# DETERMINANTS OF ENVIRONMENTAL AWARENESS INDEX AND PESTICIDE DEMAND OF TOMATO FARMERS IN INLE LAKE

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**OCTOBER, 2014**

# DETERMINANTS OF ENVIRONMENTAL AWARENESS INDEX AND PESTICIDE DEMAND OF TOMATO FARMERS IN INLE LAKE

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**A Thesis Submitted to the Post-Graduate Committee of the Yezin Agricultural University as a Partial Fulfillment of the Requirements for the Degree of Master of Agricultural Science (Agricultural Economics)**

**Department of Agricultural Economics**
**Yezin Agricultural University**

**OCTOBER, 2014**

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**DECLARATION OF ORGINALITY**

This thesis represents the original work of the author, expert where otherwise stated; it has not been submitted previously for a degree or any other University.

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**DEDICATED TO MY HUSBAND,**

**U KYAW KYAW HTUN**

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## ABSTRACT

Heavy pesticide utilization in tomato production of Inle Lake causes environmental pollution and health effects. The study attempted to observe profitability of tomato production, the pesticide used practices, externalities of pesticide utilization, environmental awareness index, determinants of environmental awareness index (EAI) and pesticide demand of tomato production in the Inle Lake. For primary data collection, 107 tomato farmers were interviewed in 7 sample villages out of 136 villages in Inle Lake, Nyaung Shwe Township during January to February 2014. The sample farmers were categorized into three groups based on the yield of tomato production. Descriptive analysis, cost and benefit analysis, environmental awareness index, linear regression model were used to fulfill the research objectives.

According to research findings, the education level of sample farmers among in Inle Lake was not too low. The farm experience and pesticide using experience were similar and the average farm size was about 0.3 ha. More than 50% of female labor was employed particularly in transplanting, weeding, harvesting and packaging. Based on the enterprise budget, the high yield group gained the highest net benefit. Nearly 40% of farmers used inorganic pesticides. Most of sample farmers applied dangerous pesticide handling practices such as spraying against the wind direction, applying with partial protective clothing and washing sprayer into lake. Lack of formal pesticide training was the major problem for the farmers. However, half of the sample farmers had higher environmental awareness index. Older farmers, small farm size owners and less pesticide using experience farmers had high environmental awareness index according to regression analysis. Education and price of pesticides positively influenced the pesticide demand.

Training and education program of proper pesticide usage would be the important role in alleviating of the misuse of pesticides and public health education will be very critical for the farm households in Inle Lake. Good Agricultural Practices (GAP), Integrated Pest Management (IPM) and forest conserving programs would be proper approaches and farmer's environmental awareness would be the major driven force for environmental conservation, therefore, the policy drive of environmental awareness would be very imperative for the future livelihoods in Inle Lake.

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| a.i | Active Ingredient |
| ˚C | Degree Celsius |
| CSO | Central Statistical Organization |
| DoA | Department of Agriculture |
| FAO | Food and Agriculture Organization |
| ha | Hectare |
| lb. | Pound |
| Kg | Kilogram |
| L | Liter |
| MMK | Myanmar Kyat |
| MMT | Million Metric Ton |
| MOAI | Ministry of Agriculture and Irrigation |
| MT | Metric ton |
| No. | Number |
| Sig. | Significant Level |
| SLRD | Settlement and Land Record Department |
| YAU | Yezin Agricultural University |

## LIST OF CONVERSION FACTORS

| | | |
|---|---|---|
| 1 Basket of Tomato | = | 30 viss of Tomato |
| 1 Long ton | = | 622.2 viss of Tomato |
| 1 Long ton | = | 1.016 Metric ton |
| 12 Ah Lan | = | 1Acre |
| 1 Acre | = | 0.4047 Hectare |

# CHAPTER 1

# INTRODUCTION

## 1.1 Vegetables and Tomato Production in Myanmar

Fresh vegetables are an essential part of a healthy diet as it is an important source of vitamins and minerals. However, vegetables can also be a source of poisonous toxic substance - pesticides because farmers use more pesticides on vegetables and high value crops than cereals and staple crops. High levels of pesticides on vegetables and high value crops have contributed to high levels of chemical residue in the food chain (Ortelli, 2006). According to FAO (2012), the Asia vegetable production was reached 240 MMT in 2012. Sixty seven percent of vegetable was produced by China and India is the second largest vegetable producing country in Asia (Figure 1.1).

Myanmar is one of the agro-based countries in Asia and commercial crops of the country are cereals, vegetables and fruits. The vegetable production of Myanmar was gradually increased from 2007 to 2010 and then decreased to over 3,200,000 MT in 2011-2013 (Table 1.1). According to the data of Settlement and Land Record Department in 2013, the sown area of vegetable in Myanmar was within the range from 503,935 ha to 541,265 ha from 2007 to 2013. After 2007, the vegetable production was more than 3,000,000 MT and the highest production (3,490,630 MT) was occurred in 2009 because of the yield of vegetable was highest (116.74 MT/ha) in 2009. Based on the data, most of the vegetable farmers in Myanmar fully utilized the vegetable sown areas because sown areas and harvested areas were nearly the same in 2007-2013 (Table 1.1).

Among the vegetables, tomato is the essential culinary crop and also excellent source of many nutrients and secondary metabolites: foliate, potassium, vitamin C and E, flavonoids, chlorophyll, beta-carotene and lycopene that are important for human health. In the world, 150 million tons of tomato were produced in 4.5 million hectares in 2012 (FAO, 2012). Among the tomato producing countries, China produced about 23% of world production according to the largest land areas of China (Figure 1.2).

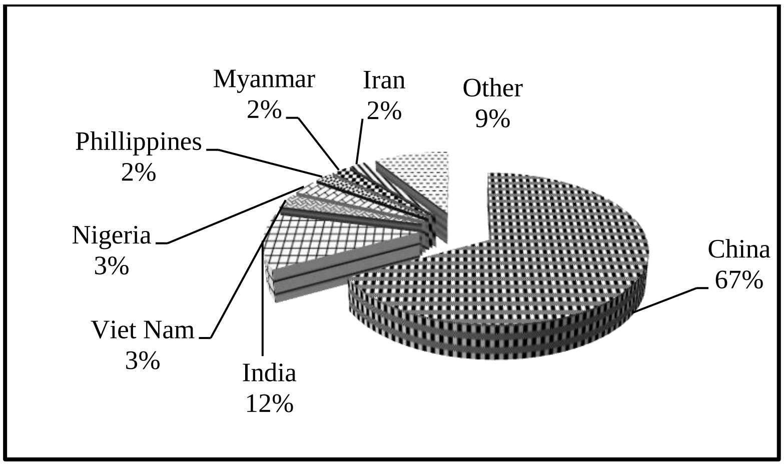



**Figure 1.1 Vegetable Productions in Asia, 2012**
Source: FAO, 2012

**Table 1.1 Vegetable Grown Areas and Production in Myanmar, 2007-2013**

| Item | 2007/08 | 2008/09 | 2009/10 | 2010/11 | 2011/2012 | 2012/13 |
|---|---|---|---|---|---|---|
| Sown area (000 ha) | 503,935 | 507,752 | 524,842 | 541,698 | 537,995 | 541,265 |
| Harvested area (000 ha) | 481,281 | 507,752 | 517,642 | 541,696 | 537,472 | 541,230 |
| Yield (MT/ha) | 106.21 | 105.84 | 116.74 | 105.54 | 104.14 | 104.18 |
| Production (MT) | 2,976,687 | 3,096,204 | 3,490,630 | 3,282,403 | 3,236,293 | 3,324,416 |

Source: SLRD, 2013

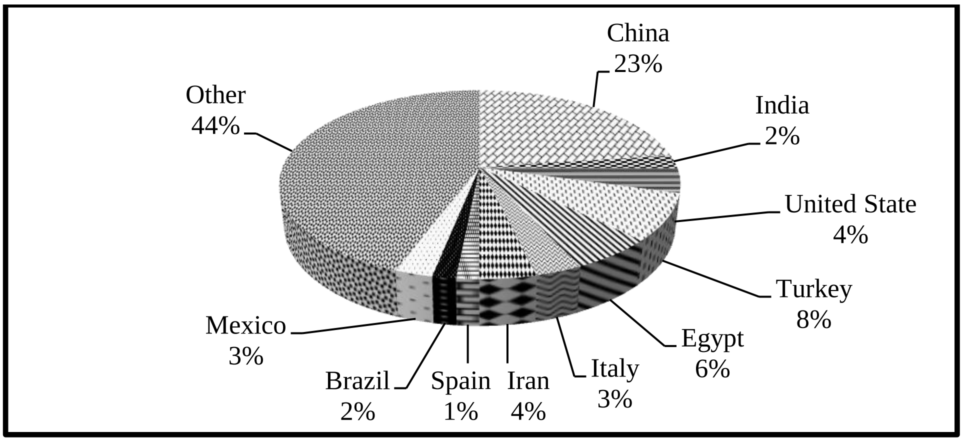



**Figure.1.2 Major Tomato Producing Countries in the World, 2010-2011**

Source: FAO, 2012

**Table 1.2 Sown Areas, Harvested Areas and Production of Tomato in Myanmar**

| Year | Sown Area (ha) | Harvested Area (ha) | Production (MT) |
|---|---|---|---|
| 2007-2008 | 42,871 | 42,871 | 2,017 |
| 2008-2009 | 44,629 | 44,629 | 2,107 |
| 2009-2010 | 44,699 | 44,699 | 2,151 |
| 2010-2011 | 45,285 | 45,285 | 2,161 |
| 2011-2012 | 43,488 | 43,488 | 2,097 |
| 2012-2013 | 44,675 | 44,675 | 2,254 |

Source: SLRD, 2013

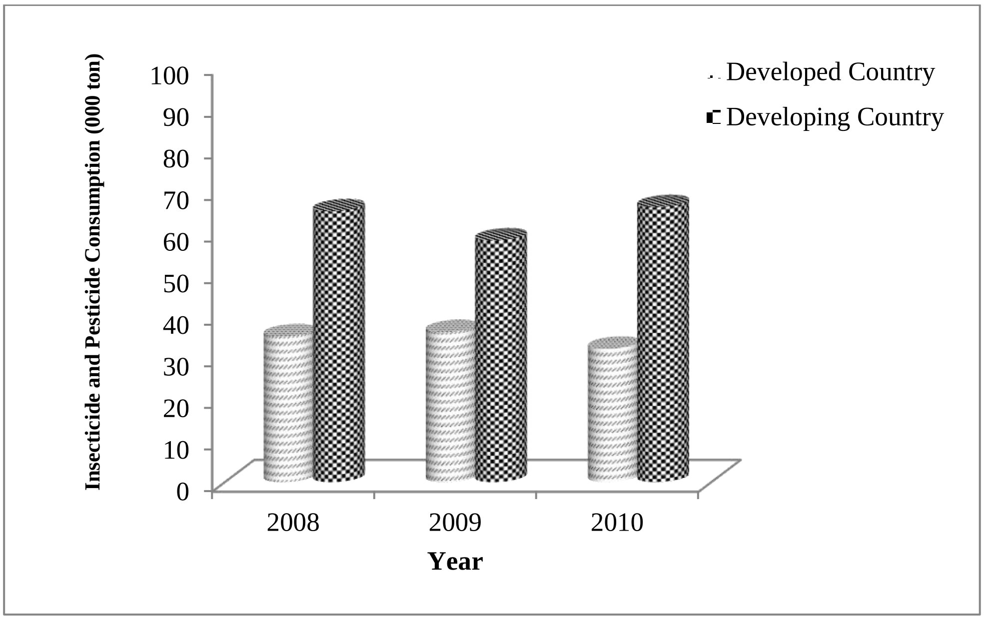



**Figure 1.3 Insecticides and Pesticides Utilization in Asia, 2008-2010**

Source: FAO, 2011

In Myanmar, tomato was grown on about 44,675 ha for the total production of 2,254 MT in 2013 (Table 1.2) (SLRD, 2013). Sown areas, harvested areas and tomato production in Myanmar were increased year by year to 2011. There are two categories of tomato: high land and low land tomatoes in Myanmar. The former is well known as Shan tomato and the latter is called Myanmar tomato among consumers and traders. The main production areas for low land tomato are Pyinmana (Nay Pyi Taw Region), several areas of Magway Region, Monywa (Sagaing Region), Dike Oo and Binnar (Bago East Region) and Watpoke (Bago West Region) (MIS, 2001). Tomato can be produced well in winter season and there is low yield in the summer and rainy season in Myanmar. Relatively cool temperature and drier condition of Southern Shan State is favorable for production of tomatoes in the whole year. High land tomato is grown in the Shan State especially in Inle Lake. Therefore, Inle Lake is the main surplus-producing area of tomato. There are several factors in the low productivity of tomato in Myanmar. Among them, pest and disease problem is the main problem. Therefore, tomato growers try to prevent by over usage of pesticides.

### 1.2 Pesticide Utilization in Asia and Myanmar

Pesticides are widely used throughout the world. For increasing the world population and food production, the utilization of high-yielding crop varieties, fertilizer application, irrigation and pesticide application becomes a predominant factor to recent global changes in food production. Pesticides have substantially contributed to the controlling of pests and increasing crop yields in meeting the food demand of escalating population and control of vector-borne diseases.

Finizo (2002) reported that pesticides can save up to 40% of crop losses. Therefore, the consumption of pesticide is significantly higher when the agriculture system transferred from the traditional to the modernization. According toAspelin (1997), the worldwide consumption of pesticides has reached 2.6 million metric tons. Of this, 85% is used in agriculture. In Asia, the use of pesticides in crop production has spread rapidly with an estimated compound growth rate of 4.4% annually since the 1950s (Rahman, 2003).

In comparison of pesticide utilization in developed and developing countries of Asia, many developing countries utilized more pesticide in agriculture than developed countries especially in 2009 and 2010 (Figure 1.3) (FAO, 2011).

Most of the imported pesticides in developing countries are chemicals which are no longer used and have been banned for agricultural use in most developed countries. However, these chemicals are still widely used in Third World countries owing to its cheaper cost, lack of better alternatives, insufficient knowledge, technology and finance. Therefore, there is a high probability that pesticide use and pesticide induced side effects will grow more rapidly in developing countries as a whole than in the developed ones. Reviewing the pesticide utilization in Southeast Asia countries, Malaysia is the highest pesticide user and followed by Thailand and Myanmar. Moreover, it can be seen that the consumption rate of these countries is increased yearly (Table 1.3) (FAO, 2011).

For the vast majority of people in Myanmar, agriculture is a primary source of livelihood. After the liberalization of market economy in 1989, most of the farmers used high yield varieties, chemical fertilizer, pesticide and herbicide because of the subsidies of government and foreign company contribute in agrochemical market. It is led to the rapid increase in the use of pesticides especially on pulses, cotton and vegetables rather than on rice. According to CSO (2012), pesticide utilization in agriculture of Myanmar gradually increased from 2003 to 2010 especially in granule type (6000,000 lb.). Occupational exposure to pesticides is the great interest in order to identify the hazards of pesticide use and the establishment of safe methods of pesticide handling. This is because pesticide misuse in various sectors of the agriculture often has been associated with health problems and environmental contamination worldwide.

**Table 1.3 Insecticide and Pesticide Utilization (ton) in Southeast Asia, 2008-2010**

| Country | 2008 | 2009 | 2010 |
|---|---|---|---|
| Lao | 0.05 | 0.49 | 0.05 |
| Malaysia | 8,399 | 16,608 | 21,636 |
| Myanmar | 871 | 591 | 1,812 |
| Thailand | 9,471 | 8,112 | 9,995 |
| Timor-Leste | 0.99 | 1.08 | - |

Source: FAO, 2011

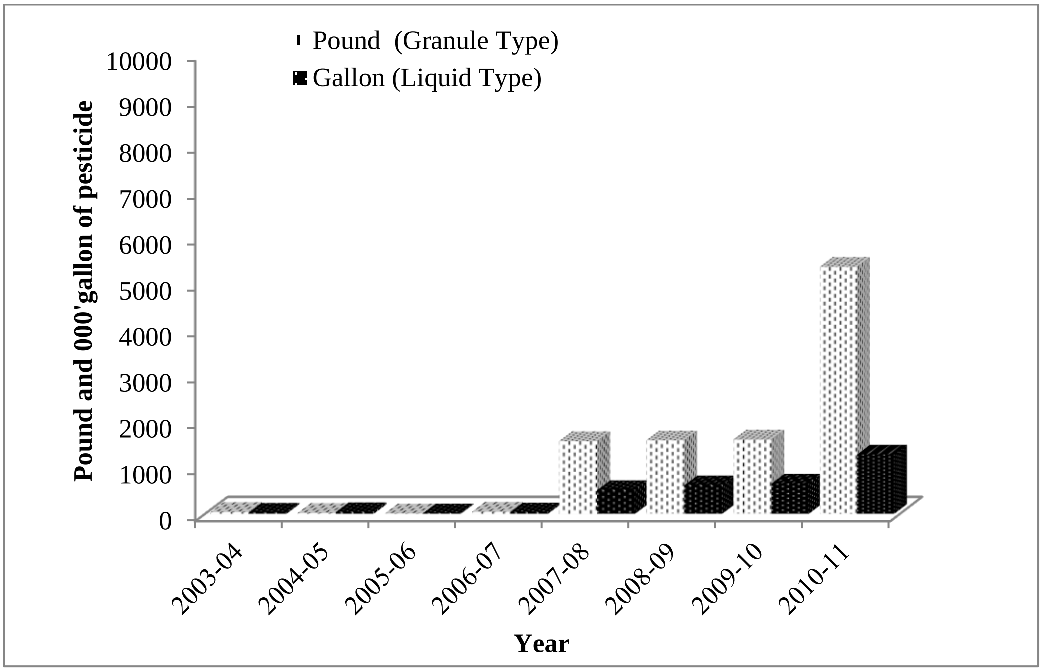



**Figure 1.4 Pesticide Utilized for Plant Protection in Myanmar**

Source: CSO, 2012

### 1.3 Externalities of Pesticide

Exposure to pesticides is one of the most important occupational risks among farmers in developing countries. Farmers use pesticides without full understanding of the impact on human health and the environment. Land clearing and conversion, overuse and misuse of chemical fertilizers and pesticides can alter the biotic interactions and patterns of resource availability in ecosystems and can have serious local, regional, and global environmental consequences. Moreover, pesticide mismanagement can give a wide range of hazards. It has been observed that long term and low dose exposure is increasingly linked to human health effects such as immune-suppression, hormone disruption, diminished intelligence, reproductive abnormalities and cancer. Pesticide pollution not only affects human health, but also affects multiple other environment factors, such as soil, surface and ground water, crop productivity, micro and macro flora and fauna, etc.

Despite the fact that dozens of pesticides are banned, severely restricted or unregistered in many countries and Fajewonyomi (1995) stated that many of them are still widely promoted and applied especially in developing countries where weak controls and dangerous work conditions make their impact even more devastating. Therefore, the farmers' rate of awareness, knowledge, attitudes and practices on pesticides use are properly considered with necessary actions taken in accordance with the recommendations.

### 1.4 Rationale of the Study

Inle Lake, the second largest inland lake in Myanmar, situated in Nyaung Shwe Township, Southern Shan State. The floating garden is a unique and traditional way of utilizing natural resources by the people living around and on the Inle Lake. Therefore, Inle Lake is also an important wetland sanctuary and one of the most famous ecotourism sites because of its traditional hydroponic nature floating garden agriculture performed by local dwellers.

Floating beds or islands are characteristically developed in the water near to the shores of the Inle Lake. They are built from coarse grasses, reeds, sedges, duckweed, and other aquatic vegetation, some of which submerged while others have floating runners with aerial parts well above the water surface. The dead parts of aquatic and marsh plants become entangled together and are bound by bog mosses and algae into expanses of fen peat which float freely. Such floating mass are sawn into blocks of 2 meters wide and up to 200 meters long. Black silt from the bottom of the lake spread over it to the extent that the bed is not sunk below the water surface. These "floating islands" are then towed into position and anchored with bamboo poles. People in Inle Lake grow various cash crops such as tomato, cauliflowers, flowers, pod, cabbage, and eggplant on floating gardens. Among them, tomato is the major cash crop especially in the flooded villages. As the tomato seed used in Inle Lake is hybrid variety, the tomato growers have to use a lot of chemical fertilizers, pesticides and insecticides. Therefore, many of people are employed in agriculture and they carry significant risk for development of pesticide risk. Moreover, most of the farmers were affected their income by buying inputs such as fertilizer and pesticides, health cost and many other factors.

According to Steve (2001), the loading capacities of eight additional pesticides commonly used in tomato cultivation were also derived for comparison; the insecticides endosulfan, esfenvalerate and carbaryl; the fungicides mancozeb and chlororthalonil; and the herbicides trifluralin and metribuzin. The loading capacities of Inle Lake for each of these pesticides to protect human health are shown in Table 1.4. The study showed that most of pesticides used in Inle Lake far exceeded the loading capacity.

Moreover, heavy pesticide usages cause pollution of water and eutrophication. There are many factors causing to water pollution that is shown in Figure 1.4 and floating garden cultivation involved 70% among them (Nilar Aung, 2012). The contaminants are coming from various sources such as agrochemicals, sewage, small-scale textile industries, gold, silver and black smiths, and hotel and resorts wastes, solid and liquid wastes from villages. Therefore, even flowing fresh water can no longer be used directly for drinking purposes due to contamination and pollution (Zin Mar Lwin, 2013). Although water in the lake was very clean and could be drunk in the past, it is not drinkable anymore in later. Moreover, Inle Lake is rich in flora and fauna with 53 species of birds and 36 species of fish including 16 endemic species. Four birds and five mammal species were observed as threatened while some mammal and fishes were listed as endemic and are facing extinction (Steve, 2001)

**Table 1.4 Pesticide Loading Capacity of Inle Lake for Tomato Cultivation**

| Items | Type | Loading capacity (kg/year) |
|---|---|---|
| Monocrotophos | Insecticide | 2.36 |
| Cypermethrin | Insecticide | 1.50 |
| Endosulfan | Insecticide | 3.07 |
| Methomyl | Insecticide | 96.0 |
| Esfenvalerate | Insecticide | 29.8 |
| Carbaryl | Insecticide | 260.0 |
| Mancozeb | Fungicide | 10.8 |
| Chlorothalonil | Fungicide | 32.1 |
| Triflualin | Herbicide | 10.5 |
| Metribuzin | Herbicide | 84.6 |

Source: Steve, 2001

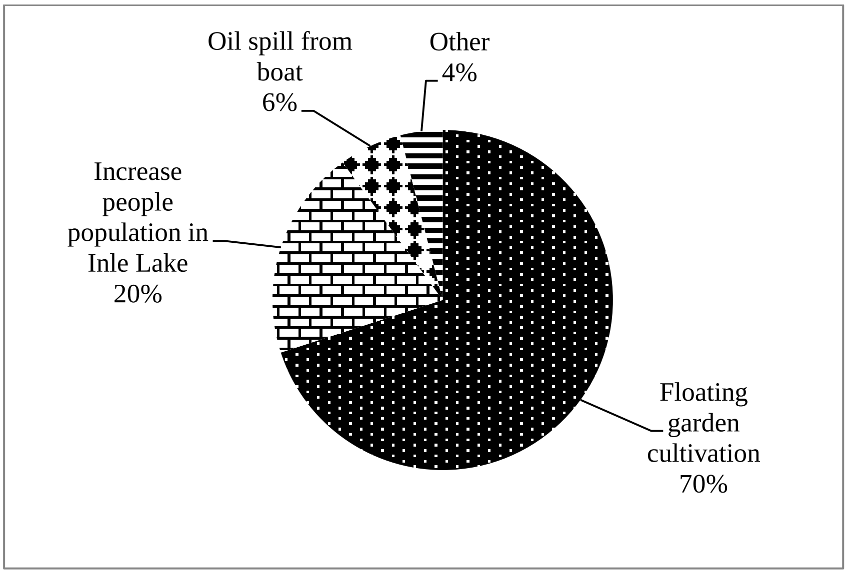



**Figure 1.5 Causes of Water Pollution in Inle Lake**

Source: Nilar Aung, 2012

As a consequence, there are many negative impacts on livelihood activities and environment issues (such as water and air pollutions) in Inle Lake. Large scale deforestation and shifting cultivation practiced are threatening severely the environmental stability of the entire watershed area of Inle Lake. The surrounding hills have also been stripped bare of trees harvested for their firewood. Deforestation and more intense agriculture on its western and northern watershed areas have brought in increasing amount of silt and nutrients into the shallow lake. As a consequence, sedimentation and siltation has been seriously affecting the surface area of the lake. Thus technical measures are needed to environmental degradation with respect to deforestation, water pollution, disposal of solid garbage and lake sedimentation.

Vegetables are the daily usage of our meal especially tomato, pepper, etc. and most consumers are facing the food unsafely nowadays. In recent year, food poisoning cases occur and it is needed to identify the information on the effect of heavy pesticide use, unsafe application techniques or other unsafe pesticide practices on vegetable yield, human health of growers and farm incomes, as well as, on the environment and the environmental awareness of the procedures and farm workers.

### 1.5 Objectives of the Study

The general objective of the study was to assess the determinants of environmental awareness and pesticide demand of tomato production in Inle Lake, Nyaung Shwe Township, and Southern Shan State, Myanmar.

Specifically, the study aimed:

1. to analyze profitability of tomato production by the selected farmers
2. to observe the pesticide used practices and pesticide externalities of tomato farmers
3. to investigate the environmental awareness index and determinants of environmental awareness index of the selected tomato farmers
4. to determine the determinants of pesticide demand of tomato production in the study area

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Impact of Pesticide Use on Human Health

Especially in the agricultural workers in many third world countries are illiterate and cannot read a pesticide instruction labels, lack trainings on the application methods of safe use of pesticides, do not wear any protective clothing, and are ignorant on safe storage and appropriate disposal of residuals (Selvarajah, 2007). One-third of the workers reported about reading the label on the pesticide packet either themselves or through help. But, only less than 3% followed the instructions. The workers often related the toxicity of pesticides to the odor of the chemical and more pungent ones were considered as more toxic. None of the applicators was found using the suggested protective gadgets, which included a face-mask with replaceable filters, goggles, head-cover, rubber gloves, full-sleeved shirts and full pants, and boots (Indria, 2009). Access to medical treatment is limited and most farmers rely on homemade remedies thus increasing the severity and duration of illnesses. Poor health and diet are other factors that are believed to increase the incidence of illnesses from exposure to pesticides in developing countries (WRI, 1998).

Inadequate or non-existent storage facilities, poor living conditions and water supplies contaminated with pesticides also affect the health of families. The major economic and environmental losses due to the application of pesticides in public health were 1.1 billion dollars per year in USA (Pimentel, 2005). Pesticides cause the acute and chronic health effects; organophosphate and carbonate groups are more important. These insecticides inhibit cholinesterase, an enzyme critical for normal functioning of the nervous system. Farm workers also experience day-to-day acute effects of pesticide poisoning, including symptoms such as headache, dizziness, muscular twitching, skin irritation, respiratory discomfort, etc.

Short term exposure to high dosage of pesticide can cause irritation of the skin, eyes, nose and throat, difficulty in breathing, impaired functioning of the lungs, delayed response to a visual stimulus, impaired memory, stomach discomfort and possible changes in the liver and kidneys. Both short and long term exposure can also affect the nervous system (Hashmi, 2011). These symptoms are more prevalent among the agricultural labors. Some farmers take their children to the field where spraying activities are taken up. As a result, accidental poisoning among children is very high (Shetty, 2011).

Probabilities of health risk were assessed relative to differential levels of pesticide use, differences in types of chemicals used and farmer characteristics, such as age, nutritional status, smoking and drinking habits. Pingali (1995) reported that the average health cost for farmers exposed to pesticides was approximately 40% higher than that for the unexposed farmers. In addition to the direct health costs, the loss in labor productivity associated with impaired health is quantified. According to Dhanraj (2012) research in India, skin problems are the most common health problem linked to pesticide use in Shirol region, itching (97.43%), eye-irritation (82.05%), and vision problems were also very common among the respondents. These are regarded as minor ailments and are often managed by the laborers themselves using home remedies. A number of more severe symptoms are also reported that include breathing problems (70.51%), dehydration/ vomiting (39.74%), cramps and diarrhea (43.58%). There were nine cases of hospitalization among the 62 cases of sickness reported in the survey of India. It was found that agricultural laborers are relatively free from illness during non-pesticide applying days. It was observed that among men there is a higher frequency of signs and symptoms, but some of the female laborers were also facing stomach problems sometimes during or after spraying. This exposure to pesticides could cause a variety of reproductive health problems in women of reproductive age group.

### 2.2 Impact of Pesticide Use on the Environment

Over 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target, including non-target species, air, water, bottom, sediments and food (Miller, 2004). Pesticide contaminates land and water when it escapes from production sites and storage tanks, when it runs off from field, when it is discarded, when it is aerially sprayed, and when it is sprayed into water to kill algae (Tashkent, 1998). Pesticide can contribute to air pollution as particles suspended in the air are carried by wind to other areas (Cornell University, 2007). Pesticides that are sprayed onto fields and used to fumigate soil can give off chemicals called volatile organic compounds, which can react with other chemicals and form a pollutant called ozone, accounting for an estimated 6% of the total ozone production (UC IPM, 2006). In the USA, pesticides were found to pollute every stream and over 90% of wells sampled in a study by the US Geological Survey (Gillion, 2007).

Certain greenhouse gas emissions arise from substances emitted from pesticides, while environmental degradation caused by pesticide use negatively affects vegetation and bio-diversity; a major tool for the fight against climate change. Agriculture, including land use change and forestry accounts for nearly one-third of global greenhouse emissions (WRI, 2008). Hashml (2011) concluded that the major source of waste chemicals and solid wastes, which are contaminated with pesticides include defective and expired bottles and containers, expired pesticides, corrugated board carton, saw dust, spent (charcoal and activated carbon) and emptied drums. With the present pesticide use pattern, the sustenance of non-target organisms, i.e., beneficial organisms, natural enemies of pests, parasites, pollinators etc., is greatly jeopardized. Pesticide runoffs that reach water bodies kill fish, water bugs, snails and aquatic plants, which are part of the food web and play an important role in maintaining the eco-balance. According to them, populations of natural enemies of pests like ladybird beetles, green lacewings, spiders and parasitoids, like Apanteles spp., Trichogramma spp., Chelonus blackburni etc., have come down (Shetty, 2011). Pesticide kills some of the susceptible pests within the population, and those that are not killed are resistant to varying extents. There are several cases of animal poisoning reported from different agro-ecosystems in India. However, there are reports about animal products such as meat, milk and eggs being contaminated by pesticide residue (ICRA, 2005).

About 64.9% of the respondents attested to the fact that pesticide usage affects their health while 24.6% attested that it has residual effects on the soil. The use of pesticide also contaminates water body thus killing the aquatic animals if it runs into the river. About 6% of the respondent are currently experience this water pollution on their farm. About 6% of the respondent are currently experience this water pollution on their farm (Akeem, 2012).

## 2.3 Awareness for Sustainable Development

There is urgent need for agricultural production models or policies that internalize the external costs of pesticide use and incorporate prevention of ill health and environmental contamination, and promote the conservation of biological capital into production processes and markets. A first step is to raise the awareness levels of the economic costs of pesticide use among the farming community. This requires serious efforts by decision makers, as well as pressure on governments from civil society. Alternate methods of pest control are needed if these damaging social and environmental impacts are to be reduced. Organic farming offers many opportunities. It has substantially lower negative externalities than conventional farming (Shetty, 2010).

Zaidi (2011) expressed the following items required for the sustainable development.

1. There is a dire need of designing, launching and implementation of outreach extension programs on the safe use of chemical pesticides.
2. Regular programs in the media, written and audio-visual are needed for the farmers to make them aware of the dangers of such materials and the safety measures to adopt while dealing with them.
3. The need to raise awareness levels among workers on the application of pesticides, the negative effects that may result from the erroneous use of pesticides and the spraying operations. It is important to know that trained laborer with the sufficient skills and knowledge on dealing with these chemicals can help avoiding the dangers that may otherwise result by adopting the wrong procedures.
4. Awareness levels on the importance of periodic health check-ups of workers on the farms, especially those dealing directly with pesticides need to be enhanced.

The main aim of environmental educational program is to provide scientific knowledge and insight into the real nature, scope, importance and conceptual clarification of the issues involved which is inevitable for sustainable development (Ushadevi, 2009). Environmental education is most effective in creating long-lasting behavioral changes that encourages people to explore, investigate issues and seek solutions regarding the environment and related social problems (Animesh, 2010). Environmental education is one of the crucial means to develop people's understanding, awareness, beliefs and attitudes concerning the environment.

### 2.4 Environmental Awareness of the Farmers

Industry, governments, and international agencies are force more aware of the environmental problems at hand and those likely to emerge in the future. In many countries, the growing concern for the environment has been accompanied by legislation control, which requires manufacturers to submit toxicity data when applying for registration of new chemicals.

Environmental awareness is defined as an understanding of natural systems with human social system (Mancl, 2003). Therefore environmental awareness is one of the challenging issues of environmental protection, sustainability and better achievements in productivity. In Myanmar, the trainings for the farmers on pesticides awareness and soil and nutrient management awareness have been conducted, yet the numbers of participants are just a tiny portion of the farmers in the whole country because the rapid development of agro-chemicals trades and private companies is accelerating the potential to use more chemicals by the farmers due to their advertisement and persuasion.

## 2.5 Environmental Awareness Index

In fact, it is very difficult to measure the environmental awareness level of the farmers and sustainability of their agricultural practices. It is also a weak sector in the agricultural and environmental research fields. Environmental awareness of the farmers has been studied by some researchers in various ways and the most commonly used method is surveying the stake-holder's perception. Using the stake holder's perception is a low cost but powerful method to evaluate their performance and environmental situation of a specific area. Resource accessing stakeholders may have an enormous depth of knowledge about the resource abundance, ecology and management (Walters, 1997). Resource views their environment in different ways and their actions are based on their perceptions, experiences and knowledge (Blaikie, 1995).

Sanzidur (2003) has studied the farmers' perceptions and their determinants concerning with the environmental impacts of modern agricultural technology in Bangladesh. To get the awareness index of the farmers, took 12 indicators of environmental impact such as farming types, age, gender, incomes, landing holding, education level, family size, training experience, extension contact, loan receiving, accessibility to media information and getting modern technology which were obtained from the pretest-focus group discussion.

## 2.6 Factors Influencing the Awareness of Farmers

Awareness is an emotional or affective behavior that is so similar to knowledge, which is the bottom stage of cognitive domain. The emotional or affective factor always relate to the cognitive factor. Knowledge is gained by facts or experience, touches, and consideration of mind to find out reasons, but awareness concerns opportunities: it is gained by touching the stimulus or environment unintentionally. Feeling is also included in evaluating it. In social studies, it could be found that many factors could result and relate to awareness, whether personal factors (such as sex, age, educational level), economic and social factors (such as career, income, information learning, etc.). These are important variables leading to the analysis of awareness (Bo Bo Lwin, 2006).

Different genders have different awareness on increasing age. Earlier studies also reported such results that higher education level labors showed high awareness (Chung, 2003). Also old farmers are likely to perceive the environmental hazards of pesticides than the young farmers due to accumulated knowledge and experience of farming systems (Bonabana, 2002).

Isin (2006) stated that in relation to the age, education, and growing experience of farmers, those who consider pesticides as being harmful were younger, better educated and had less experience in fruit growing. Also, farmers' awareness of the harmful effects of pesticides is not very strong, as they fine that beneficial effect out weight any harmful ones. Bo Bo Lwin (2006) assumed that the farmers from extended families were much more aware because they can have much more information exposure to outside. On the other hand, the farmers with dependent children might have more awareness and care about the use of agrochemicals.

If the farmers had high income, they can probably improve the awareness level. The people with high income can have facilities like TV, radio and newspapers and they can have much more exposure to information. They can spend more money and time than the poor farmers to visit urban area where they can meet people in the market and share the news and experiences. Some farmers who have exposure to extension agents from Department of Agriculture (DoA) and those who have attended the short course on EM (effective microorganism) are found to be quite aware (Theint Theint Aung, 2011). Less expensive pest management options that are less hazardous to the environment and human health need to be introduced to farmers, and create awareness regarding the hazards of mishandling pesticides if the products are to be used by vegetable farmers in Cameroon (Abang, 2013).

Therefore, farmers' awareness about pesticides should correlate with the educational status. Educated farmers can read publications and access information on the internet while the uneducated ones cannot do this, thus limiting their level of awareness due to lack of information. Moreover, illiterate farmers will find it difficult in the correct application of the pesticides in the correct proportion (Akeem, 2012). Some researchers pointed out that the level of education also affects the level of environmental awareness and behavior. But, in some papers, level of education is not significantly related to the awareness level as the majority of farmers have not much difference in educational status.

## 2.7 Factors Influencing the Pesticide Demand

Modern agricultural practices especially the use of pesticides and fertilizers have brought about by Green Revolution in many countries and have provided global food security. The usage of pesticide was influenced by socio-economic characteristics of farmers (age, farm experience, and family size), current price of pesticide, and the output price of the crop and extension service from private and public communities. Rahman (2003) stated that land holding was significantly positively associated with pesticide use indicating that large farm households use more pesticides, consistent with expectation. The availability of cash was significantly positively related with pesticide use, indicating that the greater liquidity increase use rates. The level of net additional economic gain to farmer is key underlying factor providing incentive and rationality for pesticide use. In Indonesia, the level of pesticide use in a place is strongly affected by nature and scale of the promotion and distribution policies adopted by local agribusiness agencies (Luther, 2007).

In a study in Sri Lanka, Selvarajah (2007) reported that high prices for pesticides led to a reduction in the level of pesticides used by farmers; however, households with more family members (labor available for spraying) used more pesticides. Farmers' knowledge on pest management has direct and indirect impacts on pesticide use. Direct impacts arise due to the fact that better knowledge leads to lower levels of pesticide use as the farmers' substitute pesticide with other alternative methods. Indirect impacts arise as farmers can better predict levels of pest-related damage and yield loss, and subsequently use the pesticides judiciously after such training and contacts with extension (Mariyono, 2008a).

# CHAPTER 3

# RESEARCH METHODOLOGY

## 3.1. Conceptual Framework of the Study

The aim of this study is to achieve the sustainable environment and sustainable livelihood of the farmers in Inle Lake. To achieve this goal, farmer must attain sustainable crop production and income by having the awareness on environmental preservation knowledge. This environmental awareness will rely on the socio economic characteristics and pesticide practices of farmers. Consideration of mind to achieve awareness of that phenomenon or event, and awareness has a little relation to memory or recall; it is just consciousness, distinguishing, and recognition of that stimulus to see its characteristics (Chaung, 2003). Therefore, the changes of environmental awareness of farmers will depend on education level, gender, pesticide using experience, attending training, farm size, social participation and farming experience etc. Moreover, the farmer's pesticides practices may depend on the socio-economic characteristics such as age, farm size, education attainment, and farm experience and extension services. The demand of the pesticide may also rely on the socio-economic characteristics and pesticide practices of farmers.

Farmers will have increase yield and crop income by plant protection with pesticides. However, important factors such as the health risks involved, loss of money spent on health care, loss of labor due to sickness, decreasing efficiency of work, long-term health effects of pesticides and downstream effects are not accorded equal attention. It is the external cost for pesticide user. Moreover, the environment can be affected from the pesticides externalities especially in soil, water and air. In addition, there will be other external factors such as government organization, non-government organization and private organizations which can support by policy drive and extension services to attain the sustainable production and livelihoods of farmers.

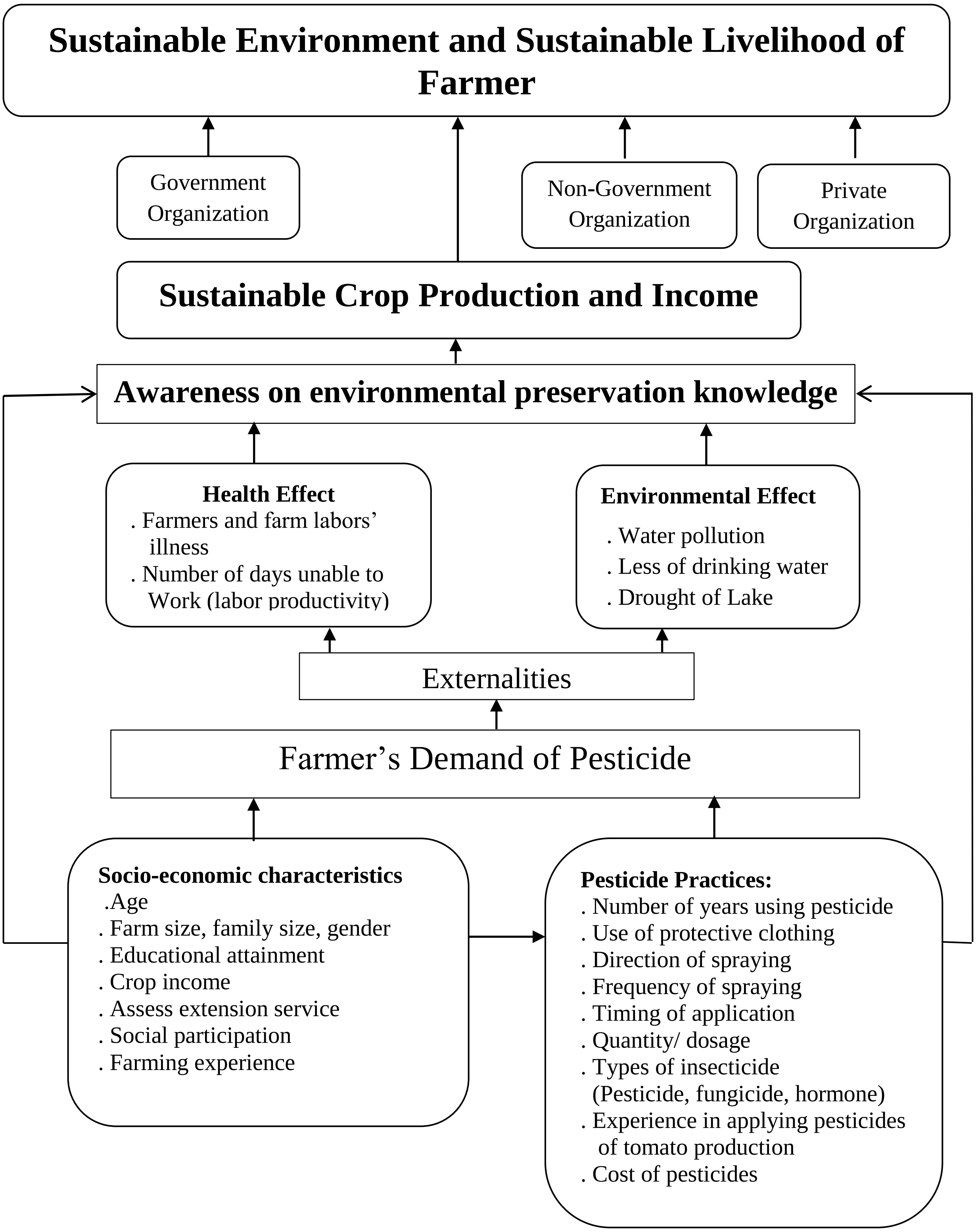



**Figure 3.1 Conceptual Framework of the Study**

## 3.2 Description of the Study Area

### 3.2.1 Location and Topography of the Study Area

Inle Lake is located between North Latitude 20˚ 2′ 32" to 20˚ 36′ 49" and East Longitude 96˚ 53′ 5" to 96˚ 56' 30" at about 890 m above sea level. It is surrounded by Nyaung Shwe, Shwe Nyaung and Taunggyi Townships and there are 29 inlets flow into the lake. The major inlets of the Lake are Yae Pa, Than Taw, Tann Tain and Nang Latt. The watershed area of the lake is about 39 $km^2$ and it is about 17.69 km in length from North to South and 6.43 km in width from East to West. Figure 3.2 demonstrates location and map of Inle Lake. It is surrounded by the mountain ranges, Sindaung range from the eastern and Letmaunggwe, Thandaung and Udaung range in the western parts (Steve, 2001). Moreover, it is the main water supplier of the Law Pita hydro power production and flowing from north to south direction.

### 3.2.2 Area and Population of Nyaung Shwe Township and Inle Lake

According to the Department of Agriculture (2013), there are 36 village tracts and 446 villages in Nyaung Shwe Township with the population of 173,099. In Inle Lake, there are 22 village tracts which contain 136 villages and the population of the lake is about 54,274 according to statistical data of 2012 (Table 3.1). `

### 3.2.3 Cropping Pattern, Sown Acreage and Production of Crops in Nyaung Shwe Township

In 2012, agricultural land use of Nyaung Shwe Township was increased from 39,983 ha to 49,405 ha (Table 3.2). The increasing population and easy access to irrigation water drove land reclamation for settlement and food production area whereby the immediate lake shore is transformed into seasonal rice fields. Nyaung Shwe Township alone has about 14,281 ha of land under cereal crop production.

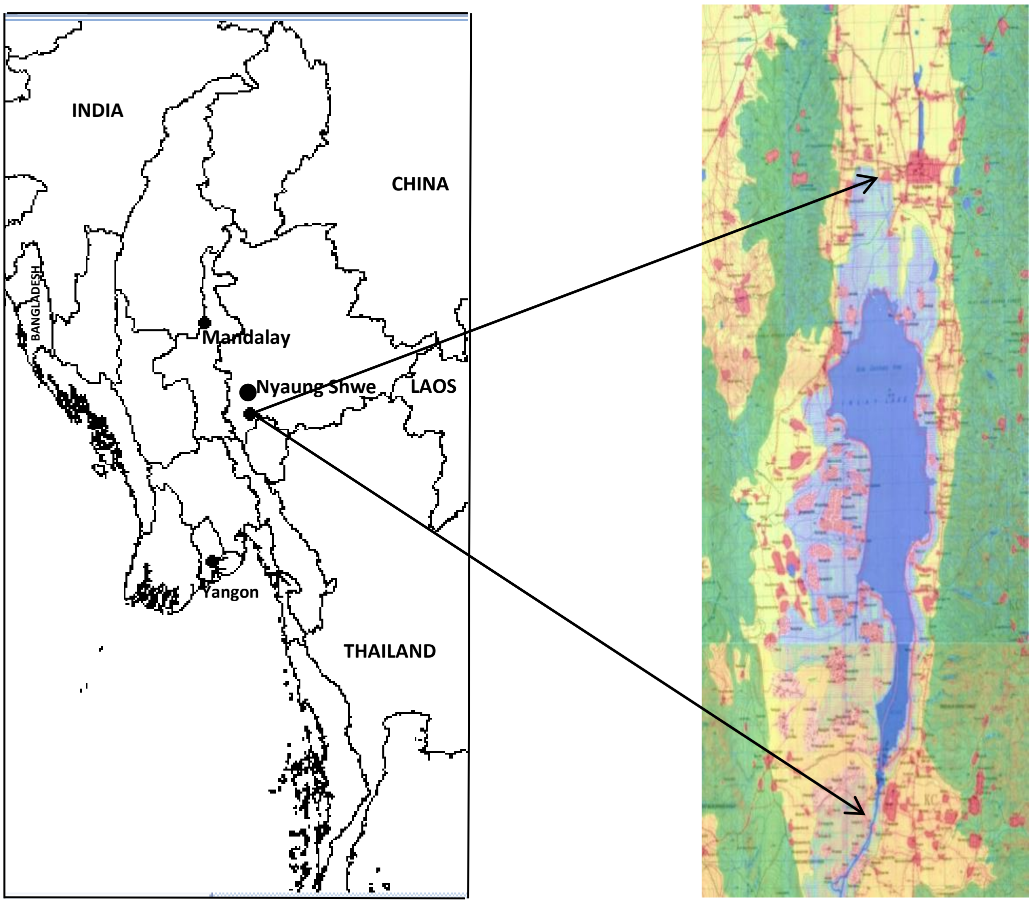



**Figure 3.2 Map of Myanmar and Location of Inle Lake**

**Table 3.1 Area and Population of the Study Township and Area, 2012**

| Item | Unit | Nyaung Shwe Township | Inle Lake |
|---|---|---|---|
| Village tract | No. | 36 | 22 |
| Village | No. | 446 | 136 |
| Population | No. | 173,099 | 54,274 |

Source: DoA, 2012

**Table 3.2 Crops Grown by Non-floating Garden Growers of Nyaung Shwe Township**

| Crops (ha) | 2008-09 | 2009-10 | 2010-11 | 2011-12 |
|---|---|---|---|---|
| Cereal | 15,043 | 15,268 | 15,460 | 14,281 |
| Pulses | 2,999 | 3,043 | 3,580 | 3,611 |
| Oil seed crops | 3,813 | 3,869 | 1,1452 | 1,1465 |
| Industrial | 6,281 | 6,374 | 7,239 | 7,170 |
| Species &betel | 1,261 | 1,277 | 1,340 | 1,355 |
| Other | 9,575 | 9,717 | 9,887 | 9,940 |
| Fodder | 1,598 | 1,621 | 1,578 | 1,583 |
| **Total** | **39,983** | **40,570** | **50,545** | **49,405** |

Source: DoA, 2012

**Table 3.3 Crops Grown by Floating Garden Growers of Inle Lake**

| Crops | Unit | 2012-2013 |
|---|---|---|
| Tomato | ha | 2,369 |
| Other vegetables | ha | 1,349 |

Source: DoA, 2012

In Inle Lake, tomato floating garden is the major crop production for Intha people. Total floating garden area is about 3,745 ha and 2,396 ha are used for the tomato floating garden. Tomato farmers always grow for two seasons; rainy season (1,914 ha) and winter season (481 ha). Tomato production in the rainy season is greater than the winter season because winter season is the peak season of tomato production in Myanmar.

The rest of the area (1,349 ha) usually plant the other vegetables and cereal crops such as eggplant, cucumber, gourd, pepper, bean, betel and rice. The numbers of farmers who produce tomato in the floating garden are 656. Among them, there are 102 farmers who possess more than 3 ha and 87 farmers who own less than 0.4047 ha. Among 136 villages in Inle Lake, Kay Lar village has the highest tomato production area and Inn Lyar village has the smallest tomato production area. Based on the data of Department of Agriculture in 2012, the average tomato production per hectare is about 73 ton (DoA, 2012).

### 3.2.4 Meteorological Condition of Nyaung Shwe Township

More rainfall precipitation was found in 2012 than 2013 that shown in Figure 3.3. The maximum rainfall precipitation of 8.85 inches was found in August 2012 while the minimum precipitation of 0.09 inches was found in March 2012. In 2013, the highest rainfall precipitation of 8.05 inches was occurred in September 2013. By comparison the rainfall in 2012 and 2013, the rain comes later than the previous year (2012) (Figure 3.3). It is because of the climate change effects and this consequences cause the drought in Inle Lake. The minimum average temperature was 16.69 ˚C and the maximum average monthly temperature was 27.54˚C within a year. So, Inle Lake is situated in temperate zone of Myanmar. The average temperature of Nyanung Shwe Township is shown in Figure 3.4.

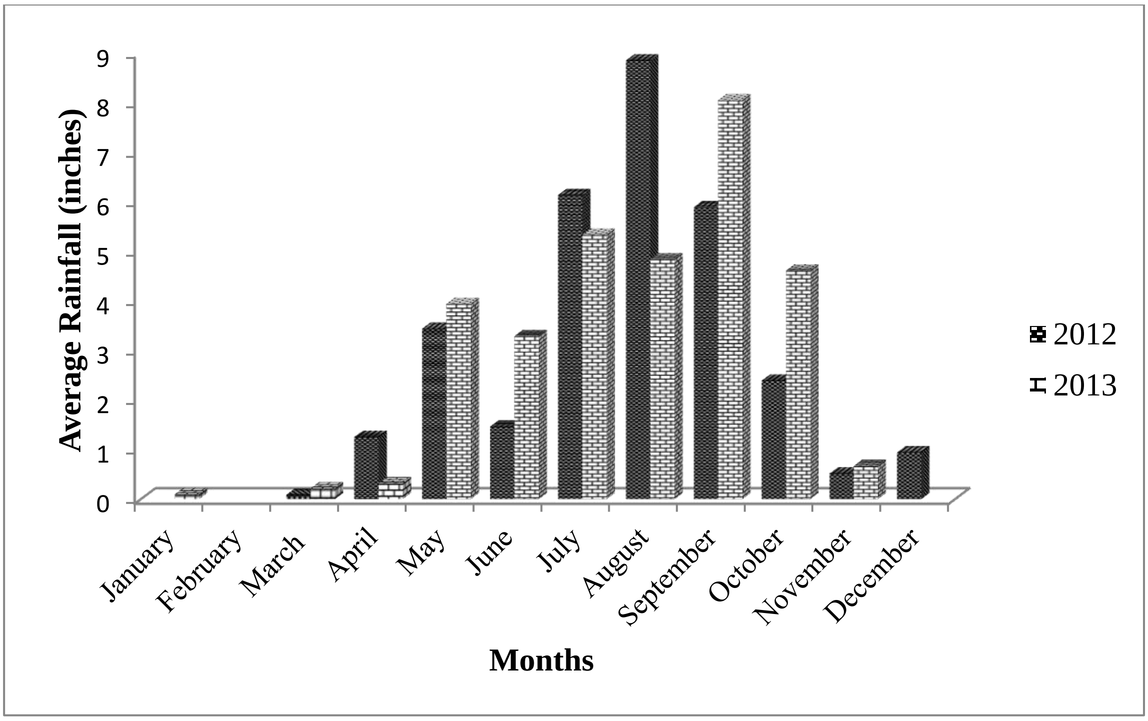



**Figure 3.3 Average Rainfall Precipitation of Nyaung Shwe Township, 2012-2013**
Source: DoA, 2013

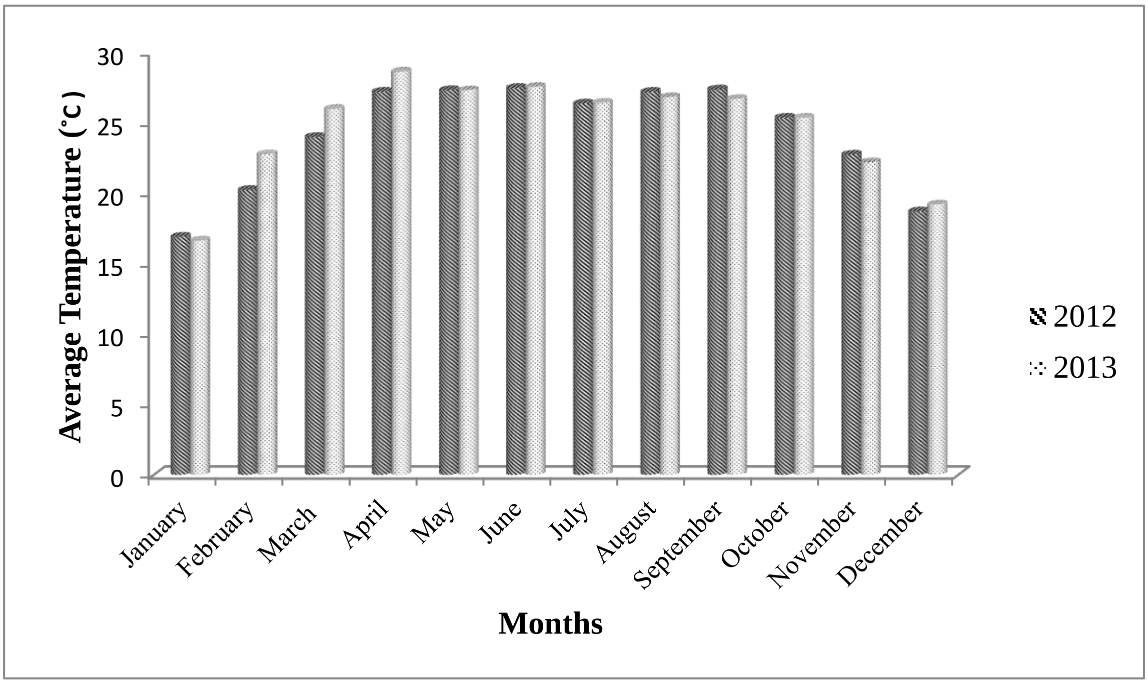



**Figure 3.4 Average Temperatures in Nyaung Shwe Township, 2012-2013**

Source: DoA, 2013

## 3.3 Data Collection Methods and Selected Villages

### 3.3.1 Data Collection Methods

Data collection was based on a field survey and secondary data. The secondary data covered the crop production, annual rainfall, land use, sown area, yield of important crops and clinical data which were obtained from Department of Agriculture in Nyaung Shwe Township, Settlement and Land Records Department (SLRD) and three villages' clinics in Inle Lake.

The household level survey covered the information about the background of family, land use, cultivation and production of crops, availability of resources, agricultural inputs, pesticide practices and environmental awareness. Data of crop production practices, cropping patterns, labor allocation, the financial situation of the households and health externalities were also collected. Household information included age of household head, education, occupation, family size, family labor and farmer's experience.

The household level survey was carried out in seven villages which were randomly selected from total villages of five village tracts (Nga Phae Chaung, Min Chaung, Tha Pyay Pin, Kay Lar and Inn Paw Kone) in Inle Lake. Three clinics in Inle Lake were also interviewed with a structured questionnaire during February 2014. Total population of selected village tracts is presented in Table 3.4.

A total of 107 households were randomly selected from seven villages namely Nga Phae Chaung, Lae Thit, Shwe Pyi Thar, Kyae Sar, Tha Pyay Pin, Inn Paw Khone and Kay Lar and interviewed (Table 3.5).

**Table 3.4 Total Population of Selected Village Tracts in Inle Lake**

| Village Tract | No. of House | No. of Household | Population |
|---|---|---|---|
| Min Chaung | 1,512 | 1,794 | 8,317 |
| Tha Pyay Pin | 1,138 | 1,207 | 5,457 |
| Nga Phae Chaung | 520 | 605 | 9,232 |
| Kay Lar | 764 | 1,109 | 4,782 |
| Inn Paw Khone | 901 | 1,147 | 4,929 |

Source: DoA, 2012

**Table 3.5 Number of Sample Farmers from Selected Villages**

| No | Selected Villages | No. of Sample Farmers |
|---|---|---|
| 1. | Inn Paw Khone | 30 |
| 2. | Lae Thit | 23 |
| 3. | Kyae Sar | 20 |
| 4. | Shwe Pyi Thar | 10 |
| 5. | Tha Pyay Pin | 10 |
| 6. | Nga Phae Chaung | 6 |
| 7. | Kay Lar | 5 |
| | **Total** | **107** |

### 3.3.2 Selected Villages

**Inn Paw Kon Village**

In Inn Paw Kon village, there are equal ratio among shopkeepers for tourism services and farmers because it is near the Phaung Taw Oo Pagoda. Additionally, there have many other job opportunities like handicraft.

**Lae Thit Village**

As Lae Thit village is always flooded in monsoon season, farmers cultivate not only tomato but also other vegetables such as eggplant, pumpkin, grout and various kinds of flower. Many people in Lae Thit are the farmers who especially grow the tomato and widely use pesticides.

**Nga Phae Chaung and Shwe Pyi Thar Villages**

The main vocation of both villages is floating garden and farmers cultivate tomato specially. Women in Nga Phae Chaung village sell the gift shop in the ancient monastery which was built for over 100 years especially in tourist season.

**Tha Pyay Pin Village**

Tha Pyay Pin village is situated in boundary of the lake; therefore, many farmers cultivate either floating garden or upland cultivation such as rice, sugarcane and other vegetables. Therefore, the farmers widely use the pesticide.

**Kyae Sar Village**

Kyae Sar Village is located in Lake, therefore, most of the farmer in this village do two types of occupation as floating garden and fishery for each 6 months of the year and cheroot business is the main source of income for women around the year.

**Kalar Village**

There are many acres of floating gardens which are grown by various kinds of vegetable particularly in tomato in Kalar village. Kalar village has the highest tomato floating garden area among the villages in Inle Lake (DoA, 2012).

### 3.3.3 Criteria for Grouping of Selected Farmers

The sample tomato farmers were classified into three groups according to yield level of tomato. The farmers who produced the ranged from 44 to 83 ton/ha of tomato was classified as low yield group. The produce the range from 84 to 113 ton/ha was defined as medium yield group and the yield of 114 to 179 ton/ha was categorized as high yield group.

## 3.4 Data Analysis

### 3.4.1 Descriptive Analysis

In this study, descriptive statistics such as the mean, percentages, and frequencies were computed to describe the socio-economic characteristics (e.g., age, educational attainment, and income) of the sample farmers and their household members. Descriptive analysis was done for current pesticide practices of the sample farmers such as: the number of years using pesticides, insecticide dosage, spraying frequency, kinds of pesticides used by the farmers, timing of application, the use of protective clothing and masks, pesticide handling practices, types of diseases caused by pesticide use, number of days the farmer/ laborer were sick/unable to work due to pesticide-related diseases, kinds of illness caused by pesticide use, cost of medication, kind of self-medication.

### 3.4.2 Cost and Return Analysis for Tomato Production

Cost and return analysis of tomato was employed by using enterprise budget. The purpose of enterprise budgeting is to show the difference in net benefits under several resources situations in such a way as to help one make management decision. Input quantities and values used in production process (costs) and output quantities and values (benefits) are the basic data required for budgets. Enterprise budgets enable to evaluate costs and returns of production process. Both cash and non-cash costs were included in the estimation of material cost and labor cost. Non-cash items for material costs were seeds, family labor, farm yard manure and cost of inputs (fertilizer & pesticide). Hired labor cost was valued by market wage rate and man days used in all farming practices. In order to estimate gross return for respective crop, average yield and effective market price were used. Benefit cost ratio was used as profitability for each crop enterprise. Total gross margin or return above variable cost and return above cash cost were calculated.

In construction of enterprise budget, first step was to calculate the gross benefit or revenue of the intended crop. Gross benefit was the level of production per hectare multiplied by the product price. Total variable cost was the total of all variable inputs into the enterprise, multiply by their respective prices. An interest rate or cost of capital charged for material inputs was also included in total variable costs. Return above variable costs, sometimes called gross margins were gross return minus total variable costs. It should include all cash and non-cash revenue from the crop. In this study, the revenue was cash value of tomato harvest and any non-cash sources of revenue.

The second step was to calculate the variables costs. Variable costs were divided into four categories (i) non-labor inputs, (ii) family labor, (iii) hired labor and (iv) interest from cash costs. Non-labor inputs were seed, fertilizer, insecticide, pesticide, animal power, tractor hire, etc. Family labor was valued with the assumption of opportunity cost of hired labor for that task. For plowing, harrowing and leveling, the farmer used with owned cattle which were charged at opportunity cost. Hired labors were labors hired to do tasks of tomato production and they were paid in kind and cash. Interest on cash costs were normally charged on cash expenses paid early in the growing season (Table 3.6).

The last step was to calculate gross margin or return above costs per hectare. Return to hired labor, management, land, capital was gross benefit minus costs of non-labor inputs, costs of hired labor inputs and interest on cash costs. Total variable costs were sum of above four categories of variable costs. Net benefit was gross benefit minus total variable costs. Expressions for estimating returns to various factors are described in Table 3.7.

**Table 3.6 Benefit and Costs of the Tomato Production**

| Item | Unit | How to calculate |
|---|---|---|
| Gross Benefit | MMK/ha | GB = Y x $P_Y$ |
| Net Benefit | MMK/ha | NB = GB - TVC |
| Total Variable Cost | MMK/ha | TVC = (Material cost+ Family labor cost + Hired labor cost + Interest on cash cost) |
| Total Variable Cash Cost | MMK/ha | TVCC = (Material cost + Hired labor cost + Interest on cash cost) |

**Table 3.7 Estimating Returns to Factors of Production**

Return to factor A = (Net Benefit + Costs of factor A)/ Amount of factor A

| Factor | Unit | How to calculate |
|---|---|---|
| Return above variable cost | Price/ha | RAVC = TR-TVC |
| Return above variable cash cost | Price/ha | RAVCC=TR-TVCC |
| Return per unit of total labor | MMK/man-day | (NB+TLC)/TMD |
| Return per unit of family labor | MMK/man-day | (NB+TFLC)/TFMD |
| Return per unit of hired labor | MMK/man-day | (NB+THLC)/THMD |
| Return per unit of cash cost | MMK | TR/TVCC |
| Return per unit of capital | MMK | TR/TVC |
| Break-even yield | ton/ha | TVC/Average price |
| Break-even price | MMK/ton | TVC/Average yield |
| Gross Margin | MMK | GM = GB - TC |
| Benefit Cost Ratio | | BCR = GB/TC |

Where,

| | | |
|---|---|---|
| GB | = | Gross Benefit |
| Y | = | Output |
| $P_{Y1}$ | = | Price of output |
| NB | = | Net Benefit |
| TVC | = | Total Variable Cost |
| TVCC | = | Total Variable Cash Cost |
| TMC | = | Total Material Cost |
| RAVC | = | Return Above Variable Cost |
| RAVCC | = | Return Above Variable Cash Cost |
| RAMC | = | Return Above Material Cost |
| GM | = | Gross Margin |
| GB | = | Gross Benefit |
| TC | = | Total Cost |
| BCR | = | Benefit Cost Ratio |
| TMD | = | Total Labor Man-day |
| TFMD | = | Total Family Labor Man-day |
| THMD | = | Total Hired Labor Man-day |

### 3.4.3 Environmental Awareness Index (EAI)

The environmental awareness index was calculated as index scores by using set of questionnaires concerning about the opinion on the use of pesticides with 15 statements. These statements are mentioned in Table 3.8.

The level of agreement on each given statement was scored according to the orientation of the statement. Scoring method used in this study is that strongly agree for the statement was scored as 5 points while 1 point for strongly disagree. The option "neutral" was scored as "3 points" and it is supposed to be the midway of agreement (neither agree nor disagree) or the condition that the respondent does not have any idea about the give statement is shown in Table 3.9.

**Table 3.8 Harmful Effects of Pesticides and Environmental Awareness**

| No. | Statements |
|---|---|
| 1 | Pesticides are very effective and essential in crop production. |
| 2 | Pesticides should be the last choice in pest control (not 1st priority). |
| 3 | Crop rotation or multi-cropping can improve soil fertility and reduce insect /disease outbreak. |
| 4 | Farmer should know the good agriculture practices such as organic farming |
| 5 | Good Agriculture Practices (GAP) will be accepted extension services provide to farmer. |
| 6 | Pesticide is very dangerous to human health as well as natural environment. |
| 7 | Some insects and animals are beneficial to crops production. |
| 8 | Insecticides kill not only pests but also other beneficial insects and organisms. |
| 9 | Pesticides can cause serious water pollution. |
| 10 | Pesticides should not be used over required amount in the future for the sake of protecting our environment. |
| 11 | Heavy application of pesticides is one of the reasons of fish reduction in the lake. |
| 12 | Present rate of pesticide usage in Inle Lake is reaching the alarming stage for future damage to the lake environment |
| 13 | There are other factors which will cause Inle Lake pollution. |
| 14 | Extension service is received from government and non-government organization. |
| 15 | Conservation of Inle Lake is the responsibilities of local people including respondents. |

**Table 3.9 Scoring System by the Orientation of the Statement**

| Level of agreement | Scores for positive statement |
|---|---|
| Strongly agree | 5 |
| Agree | 4 |
| Neutral | 3 |
| Disagree | 2 |
| Strongly disagree | 1 |

Then, the scores were summed and the awareness index was calculated by using the following formula (Bo Bo Lwin, 2006).

$$EAI = \frac{SS - \text{minimum possible scores}}{\text{difference between maximum and minimum possible scores}}$$

$$EAI = \frac{SS-15}{60}$$

EAI = Awareness Index

SS = Sum of Scores

To know the determinants of environmental awareness index of the study area, linear regression function was used. Seven independent variables which related to environmental awareness index is shown as follow

$$Z_E = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i}$$

Where,

| | | |
|---|---|---|
| $Z_E$ | = | Environmental Awareness Index (EAI) |
| $\beta_0$ | = | Constant |
| $X_{1i}$ | = | Age of farmer (year) |
| $X_{2i}$ | = | Education level of farmer (schooling year) |
| $X_{3i}$ | = | Family labor (No.) |
| $X_{4i}$ | = | Family size (No.) |
| $X_{5i}$ | = | Farm size (ha) |
| $X_{6i}$ | = | Pesticide using experience of farmer (year) |
| $X_{7i}$ | = | Gender (Male=1, Female=2) |

### 3.4.4 Input Demand Function of Tomato Production

To determine the factors affecting the demand of pesticide in the study area, linear regression function was used. There are ten independent variables which related to the pesticide demand of the farmers.

$DP = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + \ldots\ldots\ldots + \beta_{13i} X_{13i}$

Where,

| | | |
|---|---|---|
| DP | = | Applied quantity of pesticide in tomato production (Kg/ha or L/ha) |
| $X_{1i}$ | = | Education level of farmer (schooling year) |
| $X_{2i}$ | = | Pesticide using experience of farmer (year) |
| $X_{3i}$ | = | Family size (No.) |
| $X_{4i}$ | = | Lagged output price received by farmer (kyat/ton) |
| $X_{5i}$ | = | Farm income (MMK/ha) |
| $X_{6i}$ | = | Quantity of compound fertilizer (bag/ha) |
| $X_{7i}$ | = | Pesticide price (MMK/L) |
| $X_{8i}$ | = | Quantity of fungicide (Kg/ha) |
| $X_{9i}$ | = | Quantity of hormone (L/ha) |
| $X_{10i}$ | = | Environmental awareness index |

# CHAPTER 4

# RESULTS AND DISCUSSION

The socio-economic characteristics based on tomato yield levels of the sample farmers in Inle Lake are described in this chapter which may aid to understand tomato production. In addition, cost and return analyses of tomato production are presented to know the profitability of tomato production. Moreover, other information related to pesticide application (plant protection methods, pesticide practices, organic and inorganic pesticide lists, pesticide poisoning cases, pesticide training experience and drinking water sources) are shown by descriptive analysis. To know the environmental awareness of tomato farmers in Inle Lake, comparison of environmental awareness index by different yield groups and determinants of environmental awareness are explored. Factors affecting the pesticide demand of sample farmers in Inle Lake are determined in this chapter.

## 4.1 Demographic Characteristics and Income Sources of Sample Farmers in Inle Lake

### 4.1.1 Age, Education Level, Farm Experience, Pesticide Using Experience and Farm Size of Selected Farmers

In Inle Lake, the average age of selected farmers was around 40 years old in three farmers groups. The age of first two groups were range from 21 to about 69 years. The last group was composed of older farmers ranging from 26 to 75 year. The average education level between three groups was not different and most of the farmers had middle education level (6 years). The minimum education level of household head was primary level (2 years) except low yield group (4 years). The maximum educational level of household head was graduate level (15 years) in high yield group whereas high school level (11 years) was found in both medium and low yield groups. The low yield producer had more experience in farming 21 years on average but these farmers had the lowest pesticide using experience (13 years) ranging from 2 to 36 years. The same farm experience (17 years) was found in both medium and high yield groups. It is occurred that the farmers who produced the high tomato yield had the highest pesticide using experience (16 years) within the range between 2-49 years. The possession of farm among three groups was similar about 0.3 ha which was ranging from 0.06 ha to 1.5 ha in low yield group, from 0.06 ha to 1.24 ha in medium yield group and from 0.06 ha to 1.21 ha in high yield group. The same smallest farm size (0.06 ha) was found in all groups. The maximum farm size was 1.5 ha in high yield group and 1.24 ha in other two groups (Table 4.1).

**Table 4.1 Age, Education Level, Farm Experience, Pesticide Using Experience and Farm Size of Sample Farmers in Study Area**

| Item | Statistic | Low Yield Group (N=37) | Medium Yield Group (N=33) | High Yield Group (N=37) |
|---|---|---|---|---|
| Age (Year) | Mean | 43 | 40 | 40 |
| | Range | 21-63 | 21-69 | 26-75 |
| | SD | 11.9 | 11.3 | 10.8 |
| Schooling Year | Mean | 6 | 6 | 6 |
| | Range | 4-10 | 2-11 | 2-15 |
| | SD | 1.7 | 1.9 | 2.5 |
| Farm Experience (Year) | Mean | 21 | 17 | 17 |
| | Range | 2-45 | 4-50 | 2-49 |
| | SD | 11.1 | 10.7 | 10.2 |
| Pesticide Using Experience (Year) | Mean | 13 | 15 | 16 |
| | Range | 2-36 | 3-33 | 2-49 |
| | SD | 8.7 | 6.9 | 10.2 |
| Farm Size (ha) | Mean | 0.27 | 0.3 | 0.3 |
| | Range | 0.06 - 1.5 | 0.06 - 1.24 | 0.06 - 1.21 |
| | SD | 0.6 | 0.7 | 0.7 |

**Table 4.2 Family Size, Family Labor and Maximum Education Level of Farm Household Member of Selected Farmers**

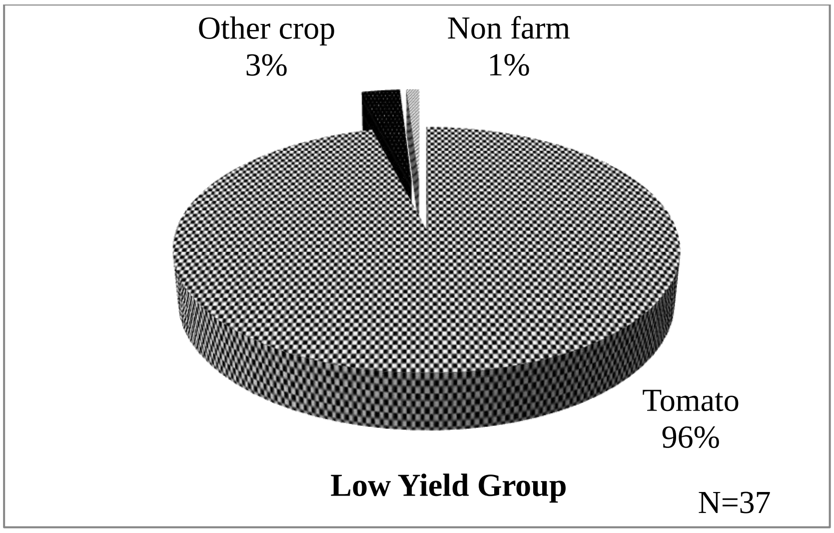
| Item | Statistic | Low Yield Group (N=37) | Medium Yield Group (N=33) | High Yield Group (N=37) |
|---|---|---|---|---|
| Family Size (No.) | Mean | 4 | 4 | 4 |
| | Range | 2-6 | 2-6 | 1-6 |
| | SD | 0.9 | 0.9 | 1.2 |
| Maximum Schooling Year | Mean | 9 | 8 | 8 |
| | Range | 5-15 | 5-15 | 3-18 |
| | SD | 3.14 | 2.8 | 3.5 |
| Family Labor in Farm (No.) | Mean | 2 | 2 | 2 |
| | Range | 1-4 | 1-5 | 0-5 |
| | SD | 0.8 | 0.9 | 1.1 |

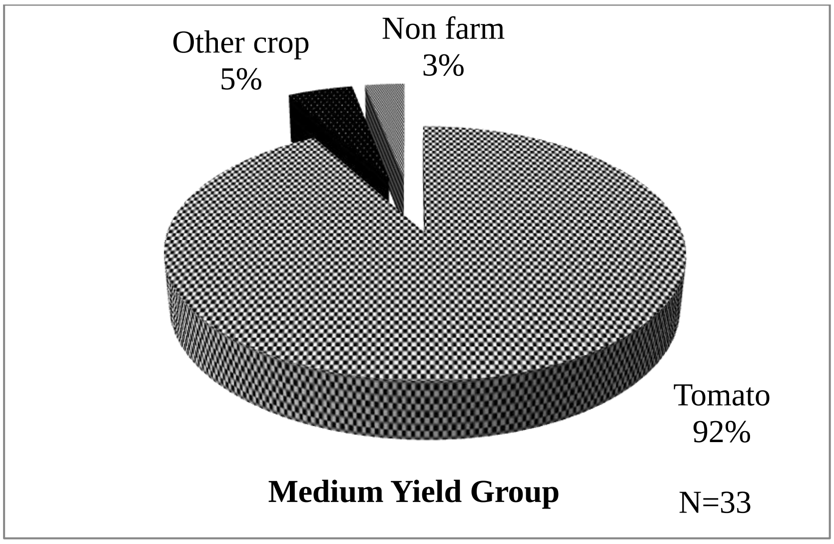
### 4.1.2 Family Size, Family Labor and Maximum Education Level of Farm Household Member of Sample Farmers in Inle Lake

The family information of the selected farmers in Inle Lake such as average value of family size, average maximum education level of household member and average family labor are described in Table 4.2. The average family members were 4 members in three groups. All of family member were ranged from 2-6 members. Among these members, about 2 on average were working on their farm in three groups. The maximum family labors were the same (5 members) among three groups and the minimum family labor was only one in both lowest and medium yield groups. The average maximum education level of household member was 9 years in low yield group and 8 years in another two groups. The ranges of the maximum education level in three groups were (3-18 years) in high yield group and (5-15 years) in other two groups respectively. Therefore, most of the sample farmers in study area attained middle school level. It seems that educational level of farm family labor was relatively higher than the head of households.

### 4.1.3 Sources of Annual Income of Sample Farmers in Inle Lake

In the study areas, it was observed that the households earned their family income mainly from two sources, i.e., farm income and non-farm income. Farm income obtained from sale of crops such as tomato, eggplant, gourd, cucumber, cauliflower, rice, cabbage, betel, pepper and bean. Some farmers earned the household income from non-farm activities which are fishing, working in government and private services, cheroot business and tourism services as shopkeeper and souvenir seller. More than 90% of farmers earned their income from crop production and about 3% of farmers obtained from other non-farm jobs. According to the result in Figure 4.1, 99% in low yield group, 97% in medium yield group and 98% in high yield group earned annual income from agriculture. Non-farm income was rather small because most of the selected villages were agro-based villages.



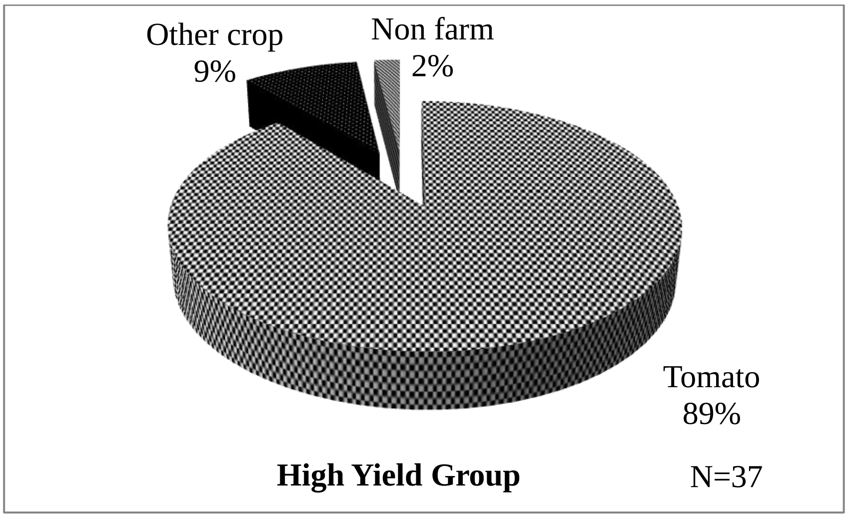




**Figure 4.1 Sources of Annual Income by Selected Farmers in Inle Lake**

By comparing income of three groups, more than 90% of crop income was gained from tomato production (96% in low yield group), (92% in medium yield group) and (89% in high yield group). Ratios of crop income attaining by the selling of other crops such as pepper, cucumber, eggplant, gourd, betel, bean and rice were greater in high yield group (9%) than low yield group (3%) and medium yield group (5.5%) because high yield group can invest high capital. So, tomato production in floating garden is the major source of income for Inthars' livelihood (Figure 4.1).

In agricultural production, low yield farmers earned major incomes within one year from particular cultivated crops were tomato (13,146,764 MMK), pepper (221,184 MMK) and cucumber (120,209 MMK). In accordance with the cropping pattern practiced by farmers who produced high tomato yield group obtained maximum farm income from tomato (24,128,603 MMK), eggplant (1,893,962 MMK) and gourd (212,369 MMK). For medium yield group, they earned their important crop income from tomato (18,319,010 MMK), cauliflower (481,015 MMK) and cabbage (436,537 MMK). Annual crop income by different crops in study area was mentioned in Appendix 1. The ratios of annual crop income distribution in three groups are shown in Figure 4.2.

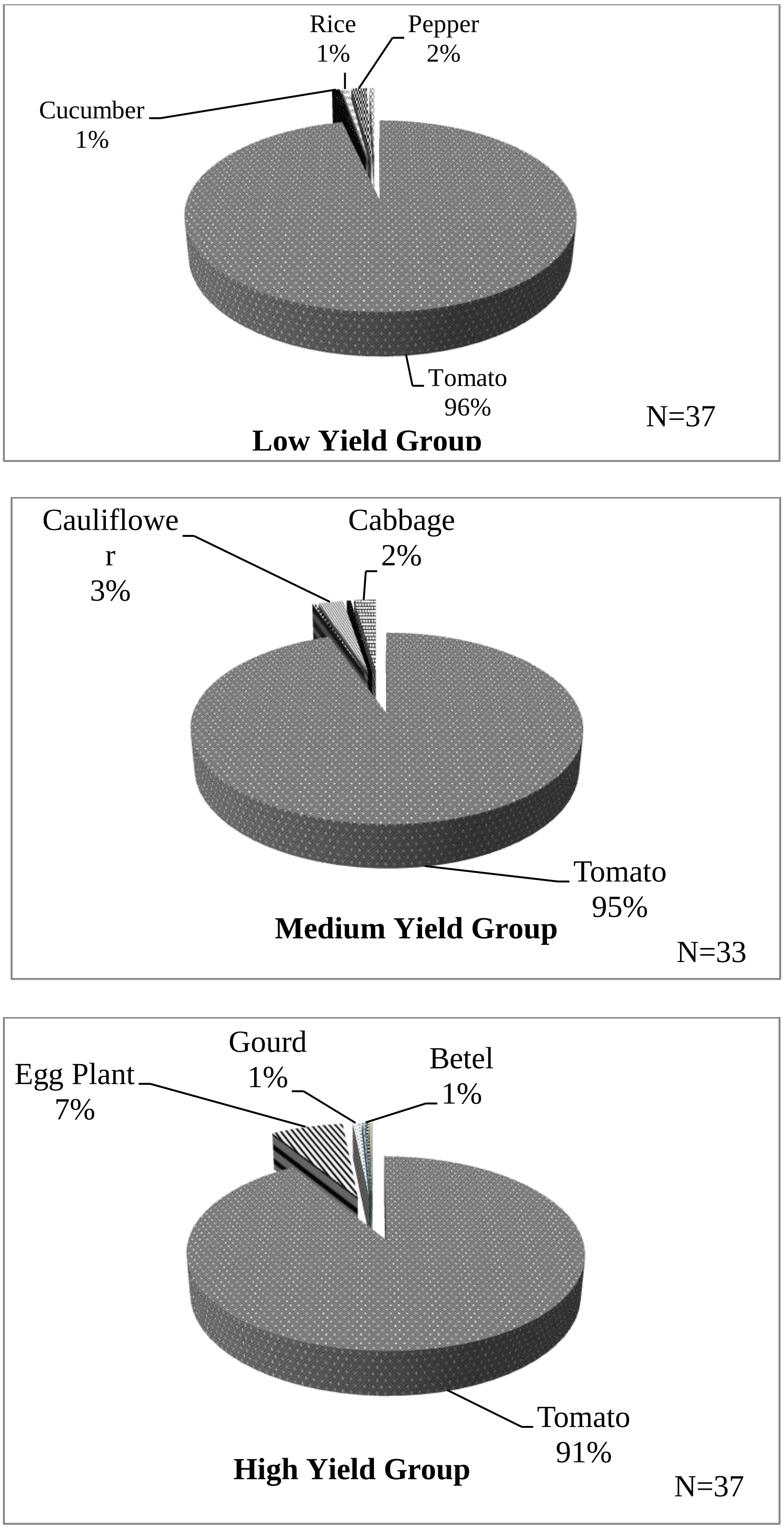



**Figure 4.2 Ratios of Annual Crops Income Distribution in Three Groups**

## 4.2 Input Utilizations and Enterprise Budget of Tomato Production in Inle Lake

### 4.2.1 Input Utilizations in Tomato Cultivation of Selected Farmers in Inle Lake

#### 4.2.1.1 Material Inputs Used in Tomato Farm

The average material input utilizations in tomato floating garden was compared based on the different yield level groups (Table 4.3). The highest average seed utilization (0.42 Kg/ha) was found in medium yield group and followed by 0.39 Kg/ha in high yield group and 0.38 Kg/ha in low yield group. Moreover, the average values of pesticide demand was not different each other because of using 52 L/ha in low yield group, 46 L/ha in medium yield group and 49 L/ha in high yield group respectively. The high yield group demanded the fungicide (85 Kg/ha) while over 71 Kg/ha were used by low and medium yield groups for tomato production. The highest demand of hormone was observed in medium yield (63 L/ha) rather than other groups (50 L/ha in high yield group and 45 L/ha in low yield group). The material inputs used of selected farmers in three groups was not significant different (Table 4.3).

#### 4.2.1.2 Labor Distribution in Tomato Production

Labor input used according to gender by sample farmers in Inle Lake is illustrated in Figure 4.3. There are two types of labor such as family labor and hired labor in the study area. According to the result, most of the farmers in three groups employed more hired labor in the tomato production such as 62% in low yield group, 71% in medium yield group and 72% in high yield group respectively. However, family labor involvement in their farm was more than 25% especially highest in low yield group (38%).

In the ratio of male and female in family labor, the percent of male labor was higher than the female labor. Relatively high number of male family labor (27%) worked in low yield group compared to 21% in medium yield group and 22% in high yield group. The female family labor was also high in the low yield group (11%). However, the ratio of female was two times greater than male in hired labor as nearly 50% of female hired labor worked in three groups. Considering the gender issue, female labor employed more than male labor in hired labor and male was more employed than female in family labor of tomato production in floating garden. Because female labors mostly worked in transplanting, weeding, harvesting, packaging and most of the male family labors worked in fertilizer and pesticide application, seed bed preparation and land preparation (Figure 4.3).

**Table 4.3 Material Inputs Used by Sample Farmers in Inle Lake**

| Item | Unit | Low Yield Group (N=37) | Medium Yield Group (N=33) | High Yield Group (N=37) | F test |
|---|---|---|---|---|---|
| | Average Quantity of Material Inputs | | | | |
| Seed | Kg/ha | 0.38 | 0.42 | 0.39 | 1.085$^{ns}$ |
| Pesticide | L/ha | 52 | 46 | 49 | 0.186$^{ns}$ |
| Fungicide | Kg/ha | 71 | 74 | 85 | 0.685$^{ns}$ |
| Hormone | L/ha | 45 | 63 | 50 | 0.925$^{ns}$ |

Note: ns = not significant

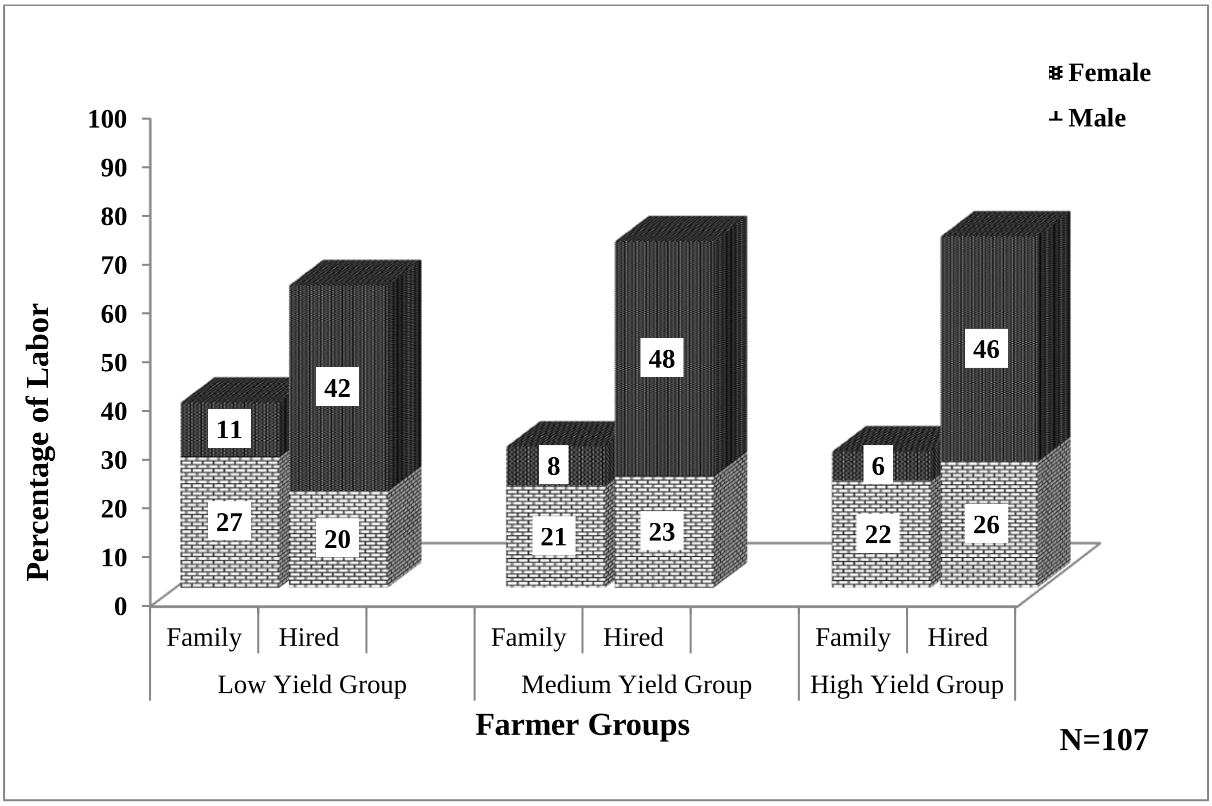



**Figure 4.3 Labor Utilization by Gender in Tomato Production**

### 4.2.2 Cost and Return Analysis of Tomato Production in Inle Lake

Cost and return analysis can compare among the profitability of the tomato farmers who produce different yield levels (low, medium and high). The economic returns from different yield levels were discussed in this section.

#### 4.2.2.1 Total Variable Cost Distribution of Tomato Production in Inle Lake

Variable cost of the tomato production was divided into two types: material cost and labor cost. Material costs of tomato production included seed cost, fertilizer cost, pesticide cost, fungicide cost, hormone cost and bamboo cost. The opportunity cost of the family labor and hired labor cost for cleaning, seed bed preparation, covering, earthing up, transplanting, cutting, fertilizer application, weeding, insecticide application, harvesting, packaging and transportation were used to compute the labor cost in this analysis. Figure 4.4 demonstrates the total variable cost distribution of tomato production in Inle Lake.

In Inle Lake, more than 60% of the total variable cost of tomato production was taken by the total material costs. The highest cost (72%) was found in medium yield group. About 30% of total variable cost was used as labor cost in three groups. Among them, low yield group (34%) and high yield group (33%) used more labor cost than medium yield group (27%).

According to the result, hired labor cost was greater than the opportunity cost of family labor in three groups. Twenty percent of total variable cost in low yield group, eighteen percent of total variable cost in medium yield group and twenty three percent of total variable cost in high yield group were found as the hired labor cost. In Inle Lake, majorities of sample farmers used more material cost because of using hybrid seed and heavy application of fertilizer and pesticide for tomato production (Figure 4.4).

#### 4.2.2.2 Comparison of Total Variable Cost and Total Revenue among Different Yield Levels in Inle Lake

By reviewing the total revenues and total variable cost of the farmers based on three groups, the farmers who produced the high tomato yield had the highest total revenue (12,184) thousand MMK and followed by medium yield group (18,341) thousand MMK and low yield group (12,968) thousand MMK. Although total revenues of three groups was different each other, the total variable costs of farmers in three groups were in similar such as 12,184 thousand MMK in high yield group, 11,532 thousand MMK in medium yield group and 11,235 thousand MMK in low yield group. So, high yield group gained the highest net benefit (Figure 4.5).

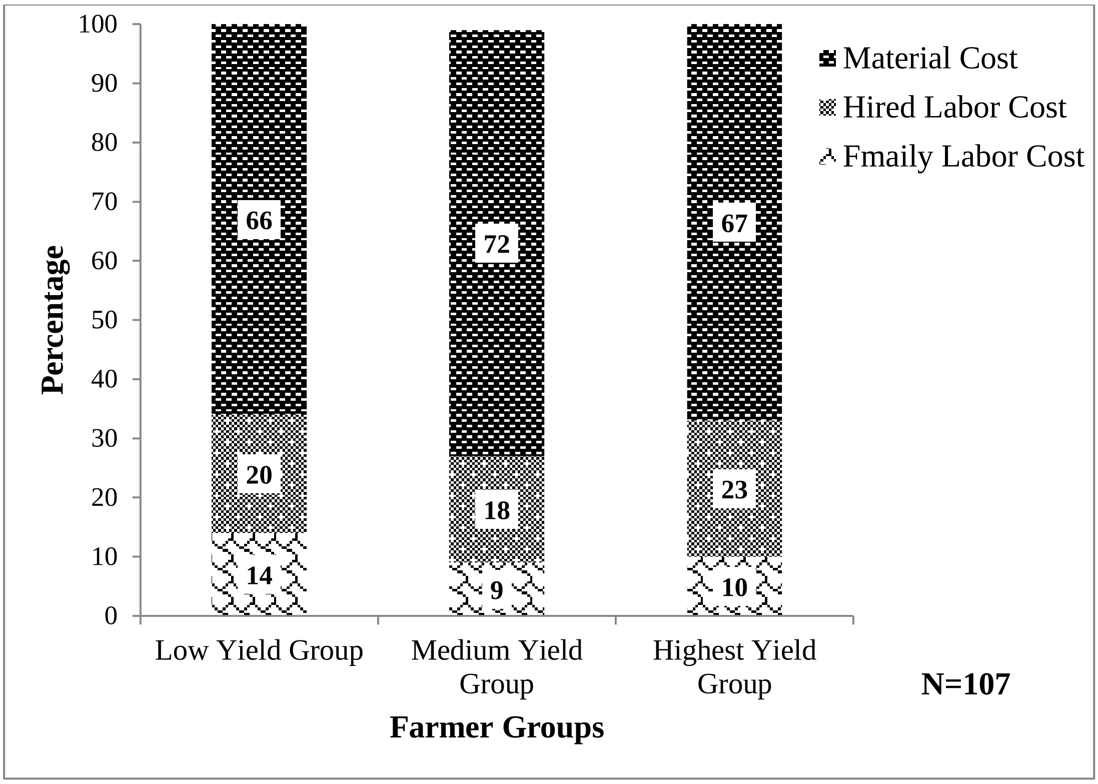



**Figure 4.4 Comparison of Total Variable Costs Based on Different Yield Levels**

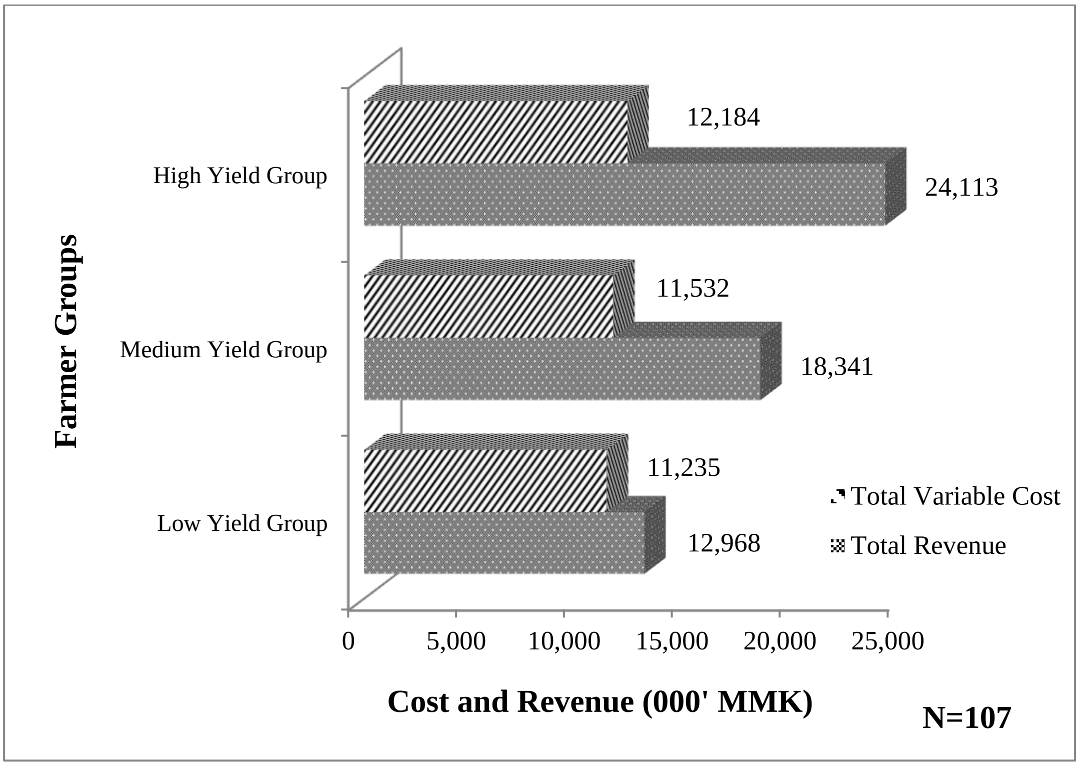



**Figure 4.5 Total Variable Cost and Total Revenue among Three Groups in Inle Lake**

#### 4.2.2.3 Enterprise Budget of Different Yield of Tomato Production in Inle Lake

Some measurement of enterprise budget based on different yield levels of tomato production is explained in Table 4.4. Total variable cost and total variable cash cost in low yield group (11,235 000'MMK/ha and 9,846 000'MMK/ha) was lower than the medium yield group (11,532 000'MMK/ha and 10,597 000'MMK/ha). The highest total variable cost and total variable cash cost found in the high yield groups (12,184 000'MMK/ha and 11,053 000'MMK/ha). So, return above variable cash cost was the highest in the high yield producer (13,060 000'MMK/ha) rather than other two groups (3,122 000'MMK/ha and 7,743 000'MMK/ha) because it was computed by gross benefit minus total variable cash cost of tomato production. The return from the hired labor and family labor investment was (3,732 MMK/ha and 5,924 MMK/ha) in low yield group, (7,965 MMK/ha and 21,631 MMK/ha) in medium yield group and (11,369 MMK/ha and 33,835 MMK/ha) in high yield group respectively. The detail calculation of enterprise budget of different yield levels was shown in Appendix 2, Appendix 3 and Appendix 4.

The highest of return per unit of cash cost was occurred in high yield group (2.2) compared to the medium yield group (1.7) and the low yield group (1.32) respectively. The benefit cost ratio of sample farmers in high yield group was 2, in medium yield group got 1.6 and in low yield group had 1.15. It means that the farmers in high yield group got 1 MMK/ha for every investment of one MMK in tomato production. So, the selected farmers in the high yield group attained the highest benefit from tomato production. Return per unit of capital and return per unit of cash cost of sample farmers in Inle Lake are demonstrated in Figure 4.6 and 4.7.

**Table 4.4 Some Measurements of Enterprise Budgets and Mean Comparison of Tomato Production per Hectare by Sample Farmers**

| Item | Unit | Low Yield Group (N=37) | Medium Yield Group (N=33) | High Yield Group (N=37) | F -test |
|---|---|---|---|---|---|
| Total Gross Benefit | 000'MMK/ha | 12,968 | 18,341 | 24,113 | 58.3*** |
| Total Variable Cost | 000'MMK/ha | 11,235 | 11,532 | 12,184 | 2.3[ns] |
| Total Variable Cash Cost | 000'MMK/ha | 9,846 | 10,597 | 11,053 | |
| Return above Variable Cash Cost | 000'MMK/ha | 3,122 | 7,743 | 13,060 | |
| Net Benefit on Gross Margin | 000'MMK/ha | 1,733 | 6,809 | 11,929 | 30.2*** |
| Return per Day of Labor | MMK/ha | 3,732 | 7,965 | 11,369 | |
| Return per Day of Family Labor | MMK/ha | 5,924 | 21,631 | 33,835 | |
| Break Even Yield | ton/ha | 55.45 | 60.4 | 66.7 | |
| Break Even Price | 000'MMK/ton | 175 | 120 | 92 | |

Note: ***, ** and * are significant level at 1%, 5% and 10%, ns = not significant

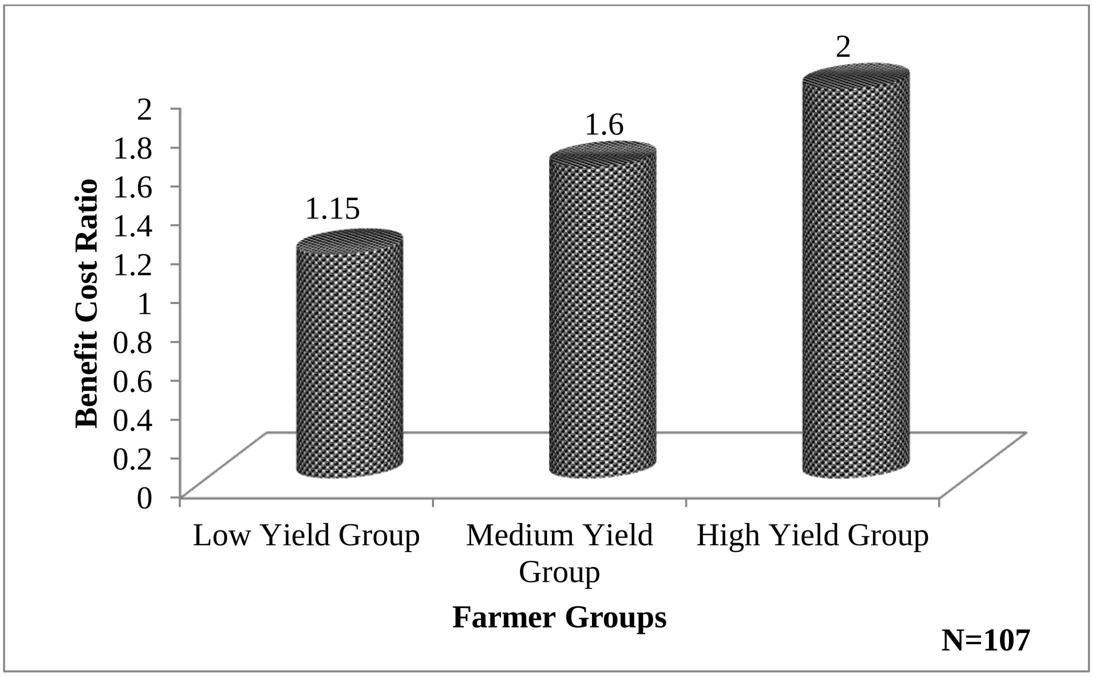



**Figure 4.6 Benefit Cost Ratio of Tomato Production in Inle Lake**

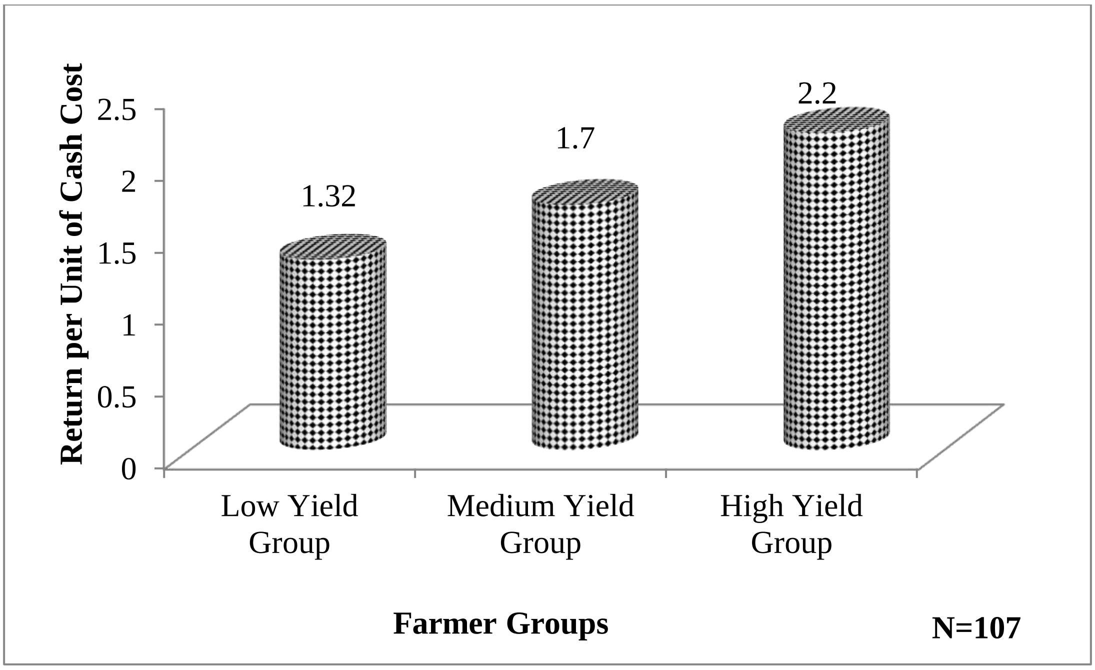



**Figure 4.7 Return per Unit of Cash Cost of Sample Farmers in Inle Lake**

**Table 4.5 Mean Paired Comparison of Gross Benefit, Total Variable Cost and Net Benefit among Three Groups by T-test**

| Item | | Mean Difference | | | | | |
|---|---|---|---|---|---|---|---|
| | | Low Group vs Medium Group | | Medium Group vs High Group | | High Group vs Low Group | |
| | Unit | T value | Sig. | T value | Sig. | T value | Sig. |
| Gross Benefit | MMK/ha | 7.021 | 0.000*** | 4.908 | 0.000*** | 9.784 | 0.000*** |
| Total Variable Cost | MMK/ha | 0.716 | $0.477^{ns}$ | 1.331 | $0.188^{ns}$ | 2.109 | 0.038** |
| Net Benefit | MMK/ha | 5.025 | 0.000*** | 3.443 | 0.001*** | 7.097 | 0.000*** |

Note: ***, ** and * are significant level at 1%, 5% and 10%, ns = not significant

#### 4.2.2.4 Mean Comparison of Gross Benefit, Total Variable Cost and Net Benefit among Three Groups

According to mean comparison by F-test analysis (Table 4.4), gross benefit and net benefit were significant at 1% probability level among three groups. However, there was no significant different in total variable cost within groups.

So, further comparison of variables was done between two groups such as low yield group and medium yield group, medium yield group and high yield group and high yield group and low yield group by T-test (Table 4.5). ANOVA result describes that gross benefit and net benefit between any two compared groups were significantly different at 1% level. However, the mean comparisons of the total variable costs were not significant between any groups of comparison. There was significant difference in total variable cost among high and low yield groups at 5% level.

## 4.3 Pesticide Practices of Sample Farmers in Inle Lake

### 4.3.1 Plant Protection Methods Used in Inle Lake

The tomato production in Inle Lake had some constraints to get the maximum yield especially due to pest and disease problem. The serious pests which occurred in tomato production in Inle Lake are green leaf hopper, pod borer, white fly and red spider.

There were four types of plant protection methods in Inle Lake such as applying inorganic pesticides, spraying mixture of chemical and organic pesticides, planting resistant varieties and practicing crop rotation to control these pests. The plant protection methods of selected farmers in Inle Lake are shown in Figure 4.8. Using inorganic pesticides was common among methods in the study area and at least 30% of farmers from each group used this method. The second popular method of selected farmers was planting the resistant varieties (31% in low yield), (29% in medium yield) and (28% in high yield).

Inorganic pesticide mixing with organic pesticides (e.g. Neem and Biogreen) was used by 14% of farmers in low yield group, 22% of farmers in medium yield group and 24 % of farmers in high yield group. The rotation with other crops such as eggplant, gourd, peeper and etc. was one of the plant protection methods. This practice was done in the study area by low yield group (21%), medium yield group (18%) and high yield group (14%). By reviewing the protection methods of Inle Lake, most of the farmers formally and widely used the inorganic pesticides to control pests and diseases (Figure 4.8).

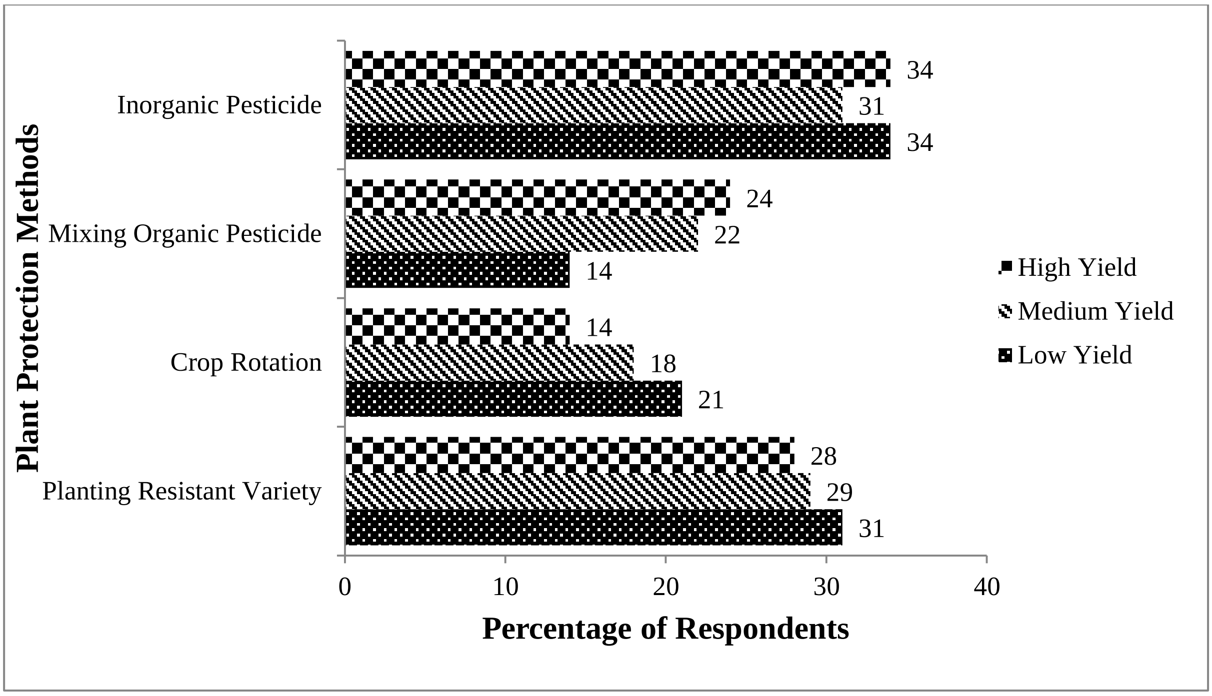



**Figure 4.8 Plant Protection Methods by Sample Farmers' group in Inle Lake, 2014**

**Table 4.6 Frequency and Spraying Interval of Pesticide Application by Sample Farmers**

| Pesticide Practices | Percent of Respondents | | | |
|---|---|---|---|---|
| | Low Yield Group (N=37) | Medium Yield Group (N=33) | High Yield Group (N=37) | F test |
| **Frequency of pesticide application** | | | | |
| 2-10 times | 21.6 | 10 | 10.8 | 6.47*** |
| 11-20 times | 64.8 | 60 | 56.7 | 4.28*** |
| More than 20 times | 13.5 | 30 | 32.4 | $0.16^{ns}$ |
| **Spraying interval (days)** | | | | |
| 4-6 | 21.6 | 28 | 21.6 | $0.30^{ns}$ |
| 7-8 | 35.1 | 36 | 62.2 | $1.08^{ns}$ |
| 8-12 | 43.2 | 36 | 16.2 | $0.72^{ns}$ |

Note: ***, ** and * are significant level at 1%, 5% and 10%, ns = not significant

### 4.3.2 Frequency and Timing of Pesticide Application by Sample Farmers

All selected farmers sprayed pesticides within the range of maximum frequency of 45 times and minimum frequency of 2 times regardless of the condition of pest infestation (Table 4.6). The average frequency of application was eighteen times in a cropping season. More than half of the farmers sprayed 11 to 20 times in a crop season of tomato production whereas 64.8% in low yield group, 60% in medium yield group and 56.7% in high yield group and significantly different at 1% level in three groups. In spraying of more than 20 times, it was conducted by 32% in high yield group, 30% in medium yield group and 13.5% in low yield group. A small percentage of respondents applied pesticides with the frequency of 2-10 times in three groups. The sample farmers in three groups reported that they always spray the pesticide before the harvesting of tomato so that the frequency and time of pesticide application depends on harvesting times.

One week interval spraying was common in all three groups because 62.2% of farmers in high yield group, 36% in medium yield group and 35.1% in low yield group operated this practice. The frequency of application is influenced by the interval of spraying (Table 4.6). The majority of farmers in low yield (43.2%) and medium yield groups (36%) sprayed pesticides at 8-12 days interval whereas only 16% of the high yield farmers practiced. It seems that medium and high yield groups applied pesticides more than 20 times with one week interval per crop season. The low yield group could spray mostly 11-20 times with wider interval. Therefore, the common frequency and spraying interval of pesticide application by selected farmers in Inle Lake was 11-20 times with 7-8 days interval (Table 4.6).

### 4.3.3 Pesticide Handling Practices by Selected Farmers

Table 4.7 presents the pesticide handling practices of selected farmers in Inle Lake. A higher proportion (32%) of the high yield group sprayed towards the wind direction compared to medium yield and low yield farmers (21% and 16% respectively). Majorities of farmers who were 67%, 78% and 84% in high, medium and low yield groups sprayed against the wind direction, thereby increasing the probability of poisoning through inhalation of chemical particles. Unfortunately, majority of low yield group (54%) sprayed pesticides with partial protective clothing (i.e., short pants/ shirt with long sleeves or T-shirt/long pants, but no masks) compared to medium yield group (42%) and high yield group (51%).

**Table 4.7 Pesticide Handling Practices by Sample Farmers in Inle Lake**

| Pesticide Practices | Percent of Respondents | | |
|---|---|---|---|
| | Low Yield Group (N=37) | Medium Yield Group (N=33) | High Yield Group (N=37) |
| **Pesticide Handling Practices** | | | |
| **Direction of spraying** | | | |
| Towards the Wind Direction | 16 | 21 | 32 |
| Against the Wind Direction | 84 | 78 | 67 |
| **Protective Clothing and Masks** | | | |
| No Protective Clothing and Mask | 8 | 24 | 14 |
| Partial Protective Clothing | 54 | 42 | 51 |
| Fully Protective Clothing | 38 | 33 | 35 |
| **Cleaning of Pesticide Sprayer** | | | |
| Not Wash | 54 | 21 | 13 |
| Wash into Lake Water | 46 | 78 | 86 |
| **Recommended Rate** | | | |
| Do Not Know | 5 | 27 | 24 |
| Know Recommended Rate | 95 | 73 | 76 |

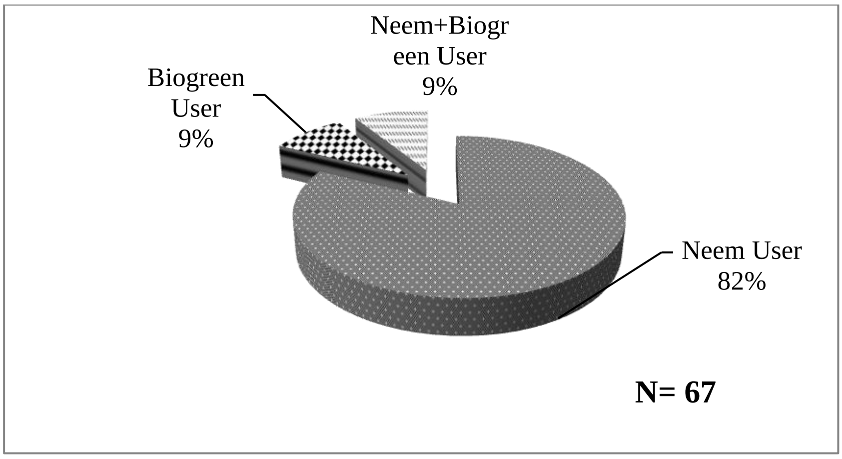



**Figure 4.9 Ratio of Farmers Who Used Organic Pesticide in the Study Area**

**Table 4.8 Brands Inorganic Pesticides of Applied by Sample Farmers in Inle Lake**
**(N=107)**

| No | Brand | Percent of Respondents |
|---|---|---|
| 1 | Golden Lion | 44 |
| 2 | Awba | 42 |
| 3 | Fam Link | 10 |
| 4 | Not Register | 8 |

Considering three groups, less than 25% of farmers did not use protective clothing and mask. One third of farmers from each group used protective clothing during pesticide application. The farmers thought that they can protect by wearing the partial clothing and masks. Fortunately, the medium yield group took little precaution in pesticide spraying compared with other two groups.

The other harmful pesticide handling practices by farmers was washing the sprayer into the Lake. A higher portion of high yield group (86%) and 78% of medium groups did these practices. Due to the limitation of pesticide knowledge, they did not know that this action was very harmful to the water of Inle Lake. Most of the farmers in Inle Lake especially in low yield group (95%) knew the recommended rate of pesticide whereas 73% in medium yield group and 76% in high yield group knew that rate. Pesticide recommended rate was given by agro-chemical company sale promotion (Table 4.7).

### 4.3.4 Organic and Inorganic Pesticide Application by Sample Farmers in Inle Lake

Figure 4.9 describes the organic pesticide lists used by sample farmers in Inle Lake. Eighty two percent of farmers used neem pesticide while nine percent of farmers applied Biogreen which was imported by Thailand Company and 9% of respondents applied mixture of neem and biogreen (Figure 4.9). There were no sample farmers who applied only organic pesticide. The sample farmers always sprayed by mixing organic and inorganic pesticide. Neem pesticide is manufactured by industry of Ministry of Industrialization which is located in Palate, Manadalay Region. It was distributed in Inle Lake by Department of Agriculture, Nyaung Shwe Township.

Chemical pesticides were sold and distributed by many private companies such as Golden Lion, Awba, Farm Link and etc. (Table 4.8). Forty four percent of respondents used inorganic pesticides that were supplied by Golden Lion Company. Some of selected farmers (42%) bought Awba brand whereas 10% of respondents applied pesticide that was produced by Farm Link Company. According to the survey data, some of the sample farmers (8%) still used unregistered chemical pesticides until now. The common brands of pesticides used in Inle Lake were Inferno (20%), Demon (13%) and Shoulin. Some of respondents used the brand name as Cypin (10%), Acephate (8%), Harricane (7%), Dozer (5%) and 777(4%) respectively. Other inorganic pesticides were used by few percent of respondents is shown in Appendix 5**.** Most of the inorganic pesticides were registered according to pesticide law except brand of 777 pesticides.

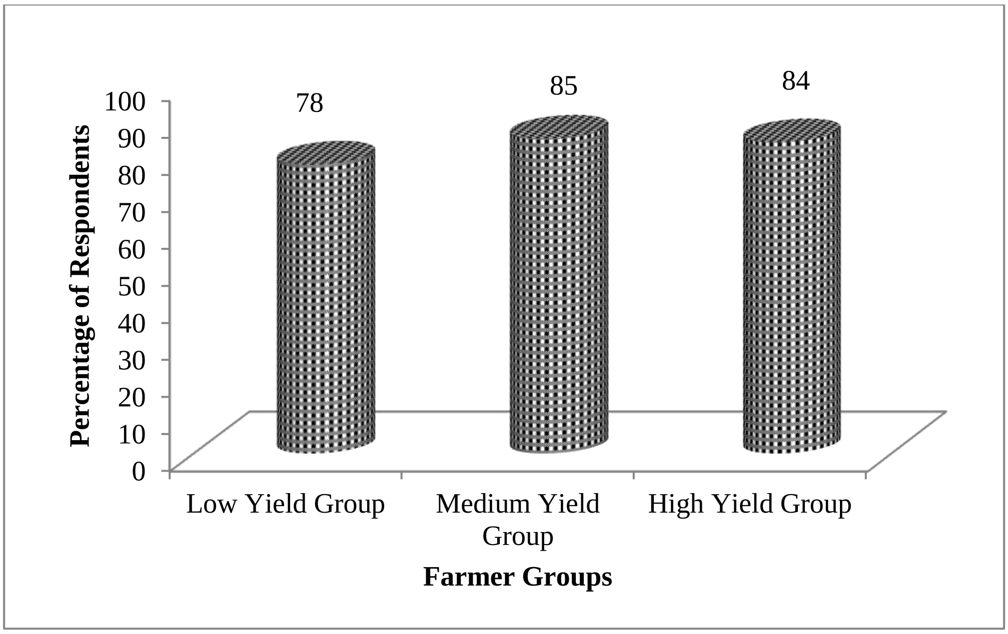



**Figure 4.10 The Ratios of Farmers Who had no Formal Pesticide Training in Inle Lake**

**Table 4.9 Constraints to Use the Organic Pesticide by Sample Farmers in Inle Lake**

| **Constraints** | **Percent of Respondents** | | |
|---|---|---|---|
| | **Low Yield Group (N=37)** | **Medium Yield Group (N=33)** | **High Yield Group (N=37)** |
| Expensive | 33 | 33 | 54 |
| Unavailability | 33 | 30 | 35 |
| No Knowledge on Organic Technology | 16 | 9 | 19 |
| Ineffective | 8 | 6 | 19 |
| Not Effective on Controlling Fungus | 8 | 6 | 5 |
| Early Ripening | 3 | 3 | 5 |
| Expired | 3 | 3 | 3 |
| Don’t Know | 3 | 3 | - |

### 4.3.5 Attendance of Selected Farmers in Pesticide Formal Training Programs of Selected Farmers

Lack of the pesticide training was the main problem for sample farmers in Inle Lake. The farmers knew informal training conducted by the agro-chemical company. Only 22% in low yield group, 15% in medium yield group and 16% in high yield group attended formal training courses conducted by the Plant Protection Division of the Department of Agriculture in Nyaung Shwe Township. It was observed in Figure 4.10, more than 75% of selected farmers did not attend the any formal training. Among three groups, number of farmers who had no formal training was greater in the medium and high yield groups (85% and 84%).

### 4.3.6 Constraints in Utilization of Organic Pesticide in Inle Lake

Compensating the utilization of organic pesticide in place of inorganic pesticides may be one of the control methods of the environmental pollution especially in Inle Lake. However, there were many constraints to follow it because inorganic pesticides were expensive, indicating by 54% of farmers in high yield group and 33% each in both low and medium yield groups more About 30% of each three groups mentioned that organic pesticide was unavailable to apply. The rest of the farmers in all groups (less than 30%) assumed that they had no organic technology, ineffective, not effective on controlling fungus, early ripening, expired and don't know (Table 4.9).

## 4.4 Source of Drinking Water and Health Externalities by Pesticide Use of Sample Tomato Farmers in Inle Lake

### 4.4.1 Types of Diseases Due to Pesticide Poisoning in Sample Farmers

There are two types of disease affecting by the pesticide utilization: long term and short term disease. The sample farmers in Inle Lake reported more short term diseases as headache, coughing, vomiting, eye pain, sneeze and chest pain rather than the long term disease. These short term diseases suffered by many sample farmers after pesticide spraying in the tomato production. In present study, no serious diseases such as lung and skin cancer caused by pesticide application were accounted. Among the short term diseases, headache symptom was the common symptom in the study area. By screening the symptoms among three groups, 40% of the farmers in the high yield group more claimed headache symptom than other two groups (36% in medium yield group and 22% in low yield group). There was no difference among groups in other disease symptoms (Table 4.10).

**Table 4.10 Short Term Diseases Responded by the Sample Tomato Farmers in Inle Lake**

| Symptoms | Percent of Respondents | | |
|---|---|---|---|
| | Low Yield Group (N=37) | Medium Yield Group (N=33) | High Yield Group (N=37) |
| Headache | 22 | 36 | 40 |
| Coughing | 10 | 12 | 10 |
| Vomiting | 8 | 12 | 5 |
| Eye Pain | 10 | 3 | 8 |
| Sneeze | 8 | 6 | 10 |
| Chest Pain | 8 | 9 | 2 |
| Nil | 34 | 22 | 22 |

**Table 4.11 Long Term Diseases Responded by the Sample Tomato Farmers in Inle Lake**

| Symptoms | Percent of Respondents | | |
|---|---|---|---|
| | Low Yield Group (N=37) | Medium Yield Group (N=33) | High Yield Group (N=37) |
| Skin Irritation | 13 | 13 | 13 |
| Stomach Ache | 13 | 2 | 10 |
| Hypertension | 8 | 2 | 12 |
| Nil | 66 | 83 | 65 |

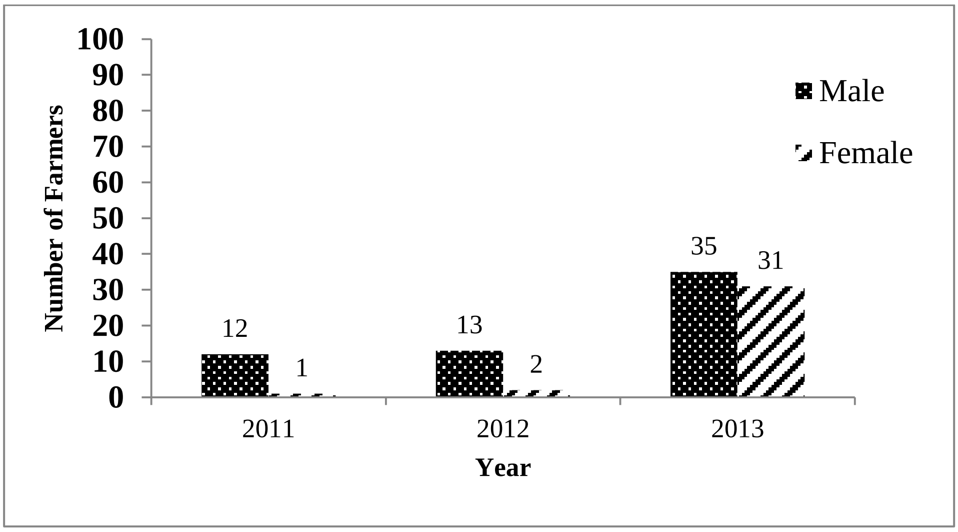



**Figure 4.11 Number of Pesticide Poison Cases in Inle Lake, 2011-2013**

Source: Official Reports of Three Villages' Clinics of Inle Lake, 2013

The symptoms which were caused by pesticide residues were long term diseases. Skin irritation, stomach ache and hypertension were long term symptoms which were noticed and reported by sample farmers in Inle Lake (Table 4.11).

### 4.4.2 Pesticide Poisoning Cases in Inle Lake

Secondary data on pesticide poisoning cases collected from three villages' of Kyae Sar, Tha Pay Pin and Kay Lar are shown in Figure 4.11. The data reveal that most of the patients were male because male labors always employed in inorganic pesticide and fertilizer application. The pesticide poisoning cases from three villages were greater in 2013 than it was in 2011 and 2012. Therefore, it can be seem that the farmer more recognize the poisoning cases than the previous years in Inle Lake. Although the ratios between the male and female patients were unequal in the early years, this ratio was nearly equal in later.

### 4.4.3 Health Costs Related to Pesticide Utilization by Selected Farmers

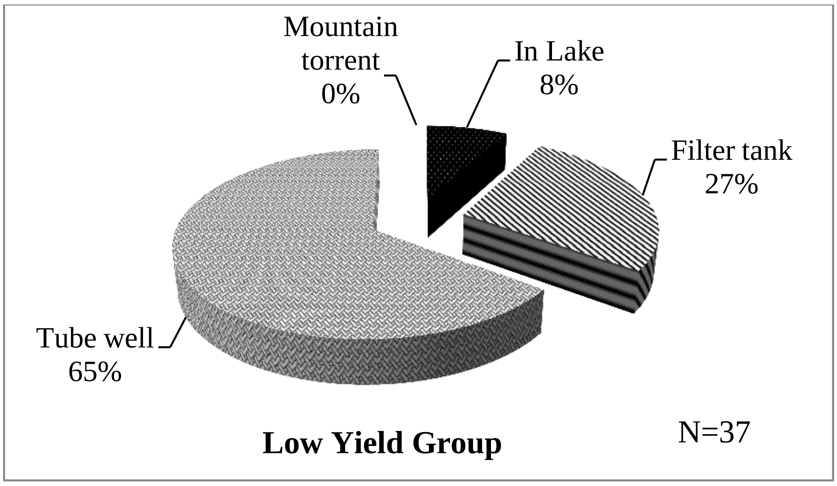
Many sample respondents practiced self-medication especially for short term cases of pesticide poisoning. For more serious cases, respondents consulted medical doctors or assistant pharmacists. In the common self-medication practices, more than half of the farmers just took a rest after applying pesticides and some respondents took cheaper traditional medicine and immediately took a bath.

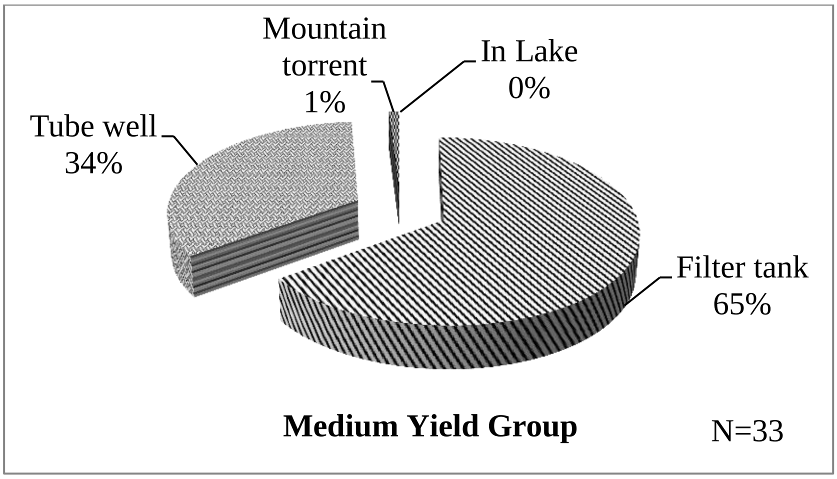
Direct and indirect costs were determined to estimate the total health cost. Direct costs included the cost of medicines, doctor fees, hospital or clinical charges and transportation cost. Indirect cost was measured in terms of the income forgone or opportunity cost of the farmers and take care person especially wife and offspring for not working on the farm due to taking care of patient. In Inle Lake, the respondents were hospitalized to the village clinic for serious poisoning cases and cost about 9,000 kyats for once. The average indirect cost of the reported farmers that included the opportunity income of farmer and care person was about 15,000 kyats for one case (Appendix 6).

### 4.4.4 Drinking Water Sources of Sample Tomato Farmers in Inle Lake

According to ASEAN-MAFF Japan project in 2006, the dissolved oxygen (DO) concentration in water was below the WHO standard 5 mg $L^{-1}$ for almost all sample area in Inle Lake. Moreover, biological investigation of coliform bacteria and E. coli bacteria count was found higher than the WHO limit that shows that the lake water is no longer fit to drink (Saw Yu May, 2012). Nowadays, the main drinking water sources of Inle Lake were lake, tube well, mountain torrent and filter tank which was established by government in Nyaung Win village. Based on the survey, most of the sample farmers accessed the drinking water from filter tank (83% of high yield group and 65% of medium yield group) and tube well (63% of low yield group) rather than other sources. In low yield group, the sample farmers obtained the drinking water from tube well (65%), filter tank (27%), from lake (8%) respectively. There were three different drinking water sources in medium yield group in which 63% from filter tank, 33% from tube well and 1% from mountain torrent. Nearly 90% of the sample farmers in the high yield group drink water from filter tank. There was no farmer who got drinking water from mountain torrent in low yield group and nobody used water for drinking from lake in both medium and high yield group (Figure 4.12).

According to result, the selected farmers in Inle Lake especially in low yield group used drinking water from lake and tube well. Therefore, these factors may be one reason for long term and short term poisoning case because of residual effects of chemical pesticide.



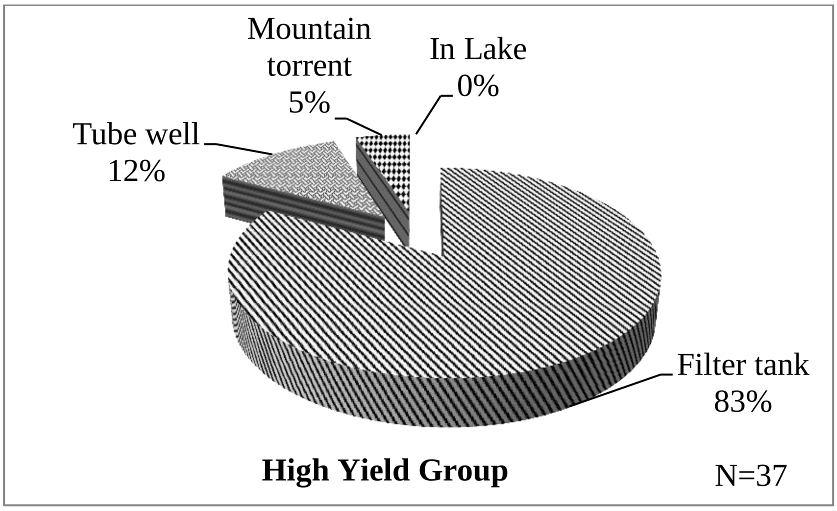




**Figure 4.12 Drinking Water Sources of Sample Farmers in Inle Lake**

### 4.5 Environmental Awareness Index and Determinants of Awareness Index in Inle Lake

In this portion, the sample farmers' environmental awareness was found out by measuring their attitudes and perceptions based on the agricultural and environmental knowledge. In addition, it was investigated the factors or situations which might have the relationship with the environmental awareness of farmers such as age, education level, gender, family labor, family size, farm size and pesticide using experience of the sample farmers.

#### 4.5.1 Environmental Awareness Index (EAI) of Selected Farmers in Inle Lake

##### 4.5.1.1 Average Environmental Awareness Score of Sample Farmers

Table 4.13 explains average, minimum and maximum scores of sample farmers' environmental awareness in Inle Lake. The average scores for statement number (1, 2, 3, 4, 11 and 14) were between and 4. It means that the selected farmers misunderstand these statements concerning with pesticide application. As average score was 2.9 in statement 10, the sample farmers had no idea whether pesticide should not be used more in the future for the sake of protecting the environment. The average scores were between 4 and 4.5 in statement number (7, 8, 12 and 13) explained that sample farmers in Inle Lake agreed on these statements such as some insects and animals are beneficial to crop production, pesticide kill not only pests but also other beneficial insect, present utilization of pesticide reach the alarming stage in Inle Lake and the Inle Lake pollution caused by other factors. There were more than 4.5 in mean of environmental awareness score for statement number (5, 6, 9 and 15). Therefore, the selected farmers strongly agreed that they have responsibility to conserve Inle Lake with utilization of new production technologies because pesticide was very dangerous to health and their environment (Table 4.12).

Average scores of environmental awareness in the study area were more than 3 (Table 4.12). Therefore, the environmental awareness of respondents was rather high. However, one fourth of respondents had no idea on knowledge of pesticide harmful effects and environmental awareness such as 22.4% of respondents had no idea on crop rotation which can improve soil fertility, 27% of farmers did not know Good Agricultural Practices (GAP) and 39.3% had no idea on over dosage pesticide application. The detail data responded by the sample farmers to each statement were shown in Appendix 7.

**Table 4.12 Environmental Awareness Scores by Sample Farmers**

| No. | Statement | Mean | Minimum | Maximum |
|---|---|---|---|---|
| 1. | Pesticides are very effective | 3.7 | 1 | 5 |
| 2. | Pesticides should be the last choice | 3.5 | 1 | 5 |
| 3. | Crop rotation can improve soil fertility | 3.8 | 1 | 5 |
| 4. | Farmer should know GAP | 3.7 | 1 | 5 |
| 5. | GAP will be accepted if extension services provide | 4.6 | 3 | 5 |
| 6. | Pesticide cause health and environmental hazards | 4.7 | 3 | 5 |
| 7. | Some insects are beneficial | 4.3 | 1 | 5 |
| 8. | Pesticide will kill beneficial insects and pests | 4.3 | 1 | 5 |
| 9. | Pesticide can cause water pollution | 4.6 | 2 | 5 |
| 10. | Pesticide should not be use over dosage | 2.9 | 1 | 5 |
| 11. | Pesticide can cause fish reduction in Lake | 3.7 | 1 | 5 |
| 12. | Now, pesticide usage is reaching alarming stage in Inle Lake | 4.3 | 1 | 5 |
| 13. | Lake pollution caused by other factors | 4.3 | 1 | 5 |
| 14. | Extension service is received | 3.4 | 1 | 5 |
| 15. | Inle Lake conservation is responsibilities of respondents | 4.8 | 3 | 5 |

**Table 4.13 Range of Environmental Awareness Index of Selected Farmers**

(N = 107)

| Range of Awareness Index | Definition | Percent |
|---|---|---|
| 0.47-0.57 | Limited awareness | 3 |
| 0.58-0.67 | Low awareness | 11 |
| 0.68-0.77 | Medium awareness | 33 |
| 0.78-0.87 | High awareness | 47 |
| 0.88-0.97 | Fully awareness | 6 |
| **Average Awareness Index** | **0.76** | |

**Table 4.14 Comparison of Environmental Awareness Index by Different Yield Groups**

| Environmental Awareness Index | No. of Respondents | | | |
|---|---|---|---|---|
| | Low Yield Group (N=37) | Medium Yield Group (N=33) | High Yield Group (N=37) | F test |
| Mean | 0.8 | 0.70 | 0.8 | 2.208 $^{ns}$ |
| Minimum | 0.58 | 0.60 | 0.47 | |
| Maximum | 0.90 | 0.90 | 0.88 | |

Note: ns= non-significant

#### 4.5.1.2 Environmental Awareness Index of Sample Farmers

According to the mentioned environmental awareness index equation, the maximum total sum of score was 75 and the minimum total sum of score was 15 whereas the possible highest index is 1 and minimum is 0. Higher awareness index means that the selected farmers have higher knowledge of environmental degradation and conservation. Calculating the response of selected farmers, the maximum awareness index was 0.97 and minimum index was 0.47. Therefore, the environmental awareness index of sample farmers were divided into five ranges based on the average score (0.76). According to the result, 47% of respondents had higher awareness index (0.78-0.87) followed by 33% of farmers who had (0.68-0.77) awareness index (Table 4.13).

This means that many farmers knew harmful effects of pesticides and had the higher environmental awareness. Only 6% of farmers had fully environmental awareness and there was 3% of farmer who had limited environmental awareness. Eleven percent of farmers had lower environmental awareness. Table 4.13 shows the environmental awareness index of sample farmers in Inle Lake.

Table 4.14 shows average, maximum, minimum environmental awareness index shown by different yield level. Based on the different yield groups, the maximum awareness index was 0.90 in both low yield group and medium yield group while 0.88 was in high yield group. In addition, the minimum awareness index was 0.60 in medium yield group, 0.58 in low yield group and 0.47 in high yield group respectively. By comparing the mean of the environmental awareness, 0.70 in medium yield group whereas low and high yield group had same (0.80) and there was no significant different in three groups. Therefore, most of sample farmers in Inle Lake had the higher environmental awareness and knew the harmful effect of pesticide.

### 4.5.2 Determinants of Environmental Awareness Index in Inle Lake

In the regression analysis for Farmer's environmental awareness index, the independent variables were age of farmer, education of the household head, family labor, family size, farm size, pesticide using experience of farmer and gender while dependent variable was environmental awareness index of tomato farmers in the study area. The mean, minimum and maximum values of the dependent and independent variables are given in Table.4.15

**Table 4.15 Descriptive Statistics of Dependent and Independent Variable of Environmental Awareness Index Function in Inle Lake**

| Variables | Unit | Minimum | Maximum | Mean |
|---|---|---|---|---|
| **Dependent Variable** | | | | |
| Environmental Awareness Index | | - 0.76 | - 0.11 | -0.2831 |
| **Independent Variables** | | | | |
| Age | Year | 3. | 4 | 3.6 |
| Schooling Year | Year | 1 | 3 | 2 |
| Family Labor | No. | 0 | 2 | 1 |
| Family Size | No. | 0 | 2 | 1 |
| Farm Size | No. | 2.66 | 0.30 | 1.77 |
| Pesticide Using Experience | Year | 2 | 49 | 15 |

**Table 4.16 Factors Affecting the Environmental Awareness Index of Tomato Farmers in Inle Lake**

| Independent Variables | Unstandardized Coefficients (B) | Standardized Coefficients (β) | T-value | Sig. |
|---|---|---|---|---|
| Constant | -0.845 | | -5.137 | 0.000 |
| Lnage | 0.151*** | 0.385 | 3.675 | 0.000 |
| Lnschooling year | 0.027 ns | 0.081 | 0.931 | 0.354 |
| Lnfamily labor | 0.051** | .0.214 | 2.285 | 0.024 |
| Lnfamily size | -0.086*** | -0.250 | -2.695 | 0.008 |
| Lnfarm size | -0.049** | -0.224 | -2.450 | 0.016 |
| Lnpesticide using experience | -0.052*** | -0.308 | -2.884 | 0.005 |
| Gender | 0.072 ns | 0.070 | 1.023 | 0.309 |

Note: Dependent Variable: Ln environmental awareness index

$R^2$ = (0.508), F = (8.490) ***

***, ** and * are significant level at 1%, 5% and 10%, ns = not significant

According to the descriptive statistics, farmers used environmental awareness index of farmer was 0.75, average age of farmers was 41 years old, mean of the schooling year was about 6 years, average family labor was 2 members, average family size was 4 persons, average farm size of farmers was 0.74 ha and average pesticide using experience was 15 years respectively. By gender issue, the percentage of male famers was 98% and the female farmer was 2%.

Table 4.16 shows the regression analysis of the environmental awareness index of sample farmers in Inle Lake. The farmers' environmental awareness index was estimated by using seven variables. Among them, age of the farmer, family size and pesticide using experience of farmers were highly significant at 1% level. Age of the farmers played one of the major roles in effecting the environmental awareness. Generally, the older people will have the higher environmental awareness. Age of farmer was positively and significantly influenced on the environmental awareness index at 1% level. If the age of farmer was older by 1%, the environmental awareness index was increased by 0.003%. The older people who concerned with nature and traditional and not easy to accept modern technology, pesticide application would have more environmental awareness. If the dependency ratio of family size was increased by 1%, the environmental awareness index will be decreased by 0.02% because family size was negatively and significantly influenced on environmental awareness index at 1% level. Big family size tomato farmers might not consider environmental awareness for their sustainable livelihood. Pesticide using experience of farmers was negatively and highly significant at environmental awareness index of farmers. If the farmer increased 1% of the pesticide using experience, the environmental awareness index went down by 0.003%. Farmers who had more experience of pesticide application might have used to this practice and did not consider harmful effect of pesticide seriously.

The family labor was also significant at 5% level. It means that if the family labor increased 1%, the environmental awareness index was increased 0.017%. More of family labor participation might more consider on safety of family member. As farm size was negatively significant at 5%, the environmental awareness index decreased by 0.13% when farm size increased 1%. The expansion of farm size to obtain more income can reduce the environmental awareness of farmers because they might have no alternative choice to avoid more using agro-chemical. Big farm family had also the same reason for reducing their environmental awareness. Although the other variable was not significantly related to the environmental awareness, these variables had the expected sign such as education of farmer and gender. The F-value showed that the selected model was significant at 1% level. The R square pointed out that the model was significant and it can explain the variation in environmental awareness in Inle Lake by 50.8% (Table 4.16).

### 4.5.3 Environmental Degradation Factors Indicated by Selected Farmers

Inle Lake pollution was caused not only pesticides but also other factors which were given by 42.1% and 46.3% of farmers (Appendix 7). As the result of the survey, there were eight factors affecting the environmental degradation of Inle Lake (Figure 4.13). It was reported that 65% of farmers pointed out that lake pollution was due to sedimentation while 44% believed it was polluted because of deforestation. Another 21% of farmers assumed as a result of extended the cultivated area. Farmers supposed that owing to tourism service (10%), some other consequence of floating garden waste (7%), due to miss management (7%), due to population growth (5%) and due to climate change (4%) correspondingly.

## 4.6 Factors Affecting the Pesticide Demand of the Sample Farmers in Inle Lake

In the regression analysis for demand function of pesticide, the independent variables were education of the household head, pesticide using experience of farmer, family size, lagged tomato price, farm income of household, quantity of compound fertilizer, pesticide price, quantity of fungicide, quantity of hormone and environmental awareness of farmer while dependent variable was pesticide demand of farmers. The mean, minimum and maximum values of the dependent and independent variables are given in Table 4.17.

According to the descriptive statistics, farmers used average quantity of pesticide was 49 L/ha, mean of the schooling year was about 6 years, average pesticide using experience was 15 years, average family size was 4 persons, average lagged output price received by farmers was 192 thousand MMK/ton, average household farm income was 19,812 thousand MMK/ha, current pesticide price paid by farmers was about 16 thousand MMK/L, average quantity of fungicide was 0.39 Kg/ha, average quantity of hormone used by farmer was 52 L/ha and environmental awareness index of farmer was 0.75 respectively (Table 4.17).

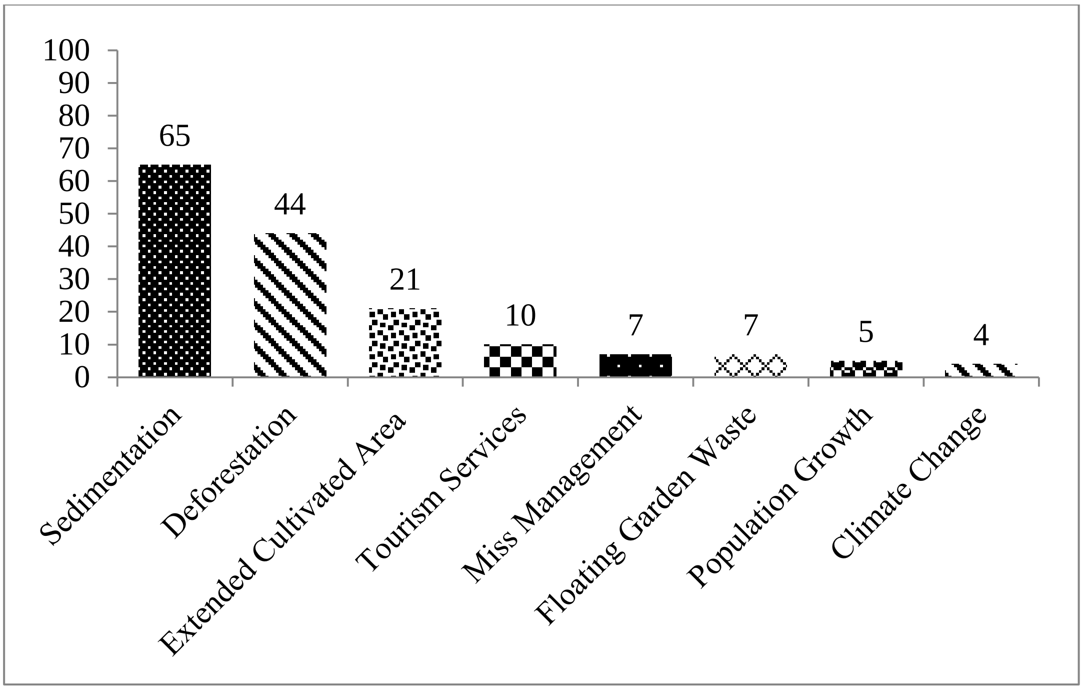



**Figure 4.13 Environmental Degradation Factors Indicated by Selected Farmers**

**Table 4.17 Descriptive Statistics of Dependent and Independent Variables for Pesticide Demand Function in Inle Lake**

| Variables | Unit | Mean | Minimum | Maximum |
|---|---|---|---|---|
| **Dependent Variable** | | | | |
| Quantity of Pesticide Used | L/ha | 49 | 5 | 148 |
| **Independent Variables** | | | | |
| Schooling Year | Year | 6 | 2 | 15 |
| Pesticide Using Experience | Year | 15 | 2 | 49 |
| Family Size | No. | 4 | 1 | 6 |
| Lagged Output Price | 000’ MMK/ton | 193 | 115 | 271 |
| Farm Income | 000’ MMK/ha | 198,00 | 700,00 | 533,7 |
| Quantity of Compound Fertilizer | Bag/ha | 71 | 17 | 178 |
| Pesticide Price | 000’ MMK/L | 17 | 7 | 40 |
| Quantity of Fungicide | Kg/ha | 77 | 5 | 237 |
| Quantity of Hormone | L/ha | 52 | 0 | 371 |
| Environmental Awareness Index | | 0.75 | 0.47 | 0.90 |

Table 4.18 illustrates the regression analysis of the demand of pesticide of sample farmers in Inle Lake. Household head's schooling year was positively and significantly influenced on the pesticide demand at 5% level. If the household head's schooling year increased by 1%, the quantity of pesticide demand will be increased by 3.531%. People who got high education level have more contact with outsiders including various input suppliers and gain not only more knowledge of new agro-based chemical products but also choice due to this reason. If the dependency ratio of pesticide price was increased by 1%, the pesticide demand will be increased by 0.001% because pesticide price was positively and significantly influenced on pesticide demand at 5% level. Farmers assumed that the pesticides with higher price were more effective and they neglected cost of pesticide which was essential input in tomato production. So that pesticide demand will be increased by higher price of pesticide.

The quantity of hormone was positively and highly significant related to pesticide demand. If the farmer increased 1% of the hormone quantity, the pesticide demand will increased by 0.235%. The demand of fungicide was also significant at 10% level. The farmers in Inle Lake always afraid of the pest and disease infestation so that they always spray the pesticide, fungicide and hormone even no attack or minor infestation of the pest and disease. Therefore pesticide usage was positively related with fungicide and hormone spraying. Although the other variables were not significantly related to the pesticide demand, these variable had the expected sign such as, pesticide using experience, family size, lagged output price, farm income, quantity of compound fertilizer and environmental awareness. The F-value showed that the selected model was significant at 1% level. The R square pointed out that the model was significant and it can explain the variation in demand of pesticide in Inle Lake by 35.0%.

**Table 4.18 Factors Affecting the Demand of Pesticide of Tomato Production in Inle Lake**

| Variables | Unstandardized Coefficients (B) | Standardized Coefficients (β) | T-value | Sig. |
|---|---|---|---|---|
| (Constant) | -32.133 ns | | -.707 | 0.481 |
| Schooling Year | 3.521** | 0.195 | 2.341 | 0.021 |
| Pesticide Using Experience | 0.298 ns | 0.069 | 0.797 | 0.427 |
| Family Size | 3.284 ns | 0.090 | 1.053 | 0.295 |
| Lagged Output Price | 0.077 ns | 0.068 | 0.794 | 0.429 |
| Farm Income | 0.005 ns | -0.124 | -1.406 | 0.163 |
| Quantity of Compound Fertilizer | 0.069 ns | 0.049 | 0.563 | 0.575 |
| Price of Pesticide | 0.001** | 0.189 | 2.181 | 0.032 |
| Quantity of Fungicide | 0.139** | 0.189 | 2.054 | 0.043 |
| Quantity of Hormone | 0.233*** | 0.351 | 3.886 | 0.000 |
| Environmental Awareness Index | -12.765 ns | -0.026 | -0.287 | 0.775 |

Note: Dependent Variable: Quantity of Pesticide Used

$R^2$ = (0.350), F = (5.165)***

***, ** and * are significant level at 1%, 5% and 10%, ns = not significant

# CHAPTER 5

# SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

This section highlights the main findings and makes conclusion drawn from the study, as well as the recommendations and policy implications that would promote sustainable tomato production, improve the crop production methods and future conservation of the Inle Lake.

## 5.1 Summary of Findings

### 5.1.1 Input Utilization, Cost and Return Analysis and Pesticide Practices of Tomato Production in Inle Lake

By analyzing the characteristics of sample farmers based on three yield level groups in Inle Lake, it was found that the average age of sample farmers was around 40 years within the range 21-75 years. The farming and pesticide applying experience were nearly the same. Among them, the farmers in low yield had the lowest pesticide using experiences (13years) less than other two groups (the highest farm experience was 21 years). The average farm size among three groups was 0.3 ha.

There was an average of four family members in the household and two people were working in their farm on average among three groups. Maximum education level of household was 9 years in low yield group and 8 years in other two groups on average. So, the average maximum education level of household was middle education level. By comparing three groups, higher schooling years was found in the high yield group (master level). In the study area, major of annual income source was crop production and more than 90% of crop income was earned by tomato production.

In tomato production in Inle Lake, the highest seed (0.42 Kg/ha) and hormone (63 L/ha) utilization was occurred in medium yield group although the highest pesticide demand was occurred in low yield group (52 L/ha). The high yield group had the highest fungicide demand (85 Kg/ha). About 30 to 38% of labor force in tomato production was family labor. Nearly 2 to 2.5 times of family labor was hired labor employed in Inle Lake tomato production. Number of female hired labor was two times greater than male.

A highest percentage of material cost (72%) was found in medium yield group while about 67% of the total variable cost was used in high yield group and in low yield group. Nearly 30% of total variable cost was used as labor cost in three groups. Among them, low yield group used more labor cost (34%) than high yield group (33%) and medium yield group

(27%). Farmers who produce the high tomato yield group had the highest total revenue (24,113 thousand MMK) and followed by the total revenue in medium yield group (18,341 thousand MMK) and low yield group (12,968 thousand MMK).

Although total revenue of three groups were different each other, the total variable cost of farmers in three groups was similar (11,235- 12,184) thousand MMK. By reviewing the return per unit of capital, it was found that 1.15 in low yield group, 1.6 in medium yield group and 2 in higher yield group. According to the ANOVA results of F-test, the mean gross benefit and net benefit were significantly different among three groups of farmers. Results of t-test showed that there was no significant difference in the means value of total variable cost between low yield and medium yield farmers and also in medium yield and high yield.

In comparison of pest control methods in Inle Lake, applying chemical pesticide was the most popular method and planting resistant varieties were the second priority method among three groups. In the mixture application of organic and inorganic pesticide, 83% of respondents used neem organic pesticide which was distributed by the Department of Agriculture, Nyaung Shwe Township. Concerning with the inorganic pesticide, the major supply was influenced by the private companies such as Awba, Golden Lion, Farm Link and etc. More than half of the farmers sprayed 11 to 20 times in one crop season of tomato production in all groups. In the spraying of more than 20 times, it was occurred that 32 % in high yield group, 30% in medium yield group and 13.5% in low yield group. The common spraying interval was seven to eight days in three groups.

By examining pesticide handling practice, it was found that 67%, 78% and 84% of three groups' respondents sprayed pesticide in wrong direction that was spraying against the wind direction. Unfortunately, only about 30% of farmers from each group wore fully protective clothing while spraying pesticide. A higher portion (86%) of high yield group washed the sprayer into the lake after spraying whereas 78% of medium yield group and 46% of low yield group did this careless mistake. Most of the farmers in Inle Lake especially in higher portion of low yield group (95%) compared to 73% in medium yield group and 76% in high yield group know the recommended rate of pesticide.

Only 22% in low yield group, 15% in medium yield group and 16% in high yield group have attended a formal training course conducted by the Plant Protection Division of the Department of Agriculture in Nyaung Shwe Township.

By screening the symptoms of short term illness between three groups, 40 % of farmers in high yield group reported headache and followed by 36% in medium yield group and 22% in low yield group. Other symptoms were coughing, vomiting, eye pain, sneeze and chest pain. In long term symptom, skin irritation was mostly occurred among the sample farmers. According to the official records from three villages' clinics, most of the patients were male.

### 5.1.2 Environmental Awareness Index of Sample Farmers

According to result, the selected farmers in Inle Lake especially in low yield group used drinking water from lake and tube well and followed by medium yield and high yield groups. Therefore, these factors may be one reason for long term and short term poisoning case because of residual effects of chemical pesticides. More than 50% of farmers had high awareness on the environmental conservation based on their responses of awareness index. According to mean comparison of environmental awareness index by different groups were occurred 0.70 in medium yield group and 0.80 in both low and high yield groups.

By discovering the determinants of environmental awareness index by observing regression model, age of the farmer, family size and pesticide using experience of farmers were highly significant at 1% level while family labor and farm size were significantly at 5% level. As the educational of farmers was not significant, the environmental awareness was not based on education status of farmers. Moreover, there was no significant in gender because the male and female awareness on environmental were not different.

### 5.1.3 Factors Affecting the Pesticide Demand in the Study Area

Determining the main factors influenced the demand of the pesticide was analyzed by the regression model. In the case of the pesticide demand function, the demand of hormone was positively significant at 1% probability level because pesticide always sprayed combining with hormone in Inle Lake. At the 5% probability level, educational level of household head and price of pesticide were positively significantly related to the pesticide demand. The fungicide was positively significant at 10% level. Although the other variables were not significantly related to the pesticide demand, these variables had the expected sign such as pesticide experience, family size, lagged output price, farm income, quantity of compound fertilizer and environmental awareness.

## 5.2 Conclusions

The average age of sample farmers was round about 40 years. In addition, the average schooling year of farmers was middle education level among three groups. There was no illiterate farmers in the study area because of the minimum education level was primary. Therefore, the education standard was not too low in Inle Lake. Myanmar Census of Agriculture (MCA) 2010 Supplementary Module data revealed that 54.3% of farm household head attained the primary education level. The possession of farm among three groups was small and similar (0.3 ha) because of the nature of the floating garden. Moreover, the extended of the cultivated area was restricted by local government for the conservation of Inle Lake.

There were two family labors in every household in study area and the rest of family members were working in fishery, public services, domestic chores and tourism services. Maximum education level of household member was middle education level. By comparing of three groups, a higher schooling years was occurred in the high yield group (master level) compared to other two groups (graduated level). It can be concluded that if the farmers have the high income by production, they can effort to upgrade their children education level. The main income source of sample farmers attained from agriculture especially in tomato production because the upland tomato was mainly produced by Inle Lake.

It was occurred that not only the input utilization but also the yield of upland tomato production in Inle Lake was high. Also in labor input based on gender issue, female labors were more employed than male labor in the tomato production particularly in transplanting, weeding, harvesting and packaging. The male labor employed largely in fertilizer and pesticide application, seed bed preparation and land preparation. The output price of tomato was high because tomato could be produced successfully around the Lake. The higher yield level got by the farmers, the higher net benefit was gained. Nearly the same output price of tomato was attained by the farmers in three groups. In Inle Lake, tomato was produced in monsoon season because of lean season of tomato production in lowland regions of Myanmar. Therefore, this is one of the conditions for having the high output price. The high yield group producers had the greatest benefit rather than another two groups because of greater benefit cost ratio.

The tomato production in Inle Lake had some constraints to get the maximum yield especially in pest and disease problems. There were four methods commonly used to control pests and diseases as applying inorganic pesticide, combining organic and inorganic pesticides, practicing crop rotation and planting the resistant variety. Among four pest control methods, the applying of inorganic pesticide was popular practice in the study area. It can be seen that most of the pesticides had already registered but some were unregistered and banned such as brand of 777 and Malardoom pesticides. It is the risky practice for the farmers in Inle Lake. According to farmers' attitude, the inorganic pesticide was more effective than other method and the main constraints applying organic pesticide (neem) were unavailability to buy in market and registered organic pesticide.

Pesticide application, regardless the infestation of pest and diseases pesticide, was applied just before the harvesting of tomato so that residual effect of chemical is threatening food safety. It is needed to educate about the harmful residual effect of pesticide. When spraying pesticide the less the number of days of interval, the more frequent the spraying would be. Most of the farmers who sprayed against the wind direction with partial protective clothing, might have limited knowledge of pesticide handling practices. Water quality was destroyed by careless washing of sprayers in the lake and over used when serious pest problem occurred regardless the recommended dosage was noticed. Drinking tube well water and lake water caused the residual effects of pesticide to man. Moreover, some of the farmers drank water in the lake when they were thirsty during farming.

Lack of the pesticide training was the major problem for the farmers in Inle Lake. The farmers attended informal training conducted by the company for sale promotion. Farmers noticed pesticide harmful effects; however, they did not have willingness to reduce the pesticide usage. The farmers in Inle Lake did not recognize the pesticide poisonings although health hazards of pesticide utilization was occurred as short and long term diseases.

According to the official records from three village clinics, the data revealed that farmers did not recognize the poisoning symptoms in the early years in Inle Lake. Generally, although environmental awareness of tomato farmers was reasonably high and they understand the dangerous effects of pesticides some of them could not agree "not to use more pesticide in future" and "pesticide spraying should be the last choice" in pest control operation. Many farmers also had not knowledge on advantages of crop rotation and organic farming in controlling pests and diseases. Most of the farmers in Inle Lake thought that not only the floating garden but also other factors affect the environmental degradation such as sedimentation, deforestation, extension of cultivated area and tourism services etc. They should fully aware of the contamination of pesticide residual as a main cause of water pollution from floating garden.

Considering the determinants of environmental awareness index, age and family labor were directly correlated with awareness. Also old farmers are likely to perceive the environmental hazards of pesticides than the young farmers due to accumulated knowledge and experience of farming systems (Bonabana, 2002).The older people who concerned with nature and traditional and not easy to accept modern technology, pesticide application would have more environmental awareness. More of family labor participation might more consider on safety of family member.

Farmers who had more experience of pesticide application might have used to this practice and did not consider harmful effect of pesticide seriously. Bo Bo Lwin (2006) assumed that the farmers from extended families were much more aware because they can have much more information exposure to outside. It is hard to interpret clearly farm size and family sizes were negatively related with environmental awareness index. One possible assumption is to produce reasonable crop production from large farm and to sustain good livelihood of big family size tomato farmers might not take care of their environmental condition. They emphasized on fully protection of pests and diseases for their expected productivity.

In pesticide demand function, education level of farmers, price of pesticide and quantity of fungicide were positively significant at 5% possible level and quantity of hormone was significantly different at 1% level. People who got high education level have more contact with outsiders including various input suppliers and gain not only more knowledge of new agro-based chemical products but also choice due to this reason. Farmers think that the pesticides with higher price are more effective so that pesticide demand will be increased by higher price of pesticide. The pesticide demand was positively and significantly related with education of household head and price of pesticide. The farmers in Inle Lake always afraid of the pest and disease infestation so that they always spray the pesticide, fungicide and hormone even no attack or minor infestation of the pest and disease. Therefore pesticide usage was positively related with fungicide and hormone spraying.

Most of the farmers in Inle Lake wanted new technologies of plant protection method that are safety their health and environmental condition. Concerning with the organic farming technology, one of local NGOs demonstrated the method of organic fertilizer by mixing the cow dung and lotus but this program was not do well because there was no plenty of cow dung manure. In this case, farmers thought organic farming practices would not be suitable for the study area even though organic farming practice is good option for conservation.

## 5.3 Recommendations

Nowadays, Inle Lake had reached the alarming state of environmental degradation as drought in the summer. Therefore, some policy recommendations are suggested to improve the crop productivity and lessen health risk of tomato farmers in their pesticide use in Inle Lake. To be improved the crop productivity research and development programs are needed to progress the pest and disease resistant tomato varieties for reducing chemical use. Crop rotation is also one of the most economically effective and non-chemical which means of decreasing the population of most soil pests. It is useful for increasing or maintaining soil fertility.

Training and education to farmers on proper pesticide usage play the important role in alleviating of the misuse in pesticide practices of tomato farmers in Inle Lake. There are NGOs and INGOs which assist concerning with environmental conservation of Inle Lake. However, the farmers did not know exactly the proper strategies for their production.

Unless strengthening and promoting of harmful effects of pesticides in present, now, Ministry of Agriculture and Irrigation (MOAI) enforced the Good Agricultural Practices (GAP) to the farmers to obtain the target yield by safety production. Growers in main surplus producing areas need to follow GAP. By doing this, growers' supplies should not exceed maximum residue limits of pesticide. In addition, extension workers should advise growers regarding chemical contamination of fresh produce. GAP extension education program needs to be carried out by extension workers and plant protection staff. With regard to pesticide spraying, the following key points are important to aware among growers which are,

- to observe the economic threshold level of pesticide
- to avoid frequent pesticide application
- to follow recommended rate of pesticide
- to abstain from using banned pesticides
- to be aware of incorrect mixing of pesticides

In addition, government should monitor the pesticide company in their formulation; packaging and promotion. Due to the lack of knowledge; most farmers learnt the use of chemicals from advertisements given by chemical sales agents visiting the village during the planting season. The advertisements always emphasized on the chemical efficiency, not disadvantages of overdoing the amount of chemicals. Government also prevents banned pesticide because some farmers in Inle Lake thought that this banned pesticide was more efficient than other.

The farmers must know that the misuse of chemical can affect the society and environment. Pursuant to the study on factors affecting the awareness of using pesticides, it was found that education was important, this took effect to use of chemicals. That will help the farmers to have actual knowledge and understanding about the danger of using pesticides, especially the effect of chemicals to themselves, society, and environment in the long term. Therefore, related officials and agencies should carry out surveys in relation to the use of chemicals by establishing the familiarity and informality with farmers in order to approach and learn existing problems caused by the use of chemicals. Thus the farmers will have more awareness of harmful effects caused by using pesticides and also their mind will be open and change their attitude to understand and cooperate with officials to solve problems together. In addition, high farmer's environmental awareness index would be the major driven force for policy package of environmental conservation in Inlay Lake for the long term development.

Therefore, a combination of pesticide regulatory policies, programs to raise farmers' awareness on the harmful effects of pesticides, and a commitment to promote IPM practices by the government as well as NGOs may safeguard poor farmers in their pursuit of increased agricultural production and resulting increase in income and standard of living.

In Inle Lake, public health education is very important for health safety of the farmers and their family members since most of the farmers were not careful in handling and storing pesticide. Many farmers cannot tell about the pesticide poisoning case because their lack of knowledge. It is needed that the cooperation of the regional public health centers and health workers such as trained nurses and village health assistants is deemed necessary in disseminating information on how to perform first aid treatment for pesticide poisoning and in distributing pamphlets on proper methods of pesticide handling in order to lessen the heath cost of farmers resulting from pesticide related-symptoms and diseases. To have the awareness, farmers must have correct knowledge and understanding about the use of chemicals.

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# APPENDIES

**Appendix 1 Average Crop Income from Different Sources of Sample Farmers**

| **Sources of Income** | **Annual Average Income (Ks/ha)** | | |
|---|---|---|---|
| | **Low Yield N=37** | **Medium Yield N=33** | **High Yield N=37** |
| Tomato | 13,146,764 (97) | 18,319,010 (94.5) | 24,128,603 (91) |
| Egg Plant | - | 53,912 (0.3) | 1,893,962 (7.1) |
| Gourd | - | - | 212,369 (0.8) |
| Cucumber | 120,209 (0.8) | - | - |
| Cauliflower | - | 481,015 (2.5) | 6,678 (0.05) |
| Rice | 91,269 (0.7 ) | 87,607 (0.4) | 38,734 (0.1) |
| Cabbage | - | 436,537 (2.2) | 28,048 (0.1) |
| Betel | - | - | 100,174 (0.3) |
| Pepper | 221,184 (1.6) | - | 45,145 (0.2) |
| Bean | 68,118 (0.5) | 5,391 (0.02) | 24,041 (0.09) |
| **Total** | **13,527,337** | **19,383,472** | **26,477,758** |

Figures in parentheses are percentages

**Appendix 2 Enterprise Budget of Tomato Farmers Who Produced Low Yield**

| Item | Unit | Level | | Effective Price | | Total Value |
|---|---|---|---|---|---|---|
| **Gross Benefit** | | | | | | |
| Tomato | ton/ha | | 64 | | 202,635 | 12,968,640 |
| **Total Gross Benefit** | | | | | | 12,968,640 |
| **Variable Cost** | | | | | | |
| **(a) Material Cost** | | | | | | |
| Seed | bag/ha | | 76 | | 6,165 | 468,540 |
| FYM | bag/ha | | 76 | | 12,345 | 938,220 |
| Fertilizer(compound) | bag/ha | | 62 | | 38,959 | 2,415,458 |
| Pesticide | L/ha | | 52 | | 17,541 | 912,132 |
| Fungicide | Kg/ha | | 71 | | 15,527 | 1,102,417 |
| Hormone | L/ha | | 45 | | 89,38 | 402,210 |
| Bamboo Strip | viss/ha | | 56 | | 708 | 39,648 |
| Bamboo Salt | no/ha | | 9,071 | | 42 | 380,982 |
| Bamboo Pole | no/ha | | 8,035 | | 35 | 281,225 |
| **Total Material Cost (a)** | **Ks/ac** | | | | | **6,940,832** |
| **(b) Family Labor Cost** | | **M** | **F** | **M** | **F** | |
| Cleaning | Md/ha | 60 | 0 | 2,841 | 2,503 | 170,460 |
| Seed bed preparation | Md/ha | 10 | 1 | 2,841 | 2,138 | 30,548 |
| Covering | Md/ha | 9 | 0 | 2,841 | 2,138 | 25,569 |
| Earthing up | Md/ha | 22 | 0 | 2,881 | 2,138 | 63,382 |
| Transplanting | Md/ha | 0 | 5 | 2841 | 2,138 | 10,690 |
| Cutting | Md/ha | 0 | 22 | 2841 | 2,138 | 47,036 |
| Fertilizer application | Md/ha | 56 | 35 | 2841 | 2138 | 233,926 |
| Weeding | Md/ha | 25 | 28 | 2841 | 2138 | 130,889 |
| | | 12 | | | | |
| Insecticide application | Md/ha | 7 | 8 | 2,841 | 2,138 | 37,7911 |
| Harvesting | Md/ha | 0 | 57 | 2,841 | 2,151 | 122,607 |
| Packaging | Md/ha | 25 | 0 | 2,841 | 2,138 | 71,025 |
| Transportation | Md/ha | 37 | 0 | 2,841 | 2,138 | 10,5117 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Total Family Labor Cost** | | **37** | | | | |
| **(b)** | **MMK/ha** | **1** | **156** | | | **1,389,160** |
| **(c) Hired Labor Cost** | | **M** | **F** | **M** | **F** | |
| | | 13 | | | | |
| Cleaning | Md/ha | 0 | 0 | 2,841 | 2,503 | 369,330 |
| Seed bed preparation | Md/ha | 3 | 8 | 2,841 | 2,138 | 25,627 |
| Covering | Md/ha | 0 | 2 | 2,841 | 2,138 | 4,276 |
| Earthing up | Md/ha | 44 | 0 | 2,881 | 2,138 | 126,764 |
| Transplanting | Md/ha | 1 | 23 | 2,841 | 2,138 | 52,015 |
| Cutting | Md/ha | 0 | 111 | 2,841 | 2,138 | 237,318 |
| Fertilizer application | Md/ha | 5 | 13 | 2,841 | 2,138 | 41,999 |
| Weeding | Md/ha | 8 | 170 | 2,841 | 2,138 | 386,188 |
| Insecticide application | Md/ha | 58 | 0 | 2,841 | 2,138 | 164,778 |
| Harvesting | Md/ha | 0 | 229 | 2,841 | 2,151 | 49,2579 |
| Packaging | Md/ha | 2 | 1 | 2,841 | 2,138 | 7,820 |
| Transportation | Md/ha | 23 | 17 | 2,841 | 2,138 | 101,689 |
| | | **27** | | | | |
| **Total Hired Labor Cost (c)** | **MMK/ha** | **4** | **574** | | | **2,010,383** |
| **(d) Interest on Cash Cost** | | | | | | |
| Material cost (a) | MMK/ha | | | | 0.1 | 694,083.2 |
| Hired labor cost (c) | MMK/ha | | | | 0.1 | 201,038.3 |
| **Interest on Cash Cost (d)** | **MMK/ha** | | | | | **895,121** |
| Total variable cost | | | | | | |
| (a+b+c+d) | **MMK/ha** | | | | | **11,235,496** |
| Total variable cash cost | | | | | | |
| (a+c+d) | **MMK/ha** | | | | | **9,846,336** |

**Appendix 3 Enterprise Budget of Tomato Farmers Who Produced the Medium Yield**

| Item | Unit | Level | | Effective Price | | Total Value |
|---|---|---|---|---|---|---|
| **Gross Benefit** | | | | | | |
| Tomato | ton/ha | | 96 | | 191,05<br>9 | 18,341,664 |
| **Total Gross Benefit** | | | | | | 18,341,664 |
| **Variable Cost** | | | | | | |
| **(a) Material Cost** | | | | | | |
| Seed | bag/ha | | 84 | | 6,274 | 527,016 |
| FYM | bag/ha | | 87 | | 12,621 | 1,098,027 |
| Fertilizer(compound) | bag/ha | | 72 | | 38,500 | 2,772,000 |
| Pesticide | L/ha | | 46 | | 15,364 | 706,744 |
| Fungicide | Kg/ha | | 74 | | 14,144 | 1,046,656 |
| Hormone | L/ha | | 63 | | 9,255 | 583,065 |
| Bamboo Strip | viss/ha | | 68 | | 3,608 | 245,344 |
| Bamboo Salt | no/ha | | 8,916 | | 45 | 401,220 |
| Bamboo Pole | no/ha | | 8,014 | | 37 | 296,518 |
| **Total Material Cost (a)** | **Ks/ac** | | | | | **7,676,590** |
| **(b) Family Labor Cost** | | **M** | **F** | **M** | **F** | |
| Cleaning | Md/ha | 38 | 0 | 2,827 | 2,009 | 107,426 |
| Seed bed preparation | Md/ha | 9 | 1 | 2,827 | 2,009 | 27,452 |
| Covering | Md/ha | 8 | 0 | 2,827 | 2,009 | 22,616 |
| Earthing up | Md/ha | 0 | 16 | 2,918 | 2,009 | 32,144 |
| Transplanting | Md/ha | 0 | 4 | 2,827 | 1,994 | 7,976 |
| Cutting | Md/ha | 0 | 13 | 2,827 | 1,994 | 25,922 |
| Fertilizer application | Md/ha | 41 | 17 | 2,873 | 2,024 | 152,201 |
| Weeding | Md/ha | 15 | 19 | 2,873 | 2,024 | 81,551 |
| Insecticide application | Md/ha | 117 | 0 | 2,827 | 1,994 | 330,759 |
| Harvesting | Md/ha | 0 | 28 | 2,827 | 2,009 | 56,252 |
| Packaging | Md/ha | 22 | 0 | 2,827 | 1,994 | 62,194 |
| Transportation | Md/ha | 10 | 0 | 2,827 | 1,994 | 2,8270 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Total Family Labor Cost (b)** | **MMK/ha** | **260** | **98** | | | **934,763** |
| **(c) Hired Labor Cost** | | **M** | **F** | **M** | **F** | |
| Cleaning | Md/ha | 148 | 0 | 2,827 | 2,009 | 418,396 |
| Seed bed preparation | Md/ha | 4 | 18 | 2,827 | 2,009 | 47,470 |
| Covering | Md/ha | 1 | 0 | 2,827 | 2,009 | 2,827 |
| Earthing up | Md/ha | 0 | 49 | 2,918 | 2,009 | 98,441 |
| Transplanting | Md/ha | 1 | 32 | 2,827 | 1,994 | 66,635 |
| Cutting | Md/ha | 0 | 126 | 2,827 | 1,994 | 251,244 |
| Fertilizer application | Md/ha | 29 | 6 | 2,873 | 2,024 | 95,461 |
| Weeding | Md/ha | 59 | 110 | 2,873 | 2,024 | 392,147 |
| Insecticide application | Md/ha | 23 | 0 | 2,827 | 1,994 | 65,021 |
| Harvesting | Md/ha | 6 | 236 | 2,827 | 2,009 | 491,086 |
| Packaging | Md/ha | 2 | 0 | 2,827 | 1,994 | 5,654 |
| Transportation | Md/ha | 4 | 6 | 2,827 | 1,994 | 23,272 |
| **Total Hired Labor Cost (c)** | **MMK/ha** | **277** | **583** | | | **1,957,654** |
| **(d) Interest on Cash Cost** | | | | | | |
| Material cost (a) | MMK/ha | | | | 0.1 | 767,659 |
| Hired labor cost (c) | MMK/ha | | | | 0.1 | 195,765.4 |
| **Interest on Cash Cost (d)** | **MMK/ha** | | | | | **963,424.4** |
| Total variable cost (a+b+c+d) | **MMK/ha** | | | | | **11,532,431** |
| Total variable cash cost (a+c+d) | **MMK/ha** | | | | | **10,597,668** |

**Appendix 4 Enterprise Budget of Tomato Farmers Who Produced High Yield**

| Item | Unit | Level | | Effective Price | | Total Value |
|---|---|---|---|---|---|---|
| **Gross Benefit** | | | | | | |
| Tomato | ton/ha | | 132 | | 182,680 | 24,113,760 |
| **Total Gross Benefit** | | | | | | 24,113,760 |
| **Variable Cost** | | | | | | |
| **(a) Material Cost** | | | | | | |
| Seed | bag/ha | | 77 | | 6,227 | 479,479 |
| FYM | bag/ha | | 61 | | 12,203 | 744,383 |
| Fertilizer(compound) | bag/ha | | 78 | | 39,249 | 3,061,422 |
| Pesticide | L/ha | | 49 | | 16,946 | 830,354 |
| Fungicide | Kg/ha | | 85 | | 15,459 | 1,314,015 |
| Hormone | L/ha | | 50 | | 7,946 | 397,300 |
| Bamboo Strip | viss/ha | | 88 | | 736 | 64,768 |
| Bamboo Salt | no/ha | | 8,534 | | 43 | 366,962 |
| Bamboo Pole | no/ha | | 8,161 | | 35 | 285,635 |
| **Total Material Cost (a)** | **MMK/ac** | | | | | **7,544,318** |
| | | | | | | |
| **(b) Family Labor Cost** | | **Male** | **Female** | **Male** | **Female** | |
| Cleaning | Md/ha | 43 | 0 | 3,122 | 2,230 | 134,246 |
| Seed bed preparation | Md/ha | 7 | 0 | 3,122 | 2,230 | 21,854 |
| Covering | Md/ha | 7 | 0 | 3,122 | 2,230 | 21,854 |
| Earthing up | Md/ha | 13 | 0 | 3,162 | 2,230 | 41,106 |
| Transplanting | Md/ha | 1 | 3 | 3,122 | 2,216 | 9,770 |
| Cutting | Md/ha | 0 | 18 | 3,122 | 2,216 | 39,888 |
| Fertilizer application | Md/ha | 56 | 18 | 3,162 | 2,243 | 217,446 |
| Weeding | Md/ha | 22 | 20 | 3,149 | 2,216 | 113,598 |
| Insecticide application | Md/ha | 118 | 2 | 3,122 | 2,216 | 372,828 |
| Harvesting | Md/ha | 0 | 25 | 3,122 | 2,216 | 55,400 |
| Packaging | Md/ha | 27 | 0 | 3,122 | 2,216 | 84,294 |
| Transportation | Md/ha | 6 | 0 | 3,122 | 2,216 | 18,732 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Total Family Labor Cost (b)** | **MMK/ha** | **300** | **86** | | | **1131016** |
| **(c) Hired Labor Cost** | | **Male** | **Female** | **Male** | **Female** | |
| Cleaning | Md/ha | 154 | 0 | 3,122 | 2,230 | 480,788 |
| Seed bed preparation | Md/ha | 5 | 9 | 3,122 | 2,230 | 35,680 |
| Covering | Md/ha | 1 | 0 | 3,122 | 2,230 | 3,122 |
| Earthing up | Md/ha | 44 | 1 | 3,162 | 2,230 | 141,358 |
| Transplanting | Md/ha | 6 | 25 | 3,122 | 2,216 | 74,132 |
| Cutting | Md/ha | 4 | 138 | 3,122 | 2,216 | 318,296 |
| Fertilizer application | Md/ha | 48 | 10 | 3,162 | 2,243 | 174,206 |
| Weeding | Md/ha | 38 | 164 | 3,149 | 2,216 | 483,086 |
| Insecticide application | Md/ha | 39 | 3 | 3,122 | 2,216 | 128,406 |
| Harvesting | Md/ha | 8 | 278 | 3,122 | 2,216 | 64,1024 |
| Packaging | Md/ha | 1 | 1 | 3,122 | 2,216 | 5,338 |
| Transportation | Md/ha | 6 | 0 | 3,122 | 2,216 | 18732 |
| **Total Hired Labor Cost (c)** | **MMK/ha** | **354** | **629** | | | **2,504,168** |
| **(d) Interest on Cash Cost** | | | | | | |
| Material cost (a) | MMK/ha | | | | 0.1 | 754,431.8 |
| Hired labor cost (c) | MMK/ha | | | | 0.1 | 250,416.8 |
| **Interest on Cash Cost (d)** | **MMK/ha** | | | | | **1,004,848.6** |
| Total variable cost (a+b+c+d) | **MMK/ha** | | | | | **12,184,350.6** |
| Total variable cash cost (a+c+d) | **MMK/ha** | | | | | **1,105,3334.6** |

**Appendix 5 Inorganic Pesticide Lists Applying by Sample Farmers in Inle Lake**

| No | Pesticides (Brand Name) | Pesticides (Active Ingredients ) | AI percentage | Brand | Target Pests |
|---|---|---|---|---|---|
| 1. | Inferno | Imidaclopid | 10WP | Golden Lion | Green Leaf Hopper |
| 2. | Demon | Abamectin | 1.8EC | Awba | Red Spider |
| 3. | Shoulin | Lamda Cyhalothrin | 2.5EC | Golden Lion | Fruit Borer, White Fly |
| 4. | Cpyin | Clorpyrifos | 20EC | Awba | Green Leaf Hopper |
| 5. | Acephate | Acephate | 75SP | Awba | Fruit Borer |
| 6. | Harricane | AlphaCyper+ Clorpyrifos | 505EC | Golden Lion | Fruit Borer |
| 7. | Dozer | Imidaclopid | 20WP | Awba | Green Leaf Hopper |
| 8. | 777 | | | Not register | Fruit Borer |
| 9. | Alarm | Lamda Cyhalothrin+ Emamectin | 15WP | Awba | Green Leaf Hopper, Fruit Borer |
| 10. | Confidence | Imidaclopid+ Clorpyrifos | | Farm Link | Fruit Borer |
| 11. | Malardoom | Malathion | 50EC | Farm Link | Red Spider |
| 12. | Harmma | Abamectin | 1.8EC | Golden Lion | Red Spider |
| 13. | Cyclone | Cyper+ Clorpyrifos | 505EC | Awba | Fruit Borer |
| 14. | Y-special | | | Not register | White Fly |
| 15. | Accept | Acetamiprid | 20WP | Farm Link | Green Leaf Hopper |
| 16. | Salad Plus | Lamda Cyhalothrin+ profenofos | 33EC | Farm Link | White Fly, Green Leaf Hopper |
| 17. | In charge | Imidaclopid | 20SL | Golden Lion | Green Leaf Hopper |
| 18. | Level | Thiodicard | 40SC | Golden Lion | Fruit Borer |

**Appendix 6 Health Cost of Farmers Who Felt Illness after Spraying Pesticide**

**N=11**

| **Average Health Cost** | **Mean** | **Maximum** | **Minimum** |
|---|---|---|---|
| **Direct Cost** | | | |
| Transporting Charges | 1,000 | 10,000 | 0 |
| Medicine | 5,000 | 35,000 | 0 |
| Doctor Fee | 3,000 | 5,000 | 0 |
| **Indirect Cost** | | | |
| Opportunity Cost of Sick Person | 3,000 | 9,000 | 0 |
| Opportunity Cost of Care Person | 2,500 | 5,000 | 0 |

**Appendix 7 Percent of Sample Farmers in Environmental Awareness Score**

**(N=107)**

| **Question No.** | **Percent of Respondents** | | | | |
|---|---|---|---|---|---|
| | **Strongly Disagree** | **Disagree** | **Neutral** | **Agree** | **Strongly Agree** |
| 1 | 4.7 | 17.8 | 8.4 | 36..4 | 32.7 |
| 2 | 3.7 | 26.2 | 15.9 | 20.6 | 33.6 |
| 3 | 3.7 | 5.6 | 22.4 | 47.7 | 20.6 |
| 4 | 5.6 | 6.5 | 27.1 | 29 | 31.8 |
| 5 | 0 | 0 | 7.5 | 28 | 64.5 |
| 6 | 0 | 0 | 0.9 | 31.8 | 67.3 |
| 7 | 6.5 | 2.8 | 4.7 | 30.8 | 55.1 |
| 8 | 3.7 | 2.8 | 8.4 | 29.9 | 55.1 |
| 9 | 0 | 0.9 | 2.8 | 32.7 | 63.6 |
| 10 | 15.9 | 15.9 | 39.3 | 25.2 | 3.7 |
| 11 | 4.7 | 9.3 | 21.5 | 42.1 | 22.4 |
| 12 | 0.9 | 4.7 | 2.8 | 50.5 | 41.1 |
| 13 | 1.9 | 4.7 | 4.7 | 42.1 | 46.7 |
| 14 | 21.5 | 10.3 | 5.6 | 28 | 34.6 |
| 15 | 0 | 0 | 2.8 | 15.9 | 81.3 |