable farmers.

4. Insufficient human resources in the current extension system, lack of capacity of extension officers on IPM, lack of resources and institutional support for IPM promotion and, improving the knowledge and attitudes of farmers' towards IPM need to be addressed in the short-run for an effective IPM promotion in vegetable sector.

6.3 Recommendations

Addressing policy related issues

1. Advocacy on policy issues across the country and encouraging the agencies and policymakers to incorporate 'vegetable IPM' in their routine programmes and activities.

   IPM should be taken as one of the priority policies of the extension programme both at the national and provincial level, through initiating measures to promote and popularize vegetable IPM among farmers by allocating sufficient resources and building capacities of the relevant officers in the system.

Support in innovations

2. New research focused on vegetable IPM and related issues should be promoted by the government by allocating resources.

   Especially, developing simplified and specific IPM packages, mainly for major pest and diseases of vegetables and popularizing such innovations among farmers through action research need to be done in the long-run.

Addressing the knowledge and attitudinal gap

3. It is recommended to fill the existing knowledge and attitudinal gaps of farmers and extension officers in IPM through following measures.
    I. Develop and implement a tailor-made IPM training program for IPM trainers (SMOs) and the extension officers working at the field level (AIs and AOs).
    II. Conduct awareness programmes to change farmers' attitudes towards management of pests and diseases concerning economic threshold level.

Practicing IPM at field level

4. Conduct 'participatory vegetable IPM trials' in major vegetable growing districts, (as pilot programmes) to motivate farmers towards IPM. Farmer Field School approach is recommended to begin the programme.

    In these programmes, use Agriculture Research and Production Assistants (ARPAs) as *'messengers'* to transfer information among farmers and AIs, on IPM related awareness and troubleshooting.

Creating consumer awareness and interest in using IPM products

5. Create a special price and a market for IPM based vegetable products by providing IPM certification system which is similar to the one concerning organic products.

6. Launch awareness campaigns using mass media to enable vegetable consumers identify and motivate them to purchase 'pesticide free vegetable products'.

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