FACTORS AFFECTING THE DEMAND OF INPUTS FOR CABBAGE AND CAULIFLOWER PRODUCTION IN TATKON TOWNSHIP, NAY PYI TAW

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FACTORS AFFECTING THE DEMAND OF INPUTS FOR CABBAGE AND CAULIFLOWER PRODUCTION IN TATKON TOWNSHIP, NAY PYI TAW

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The thesis attached here to, entitled **"FACTORS AFFECTING THE DEMAND OF INPUTS FOR CABBAGE AND CAULIFLOWER PRODUCTION IN TATKON TOWNSHIP, NAY PYI TAW"** was prepared and submitted by Thin Thin Oo under the direction of the chairperson of the candidate supervisory committee and has been approved by all members of that committee and the board of examiners as a partial fulfillment of the requirements for the degree of **MASTER OF AGRICULTURAL SCIENCE (AGRICULTURAL ECONOMICS)**.

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This thesis represents the original work of the author, except where otherwise stated. It has not been submitted previously for a degree at any other University.

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ABSTRACT

In this study, the socio-economic characteristics, cultural practices, cost and benefit and factors affecting the demand of inputs for cabbage and cauliflower production were investigated. The survey was carried out from January to February 2014. The primary data were collected by interviewing 120 sample farmers from Nweyit and Kyartharai villages in Tatkon Township, Nay Pyi Taw. Descriptive analysis, benefit-cost analysis and demand function were used in data analysis.

All sample farmers used improved seeds imported from Thailand and China. All applied urea fertilizers were imported from China and several brands of compound fertilizers and pesticides were available in the market. Some imported fertilizer and pesticide brands were not registered. All sample farmers did not receive the official recommended rate of fertilizer application by MoAI for cabbage and cauliflower production. About 80% of sample farmers accessed the information of pesticide application techniques from company sale agents, local dealers and other farmers. Only 7.5% farmers got information of pesticide application from extension agents. All sample farmers did not receive agricultural credit from MADB for vegetable production and most farmers relied on credit from cooperative society and local money lenders with the interest rate of 2.5% and 6.7% per month respectively.

In cost and return analysis, sample farmers faced high production costs including high labor wages, input prices and unstable product price. The benefit cost ratio was 3.4 in cabbage and 1.3 in cauliflower production. Based on inputs demand functions, demand of seed was negatively influenced by current seed price in cabbage production but positively affected in cauliflower production. In both cabbage and cauliflower production, buying seed in credit transaction was one of the important influencing factors. Demand of urea fertilizer was positively affected by lagged crop prices and total family labors and negatively influenced by quantity of FYM. Current compound and pesticide prices were the most influencing factors on specific input demands.

Based on the research findings, it is needed to develop seed industry in order to meet the growing demand for qualified vegetable seeds through public private partnership. Enforcement on rules and regulations of imported fertilizers is also vital to protect the farmers from the fake product and undesired product utilization. MADB should strengthen the credit not only for rice production but also for vegetable production. The government should accelerate public extension services and training programs on pesticide application in vegetable production. Factors reducing the input prices such as relaxing the implicit tax, developing the infrastructure and creating the competitive agrochemical market should be taken into account. Facilitating market infrastructure such as storage, transportation facilities, providing market information and enhancing marketing extension education are essential in order to reduce perishable crop price fluctuation suffered by vegetable growers.

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LIST OF ABBREVIATIONS

ac	Acre
BCR	Benefit cost ratio
DoA	Department of Agriculture
FAO	Food and Agriculture Organization
FYM	Farm yard manure
g	Gram
ha	Hectare
HH	Household
Kg	Kilogram
Ks	Kyats
L	Liter
MADB	Myanma Agricultural Development Bank
MoAI	Ministry of Agriculture and Irrigation
MT	Metric ton
TV	Television

LIST OF CONVERSION FACTORS

1 Hectare	2.471 Acres
1 Metric ton	1000 Kilograms
1 Metric ton	1000 Liters
1 Metric ton	2 Cartloads of farm yard manure

CHAPTER I

INTRODUCTION

1.1 Importance of Vegetable Production

Vegetable production is an activity that can play an important role in improving the livelihood conditions of small-scale and resource-poor farmers in tropical countries, since vegetables constitute both an opportunity for diet improvement and a source of income (Gioseffi 2008). Growing vegetables is 4 to 8 times more remunerative than cereals and it also generates employment in the rural areas. To produce vegetables successfully, it is required proper use of all available resources in developing countries (Singh et al. 2011).

1.2 Role of Inputs in Vegetable Production

The increase in population and food demand of vegetables has resulted in an increase use of fertilizer and pesticides in the production of high-value cash crops and vegetables. The consumption of fresh fruits and vegetables is also increasing as consumers struggle to eat healthy diets and benefit from the all-year round availability of these products. However, traditional vegetable farming systems (without any chemical input) are incapable of meeting this challenging demand (Gerken et al. 2001).

Vegetable seed enterprises have contributed to increasing production by 20-30% and have generated 2-3 times more income than cereal crops from the same piece of land, other production factors remaining the same (FAO 2009). Seed is the basic, least expensive and most important input in agriculture, which holds the key to farm productivity and profitability. Quality seed largely determines the success of modern farming as other management and cultural practices come into play only after the germination of seeds and establishment of seedlings. In fact, seed is the real vehicle of production and other inputs like water and fertilizer can be regarded as fuel. Inputs such as fertilizer, manure and irrigation are needed to realize the potential of seed, whereas pesticides restrict the loss of output. A quality seed offers a great potential for boosting agricultural production (Hosmani 2007).

Successful vegetable growers are careful in proper use of organic and inorganic fertilizer to meet the plants' nutritional needs. Vegetables are generally heavy users of nutrients in comparison to other field crops. Fields planted repeatedly to vegetables may need more attention to fertilization than fields rotated into pasture or other agronomic crops (http://pods.dasnr.okstate.edu/docushare/dsweb/Get/.../HLA-6000web.pdf*)*.

Inorganic fertilizer is one of the agricultural technologies that have huge potential for raising the productivity of poor smallholders, enabling them to increase income, accumulate assets, and set themselves economically on a pathway out of poverty (Benson et al. 2012).

In vegetable nutrition and fertilization, nitrogen is one of the most important nutrients. Nitrogen fertilizers are becoming more and more expensive while organic fertilizers have a slow nutrient release, both constituting a constraint for vegetable production in developing countries. Therefore, there is a need for a quick-acting and cheap nitrogen fertilizer (Gioseffi 2008).

Pests and diseases are main constraints to vegetable production in the tropics and infestation varies with seasons. Most farmers use more pesticide in the dry season than the rainy season because they grow more vegetables in the dry season. Many farmers spray against insects than diseases and insect pests are more serious in the dry season (Ngowi et al. 2007).

1.3 Vegetable Production in Myanmar

Myanmar is home of the numerous horticulture crops, due to its various tropical, sub-tropical and temperate climatic conditions. More than hundred kinds of vegetables are growing in different agro-ecological regions of Myanmar. Vegetables constitute an important segment of the agricultural economy. Besides, vegetables are rich in sources of vitamins and play an important role and ensuring nutritional food security (Tin Htut Oo and Nwe Ni Win 2008).

Most vegetables are grown in the central part of Myanmar, mainly Dry Zone areas. Other major production areas are Shan State, Mandalay, Sagaing and Magway regions (Maung Maung Yi 2009). Total crops sown area is about 20.41 million hectares having the cropping intensity of 162%. The vegetable crops engage about 4% of the total cropping area of the country. Total vegetables growing area in Myanmar was 541,268 hectare in 2012-2013 (MoAI 2013). Appendix 1 shows some vegetables grown area in Myanmar in 2012-2013.

In Myanmar, vegetable crop yields and quality are still low. Rapid early growth is very important for vegetables and for that high fertility level is required. Yield reduction is mainly due to inadequate mineral nutrition. Thus, vegetable growers should understand the principles of proper nutritional management. In order to overcome these difficulties, a successful fertilizer and pesticide management in vegetable growing plays a key role and its proper understanding is of vital importance for growing a good crop of vegetable (Kyi Myint 2009).

Vegetables are widely grown in the whole country but almost all the quantities are for domestic consumption and only the insignificant amount of fruits and vegetables are exported through across the border trade to China. At present, a limited quantity of cabbage, cauliflower, potato, tomato, broccoli, lime, sweet pepper and asparagus are being exported through border and normal trade by some companies (Aung Hlaing 2009).

1.3.1 Cabbage and Cauliflower Production

Cabbage is one of the popular vegetables in Myanmar and it is used as a dish or use as an ingredient of a dish or a salad. It has a good taste and is available everywhere with a reasonable price. Based on the agro-ecological zone, cauliflower and cabbage can be produced in both highland and lowland areas. In highland areas, they are produced during the rainy season whereas they can be grown as cool season crop in lowland area (Nyein Nyein Thaung 2011).

In Myanmar, cabbage and cauliflower grown areas are increasing from 28,219 hectares (2008-09) to 31,095 hectares (2012-13) and from 24,303 hectares (2008-09) to 27,154 hectares (2012-13) (MoAI 2013). Cabbage and cauliflower prices fluctuate from month to month and from year to year. Farmers can get profits in a short time if vegetables are grown. Cabbage and cauliflower can be grown with the multiple cropping systems. Two or three crops including cabbage and cauliflower can be grown within a year (http:// www. networkmyanmar.org/images/stories/PDF8/207newsn.pdf THE NEW LIGHT OF MYANMAR Wednesday, 20 July, 2011).

1.4 Problem Statement

In Nay Pyi Taw Council area, Tatkon Township is one of the largest vegetable production areas and the farmers in this township receive more income from vegetable production. Moreover, Tatkon areas produce several kinds of horticultural crops especially cabbage and cauliflower. Peoples' consumption of food such as meat, fruits and vegetables are also raised. Vegetable production in Myanmar has been increasing due to high local demand and export potential to neighboring countries. Crop yields depend upon many factors such as climate, technologies, variety, pest control, soil fertility and fertilizer application, mechanization, etc. Among these factors, improved seed, fertilizer and pesticide may be the main factors for yield increase in Myanmar.

Fertilizers play an important role in increasing the fertility of the soil and thus crop productivity. However, fertilizer consumption also depends on various factors such as farming method, cropping pattern, irrigation pattern, different socio-economic characteristics, availability of technology and information, variety and quality of seed as well as access to capital and credit and other inputs. And also pesticide institutes the key control approach for management of pests and diseases in vegetable production. Together with improved seeds and fertilizers, pesticides have helped in vegetable productivity. But most of farmers in Myanmar are insufficient in financial investment to buy quality seeds and inputs such as fertilizers and pesticides. The price of fertilizer, pesticide, fungicide and herbicide are rather expensive. Formal credit does not been supported to vegetable production.

With the significant increase in fertilizer price over time it is likely that the demand for fertilizer is decreased significantly. Farmers' purchasing power for inputs is eroded by increasing costs of production while output prices are remained sluggish. In addition the problems of improved seed, research, extension and development in Myanmar are particularly acute for vegetables other than the primary commodities such as rice, oilseed crops and pulses. The requirements of capital investments, improved seed, fertilizer and pesticide are closely linked problems for farmers. In Myanmar, pesticide and fertilizer uses data of vegetables production is notoriously poor. A study is needed to know the situation of inputs usage in vegetable production and factors affecting the demand of inputs. This study is to reflect the condition of inputs utilization in cabbage and cauliflower production in the study area. Moreover it is to recognize what factors influence in the demand of inputs.

1.4 Objectives of the Study

The major objective of the study is to analyze the demand of inputs for cabbage and cauliflower production in the study area. The specific objectives are as follows:

1. To study the demographic characteristics and cultural practices on cabbage and cauliflower production in the study area;
2. To observe the cost and benefit of cabbage and cauliflower production in the study area and
3. To examine the demand functions of improved seed, fertilizer and pesticide for cabbage and cauliflower production.

CHAPTER II
LITERATURE REVIEW

2.1 Role of Inputs in Vegetable Production

The commercialization, specially the increased vegetable cultivation, has enhanced by the use of modern agricultural technologies. Recently, the use of modern technologies like improved varieties, fertilizer, pesticides, growth hormones, and modern cultivation practices is the common practice in commercial vegetable production. The trend of using improved varieties, mostly hybrids, has increased substantially. Most of the hybrid varieties are high input responsive compared to local varieties (Mundlak et al. 2004).

Nowadays, farmers replace their traditional crop cultivars with improved varieties. The improved varieties such as hybrids provide higher economic return due to their higher production potential and thus provide better livelihood opportunities (Eisses and Chaikam 2002). Organic and inorganic fertilizers are found to increase the yield of maize and vegetables such as pepper, tomato, okra and melon significantly (Ipinmoroti et al. 2003). One of the most important and necessary resources is fertilizer, which provides the nutrients needed by plants to grow properly and yield a quality product.

The use of market oriented organic fertilizer is being encouraged to improve soil fertility and there is the need to determine the economic rationale of this technology. The study determined the change in net income of users of commercial organic fertilizer (UCOF) relative to non-users of fertilizers (NUF) in vegetable crop production in Osun State of Nigeria. Analyses indicated that UCOF applied 610 Kg per hectare of commercial organic fertilizer resulting in additional yield (3,375 Kg per hectare) and rate of returns (401%) over and above the NUF, making the use of organic fertilizer technology economically superior to non-use of fertilizers. Constraints to the use of commercial organic fertilizer are doubtful efficiency; heavy weed infestation, bulkiness and lack of funds in descending order of importance which if eliminated will boost demand for commercial organic fertilizer and improve production of vegetable for consumption (Alimi et al. 2006).

Similarly, the demand for vegetables has increased in many parts of the Asia (Midmore and Jansen 2003). The increasing urban demand for vegetables in Thailand has been met through peri-urban areas in the central plains, northern valleys and highland rural areas. Such an ever-increasing demand has also stimulated the innovations that contribute to the increased production and quality of the vegetable crops. The improved seed system and hybrid varieties as end product of the innovation technology in the agriculture are used by many farmers to increase the production. The bio-innovation process for the agricultural boost is supported by various agencies, government to private research centers, commercial firms including seed companies, and local informal networks like traders and seed agents.

Seeds are basic agricultural input. More importantly quality seeds of any preferred varieties are basis of improved agricultural productivity since they respond to farmers needs for both their increasing productivity and crop uses (Pelmer 2005). Aloyce et al. (2000) studied factors influencing the adoption of improved maize seeds and the use of inorganic fertilizer for maize production by farmers in the intermediate and lowland zones of Tanzania. The results indicated that availability of extension services, on-farm field trials, variety characteristics and rainfall were the most important factors that influenced the extent of adopting improved maize seeds and the use of inorganic fertilizer for maize production.

2.2 Review of the Studies on Demand of Seed, Fertilizer and Pesticide

2.2.1 Utilization Patterns of Inputs

The importance of quality seeds in increasing yield has been widely recognized. With no market access to good quality seed, farmer-to-farmer exchange is generally the major source of seeds in Bangladesh. Continuous saving of seeds from own harvest for seed purpose without proper cleaning would seriously affect seed health leading to lower yields (Mew 1997).

Sigh et al. (2013) studied the use of hybrids or high yielding varieties, access to knowledge and technologies, interactive demonstrations, better input delivery systems, good communication, and proper utilization of available resources would be very useful in enhancing the vegetables' productivity, and ensuring the food and nutritional security to the tribal community Mizoram. The time of sowing of cabbage and cauliflower were November and the seed rates were 400-500 grams per hectare. Normally 300 to 350 grams of seed will produce enough plants for 1 hectare in cauliflower production in Minnesota (http:// www.nr. gov.nl.ca/.../ crops/).

The specific fertility for an individual field program should be based on recommendations from soil tests. In general, fertility requirements are 100 to 180 pounds of nitrogen, 0 to 150 pounds of phosphorus, and 0 to 250 pounds of potassium per acre for cabbage and cauliflower production. The amount of nitrogen and potassium applied at or prior to planting and the number of side-dressings and amount per side-dressing depend on the texture and native fertility of the soil. Cole crops grown on sandy soils should receive lower amounts of nitrogen and potassium at more frequent intervals than those grown on finer-textured soils where a fertilizer application is generally sufficient (http://www. extension.umn.edu/garden/fruit-vegetable/growing-broccoli-cabbage-and-cauliflower-in-minnesota/index.html).

Pesticide use practices of vegetable farmers were investigated during surveys conducted in major vegetable production zones of the humid tropics of Cameroon. The surveys aimed to elucidate farmers' crop calendar, pesticide spray schedule and frequency. Farmers' knowledge was determined on pest targets, quantities and major active ingredients used, and training received in vegetable production. It was found that weekly spray of pesticides was the most common practice; 40% sprayed insecticide, 28% sprayed fungicides. Farmers applied 0.5-9 liters of pesticide per year, 10-49 Kg, and 10 to 49 packets of chemicals depending on farm size (Abang et al. 2013).

Horna et al. (2008) studied the insecticide use on vegetables in Garna. Tomato, cabbage and garden egg are important crops for small-scale farmers and migrants in the rural and peri-urban areas of Ghana. Farmers in the study areas had some difficulties distinguishing among types of chemical inputs. On vegetables such as cabbage, tomato and garden egg, the current recommendation in Ghana was to apply Karate 2.5 EC at the rate of 200 –800 ml / ha. Cabbage producers applied by far the highest volumes of Karate/ha, on average 6.3 L/ha totaling US$ 56. Cabbage production was relatively labor intensive given the short period of cultivation (90 days or less), the limit use of technological equipment and machinery, and the small size of plots (less than 0.3 Ha on average).

Jeyanthi and Kombairaju (2005) examined the pest management practices in four important vegetable crops, viz. chillies, cauliflower, brinjal and bhendi using farm level cross-sectional data in India. Average pesticide usage has been estimated at 5.13, 2.77, 4.64 and 3.71 Kg active ingredient per hectare on chillies, cauliflower, brinjal and bhendi crops, respectively. On an average, cauliflower and brinjal were each given 15 applications, chillies is given 13 and bhendi is given 12 applications. About 87 per cent of cauliflower growers applied pesticides amounting to 4 Kg or less of a.i/ha and the remaining applied more than this quantity. The inter-farm variation in pesticide-use intensity ranged from 1.27 Kg of a.i/ha to 6.43 Kg of a.i/ha. Farms in the low range of pesticide-use intensity (1-2 Kg of a.i/ha) formed 24.44 per cent, whereas with high range (more than 6 Kg of a.i/ha) formed only 4.44 per cent. Highest number of farms (44.44 per cent) was observed in the pesticide-use intensity range of 2 to 3 Kg of a.i/ha. The study has suggested that for reducing pesticide-use, farmers need to be educated about different nonchemical control methods and should be encouraged to adopt integrated pest management (IPM) practices.

Smallholder farmers in Northern Tanzania grow vegetables that include tomatoes, cabbages and onions and use many types of pesticides to control pests and diseases that attack these crops. Based on the use of questionnaires and interviews that were conducted in Arumeru, Monduli, Karatu and Moshi rural districts, this study investigates farmers' practices, perceptions and related cost and health effects on vegetable pest management using pesticides. The types of pesticides used by the farmers in the study areas were insecticides (59%), fungicides (29%) and herbicides (10%) with the remaining 2% being rodenticides. Pesticides were bought from pesticides shops (60%), general shops (30%) and cooperative shops (10%). The pesticides were supplied in containers ranging from 0.5 to 5 l Kg or in packets ranging from 0.5 to 25 Kg. Up to 90% of farmers had a maximum of 3 pesticides in a mixture. More than 50% of the respondents applied pesticides up to 5 times or more per cropping season depending on the crop (Ngowi et al. 2007).

2.2.2 Factors Influencing the Demand of Inputs

It is widely accepted that increased use of purchased inputs (seeds, chemicals and fertilizers) has a critical place, alongside organic soil fertility enhancement practices. In general, emphasis has been on national or regional demand estimates for total fertilizer or nutrient application on all crops. In developed countries, it is generally agreed that fertilizer demand is price inelastic. This may be due to lack of an economic substitute to chemical fertilizer. Generally, in less developed countries the demand for fertilizer is thought to be more elastic under the assumption of readily available substitutes such as manure and other organic materials. However, the demand for fertilizer may differ from country to country due to the factors such as cultural practices, climate, soil type, crop grown and farm structure (Ekanayake 2006).

Magana et al. (2011) examined the factors that affect smallholder farmers' demand for purchased fertilizer and seed using cross section data from 160 farmers in Lilongwe District, Malawi. The study found that education, field size (plot of land cultivated) and household size have significant negative relationship with the share of fertilizer purchased and positively related with share of seed. The results from the study, both price of seed and fertilizer are significant at 1% with a positive association on share of fertilizer and negative association on share of seed, showing that the price of this inputs significantly affect farmers demand for purchased inputs. The results are similar with findings of other studies like Njiwa (2007) who found a positive relationship between price of fertilizer and intensity of its use.

Smale and Birol (2013) studied the smallholder demand for maize hybrids and selective seed subsidies in Zambia. The study found that farmers with a lower poverty headcount are more likely to receive subsidized seed. In addition, a segment of farmers with a high predicted demand for hybrid seed are not reached by the Farmer Input Support Program FISP—and they are poorer in terms of land and income than those who obtain the subsidy. The seed price was positively related to the quantity of seed because of controlling for the effect of the subsidy.

Empirical studies identify numerous variables as being important to a household's decision to use a new technology. Kherallah et al. (2001) reported that market price of fertilizer had a negative effect, as economic theory would suggest, on fertilizer use in Benin. This result suggested that household use of fertilizer decreased as its price increased and its use increased as price decreased. Interestingly, the corresponding variable for fertilizer use in their study in Malawi was not found to be significant. Farm size has a positive impact on a household's decision to adopt and use a new technology such as fertilizer in Benin and Malawi. Households with larger cultivated areas tended to have more productive assets and fewer credit constraints than smaller ones.

Kayarkanni (2000) studied fertilizer use in three major crops in Mudurai district of Tamil Nadu from a survey of 324 farmers. The relative price of fertilizer had a greater influence on fertilizer use. It was also found that fertilizer demand for the three crops was price inelastic. It was inferred that other things remaining constant fertilizer use on tenant farm was more than that on owner farms. The co-efficient of irrigation system dummy was found to be negative and significant for sugarcane and cotton crops. This implied that the use of fertilizer was found to be higher in irrigation system other than the cannel system.

Knepper (2002) analyzed that the factors affecting the total quantity of fertilizer a household uses in Zambia. This study found to significantly increase a household's likelihood of using fertilizer include total cropped area, ownership of farming assets, and proximity to a fertilizer depot.

Ebong et al. (2006) examined that the demand for fertilizer technology by the smallholder crop farmers for sustainable agricultural development in Akwa Ibom State, Nigeria. Using a linear regression analysis the result indicated farm size, price of fertilizer, price of manure (a substitute) and farmer's education to be important variables that significantly affected the demand for fertilizer in the State.

The level of fertilizer use, especially overuse, as well as farming practices in Northern China have a great impact on the water quality downstream and affect an enormous number of people. This study analyzed the factors influencing the farmers' decisions on fertilizer use and the implications for water quality. The analysis was based on a survey of 349 farm households. It takes into consideration both farm and farmer specific characteristics and farmers' subjective evaluations of factors shaping their decisions. Regression models were used to examine the determinants of fertilizer use intensity across farm households and to investigate the factors influencing the overuse of nitrogen. The results suggested that many of these subjective factors have great significance in determining famers' decisions. The results also showed that irrigation, gains in crop yield and higher earning goals are positively correlated with fertilizer use intensity, while farm size, manure application, soil fertility and the distance to fertilizer markets are negatively correlated. Investigation of the overuse problem showed that higher education level significantly reduces the probability of over-fertilization (Zhou et al. 2010).

Bayite-Kasule et al. (2011) focused on both supply-side and demand-side issues that determine inorganic fertilizer use by smallholder farmers in four study areas in the Central and Eastern regions of Uganda. A survey on fertilizer acquisition and use was administered to 275 farmers who were randomly selected from lists of fertilizer users and non-users in each survey cluster. The overall objective of this study was to investigate demand-side constraints to fertilizer use by smallholder farmers in Uganda. A quantitative analysis was carried out to identify the major determinants of fertilizer use by farmers. Also, key characteristics of the farmers were examined disaggregated by fertilizer use and non-use. At household level, the household head being a woman and the number of years the head of household has engaged in farming are negatively associated with fertilizer use, whereas somewhat higher asset ownership, involvement in off-farm work of a skilled nature, and a subjective assessment that quality of the soil one farms is poor have a positive effect on fertilizer use.

Mudi and Giri (1999) conducted the study on variation in the pattern of fertilizer use between Aman paddy and potato and their economics in West Bengal. Primary survey was conducted purposively in selected three village of Ghatal block in the district of Midnapur for the study. They found that farms used different types of fertilizer in different forms and combinations either as single nutrient fertilizer or a mixed nutrient fertilizer and branded, unbranded or in the combination of both. They concluded that the potato growers had inclination to use mixed fertilizers along with single nutrient fertilizer. Paddy growers preferred the use of single nutrient branded fertilizer in majority cases. There was a positive correlation (0.39) between percentage of nitrogen placed as top dressing and yield.

Suma (2007) studied the demand for chemical fertilizer in Karnataka. The study found that the coefficient of irrigated area and quantity of FYM applied were negative and not significant. The coefficient of fertilizer price was negative indicating that a unit increase in the price of fertilizer reduces the quantity demanded of fertilizer by 0.54 unit. Thus inelastic demand was observed for fertilizer.

Hansen (2004) estimates nitrogen fertilizer demand elasticity for Danish crop farms using the dual profit function approach on micro panel data. The model includes several farm specific parameters, allowing estimating the mean demand elasticity and testing for homogeneity of elasticity across panel farms. The mean own price elasticity for nitrogen is –0.45, and there is a significant standard deviation from this mean for individual farms of 0.24.

Demand for pesticides, inorganic and organic fertilizers were jointly estimated using survey data from 81 randomly selected ‘contract hybrid vegetable and cereal seed growers’ in northwestern Bangladesh. Pesticide cost accounts for 6.9 % of the gross value of output in hybrid vegetable seeds and 3.2% in cereals. About 87% of farmers used pesticides at least once with mean number of applications 4.4. Twenty-five brands of pesticides were used including a substantial number of banned pesticides. Price elasticity of demand for pesticides, fertilizers and biofertilizers were estimated at –0.83, –0.21 and –1.13, respectively. Farmers treat chemical fertilizers and pesticides as complements since the demand for fertilizer decreases when pesticide price increase (Birthal et al. 2000).

It is likely that the level of pesticide use varies across crops, severity of pest and disease infestation, agro-ecological factors, socioeconomic factors, and knowledge of crop management practices. In general, farmers use more pesticides on vegetables and high value crops than cereals and staple crops (Ali and Hau 2006).

Many factors affect both the level and intensity of pesticide used for a crop. From an economic point of view, the decision to use pesticides is related to price of pesticides, expected crop prices at the time of harvest (ex-ante price), price of other agricultural inputs, and farmers' expected net returns from selling the produce (Carlson and Wetzstein, 1993).

Rahman (2003) suggested that some rice farmers in Bangladesh treated pesticides as a substitute for fertilizers; they increased pesticide use on rice as fertilizer prices increased. Size of farm affected level of pesticide use. Land ownership was significantly positively associated with pesticide use indicating that large farm households used more pesticide. The availability of credit was significant and positively related with pesticide use indicating that greater liquidity increase level of pesticide use. An increase in the price of pesticide is expected to reduce its demand. In a study in Sri Lanka, Selvarajah and Thiruchelvam (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.

Moe Thida Kyaw (2012) examined the fertilizer and pesticides demand function of rice production in Nay Pyi Taw, Myanmar. In this study, the selected fertilizers and pesticides for farmer's demand functions were urea, t-super, potash, compound, folia and pesticides. Based on the regression analysis, crop price and factor share of crop production were the most important influencing factors for the demanded quantity of selected agrochemicals in paddy production. There was statistically significant at 1% level in all demand functions except compound fertilizer demand in which factor share of agrochemical and crop price were significant at 5% level. The own price of selected agrochemical has significantly influenced by potash, folia and pesticide demanded quantity of the sampled farmers. There were negative relationship between own price of selected agrochemicals and their input quantity used in crop production.

2.3 Input Demand Function

Demand is defined as the quantity of a commodity that buyers are willing and able to buy at a specified price in a given market and at a particular time. This demand is termed "effective" as it is backed by the ability to pay for such goods. Therefore individuals (consumers) are prepared to pay for goods and services, because of their values (Tanko and Mbanasor, 2000). The quantity of a commodity demanded is a function of factors referred to as determinants of demand. The demand function in its implicit form can be presented as:

Q_d = f (P, T, Pr, Y, F)

Where

Q_d= quantity of product demanded by a consumer

P = product price

T = taste and preference of consumers

P_r = price of related products

Y = consumers' income

F = family (household) size.

On the basis of *ceteris paribus*, other variables (determinants) can be held constant to observe the effect that a particular variable exert on demand. Price is a major determinant of effective demand (Ebong et al. 2006).

In the estimation of input demand, different approaches have been suggested and adopted, cited by (Chembezi 1990), identifies two approaches direct and indirect estimation. Indirect approaches include deriving demand functions from agronomic response functions and research. Direct methods include estimating demand functions directly from observed market data on input consumption and prices, and the prices or amounts of farm output.

Seed demand estimation plays a very important role in management decision making both by the government and seed growers. Some idea about the future is a prerequisite for making decisions in various aspects of seed supply management. Seed demand forecasting is the process of making projections of demand for products by examining past and present performance levels, combined with an assessment of available products and markets. This may be carried out within the government service or by individual companies in a purely commercial context (FAO 2006).

Warjiyo and Huffman (1997) stated that costs insured that farmers' demand for most inputs depend not only on current exogenous factors but also on past use and expectations about future use. These were arguments that agricultural input demand functions, at least for the developed countries, are dynamic, requiring some time for full adjustment to exogenous economic shock to occur in United State of America.

Denny (1992) identified two different approaches to dynamic input demand. First, there were theory-based models where dynamics arise from optimal agent behavior and second, data-based dynamic models had been used where dynamics are used to describe the pattern of input use but do not arise from explicitly optimal agent behavior. The models leading to quasi-fixed inputs in agriculture for developed countries were ones built largely upon a hypothesis of significant internal costs associated with resource adjustment (Barro and Martin 1995).

Economic theory suggests that the quantity of fertilizer used will be a function of expected output prices, the price of fertilizer, prices of related inputs, and the productivity of fertilizer and related inputs. A producer's demand for fertilizer is derived from the underlying production function and demand for the commodities produced with the fertilizer. To derive the input demand function, one forms the profit function in terms of output price, the production function, and costs associated with the inputs. Maximization of profits with respect to the quantity of inputs by taking the partial derivatives of the profit function with respect to the inputs, setting the partial derivatives equal to zero and solving these equations for the quantity of inputs, yields the input demand functions. If one assumes a Cobb- Douglas production function, the demand function for the inputs will be linear in the logarithms. This functional form is appropriated for the analysis of fertilizer demand (Carmen 1979).

Yeager et al. (2011) used 10 years of continuous data for 218 farms in central Kansas to estimate input demands for labor, livestock, seed, fertilizer, chemicals, repairs, fuel, and capital. Additional variables of interest were tillage method, percent of labor devoted to crop production, and average total assets. The farms denoted as no-till had an increased demand for seed and chemicals. The farms with a greater percentage of labor devoted to crop production had an increased demand for seed, fertilizer, chemicals, repairs, fuel, and capital. Larger farms in terms of average total assets had an increased demand for labor and capital.

Sokleang et al. (2004) analyzed that factors were affecting the demand for chemical fertilizers provided that firstly, the demand for urea was significantly affected by its price, manure price, un-husked rice price and fertilizer subsidy policy; secondly, the demand for Triple Super Phosphate was definitely influenced by its price, manure price, annual rainfall and fertilizer policy subsidy; thirdly, the demand for Ammonium Sulfate was significantly affected by only its price and manure price; finally, the demand for Potassium Chloride was meaningfully impacted on by its price, manure price and annual rainfall in Java Island. This research used the secondary data in time series of 20 years (1981-2000), which obtained from some relevant institutions and it applied the Ordinary Least Square (OLS) was used to analyze data in form of static and dynamic model.

Quddus et al. (2008) stated that the factors which had been affecting demand for fertilizer as specified equations for nitrogen, phosphorus and potash were estimated by using both the static as well as the dynamic models. The results were acceptable from both an economic and statistical point of view. The estimated price elasticity of demand demonstrates variations between the nutrients. The Cobb-Douglas production function had been applied to the analysis and Ordinary Least Square in double log form was used for estimation. The results suggested that the demand for nitrogen and phosphorus were price inelastic both in the short run as well as in the long run while for potash fertilizer.

CHAPTER III

RESEARCH METHODOLOGY

3.1 Conceptual Framework of the Study

There are many influencing factors to manage the use of inputs in cabbage and cauliflower production. There was strong relationship between input consumption of the farmers and selected demographic factors (Nwagbo and Achoja 2001). Demographic characteristic such as age, education, farming experience, total sown area, household assets and family labors would be related to input demand, cultural practices, and farmers' behaviors. Cultural practices can differ depending on access and farmers' behaviors. Farmers' behaviors such as selection on seed brands, farmers' knowledge on types of fertilizer and pesticide, advantages and constraints of cultivation dominant the cultural practices. Farmers' behaviors can be changed based on their access and make decision on selecting cropping pattern, intensity and input application. Types of access are buying inputs in credit transaction, information of input utilization, market, extension education and credit.

The decision on the use of purchased inputs required inputs and information on prices but prices can be particularly uncertain and variable (Maganga et al. 2011). Prices of inputs, output and labor wages influence the demand of inputs and cultural practices (Figure 3.1).

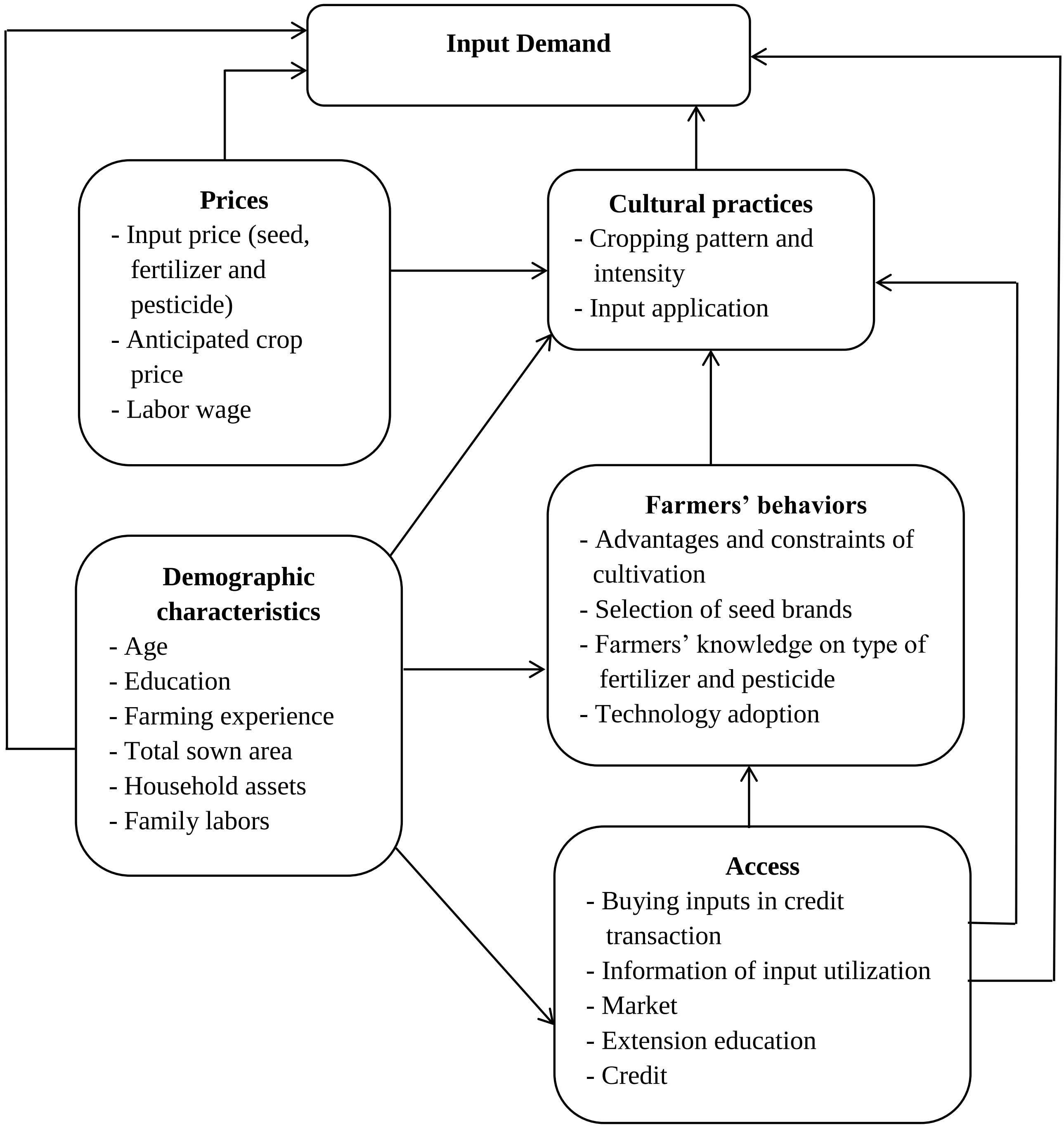


Figure 3.1 Conceptual framework of the input demand by the sample farmers

3.2 General Description of Study Area

Tatkon Township is situated between latitude 20˚20' north and east longitudes 96˚ 30'. The area of Tatkon Township was 180,237 hectares and the cultivated area was 39,639 hectares, 21.9% of total area. The percentage share of cultivated land utilization in Tatkon Township (2012-13) was shown in Figure 3.1. The area of paddy land (Le) was about 18,704 hectares and dry land (Ya) was about 20,930 hectares. The vegetable grown area in 2012-13 was 1,102 hectares in Tatkon Township (DoA 2013). Tatkon Township was selected due to its large sown area of vegetables in Nay Pyi Taw Council. A map of the study area is showed in Appendix 2.

3.3 Data Source and Data Collection

Primary data were collected in Takkon Township from January to February 2014. The household level survey was carried out in two villages (Table 3.1). A total of 120 sample farmers were personally interviewed in which 60 farmers from Nweyit village and 60 farmers from Kyartharai village with a set of structured questionnaires to obtain the primary data using random sampling method.

Demographic characteristics of cabbage and cauliflower farmers such as age, household head’s education level, household's experience in cabbage and cauliflower production, family size and family labor were collected. And also cultural practices of cabbage and cauliflower production such as land owned, vegetables production area, varieties used, seed rate per hectare, cropping patterns, animal husbandry, utilization of fertilizer, seed, pesticide and fertilizer use behaviors in farming activities were collected.

Detail costs (hired labor cost, non-labor input cost, interest on cash cost) and returns of cabbage and cauliflower production, constraints and perspective of cabbage and cauliflower farmers were also composed in data collection. The relevant secondary information was taken from official records of Ministry of Agriculture and Irrigation (MoAI) and Department of Agriculture (DoA).

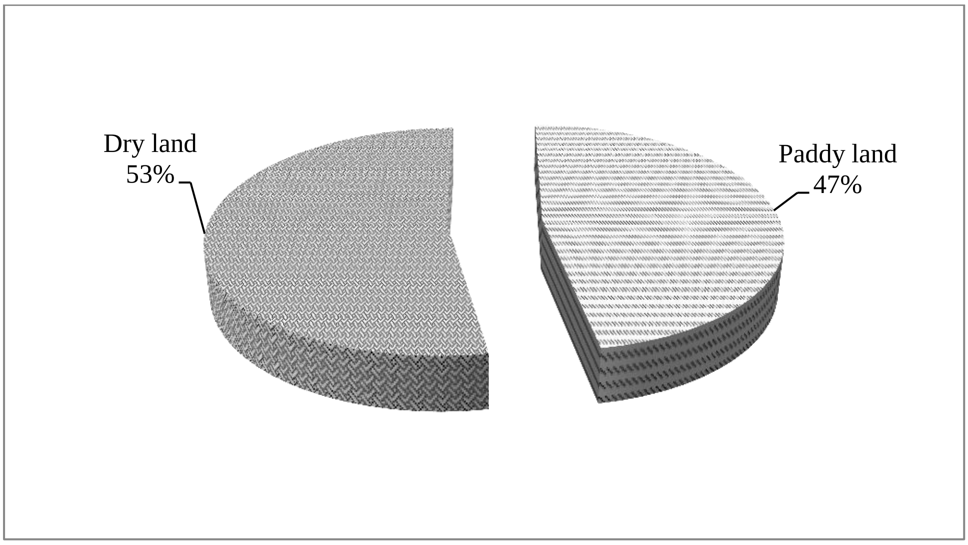


Figure 3.2 Percentage share of cultivated land utilization in Tatkon Township (2012-13)

Source: DoA (2013)

Table 3.1 Information of farm households in the study area

Village	Village tract	Population	Total No. of HH	No. of farm HH
Nweyit	Nweyit	3955	660	355
Kyartharai	Kyartharai	2546	462	332

Note: HH= Household

Source: DoA (2013)

3.4 Analytical Method

Collected data were compiled in the Microsoft Excel program. The analysis was employed with demographical approach, descriptive method, and regression model using Excel Software and Statistical Packages for Social Science (SPSS) version 16. The analytical techniques included descriptive analysis, cost and return analysis and input demand functions for agrochemicals (seed, fertilizer and pesticide) for cabbage and cauliflower production.

3.4.1 Descriptive Analysis

Descriptive analysis was used to know farmer social characteristics and to describe socio-economic features of the respondents and their knowledge on agricultural inputs such as seed, fertilizer and pesticide management and existing cropping patterns, yield and problems of using pesticide. Mean, percentages and frequency counts were included in descriptive measurement.

3.4.2 Cost and Return Analysis

Enterprise budgets are important decision making tools. They can help individual producers determine the most profitable crops to grow, develop marketing strategies, obtain financing necessary to implement production plans, and make other farm business decisions. An enterprise budget is a physical and financial plan for raising and selling a particular crop or livestock commodity. It is a physical plan because it indicates the type and quantity of production inputs and the output, or yield, per unit. It is also a financial plan, because it assigns costs to all the inputs used in producing the commodity. Budgets are calculated in units of one acre to facilitate budgeting for different enterprise sizes and to simplify calculations (Carkner 2000).

An enterprise budget is a detailed accounting of revenues and expenses related to a profit center within a business. Enterprise budgets are important tools in determining profitability of individual ventures (Peabody 2007).

In this study, the concept of enterprise budget was used to evaluate the profitability of cabbage and cauliflower production. Variable costs were taken into account;

(1) Material input cost,

(2) Hired labor cost,

(3) Family labor cost and

(4) Interest on cash cost.

Enterprise budget enables to evaluate the cost and return of production process. Hired labor costs were valued by market wage rates and man days used in all farming practices. In order to estimate gross return for respective crops, average yield and average price were used. Benefit cost ratio was used as profitability measures for each crop enterprise computing total gross margin or return above variable cost and return above cash costs. Input quantities and values used in production process (costs) and output quantities and values (benefits) are the basic data required for budgets (Olson 2009).

In this study, the profitable procedures were used as follow;

RAVC = TGR – TVC

RACC = TGR – TVCC

BCR = TGR/ TVC

Where;

RAVC = Return above variable cost

RACC = Return above cash cost

BCR = Benefit cost ratio

TGR = Total gross return

TVC = Total variable cost

TVCC = Total variable cash cost

3.4.3 Input Demand Function

The demand for production inputs is a derived demand based on the demand for the final product. Fertilizer is one of a number of inputs used in crop production (Hoy 1979). Economic theory suggests that the quantity of fertilizer used will be a function of expected output prices, the price of fertilizer, prices of related inputs, and the productivity of fertilizer and related inputs.

To analyze the agricultural input demand functions of cabbage and cauliflower production, farmers' demands for each input represent a vital factor market. Demand decisions for inputs are accordingly represented by many factors.

To determine the factors affecting the demand of input (seed, fertilizer and pesticide) of the cabbage and cauliflower production, linear regression function was used. The dependent variable was applied quantity of inputs (seed, fertilizer and pesticide) in cabbage and cauliflower production by sample farmers and independent variables were household head’s education level, household head’s experience, total sown area, cropping intensity, total family labor, quantity of FYM, quantity of gypsum, quantity of urea, lagged crop price, current input prices and buying inputs in credit transaction.

The regression function was as follow:

(1) Demand Function for Seed in Cabbage/Cauliflower Production

$$\text{Ln } D_S = \beta_0 + \beta_1 \text{ Ln } X_{1i} + \beta_2 \text{ Ln } X_{2i} + \beta_3 \text{ Ln } X_{3i} + \beta_4 \text{ Ln } X_{4i} + \beta_5 \text{ Ln } X_{5i} + \beta_6 \text{ Ln } X_{6i} + \beta_7 \text{ Ln } X_{7i} + \beta_{8i} \text{ Ln } X_{8i} + \beta_{1i} D_{1i} + \mu_i$$

Where,

D_S = Applied quantity of seed in cabbages/cauliflower production (g/ha)

X_{1i} = Household head's education level of farmer (schooling year)

X_{2i} = Year of farm experience in cabbage/cauliflower production (year)

X_{3i} = Total sown area (hectare)

X_{4i} = Cropping intensity (%)

X_{5i} = Total family labor (No.)

X_{6i} = Quantity of FYM (MT/ha)

X_{7i} = Quantity of gypsum (Kg/ha)

X_{8i} = Current seed price (Ks/g)

D_{1i} = Buying seed in credit transaction (credit=1, not=0)

Ln = Natural logarithm

i = 1……….n

μ_i = Disturbance term

(2) Demand Function for Urea Fertilizer in Cabbage/Cauliflower Production

$$\text{Ln } D_U = \beta_0 + \beta_1 \text{ Ln } X_{1i} + \beta_2 \text{ Ln } X_{2i} + \beta_3 \text{ Ln } X_{3i} + \beta_4 \text{ Ln } X_{4i} + \beta_5 \text{ Ln } X_{5i} + \beta_6 \text{ Ln } X_{6i} + \beta_7 \text{ Ln } X_{7i} + \beta_{8i} \text{ Ln } X_{8i} + \beta_{1i} D_{1i} + \mu_i$$

Where,

D_U = Applied quantity of urea fertilizer in cabbage/cauliflower production (Kg/ha)

X_{1i} = Household head's education level of farmer (schooling year)

X_{2i} = Year of farm experience in cabbage/cauliflower production (year)

X_{3i} = Total sown area (hectare)

X_{4i} = Cropping intensity (%)

X_{5i} = Total family labor (No.)

X_{6i} = Quantity of FYM (MT/ha)

X_{7i} = Lagged output price received by farmer (Ks/head)

X_{8i} = Current urea price (Ks/Kg)

D_{1i} = Buying fertilizer in credit transaction (credit=1, not=0)

Ln = Natural logarithm

i = 1……….n

μ_i = Disturbance term

(3) Demand Function for Compound Fertilizer in Cabbage/Cauliflower Production

$$\text{Ln } D_C = \beta_0 + \beta_1 \text{ Ln } X_{1i} + \beta_2 \text{ Ln } X_{2i} + \beta_3 \text{ Ln } X_{3i} + \beta_4 \text{ Ln } X_{4i} + \beta_5 \text{ Ln } X_{5i} + \beta_6 \text{ Ln } X_{6i} + \beta_7 \text{ Ln } X_{7i} + \beta_{8i} \text{ Ln } X_{8i} + \beta_{1i} D_{1i} + \mu_i$$

Where,

D_C = Applied quantity of compound fertilizer in cabbage/cauliflower production (Kg/ha)

X_{1i} = Household head's education level of farmer (schooling year)

X_{2i} = Year of farm experience in cabbage/cauliflower production (year)

X_{3i} = Total sown area (hectare)

X_{4i} = Cropping intensity (%)

X_{5i} = Total family labor (No.)

X_{6i} = Quantity of FYM (MT/ha)

X_{7i} = Quantity of urea fertilizer (Kg/ha)

X_{8i} = Current compound price (Ks/Kg)

D_{1i} = Buying fertilizer in credit transaction (credit=1, not=0)

Ln = Natural logarithm

i = 1……….n

μ_i = Disturbance term

(4) Demand Function for Pesticide in Cabbage/Cauliflower Production

$$\text{Ln } D_P = \beta_0 + \beta_1 \text{ Ln } X_{1i} + \beta_2 \text{ Ln } X_{2i} + \beta_3 \text{ Ln } X_{3i} + \beta_4 \text{ Ln } X_{4i} + \beta_5 \text{ Ln } X_{5i} + \beta_6 \text{ Ln } X_{6i} + \beta_7 \text{ Ln } X_{7i} + \beta_{8i} \text{ Ln } X_{8i} + \beta_{1i} D_{1i} + \mu_i$$

Where,

D_P = Applied quantity of pesticide in cabbage/cauliflower production (L/ha)

X_{1i} = Household head's education level of farmer (schooling year)

X_{2i} = Year of farm experience in cabbage/cauliflower production (year)

X_{3i} = Total sown area (hectare)

X_{4i} = Cropping intensity (%)

X_{5i} = Total family labor (No.)

X_{6i} = Quantity of FYM (MT/ha)

X_{7i} = Quantity of gypsum (Kg/ha)

X_{8i} = Current pesticide price (Ks/L)

D_{1i} = Buying pesticide in credit transaction (credit=1, not=0)

Ln = Natural logarithm

i = 1……….n

μ_i = Disturbance term

CHAPTER IV
RESULTS AND DISCUSSION

4.1 Demographic Characteristics of the Sample Farmers in the Study Area

In the study area, average age of the sample farmers was around 45 years, ranging from 23 to 70 years old. In cabbage and cauliflower production, average farming experience was around 21 years ranging from 3 to 45 years. Most of the sample farmers were in primary education level; average schooling year was 6.3 years ranging from 3 to 15 years.

In the study area, family size ranged from 2 to 8 persons and average family size was 4.5 persons. Number of family labors ranged from 1 to 6 persons and average family labors was 2.9 persons. By investigating average farm size, paddy land (Le) was 0.47 hectares and ranging from 0.4 to 3.24 hectares while dry land (Ya) was 1.42 hectares and ranging from 0.4 to 14.16 hectares (Table 4.1). In terms of cultivated land type of the sample farmers, 48%, 47% and 3% of sample farmers respectively owned dry land only, both dry land and paddy land and dry land only. Tenants were composed of 2% of the sample farmers (Figure 4.1).

4.1.1 Livestock Breeding, Farm and Household Assets of the Sample Farmers

The percentages of sample farmers who had livestock breeding were shown in Table 4.3. In the study area, 87.5% of the sample farmers owned cattle mainly for land preparation. Pigs and chicken were raised for meat production by 5% and 34.2% of the sample farmers (Table 4.2)

More or less 90% of sample farmers owned plough, harrow, bullock cart, sprayer, water pump and pipe as these farm assets were essential farm equipment for traditional farming system (Table 4.3). Because of modern technology and changing society, about 60% of farmers could use bicycle, motorcycle and mobile phone. Power tiller and solar plate were also owned by few farmers (about 7%) in the study area.

Table 4.1 Demographic characteristics of the sample farmers in the study area

Items	Unit	Mean	Range	Standard deviation
Age	Year	45.0	23 - 70	11.89
Farming experience	Year	21.1	3 - 45	11.47
Education	Year	6.3	3 - 15	2.94
Family size	No.	4.5	2 - 8	1.35
Family labor	No.	2.9	1 - 6	1.24
Farm size				
- Paddy land	ha	0.47	0.40 - 3.24	0.67
- Dry land	ha	1.42	0.40 - 14.16	1.59

N=120

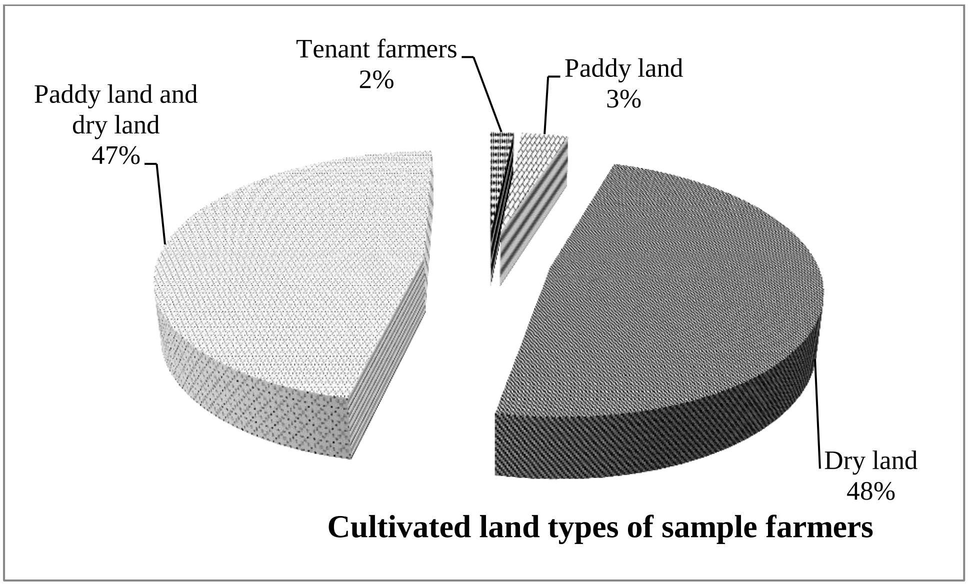


Figure 4.1 Cultivated land types of the sample farmers in the study area

Table 4.2 Percentage of the sample farmers who had livestock breeding

Items	Number of farmers
Cattle	
- Draught	85 (87.5)
- Dairy	8 (7.5)
Pig	6 (5.0)
Chicken	42 (34.2)

N=120

Note: Figures in the parentheses represent percentage.

Table 4.3 Farm and household assets of the sample farmers

Items	Number of farmers
Plough	108 (90.0)
Harrow	109 (90.8)
Bullock cart	85 (87.5)
Power tiller	9 (7.5)
Sprayer	118 (98.3)
Pump	119 (99.1)
Pipe	119 (99.1)
TV	58 (48.3)
Solar plate	8 (6.6)
Bicycle	82 (68.3)
Motor cycle	72 (60.0)
Mobile phone	70 (58.3)

N=120

Note: Figures in the parentheses represent percentage.

4.2 Cropping Patterns and Inputs Used in the Study Area

4.2.1 Cropping Patterns of the Sample Farmers

In the study area, corn and green gram were grown as the first crop in monsoon season. After harvesting corn and green gram, most farmers grew vegetables especially cabbage and cauliflower. Corn, green gram, cabbage and cauliflower were the dominant crops among the cropping patterns in Tatkon Township. The cropping patterns mostly grown in Tatkon Township were presented in Table 4.4. Among corn based cropping patterns, corn followed by cabbage/cauliflower cropping pattern was grown by 34.9% of the sample farmers.

Among green gram based cropping patterns, green gram followed by cabbage/cauliflower cropping pattern was grown by 11.9% of the sample farmers while green gram followed by other crops pattern was applied by 13.9%. The other crops in monsoon season were chilli, carrot, eggplant and sesame. The other crops in winter season were onion, watermelon, tomato, carrot, chilli, radish and groundnut. It was found that corn based and green gram based triple cropping patterns including cabbage/cauliflower were grown by 9.7% and 6% of the sample farmers respectively.

There were several reasons for the cultivation of cabbage and cauliflower in the study area (Figure 4.2). The sample famers decided to cultivate the cabbage and cauliflower mainly based on high income (40.8%), high price (28.3%), good marketing condition (23.4%) and followed by usual crops (7.5%). In the study area, most farmers cultivated cabbage and cauliflower (45%), cauliflower only (34.2%) and cabbage only (20.8%) (Figure 4.3).

Table 4.4 Cabbage and cauliflower based various cropping patterns

Cropping pattern	Frequency
Corn-Cabbage/Cauliflower	85 (34.9)
Corn-Cabbage/Cauliflower- Other	14 (5.7)
Corn-Cabbage/Cauliflower- Cabbage/Cauliflower	6 (2.4)
Corn-Other-Cabbage/Cauliflower	4 (1.6)
Corn-Other (onion, watermelon, tomato etc.)	34 (13.9)
Green gram-Cabbage/Cauliflower	29 (11.9)
Green gram-Cabbage/Cauliflower- Other	6 (2.4)
Green gram-Cabbage/Cauliflower- Cabbage/Cauliflower	5 (2.0)
Green gram-Other-Cabbage/Cauliflower	4 (1.6)
Green gram-Other	30 (12.3)
Other-Cabbage/Cauliflower	17 (7.0)
Other (chilli, carrot, eggplant etc.)-Other	9 (3.7)
Total	243 (100)

Note: Figures in the parentheses represent percentage.

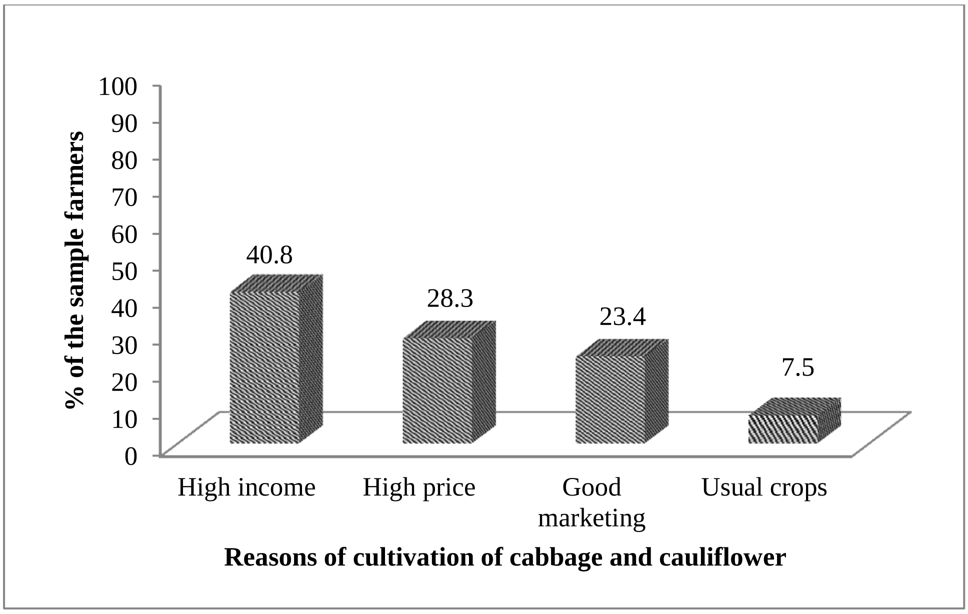


Figure 4.2 Reasons of cultivation of cabbage and cauliflower by the sample farmers

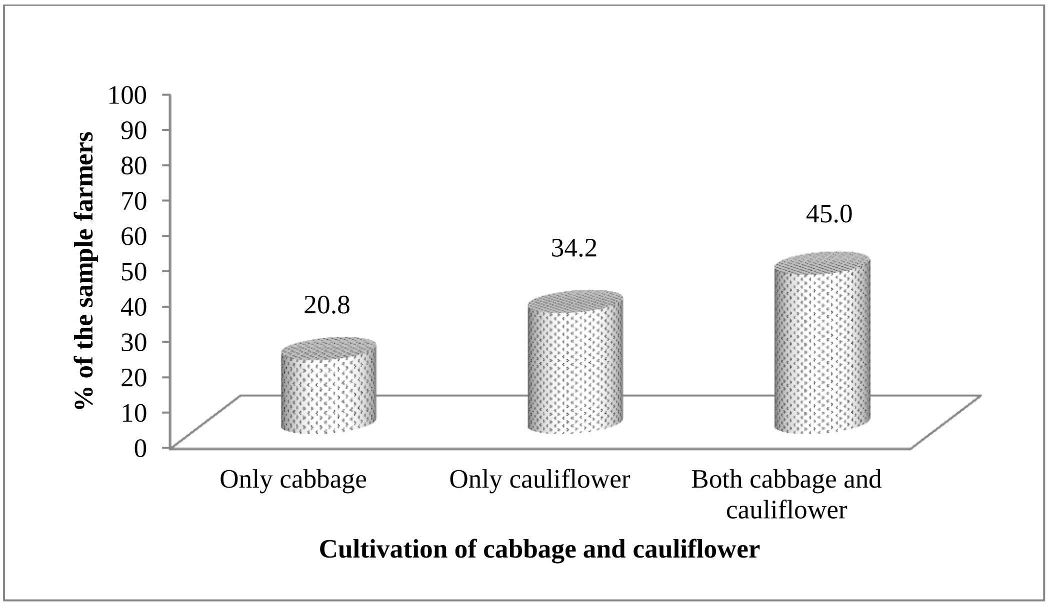


Figure 4.3 Cultivation of cabbage and cauliflower by the sample farmers

4.2.2 Cabbage and Cauliflower Seeds and Seed Rate Used

In Myanmar, some vegetables especially cabbage and cauliflower were imported from foreign countries such as Thailand and China etc. In cabbage production, 6 cultivated seed brands were observed in the study area. “Crown” was the most popular cabbage brand and 79.7% of the sample farmers used it. The other brands were “588”, “123”, “073”, “Grand 11”, “Grand Eden” and very few farmers grew them (Table 4.5). There were 13 popular cauliflower seed brands in the study area. Among 95 sample farmers of cauliflower production, 37.9% of sample farmers grew “444” cauliflower brand while 12.6% and 11.6% of sample farmers grew “007” and “big top” brand respectively (Table 4.6). The average seed rate of cabbage was 253.3 (g/ha) and cauliflower was 278.9 (g/ha) in the study area. The maximum seed rate of cabbage was 494.2 (g/ha) and minimum seed rate was 98.8 (g/ha). The maximum seed rate of cauliflower was 494.2 (g/ha) and minimum seed rate was 148.3 (g/ha) (Table 4.7). It can be compared that the seed rate of cabbage and cauliflower were 400-500 (g/ha) in Marzon, India (Sigh et al. 2013).

There were different reasons for choosing improved seed brands. Selection of seed brands was mainly based on good quality (49%), resistance to pest and disease (42%), short duration (1%), cheaper price (1%) and other reasons (7%) respectively (Figure 4.4).

Moreover most farmers often changed improved seed brands (Table 4.8). Frequency of changing seed brands made by the sample farmers was two years interval (32%), three years interval (22%) and one year interval or four years interval (13% for each). Twenty percent of the sample farmers did not change the seed brands. It was observed that sample farmers have different reasons for changing the seed brands. About 41.7% of sample farmers changed the seed brands because of low quality whereas about 34.4% of them changed it because of poor germination (Table 4.9).

Table 4.5 Cultivated seed brands of cabbage in the study area

No.	Cultivated seed brands	Number of farmers
1	Crown	63 (79.7)
2	588	8 (10.1)
3	123	4 (5.1)
4	Grand 11	2 (2.5)
5	073	1 (1.3)
6	Grand Eden	1 (1.3)
	Total	79 (100)

Note: Figures in the parentheses represent percentage.

Table 4.6 Cultivated seed brands of cauliflower in the study area

No.	Cultivated seed brands	Number of farmers
1	444	36 (37.9)
2	007	12 (12.6)
3	Big top	11 (11.6)
4	073	9 (9.5)
5	Pan	6 (6.3)
6	106	6 (6.3)
7	588	5 (5.2)
8	White Gold	4 (4.2)
9	Oki	2 (2.1)
10	Tarbo	1 (1.1)
11	Winter	1 (1.1)
12	Candid Charm	1 (1.1)
13	Jumbo	1 (1.1)
	Total	95 (100)

Note: Figures in the parentheses represent percentage.

Table 4.7 Amount of improved seed used for cabbage and cauliflower production

Items	Unit	Cabbage (N=79)	Cauliflower (N=95)
Mean	g/ha	253.3	278.9
Minimum	g/ha	98.8	148.3
Maximum	g/ha	494.2	494.2

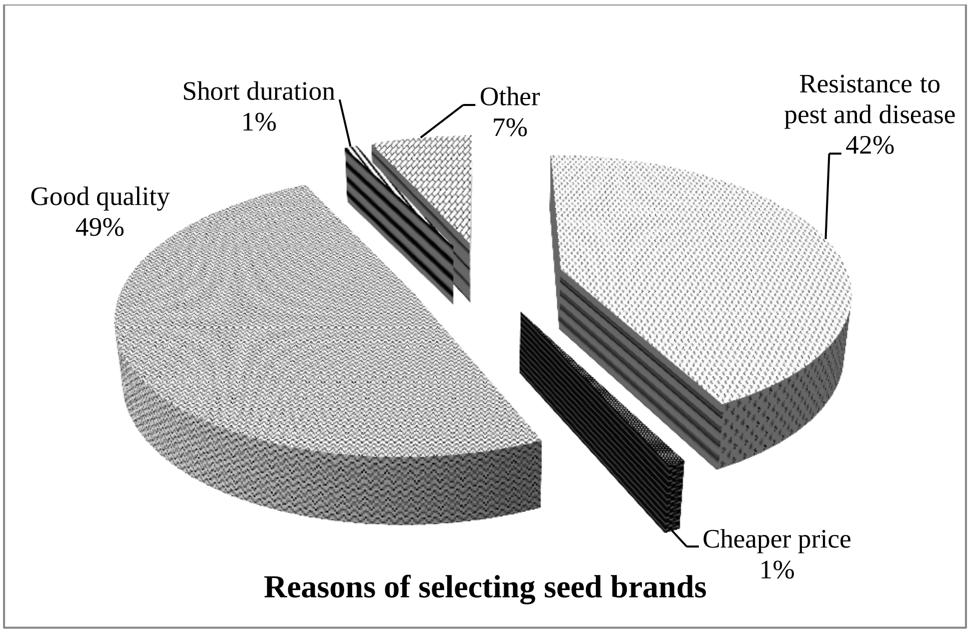


Figure 4.4 Reasons of selecting seed brands by the sample farmers

Table 4.8 Time interval of changing different seed brands of the sample farmers

Items	Number of farmers
One year interval	16 (13)
Two years interval	38 (32)
Three years interval	26 (22)
Four years interval	16 (13)
No change	24 (20)
Total	120 (100)

Note: Figures in the parentheses represent percentage.

Table 4.9 Reasons of changing seed brands of the sample farmers

Items	Number of farmers
Low quality	40 (41.7)
Poor germination	33 (34.4)
New seed brands	9 (9.4)
Less resistance to pest and disease	8 (8.3)
Other	6 (6.2)
Total	96 (100)

Note: 24 sample farmers did not change the seed brand.

Figures in the parentheses represent percentage.

4.2.3 Sources and Types of Buying Inputs

Buying inputs such as seeds, fertilizers and pesticides were available in native villages and Tatkon Town. Farmers bought seeds and fertilizers equally from their native villages as well as from Tatkon. As shown in the Figure 4.5, 50.8% of the sample farmers bought improved seed from Tatkon and 49.2 % bought from the village (Nweyit). In the case of fertilizer, 55% of the sample farmers bought fertilizer from Tatkon and 45% bought in their native villages. In the case of pesticide, only 39.2% of the sample farmers bought pesticide from Tatkon whereas 60.8% bought in their native villages because of sale by agro-chemical company. It can be pointed out that it was one of the improvements of communication technology in the study area.

There were two types of transaction in buying inputs in the study area. About 91.7% of the sample farmers bought seeds in cash and 8.3% of the sample farmers bought in credit. About 55% of the sample farmers bought fertilizer in cash and 45% bought in credit. In the case of the pesticide, 14.2% of the sample farmers bought pesticide in cash and 85.8% of the sample farmers bought in credit (Figure 4.6). Although the price of inputs in credit was higher than the price in cash, most farmers chose buying fertilizers and pesticides with credit system probably due to their lack of capital for input demand.

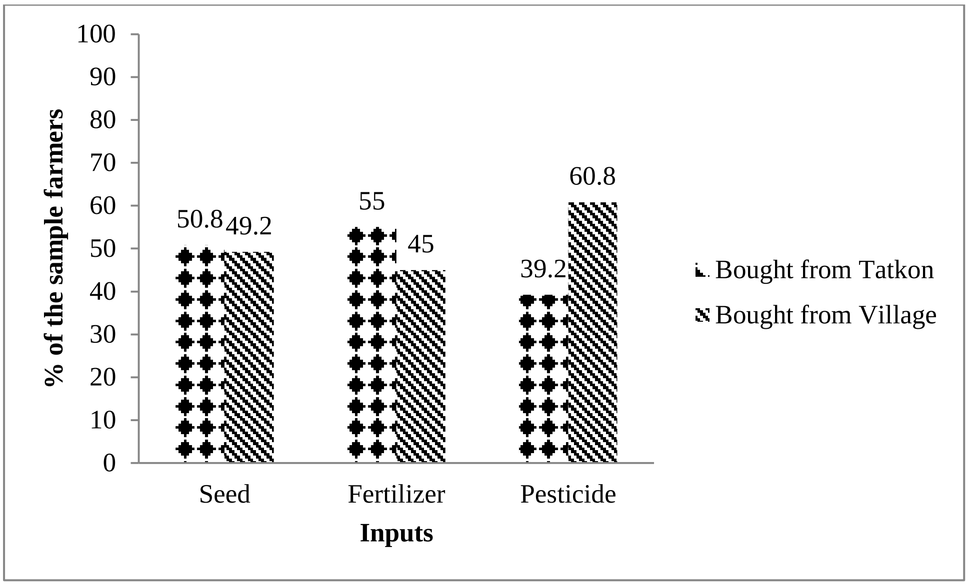


Figure 4.5 Sources of inputs suppliers for the sample farmers

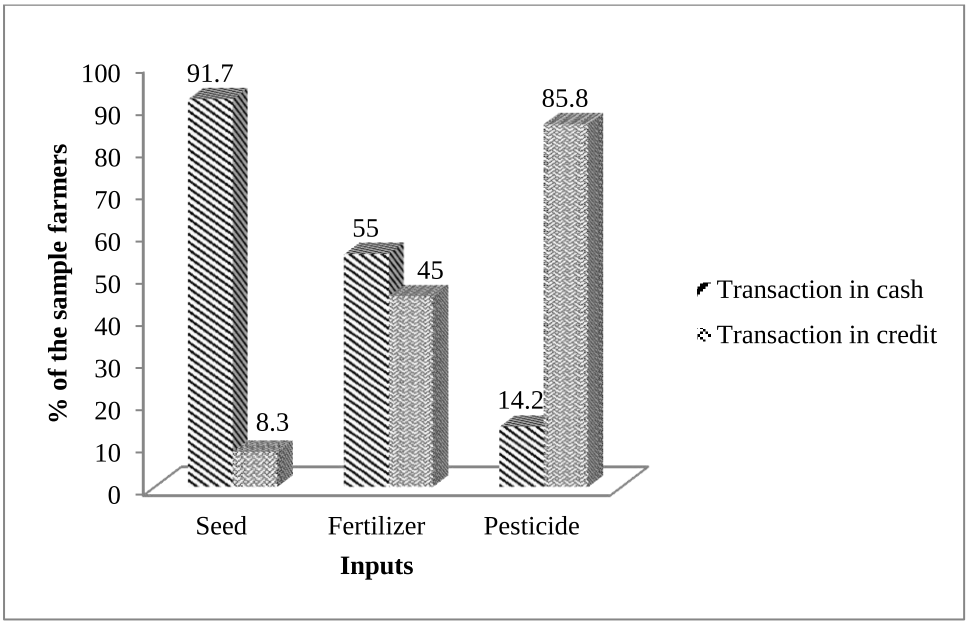


Figure 4.6 Types of transaction in buying inputs by the sample farmers

4.2.4 Fertilizer Application of the Sample Farmers in the Study Area

Majority of sample farmers applied organic and chemical fertilizers in the cabbage and cauliflower production. They used farm yard manure (FYM), gypsum (various local made) and compound fertilizer in land preparation. Farm yard manure (FYM) was used as organic fertilizer and urea, compound and gypsum were used as inorganic fertilizer.

By observing fertilizer application in cabbage and cauliflower cultivation, minimum amount of FYM (1.2 MT/ha), urea (123.6 Kg/ha), compound (61.8 Kg/ha) and gypsum (95.1 Kg/ha) were found to be the same. Although maximum amount of urea was two times greater in cabbage (864.9 Kg/ha) than cauliflower (471.3 Kg/ha), FYM (12.4 MT/ha), compound (494.2 Kg/ha) and gypsum (1482.6 Kg/ha) were applied the same amount in these two crops (Table 4.10 and Table 4.11).

In terms of average usage in this study area, 5.2 (MT/ha) of FYM, 420.2 (Kg/ha) of urea, 152 (Kg/ha) of compound and 255.8 (Kg/ha) of gypsum were applied in cabbage production. In cauliflower, lesser amounts of average usages were applied. The different average amounts of organic and inorganic fertilizers application were not significant between cabbage and cauliflower production (Table 4.12).

High range of fertilizers application was found in cabbage and cauliflower production. All sample farmers did not receive the official recommended rate of fertilizers by Ministry of Agriculture and Irrigation for cabbage and cauliflower production.

In general, fertility requirements for cabbage and cauliflower production are 243.7 to 439.2 Kg of urea, 0 to 168.5 Kg of phosphorus, and 0 to 280.7 Kg of potassium per hectare in Minnesota (http://www.extension.umn.edu/ garden/ fruit-vegetable /growing-broccoli-cabbage-and-cauliflower-in-minnesota /index.html).

All sample farmers used urea fertilizer imported from China. Many different brands of compound fertilizer applied by the sample farmers were products of Yeeshin (46.9%), products of Thailand (19.7%), Golden Key's product (14.2%), Markoda's product (12%), Awba's product (7.6%), Armo's product (4.4%) and other brands (14.2%) such as Golden lion, Diamond star and Wisarra (Figure 4.7).

Table 4.10 Fertilizer utilization in cabbage production

Items	Units	Minimum	Maximum	Mean
Urea	Kg/ha	123.6	864.9	420.2
Compound	Kg/ha	61.8	494.2	152.0
FYM	MT/ha	1.2	12.4	5.2
Gypsum (Various local made)	Kg/ha	95.1	1482.6	255.8

N=79

Table 4.11 Fertilizer utilization in cauliflower production

Items	Units	Minimum	Maximum	Mean
Urea	Kg/ha	123.6	471.3	384.9
Compound	Kg/ha	61.8	494.2	147.4
FYM	MT/ha	1.2	12.4	4.7
Gypsum (Various local made)	Kg/ha	95.1	1482.6	173.0

N=95

Table 4.12 Mean paired comparison of FYM, urea, compound and gypsum between cabbage and cauliflower production

Items	Mean difference				
	Unit	Cabbage	Cauliflower	t-value	Sig.
Urea	Kg/ha	420.2	384.9	1.6	0.111^{ns}
Compound	Kg/ha	152.0	147.4	0.35	0.725^{ns}
FYM	MT/ha	5.2	4.7	0.92	0.358^{ns}
Gypsum (Various local made)	Kg/ha	255.8	173.0	1.07	0.286^{ns}

Note: ns= not significant

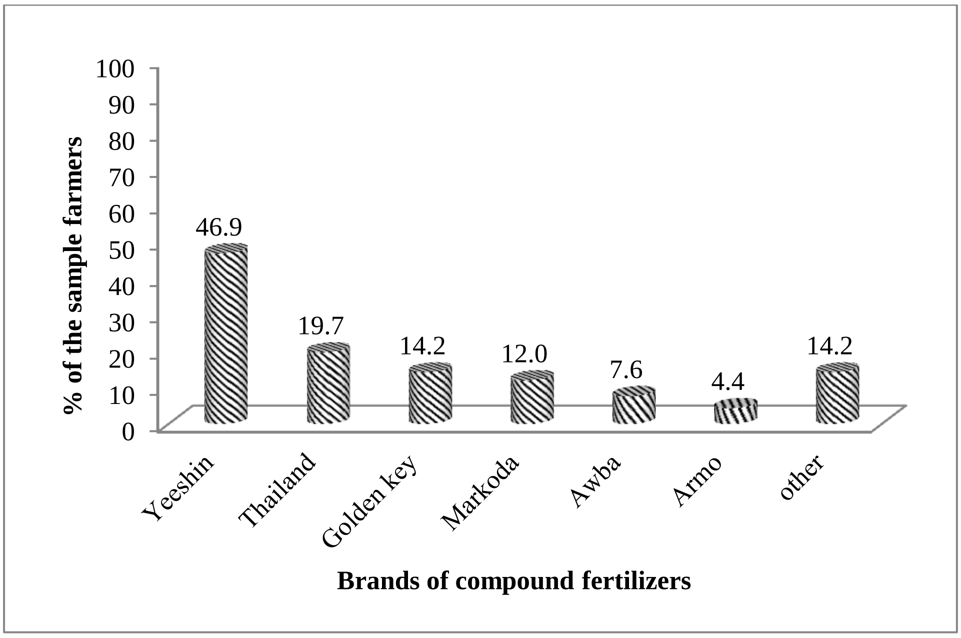


Figure 4.7 Different brands of compound fertilizer used by the sample farmers

To understand the farmers' knowledge and attitude on application of inorganic fertilizers, it was examined their understanding on inputs' qualities and nutritional values. Most farmers (63.3%) did not recognize N, P, K content in compound fertilizer while 36.7% of the sample farmers recognized N, P, K content in compound fertilizer (Figure 4.8).

In case of seeds importing from outside country, the highest percent (80.8%) of the sample farmers said that no label in Myanmar language on the seed package and about 19.2% of the sample farmers said that label in Myanmar language on the seed package. In the pesticide application, most farmers (88.3%) said that their purchased pesticide mentioned label in Myanmar language on the pesticide package while 11.7% of the sample farmers said that no label in Myanmar language on the pesticide package (Figure 4.9).

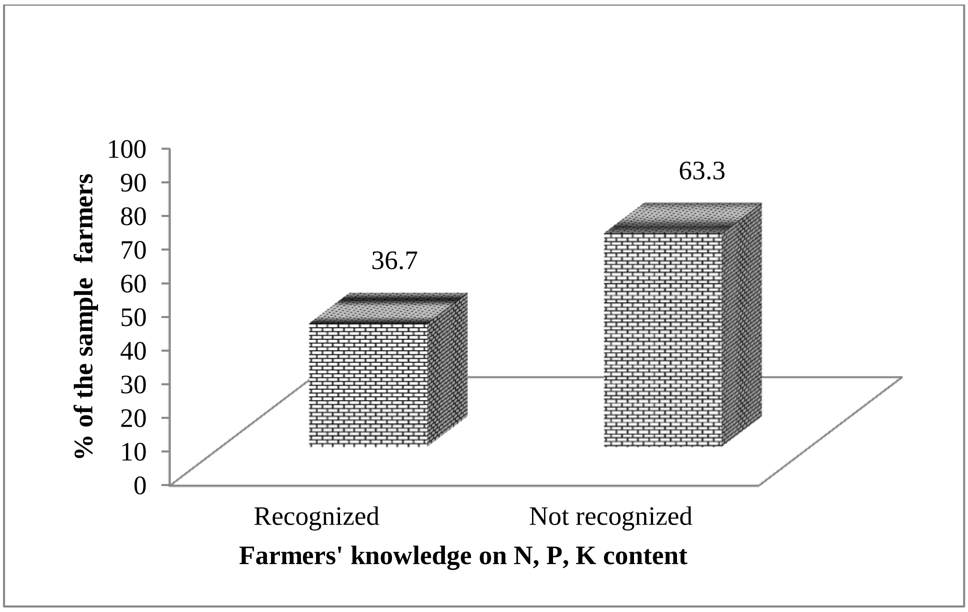


Figure 4.8 Knowledge of the sample farmers on N, P, K content in compound fertilizer

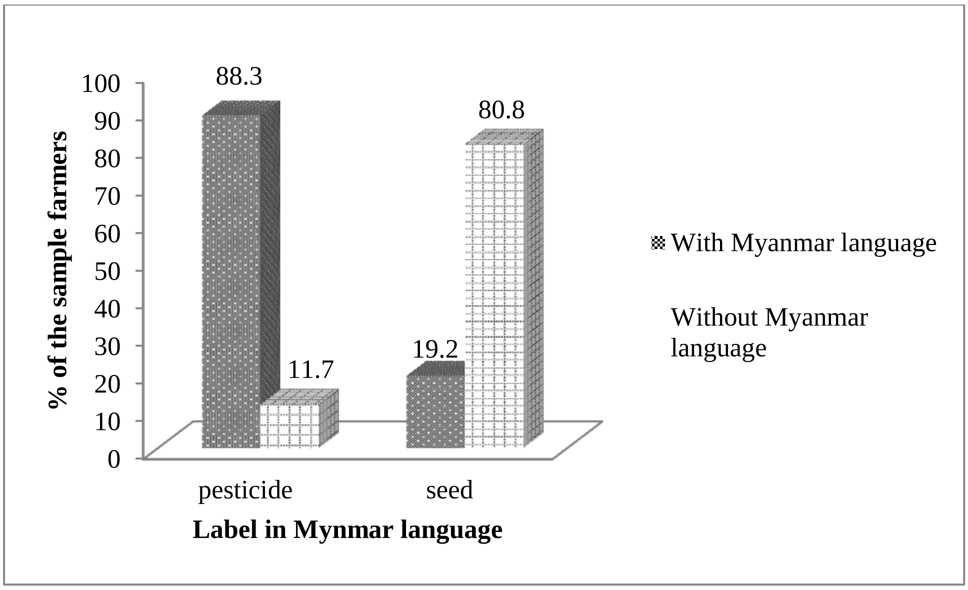


Figure 4.9 Label in Myanmar language on the pesticide and seed packages

4.2.5 Practices of Pesticide Application

Infestation of pests and disease was one of the major constraints in cabbage and cauliflower production in the study area. Major pests were diamond back moth and aphid in cabbage and cauliflower production. All sample farmers applied pesticides in cabbage and cauliflower production. Farmers applied 0.7 to 35.8 liters per hectare (L/ha) of pesticides in cabbage production and 0.6 to 23 liters per hectare (L/ha) of pesticides in cauliflower production (Table 4.13). In average, cabbage production demanded more pesticides (7.3 L/ha) than cauliflower (6.6 L/ha). There were different active ingredients and quality in different brands. High range of pesticide application was found in the study area.

Concerning with farmers' favorite brands of pesticides, 43.5%, 36.5%, 7.5% and 1.7% of sample farmers used the products from Awba, Nichimin, War War Agro Companies and Thailand. Other various brands (Golden key, Neem pesticide and Minmahor) not popular like the above mentioned were used by 10.8% of sample farmers (Figure 4.10). There were various reasons for selecting of pesticide brands. Most farmers (95%) selected pesticide brands based on the effectiveness of pesticide whereas 3% of the sample farmers based on low cost of pesticide (Figure 4.11).

According to the study, most farmers sprayed agrochemical against insects than disease and 95% of the sample farmers sprayed insecticide whereas 4% and 1% of sample farmers sprayed fungicide and other. It was due to more serious infestation of pests in cabbage and cauliflower cultivation. Abang (2013) studied that pests and diseases were important constraints to vegetable production in the tropics. Most farmers sprayed against insects than diseases and this could also suggest that insect pests are more serious in the dry season.

Examining their spraying techniques, most farmers (48.3%) applied pesticide 7 days interval and about 30% of sample farmers applied 10 days interval. Even 5 days interval spraying was done by 21.7% of the farmers (Figure 4.12). About 43% of the sample farmers used two brands of pesticide while 39% used more than two brands (Figure 4.13).

Table 4.13 Amount of pesticide used for cabbage and cauliflower production

Items	Unit	Cabbage (N=79)	Cauliflower (N=95)
Mean	L/ha	7.3	6.6
Minimum	L/ha	0.7	0.6
Maximum	L/ha	35.8	23.0

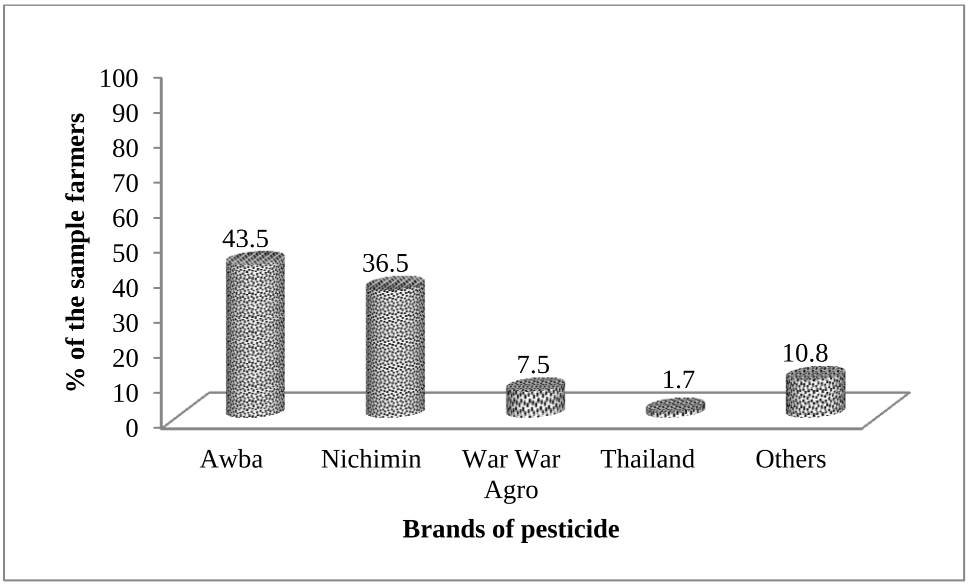


Figure 4.10 Utilization of different pesticide brands by the sample farmers

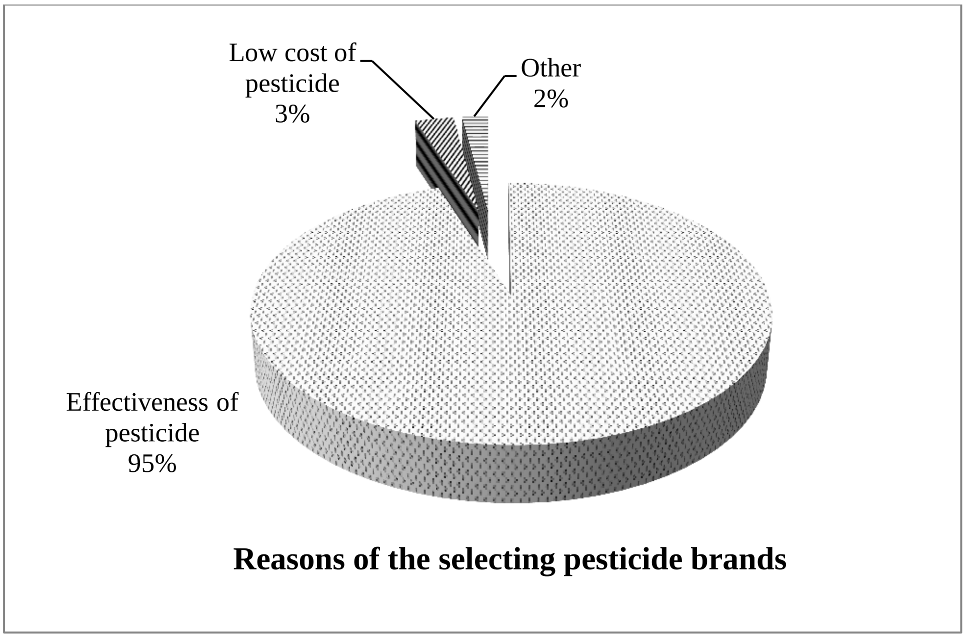


Figure 4.11 Reasons of the selecting pesticide brands by the sample farmers

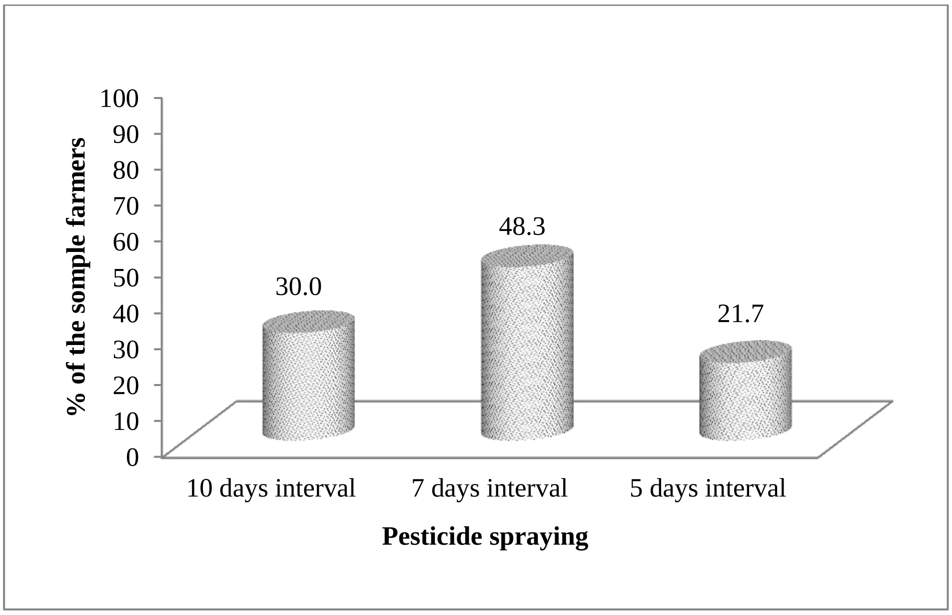


Figure 4.12 Time interval of pesticide spraying by the sample farmers

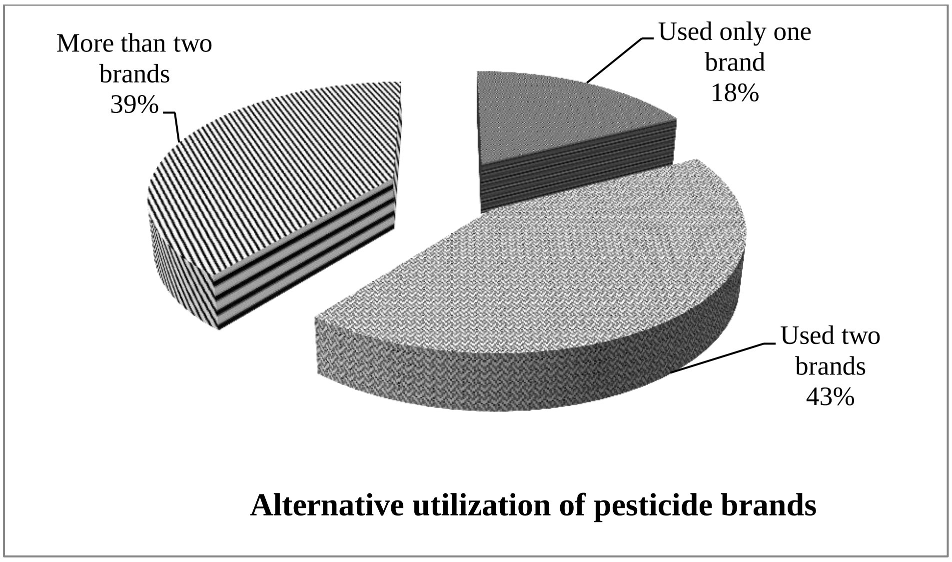


Figure 4.13 Alternative utilization of pesticide brands by the sample farmers

Farmers' behavior on pesticide handling practice was examined. Majority of farmers (72.5%) always read pesticide usage instruction before spraying whereas 20% of them sometimes read the instruction and 7.5% never read the instruction (Figure 4.14). In the case of pesticide dosage to be followed, about 62% of sample farmers used instructed amount of pesticide mentioned on pesticide brands, 35% used more than instructed amount and 3% used less than instructed amount (Figure 4.15). The results of the study showed that most farmers (50.8%) used only family labors for pesticide spraying whereas about 14.2% of the sample farmers used only hired labors and 35% used both types of labors (Figure 4.16).

4.2.6 Access to Information of Pesticide Spraying

All farmers accessed the information of spraying pesticide in cabbage and cauliflower production from many sources (Table 4.14). Those sources were agents of agrochemical companies (40.8%), local dealers (12.5%), other farmers (9.2%) and extension agents (5%). Some farmers got information from more than one source. They were company sale agents and dealers (15%), company sale agents and other farmers (14%) and company sale agents and extension agents (2.5%).

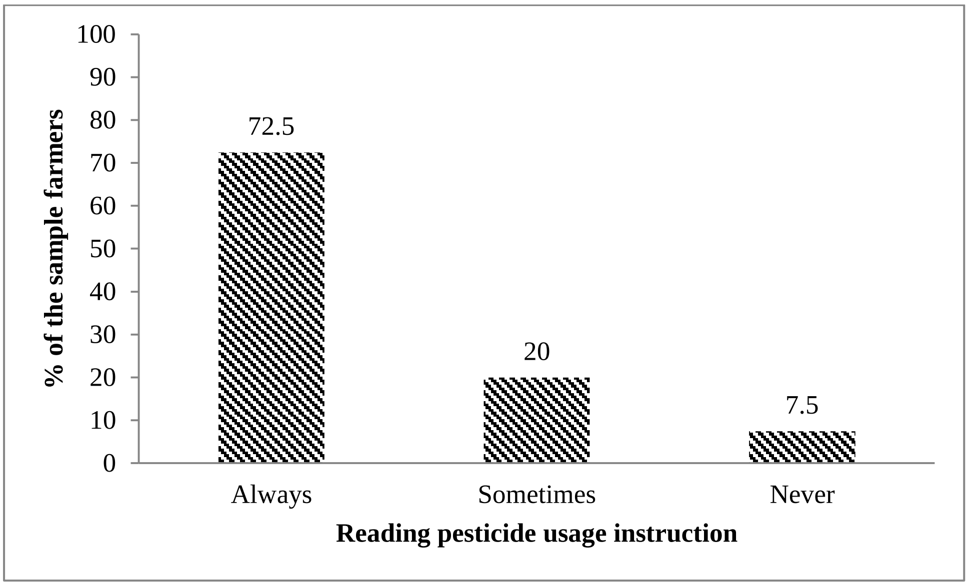


Figure 4.14 Reading pesticide usage instructions by the sample farmers

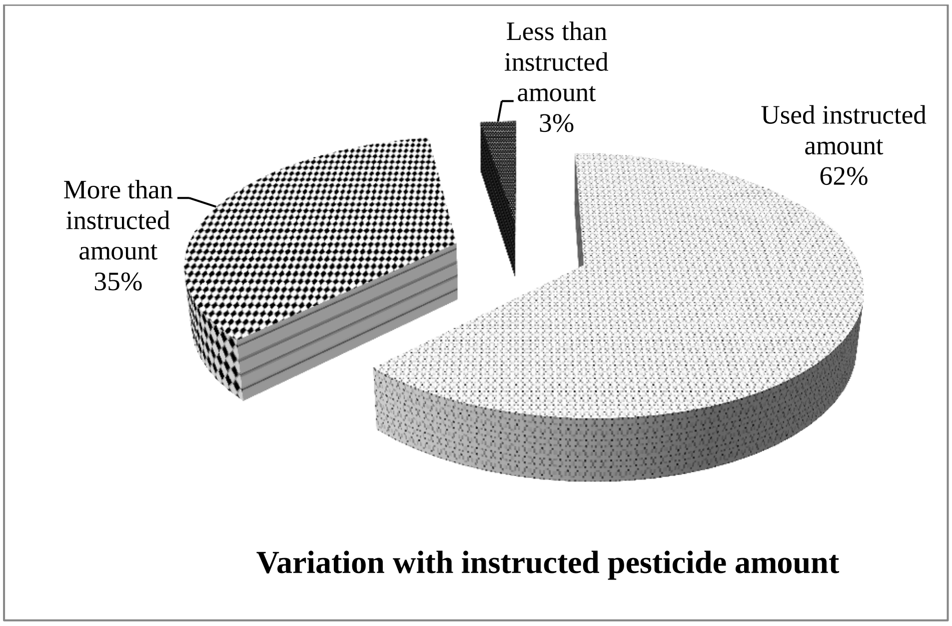


Figure 4.15 Variation with instructed pesticide amount used by the sample farmers

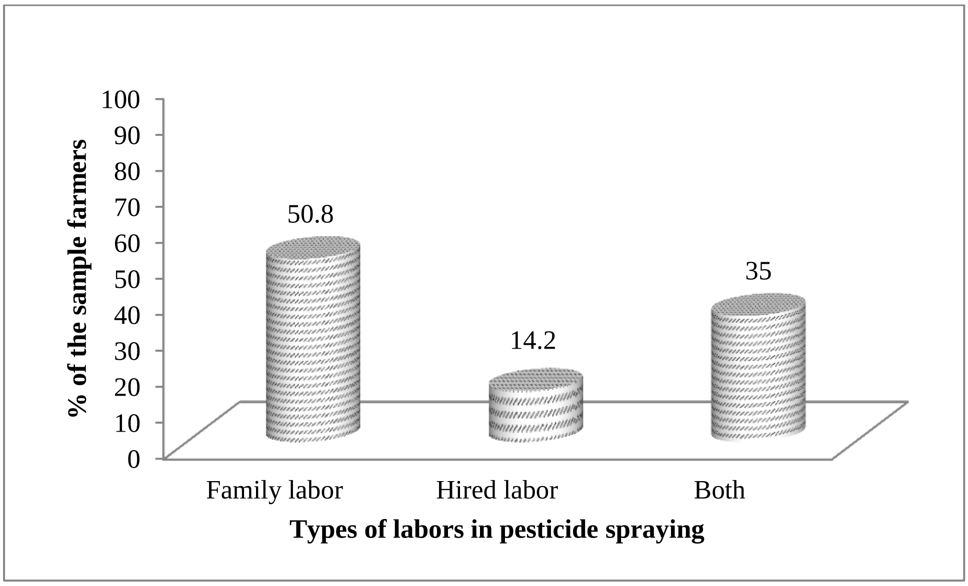


Figure 4.16 Types of labor in pesticide spraying of the sample farmers

Table 4.14 Information sources of spraying pesticides and handling practices by the sample farmers

Name	Number of farmers
Company sale agents	49 (40.8)
Dealers	15 (12.5)
Other farmers	11 (9.2)
Extension agents	6 (5.0)
TV/radio	1(0.8)
Company sale agents + Dealers	18 (15.0)
Company sale agents + Other farmers	17 (14.2)
Company sale agents + Extension agents	3 (2.5)
Total	120 (100)

Note: Figures in the parentheses represent percentage.

4.3 General Constraints of the Sample Farmers in the Study Area

Major constraints described by the sample farmers were unstable price of product (63%) and credit needs (47%). Some farmers complained pest and disease problems (18%), poor soil condition (17%), poor quality seeds (13%) and high input costs (13%) (Table 4.15).

4.3.1 Constraints in Pesticide Spraying

As pesticide application was one of the essential management practices, the sample farmers faced some constraints such as high cost of pesticide (41.7%), poor knowledge of technology (5.8%) and information needs for health (14.2%). About 38.3% of the sample farmers did not have any problems in the pesticide spraying (Figure 4.17).

4.3.2 Credit Availability

In the study area, 63% of sample farmers were in debt as shown in Figure 4.18. Among the farmers in debt, 50% of sample farmers borrowed money from Cooperative society and 38% of the sample farmers borrowed from local money lenders and 12% borrowed from both sources (Figure 4.19). The average credit amount was 69,608 kyats per farmer from cooperative society and 366,000 kyats per farmer from money lenders. The interest rates of cooperative and money lenders were 2.5% and 6.7% per month respectively (Table 4.16). Availability of credit from Myanma Agricultural Development Bank (MADB) for vegetable production was absent.

Table 4.15 General constraints of the sample farmers in the study area

Items	Number of farmers
Unstable price of product	75 (63)
Credit need	56 (47)
Problems of pest and disease	22 (18)
Poor soil condition	20 (17)
Poor quality seed	16 (13)
High input cost	16 (13)
Insufficient underground water	8 (7)
Need of technology	3 (2)

N=120

Note: Figures in the parentheses represent percentage.

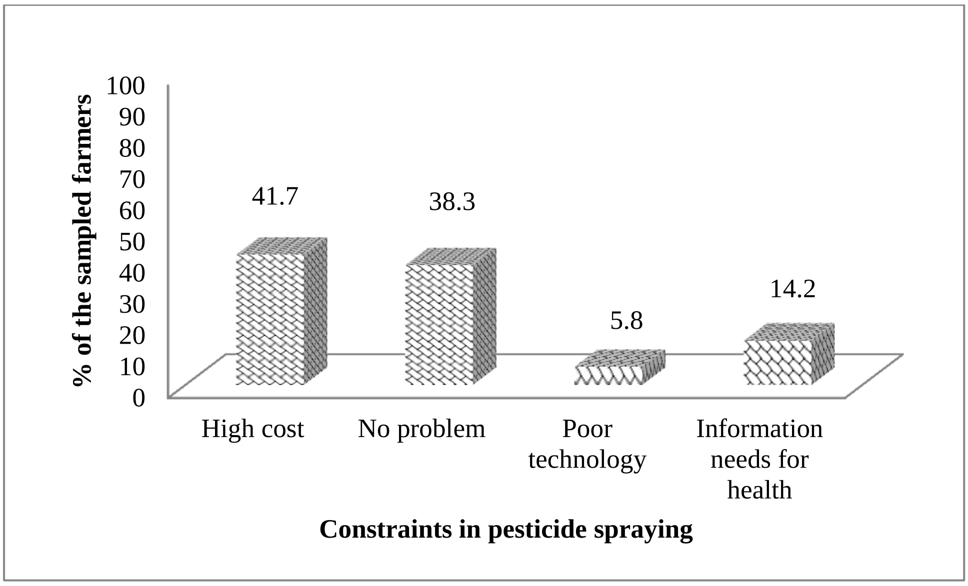
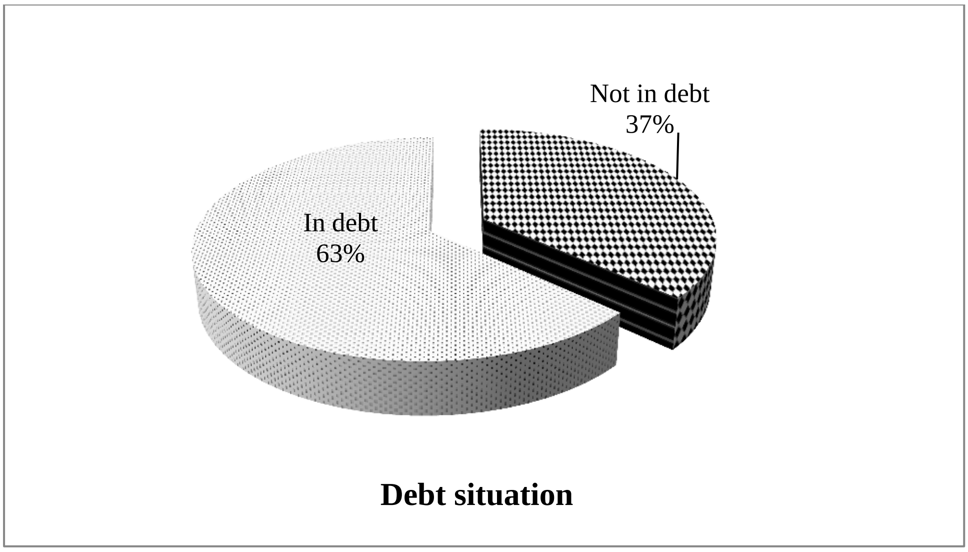
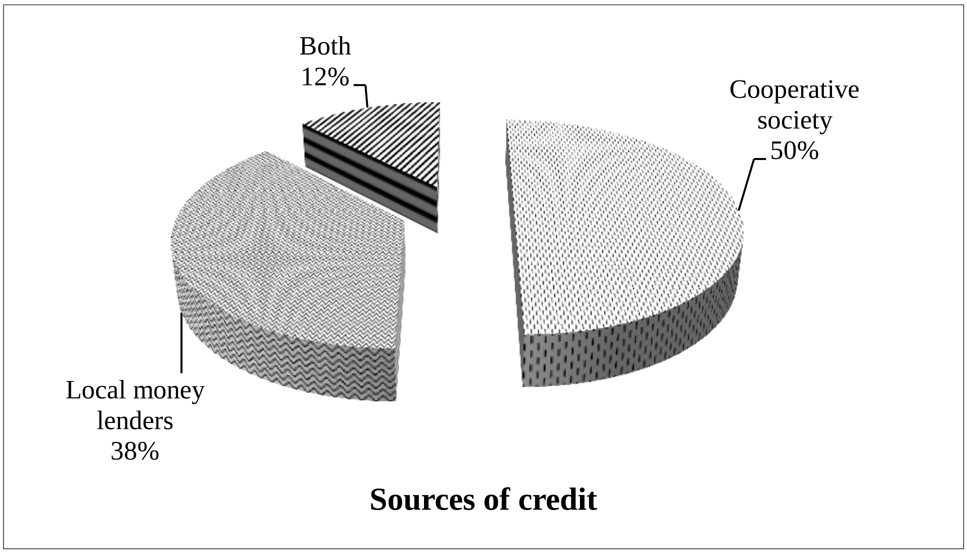


Figure 4.17 Constraints in pesticide spraying of the sample farmers



N=120

Figure 4.18 Debt situations of the sample farmers



N=76

Figure 4.19 Sources of credit by the sample farmers

Table 4.16 Credit amount and interest rate

Items	Average credit amount (Ks/farmer)	Average interest rate per month (%)
Cooperative society (N=51)	69,608	2.5
Local money lenders (N=25)	366,000	6.7

4.4 Cost and Return Analysis of Cabbage and Cauliflower Production in the Study Area

Enterprise budget was used to analyze cost and return for the cabbage and cauliflower production in the study area. Variable costs of production were included material input costs, hired labor costs, family labor opportunities costs and interest on cash costs. To determine gross return for cabbage and cauliflower, average yield and average unit price were used. The enterprise budgets for cabbage and cauliflower production per hectare basis were presented in Appendix 3 and per acre basis were presented in Appendix 4. Break-even yield of cabbage production was 10,933 (heads/ha) and cauliflower was 15,136 (curds/ha). Break-even price of cabbage was 42 (Ks/head) and cauliflower was 128 (Ks/curd) (Table 4.17).

In cabbage production, average yield was 37,534 heads per hectare and average price was 146 (Ks/head). Total material cost was 807,507 Ks/ha including seeds (63,068 Ks/ha), FYM (55,332 Ks/ha), urea fertilizer (171,456 Ks/ha), compound fertilizer (107,823 Ks/ha), gypsum (55,046 Ks/ha), hormone (16,417 Ks/ha), pesticide (219,213 Ks/ha), diesel (119,152 Ks/ha). Total family labor cost was 270,081 Ks/ha including plowing (59,195 Ks/ha), harrowing (19,873 Ks/ha), seeding (5,333 Ks/ha), weeding (8,698 Ks/ha), making planting holes (3,941 Ks/ha), transplanting (1,908 Ks/ha), watering manual (98,261 kyat per hectare), earthing up (2,337 Ks/ha), inter-cultivation (2,930 Ks/ha), irrigation canal making (6,924 Ks/ha), irrigation (15,154 Ks/ha), fertilizer application (13,495 Ks/ha) and pesticide application (32,029 Ks/ha).

Total hired labor cost was 358,962 Ks/ha including plowing (70,258 Ks/ha), harrowing (6,131 Ks/ha), seeding (1,001 Ks/ha), weeding (11,026 Ks/ha), making planting holes (5,818 Ks/ha), transplanting (27,212 Ks/ha), watering manual (50,515 Ks/ha), earthing up (44,415 Ks/ha), inter-cultivation (35,517 Ks/ha), irrigation canal making (60,621 Ks/ha), irrigation (13,559 Ks/ha), fertilizer application (6,897 Ks/ha) and pesticide application (25,992 Ks/ha). Return above cash cost was 4,102,157 (Ks/ha) and return above variable cost was 3,832,076 (Ks/ha). Hence total gross benefit for cabbage production was 5,426,543 (Ks/ha) and total variable cost was 1,594,467 (Ks/ha). The benefit-cost ratio was 3.4.

In cauliflower production, average yield for cauliflower production was 20,217 curds per hectare and their average price was 130 (Ks/curd). Total material cost was 830,311 Ks/ha including seeds (169,014 Ks/ha), FYM (52,589 Ks/ha), urea fertilizer (156,262 Ks/ha), compound fertilizer (110,191 Ks/ha), gypsum (49,509 Ks/ha), hormone

(15,457 Ks/ha), pesticide (180,228 Ks/ha), diesel (97,061 Ks/ha). Total family labor cost was 415,524 Ks/ha including plowing (53,582 Ks/ha), harrowing (20,106 Ks/ha), seeding (5,376 Ks/ha), weeding (11,080 Ks/ha), making planting holes (3,446 Ks/ha), transplanting (1,821 Ks/ha), watering manual (89,645 Ks/ha), earthing up (1,665 Ks/ha), inter-cultivation (2,602 Ks/ha), irrigation canal making (7,205 Ks/ha), irrigation (14,397 Ks/ha), fertilizer application (14,059 Ks/ha), pesticide application (33,306 Ks/ha), harvesting (61,931 Ks/ha) and transportation (95,303 Ks/ha).

Total hired labor cost was 556,776 Ks/ha including plowing (71,399 Ks/ha), harrowing (7,231 Ks/ha), seeding (1,014 Ks/ha), weeding (7,842 Ks/ha), making planting holes (5,657 Ks/ha), transplanting (25,425 Ks/ha), watering manual (60,422 Ks/ha), earthing up (44,075 Ks/ha), inter-cultivation (35,023 Ks/ha), irrigation canal making (60,613 Ks/ha), irrigation (9,663 Ks/ha), fertilizer application (7,725 Ks/ha), pesticide application (19,209 Ks/ha), harvesting (70,671 Ks/ha) and transportation (130,807 Ks/ha). Return above cash cost was 1,046,520 (Ks/ha) and return above variable cost was 630,996 (Ks/ha). Hence total gross benefit for cabbage production was 2,600,198 (Ks/ha) and total variable cost was 1,969,203 (Ks/ha). The benefit-cost ratio was 1.3.

In cabbage and cauliflower production, the benefit-cost ratio is different. In cabbage production, current crop price was 146 (Ks/head) and the lagged crop price was 119 (Ks/head). But the current price of cauliflower was 130 (Ks/curd) and lagged crop price was 217 (Ks/curd) in Figure 4.20. Current price of cabbage was higher than its lagged price whereas current price of cauliflower was lower than its lagged price. Average yield of cabbage production was 37,534 heads per hectare and 20,217 curds per hectare in cauliflower production. In cabbage production, cost of cultivation was low because cabbage was sold as standing crop and there were no harvesting and transportation costs.

Table 4.17 Enterprise budget for cabbage and cauliflower production (Ks/ha)

Items	Cabbage (N=79)	Cauliflower (N=95)
Total gross benefit (GB)	5,426,543	2,600,198
Total material cost (a)	807,507	830,311
Total family labor cost (b)	270,081	415,524
Total hired labor cost (c)	358,962	556,776
Interest on cash cost (d)	157,918	166,591
Total variable cash cost (TVCC) (a+c+d)	1,324,387	1,553,678
Total variable cost (TVC) (a+b+c+d)	1,594,467	1,969,203
Return above cash cost (GB-TVCC)	4,102,157	1,046,519
Return above variable cost (GB-TVC)	3,832,076	630,996
Benefit cost ratio (GB/TVC)	3.4	1.3
Break-even yield (units/ha)	10,933	15,136
Break-even price (Ks/unit)	42	128

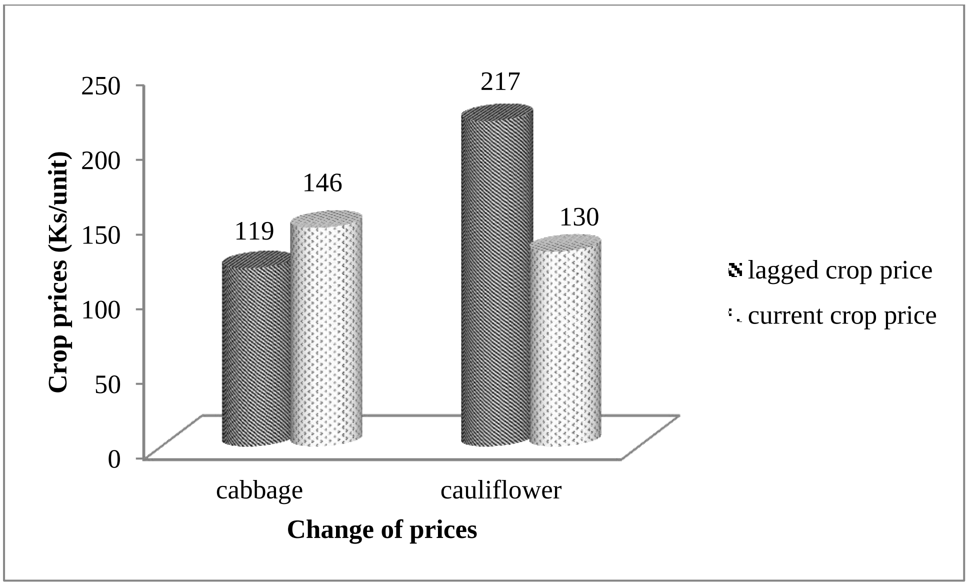


Figure 4.20 Change of prices in cabbage and cauliflower marketing

4.5 Factors Affecting the Demand of Inputs (Seed, Fertilizer and Pesticide) in Cabbage and Cauliflower Production in the Study Area

To determine the factors affecting the demand of agricultural inputs (seed, fertilizer and pesticide), log linear regression function was employed. The specific input demand functions of cabbage and cauliflower production were estimated by using these variables: household head's education level, household head's farm experience in cabbage and cauliflower production, total sown area, cropping intensity, total family labors, quantity of FYM, quantity of gypsum, lagged crop price and current input prices and buying inputs in credit transaction.

4.5.1 Descriptive Statistics of Dependent and Independent Variables of Seed Demand Function in Cabbage Production

According to the descriptive statistics, average quantity of seed applied by sample farmers was 253.3 (g/ha), average household head's education level was 6.3 years, average household head's experience was 21.6 years, average total sown area was 2.3 hectares, average cropping intensity was 188.5%, average total family labors was 2.9, average quantity of FYM was 5.2 (MT/ha) ,average quantity of gypsum (various local made) was 255.8 (Kg/ha) and average current seed price was 263.7 (Ks/g) as shown in Table 4.18.

Based on the results, seed demand for cabbage production was negatively affected by current seed price and quantity of FYM at highly significant level. It means that if current seed price increases by 1%, seed demand will be 0.29% decreased. In the case of price elasticity, the unstandardized B was less than unity (B<1), implying that the demand for seed was inelastic. Other things being equal, 1% increase in quantity of FYM will decrease seed demand by 0.16%. It showed the current cultural practiced on the application of FYM. Most farmers always use FYM from their owned livestock in their field crop production and do not buy it from other sources. Because of the limited availability of FYM resource, the quantity of FYM application will be decreased when the seed utilization amount is increased with large scale production.

Demand quantity of seed was positively related to the buying seed in credit transaction and household head's experience at 5% level and 10% level respectively. If buying seed in credit transaction increases by 1%, the demand quantity of seed will be increased by 0.17%. If household head's experience increase by 1%, the demand quantity of seed will be 0.09% increased (Table 4.19). The result showed the role of credit availability in cabbage production. In addition, the farming experience is a forcing factor to use more cabbage seeds in order to avoid the seedling losses by the unpredictable weather condition.

Table 4.18 Descriptive statistics of dependent and independent variables in seed demand function for cabbage production

Variables	Units	Minimum	Maximum	Mean	Std. deviation
Demanded quantity of seed	g/ha	98.8	494.2	253.3	155.3
Household head's education level	Year	3.0	11.0	6.3	2.3
Household head's experience	Year	3.0	45.0	21.6	11.4
Total sown area	Hectare	0.3	17.2	2.3	2.2
Cropping intensity	Percent	114.1	300.0	188.5	36.4
Total family labor	Number	1.0	6.0	2.9	1.3
Quantity of FYM	MT/ha	1.2	12.4	5.2	3.2
Quantity of gypsum	Kg/ha	95.1	1482.6	255.8	345.2
Current seed price	Ks/g	180.0	650.0	263.7	130.3

N=79

Table 4.19 Factors affecting the demand of seed for cabbage production

Independent variables	Unstandardized Coefficients (B)	Standardized Coefficients (β)	t-value	Sig.
Constant	8.00***		8.32	0.000
Household head’s education level	-0.03^{ns}	-0.05	-0.40	0.692
Household head's experience	0.09*	0.25	1.96	0.059
Total sown area	-0.03^{ns}	-0.08	-0.63	0.536
Cropping intensity	-0.20^{ns}	-0.19	-1.37	0.179
Total family labor	-0.08^{ns}	-0.17	-1.29	0.208
Quantity of FYM	-0.16***	-0.39	-3.05	0.005
Quantity of gypsum	0.06^{ns}	0.13	1.01	0.321
Current seed price	-0.29***	-0.52	-4.02	0.000
Buying seed in credit transaction	0.17**	0.27	2.06	0.048

Note: R^2= (0.584), F= (4.683), Sig= 0.001

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

4.5.1 Descriptive Statistics of Dependent and Independent Variables of Seed Demand Function in Cauliflower Production

Table 4.20 showed that the descriptive statistics of dependent and independent variables of seed demand function for cauliflower production. Average quantity of seed applied by sample farmers was 278.9 (g/ha), average household head's education level was 6.4 years, average household head's experience was 20.5 years, average total sown area was 2.1 hectare, average cropping intensity was 189.4%, average total family labors was 3, average quantity of FYM was 4.7 (MT/ha), average quantity of gypsum was 173 (Kg/ha) and average current seed price was 607.7 (Ks/g).

The results of the estimation of demand function of seed for sample farmers were described in Table 4.21. Demand quantity of seed was positively influenced by household head's education level, quantity of gypsum and buying seed in credit transaction at 5% and 10% level respectively. Other things being equal, 1% increase in household head's education level, quantity of gypsum and buying seed in credit transaction will increase quantity of seed by 0.31%, 0.17% and 0.67% respectively.

In cauliflower production, demand quantity of seed was positively related to current seed price at highly 1% level. If the current seed price increases by 1%, the demand of seed will be increased by 1.65%. In case of price elasticity, the unstandardized B was greater than unity (B>1), indicating that the demand for seed was elastic. If the quality of cauliflower seed is not good enough, it starts flowering in the nursery and the quality of curd is not marketable. Farmers believed that good quality seeds contribute quality products with high yield. Due to farmers' belief and their experience, they must pay high price for good quality seed. Although the price of cauliflower seed was high, sample farmers chose good quality seed regardless of high price. Smale and Birol (2013) found that the seed price was positively related to the demand quantity of seed in Zambia because of the effect of the subsidy. Prices of subsidy F1 hybrids were higher than the prices of other types of seed.

Table 4.20 Descriptive statistics of dependent and independent variables in seed demand function for cauliflower production

Variables	Units	Minimum	Maximum	Mean	Std. deviation
Demanded quantity of seed	g/ha	148.3	494.2	278.9	155.3
Household head's education level	Year	4.0	15.0	6.4	2.5
Household head's experience	Year	3.0	40.0	20.5	10.9
Total sown area	Hectare	0.3	17.2	2.1	2.1
Cropping intensity	Percent	82.5	300.0	189.4	34.2
Total family labor	Number	1.0	6.0	3.0	1.3
Quantity of FYM	MT/ha	1.2	12.4	4.7	3.2
Quantity of gypsum	Kg/ha	95.1	1482.6	173.0	305.4
Current seed price	Ks/g	400.0	850.0	607.7	78.5

N=95

Table 4.21 Factors affecting the demand of seed for cauliflower production

Independent variables	Unstandardized Coefficients (B)	Standardized Coefficients (β)	t-value	Sig.
Constant	-7.46*		-1.84	0.079
Household head's education level	0.31**	0.38	2.08	0.049
Household head's experience	-0.10^{ns}	-0.23	-1.50	0.147
Total sown area	0.01^{ns}	0.03	0.19	0.848
Cropping intensity	0.10^{ns}	0.07	0.41	0.685
Total family labor	0.14^{ns}	0.24	1.56	0.133
Quantity of FYM	-0.02^{ns}	-0.05	-0.28	0.782
Quantity of gypsum	0.17*	0.39	1.97	0.061
Current seed price	1.65**	0.57	2.75	0.012
Buying seed in credit transaction	0.67*	0.42	1.93	0.067

Note: R^2= (0.526), F= (2.711), Sig= 0.027

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

4.5.1 Descriptive Statistics of Dependent and Independent Variables of Urea Fertilizer Demand Function in Cabbage Production

Table 4.22 showed the descriptive statistics of dependent and independent variables of urea fertilizer demand function for cabbage production. According to the descriptive statistics, average quantity of urea applied by sample farmers was 420.2 (Kg/ha), average household head's education level was 6.3 years, average household head's experience was 21.6 years, average total sown area was 2.3 hectares, average cropping intensity was 188.5%, average total family labors was 2.9, average quantity of FYM was 5.2 (MT/ha), average lagged crop price was 119 (Ks/head) and average current urea price was 407.5 (Ks/Kg).

Based on the results of log linear regression analysis, urea fertilizer demand for cabbage production was positively affected by household head's experience, total family labor and lagged crop price at highly significant 1% level (Table 4.23). It means that if household head's experience increase by 1%, urea demand will be 0.13% increased. Other things being equal, 1% increase in total family labor and lagged crop price will increase the demand of urea by 0.19% and 1.69% respectively. Urea fertilizer was applied many times mostly by family labors throughout the cabbage production period. Lagged crop price was sometimes increased in market demand. At that time, farmers could use more quantity of urea because of more income from high price of selling lagged crops. Demand of urea fertilizer was negatively influenced by quantity of FYM. Other things being equal, 1% increase in quantity of FYM will decrease the demand of urea fertilizer. Sample farmers understood that FYM substituted in place of urea's nutrition where urea was not applied as required.

Demand of urea fertilizer was positively related to current urea price at 5% level as shown in Table 4.23. If current urea price increases by 1%, the demand of urea will be increased by 1.76%. In case of price elasticity, the unstandardized B was greater than unity (B>1), the demand for urea fertilizer was elastic. All sample farmers used urea fertilizer imported from China and they had no opportunity to choose the alternative or cheaper brand. As urea is essential input for soil improvement, urea demand will still increase when its price is becoming high. The results are similar with findings of other studies like Njiwa (2007) who found a positive relationship between the demand of fertilizer and its price.

Table 4.22 Descriptive statistics of dependent and independent variables in urea fertilizer demand function for cabbage production

Variables	Units	Minimum	Maximum	Mean	Std. deviation
Demanded quantity of urea	Kg/ha	123.6	864.9	420.2	155.3
Household head's education level	Year	3.0	11.0	6.3	2.3
Household head's experience	Year	3.0	45.0	21.6	11.4
Total sown area	Hectare	0.3	17.2	2.3	2.2
Cropping intensity	Percent	114.1	300.0	188.5	36.4
Total family labor	Number	1.0	6.0	2.9	1.3
Quantity of FYM	MT/ha	1.2	12.4	5.2	3.2
Lagged crop price	Ks/head	80.0	145.0	119.0	14.4
Current urea price	Ks/Kg	340.0	500.0	407.5	18.9

N=79

Table 4.23 Factors affecting the demand of urea fertilizer for cabbage production

Independent variables	Unstandardized Coefficients (B)	Standardized Coefficients (β)	t-value	Sig.
Constant	-13.37**		-2.68	0.010
Household head's education level	0.04 ns	0.4	0.45	0.653
Household head's experience	0.13***	0.25	2.92	0.005
Total sown area	-0.05 ns	-0.09	-0.99	0.327
Cropping intensity	0.06 ns	0.03	0.36	0.717
Total family labor	0.19***	0.23	2.70	0.009
Quantity of FYM	-0.13**	-0.19	-2.24	0.029
Lagged crop price	1.69***	0.59	6.94	0.000
Current urea price	1.76**	0.19	2.16	0.035
Buying fertilizer in credit transaction	-0.06ns	-0.08	-0.85	0.399

Note: R^2= (0.595), F= (9.812), Sig= 0.000

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

4.5.2 Descriptive Statistics of Dependent and Independent Variables of Urea Fertilizer Demand Function in Cauliflower Production

According to the descriptive statistics of urea demand in cauliflower production, average quantity of urea applied by sample farmers was 384.9 (Kg/ha). Average household head's education level was 6.4 years, average household head’s experience was 20.5 years, average total sown area was 2.1 hectares, average cropping intensity was 189.4%, average total family labors was 3, average quantity of FYM was 4.7 (MT/ha), average lagged crop price was 217.4 (Ks/curd) and current urea price was 405.7 (Ks/Kg). The descriptive statistics of the demand function for urea fertilizer in cauliflower production are described in Table 4.24.

Demand quantity of urea fertilizer was positively influenced by the lagged crop price received by farmer and total family labors at highly 1% level and 5% level respectively. It means that if the lagged crop price increases by 1%, the demand quantity of urea will be increased by 1.07% and if total family labors increase by 1%, the demand quantity of urea will be increased by 0.2%. Urea fertilizer was applied many times and application was done by their family labors throughout the cauliflower cultivation period. If the lagged crop price is high, it will be incentive for farmers to use more fertilizer. Urea demand was negatively related to the quantity of FYM at 5% level. It means that if the large quantity of FYM demanded by 1%, urea demand will be 0.14% decreased (Table 4.25).

Table 4.24 Descriptive statistics of dependent and independent variables in urea fertilizer demand function for cauliflower production

Variables	Units	Minimum	Maximum	Mean	Std. deviation
Demanded quantity of urea	Kg/ha	123.6	471.3	384.9	136.0
Household head's education level	Year	4.0	15.0	6.4	2.5
Household head's experience	Year	3.0	40.0	20.5	10.9
Total sown area	Hectare	0.3	17.2	2.1	2.1
Cropping intensity	Percent	82.5	300.0	189.4	34.2
Total family labor	Number	1.0	6.0	3.0	1.3
Quantity of FYM	MT/ha	1.2	12.4	4.7	3.2
Lagged crop price	Ks/curd	160.0	350.0	217.4	37.7
Current urea price	Ks/Kg	340.0	480.0	405.7	14.1

N=95

Table 4.25 Factors affecting the demand of urea fertilizer for cauliflower production

Independent variables	Unstandardized Coefficients (B)	Standardized Coefficients (β)	t-value	Sig.
Constant	-4.71^{ns}		-0.64	0.523
Household head's education level	0.07^{ns}	0.06	0.53	0.597
Household head's experience	0.04^{ns}	0.07	0.70	0.486
Total sown area	-0.04^{ns}	-0.07	-0.64	0.526
Cropping intensity	-0.01^{ns}	-0.05	-0.45	0.655
Total family labor	0.20**	0.23	2.30	0.025
Quantity of FYM	-0.14**	-0.23	-2.09	0.040
Lagged crop price	1.07***	0.45	4.09	0.000
Current urea price	0.87^{ns}	0.08	0.75	0.454
Buying fertilizer in credit transaction	-0.11^{ns}	-0.15	-1.50	0.138

Note: R^2= (0.313), F= (3.533), Sig= 0.001

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

4.5.3 Descriptive Statistics of Dependent and Independent Variables of Compound Fertilizer Demand Function in Cabbage Production

Table 4.26 showed that the descriptive statistics of dependent and independent variables of compound fertilizer demand function in cabbage production. In the result of descriptive statistics, average quantity of compound fertilizer was 152 (Kg/ha). Average household head's education level was 6.3 years, average household head’s experience was 21.6 years, average total sown area was 2.3 hectares, average cropping intensity was 188.5%, average total family labors was 2.9, average quantity of FYM was 5.2 (MT/ha), average amount of urea fertilizer was 420.2 (Kg/ha) and average current compound price was 672 (Ks/Kg).

The results of the estimation of the demand function of compound fertilizer for the sample farmers in the study areas were described in Table 4.27. Demand quantity of compound fertilizer of cabbage production was positively and significantly influenced by cropping intensity, quantity of urea and total sown area at 5% level and 10% level respectively. Other things being equal, 1% increase in cropping intensity, total sown area and quantity of urea will increase the demand of compound fertilizer by 0.59%, 0.16% and 0.34% respectively. Farmers understood that compound and urea fertilizers have the different nutrient contents. According to the farmers’ experience and usual practices, they made a combined ratio of compound and urea fertilizers to get complementary effect on crop. Therefore demand of compound and urea was found in the same trend.

Demand quantity of compound fertilizer was negatively and significantly related to current compound price at 5% level. It means that if current compound price increases by 1%, demand quantity of compound will be decreased by 0.53%. In the case of price elasticity, the unstandardized B was less than unity ($B<1$), implying that the demand for compound fertilizer was inelastic.

Table 4.26 Descriptive statistics of dependent and independent variables in compound fertilizer demand function for cabbage production

Variables	Units	Minimum	Maximum	Mean	Std. deviation
Demanded quantity of compound	Kg/ha	61.8	494.2	152.0	88.4
Household head's education level	Year	3.0	11.0	6.3	2.3
Household head's experience	Year	3.0	45.0	21.6	11.4
Total sown area	Hectare	0.3	17.2	2.3	2.2
Cropping intensity	Percent	114.1	300.0	188.5	36.4
Total family labor	Number	1.0	6.0	2.9	1.3
Quantity of FYM	MT/ha	1.2	12.4	5.2	3.2
Quantity of urea	Kg/ha	123.6	864.9	420.2	155.3
Current compound price	Ks/Kg	360.0	940.0	672.0	260.0

N=79

Table 4.27 Factors affecting the demand of compound fertilizer for cabbage production

Independent variables	Unstandardized Coefficients (B)	Standardized Coefficients (β)	t-value	Sig.
Constant	5.62*		1.96	0.055
Household head's education level	-0.16^{ns}	-0.13	-1.11	0.270
Household head's experience	-0.06^{ns}	-0.08	-0.66	0.514
Total sown area	0.16*	0.25	1.90	0.062
Cropping intensity	0.59**	0.26	2.06	0.044
Total family labor	-0.13^{ns}	-0.12	-1.08	0.283
Quantity of FYM	0.16^{ns}	0.18	1.62	0.110
Quantity of urea	0.34**	0.28	2.22	0.030
Current compound price	-0.53**	-0.32	-2.45	0.018
Buying fertilizer in credit transaction	0.02^{ns}	0.02	0.14	0.888

Note: R^2= (0.347), F= (3.042), Sig= 0.004

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

4.5.4 Descriptive Statistics of Dependent and Independent Variables of Compound Fertilizer Demand Function in Cauliflower Production

In the result of descriptive statistics, average quantity of compound fertilizer of cauliflower production was 147.4 (Kg/ha). Average household head's education level was 6.4 years, average household head's experience was 20.5 years, average total sown area was 2.1 hectares, average cropping intensity was 189.4%, average total family labors was 3, average quantity of FYM was 4.7 (MT/ha), average urea fertilizer was 384.9 Kg/ha and current compound price was 699.1 (Ks/Kg) as shown in Table 4.28.

According to the regression analysis, demand quantity of compound fertilizer for cauliflower production was positively and significantly related to quantity of FYM at 5% level. It means that if quantity of FYM increase by 1%, the demand quantity of compound fertilizer will be 0.18% increased. Farmers believed that FYM and compound fertilizer have the different nutrient contents. In this case, farmers' usual practice of fertilizer application indicated that demand of compound fertilizer was complemented with the amount of FYM in this study area.

Demand quantity of compound fertilizer was negatively and significantly affected by current compound price at 1% level. Other things being equal, 1% increase in current compound price will decrease the demand quantity of compound fertilizer by 0.74% (Table 4.29). In the case of price elasticity, the unstandardized B was less than unity (B<1), the demand for compound fertilizer was inelastic.

Table 4.28 Descriptive statistics of dependent and independent variables in compound fertilizer demand function for cauliflower production

Variables	Units	Minimum	Maximum	Mean	Std. deviation
Demanded quantity of compound	Kg/ha	61.8	494.2	147.4	83.6
Household head's education level	Year	4.0	15.0	6.4	2.5
Household head’s experience	Year	3.0	40.0	20.5	10.9
Total sown area	Hectare	0.3	17.2	2.1	2.1
Cropping intensity	Percent	82.5	300.0	189.4	34.2
Total family labor	Number	1.0	6.0	3.0	1.3
Quantity of FYM	MT/ha	1.2	12.4	4.7	3.2
Quantity of urea	Kg/ha	123.6	471.3	384.9	136.0
Current compound price	Ks/Kg	360.0	940.0	699.1	239.9

N=95

Table 4.29 Factors affecting the demand of compound fertilizer for cauliflower production

Independent variables	Unstandardized Coefficients (B)	Standardized Coefficients (β)	t-value	Sig.
Constant	9.47***		4.26	0.000
Household head's education level	-0.12 ns	-0.09	-0.84	0.401
Household head's experience	0.11 ns	0.18	1.56	0.124
Total sown area	0.02 ns	0.03	0.28	0.781
Cropping intensity	-0.07 ns	-0.03	-0.27	0.790
Total family labor	-0.15 ns	-0.16	-1.47	0.153
Quantity of FYM	0.18**	0.26	2.41	0.019
Quantity of urea	0.10ns	0.09	0.79	0.434
Current compound price	-0.74***	-0.33	-2.75	0.008
Buying fertilizer in credit transaction	-0.08 ns	-0.09	-0.85	0.398

Note: R^2= (0.279), F= (2.757), Sig= 0.009

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

4.5.5 Descriptive Statistics of Dependent and Independent Variables of Pesticide Demand Function in Cabbage Production

Table 4.30 showed that the descriptive statistics of dependent and independent variables of pesticide demand function in cabbage production. Average quantity of pesticide was 7.6 (Kg/ha). Average household head's education level was 6.3 years, average household head’s experience in cabbage and cauliflower production was 21.6 years, average total sown area was 2.3 hectares, average cropping intensity was 188.5%, average total family labors was 2.9, average quantity of FYM was 5.2 (MT/ha), average quantity of gypsum was 255.8 (Kg/ha) and current pesticide price was 71,986.8 (Ks/L).

Based on the results of log linear regression analysis, demand quantity of pesticide was positively and significantly influenced by total family labors at 10% level. It means that if total family labors increase by 1%, demand quantity of pesticide will be increased by 0.49%. According to the nature of crop, cauliflower was seriously infested by pests and the amount of pesticide usage was high. In farming practices, pesticide application was mostly done by the family members. As a consequence, the more family members will be used for the more pesticide application in cauliflower production.

In this pesticide demand function of cabbage production, current pesticide price was negatively related to the demand quantity of pesticide at highly significant 1% level. Other things being equal, 1% increase in current pesticide price will decrease the demand quantity of pesticide by 0.86%. In the case of price elasticity, the unstandardized B was less than unity (B<1), indicating that the demand for pesticide was inelastic. The results of the estimation of the demand function of pesticide of the sample farmers in the study area were described in Table 4.31.

Table 4.30 Descriptive statistics of dependent and independent variables in pesticide demand function for cabbage production

Variables	Units	Minimum	Maximum	Mean	Std. deviation
Demanded quantity of pesticide	L/ha	0.7	35.8	7.6	6.4
Household head's education level	Year	3.0	11.0	6.3	2.3
Household head's experience	Year	3.0	45.0	21.6	11.4
Total sown area	Hectare	0.3	17.2	2.3	2.2
Cropping intensity	Percent	114.1	300.0	188.5	36.4
Total family labor	Number	1.0	6.0	2.9	1.3
Quantity of FYM	MT/ha	1.2	12.4	5.2	3.2
Quantity of gypsum	Kg/ha	95.1	1482.6	255.8	345.2
Current pesticide price	Ks/L	12,733.3	152,500.0	71,986.8	42,845.2

N=79

Table 4.31 Factors affecting the demand of pesticide for cabbage production

Independent variables	Unstandardized Coefficients (B)	Standardized Coefficients (β)	t-value	Sig.
Constant	9.18**		2.41	0.024
Household head's education level	0.05^{ns}	0.02	0.15	0.884
Household head's experience	0.30^{ns}	0.21	1.66	0.109
Total sown area	-0.01^{ns}	-0.01	-0.07	0.942
Cropping intensity	-0.17^{ns}	-0.04	-0.26	0.795
Total family labor	0.49*	0.24	1.87	0.074
Quantity of FYM	0.20^{ns}	0.11	0.83	0.417
Quantity of gypsum	-0.15^{ns}	-0.11	-0.78	0.445
Current pesticide price	-0.86***	-0.71	-5.29	0.000
Buying pesticide in credit transaction	0.18^{ns}	0.09	0.62	0.541

Note: R^2= (0.640), F= (4.494), Sig= 0.000

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

4.5.6 Descriptive Statistics of Dependent and Independent Variables of Pesticide Demand Function in Cauliflower Production

According to the result of descriptive statistics, average quantity of pesticide used in cauliflower production was 6.6 Kg/ha. Average household head's education level was 6.4 years, average household head's experience in cabbage and cauliflower production was 20.5 years, average total sown area was 2.1 hectares, average cropping intensity was 189.4%, average total family labors was 3 persons, average quantity of FYM was 4.7 (MT/ha), average gypsum was 173 (Kg/ha) and current pesticide price was 62,797.6 (Ks/L) as shown in Table 4.32.

Demand quantity of pesticide was positively and significantly related to household head's experience at 10% significant level. It means that if household head's experience increase by 1%, the demand quantity of pesticide will be increased by 0.34%. Sample farmers worried the failure of expected income because infestation of pest was serious in cauliflower production. According to their experience, they needed to use more amount of pesticide for protection of pest.

Pesticide demand was negatively and significantly affected by current pesticide price at 1% level. Other things being equal, 1% increase in current pesticide price will decrease the demand quantity of pesticide by 0.8%. In the case of price elasticity, the standardized B was less than unity (B<1), the demand for pesticide was inelastic. The results of the estimation of the demand function of pesticide of the sample farmers in the study area were described in Table 4.33.

Table 4.32 Descriptive statistics of dependent and independent variables in pesticide demand function for cauliflower production

Variables	Units	Minimum	Maximum	Mean	Std.deviation
Demanded quantity of pesticide	L/ha	0.6	23.0	6.6	4.7
Household head's education level	Year	4.0	15.0	6.4	2.5
Household head's experience	Year	3.0	40.0	20.5	10.9
Total sown area	Hectare	0.3	17.2	2.1	2.1
Cropping intensity	Percent	82.5	300.0	189.4	34.2
Total family labor	Number	1.0	6.0	3.0	1.3
Quantity of FYM	MT/ha	1.2	12.4	4.7	3.2
Quantity of gypsum	Kg/ha	95.1	1482.6	173.0	305.4
Current pesticide price	Ks/L	10,666.7	152,500.0	62,797.6	45467.6

N=95

Table 4.33 Factors affecting the demand of pesticide for cauliflower production

Independent variables	Unstandardized Coefficients (B)	Standardized Coefficients (β)	t-value	Sig.
Constant	11.43***		3.27	0.004
Household head's education level	-0.41	-0.16	-1.10	0.281
Household head's experience	0.34*	0.30	1.97	0.061
Total sown area	0.13^{ns}	0.13	0.81	0.428
Cropping intensity	-0.53^{ns}	-0.14	-0.89	0.381
Total family labor	-0.17^{ns}	-0.10	-0.73	0.470
Quantity of FYM	0.14^{ns}	0.10	0.63	0.532
Quantity of gypsum	0.22^{ns}	0.18	1.03	0.312
Current pesticide price	-0.80***	-0.83	-5.28	0.000
Buying pesticide in credit transaction	0.11^{ns}	0.05	0.39	0.699

Note: R^2= (0.617), F= (3.945), Sig= 0.000

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

CHAPTER V
CONCLUSION AND POLICY IMPLICATION

5.1 Summary of Findings and Conclusion

Myanmar, being predominantly agricultural based, has to depend on agriculture sector for contribution to output and also for generating employment opportunities to its population. For achieving increased vegetable production through improving soil fertility, fertilizers constitute a key component of the modern farm technology. As a consequence, the application of fertilizer with fertilizer responsive hybrids and high yielding varieties and expansion of irrigation facility which result in increased food production. In this occasion, it is important to apply suitable fertilizer in vegetable production and practices of inputs application is influenced on the crop production as well. In this study, the demographic characteristics, cultural practices, cost and benefit and factors affecting the demand of inputs for cabbage and cauliflower production were studied.

The results indicated that average age of the sample farmers was around 45 years and most of them were in primary education level. Average farming experience was around 21 years in cabbage and cauliflower production. Half of family members worked in their farms. Most farmers were land owner-operators and pure tenant farmers were only 2%. More than half of the sample farmers owned cattle for in land preparation. Most farmers (about 90%) had traditional farm implements such as plough, harrow, sprayer, pump and pipe. Only few sample farmers (7.5%) owned power tiller. In the study area, about half of the sample farmers had mobile phones, motorcycles and bicycles.

Sample farmers mostly grew corn and green gram as monsoon crop and vegetable especially cabbage and cauliflower as winter crops. The average seed rate of cabbage was 253.3 (g/ha) and cauliflower was 278.9 (g/ha) in the study area. All cabbage and cauliflower seeds were imported from neighboring countries such as China and Thailand. But most seed brands were not registered and there was no grantee for germination, products' quality and no exact information for cultivation. There was no label in Myanmar language mentioned in most seed brands. Most farmers often changed alternative seed brands due to low quality, poor germination, less resistance to pest and disease and other problems if one seed brand was continuously grown. Sample farmers bought improved seed from the village (Nweyit) and Tatkon Town. There were two types of transactions in buying seeds in the study area. About 91.7% of the sample farmers bought seeds in cash and 8.3% of the sample farmers bought it with credit.

Most farmers applied FYM and gypsum in the land preparation. Average amount of FYM was 5.2 (MT/ha) and the gypsum was 255.8 (Kg/ha) in cabbage production and average amount of FYM was 4.7 (MT/ha) and the gypsum was 173 (Kg/ha) in cauliflower production.

All sample farmers applied urea fertilizer which was China products in cabbage and cauliflower production. There were several brands of compound fertilizers. The most popular brand of compound fertilizer was Golden Cock from Yeeshin Company. Some compound fertilizer brands were imported from Thailand illegally. Average amount of urea fertilizer applied was 420.2 (Kg/ha) and compound fertilizer applied was 152.0 (Kg/ha) in cabbage production. Average amount of urea fertilizer utilization was 384.9 (Kg/ha) and the average amount of compound fertilizer utilization was 147.4 (Kg/ha) in cabbage production. More than half of farmers did not recognize N, P, K content of compound fertilizer. All sample farmers did not receive the official recommended rate of fertilizers by Ministry of Agriculture and Irrigation for cabbage and cauliflower production.

In the study area, sample farmers used various brands of pesticide. There were various reasons for selecting of pesticide brands. Most farmers selected pesticide brands based on effectiveness of pesticide. Some pesticide brands were not mentioned their specification in Myanmar language on pesticide package. The most popular brands of pesticide were products from Awba and Nichimin Company. Farmers applied 0.7 to 35.8 (L/ha) of pesticide in cabbage production and 0.6 to 23 (L/ha) of pesticide in cauliflower production. Most of the sample farmers used two brands of pesticide, 39% of them used more than two brands and 18% used only one brand. It was found that weekly schedule of pesticide spraying was the most common practice by the sample farmers and 95% of the farmers sprayed insecticide. Fungicide and other were used by very few farmers.

To be follow pesticide usage instruction, most farmers (72.5%) always read pesticide usage instruction. According to the perception and experience of sample farmers, most farmers used instructed amount of pesticide, whereas some farmers used more or less amount of instructed pesticide dosage. All farmers accessed the information on pesticide spraying techniques in cabbage and cauliflower production from company agents, dealers, others farmers, extension agents and radio. About 80% of farmers received the information of pesticide application conducted by company agents, local dealer and other farmers. Only 7.5% of the sample farmers received it from extension agents.

Some obstacles encountered by the sample farmers were unstable product price and credit need for crop production. The sample farmers did not receive agricultural credit from MADB for vegetable production and most farmers received credit from cooperative society and local money lenders with a high interest rate of 2.5% and 6.7% per month respectively. Some farmers (18%) had the problems of pest and disease in cabbage and cauliflower production. In the pesticide application, most farmers faced high cost of pesticide and poor technology of pesticide application.

According to cost and return analysis, sample farmers faced high production cost including high labor wages and input prices. Total variable cost of cabbage production was lower than that of cauliflower production, additionally total gross benefit of cabbage was higher because of getting higher price, and consequently, cabbage production was more profitable than cauliflower production.

In the farm gate sale of cauliflower, the price of cauliflower during harvest time decreased comparing to the lagged crop price. All sample farmers faced the unstable product price and the benefit cost ratio was 1.3. In the cabbage production, harvesting cost and transportation cost did not include in the total variable cost because of selling transaction at outstanding crops. And then the crop price received by farmers was higher than the lagged crop price. The benefit cost ratio of cabbage production was 3.4. Therefore cabbage production was economically more attractive for farmers.

Among factors affecting the input demand functions, demand of seed was negatively influenced by current seed price in cabbage production and positively influenced in cauliflower production at 1% and 5% level respectively. In both cabbage and cauliflower production, demand of seed was positively related to buying seed in credit transaction at 5% and 10% level. Demand of urea fertilizer was positively affected by lagged crop prices and total family labors but negatively influenced by quantity of FYM. Current compound and pesticide prices were the most influencing factors in specific input demands at highly significant level.

5.2 Policy Implication

Vegetable production can be highly profitable than other crops. Since cultivation of vegetable crops involves intensive cultural operations starting from sowing to marketing, it provides more and regular employment opportunities in rural areas. Using optimal improved seed, fertilizer and pesticide is important to the advancement of the vegetable production. Agrochemical and seeds consumption also depends on various factors such as farming methods, cropping patterns, irrigation patterns, different demographic characteristics, availability of technology and information, varieties and quality of seeds and access to capital and credit.

The finding related that the improved seed varieties as well as other inputs like inorganic fertilizer and pesticide were major needs in cabbage and cauliflower production. Most seed brands grown in the study area were not only registered but also guaranteed for germination, products' quality and no specific information for seed varieties. Under this condition, it is needed to develop seed industry in order to meet the growing demand for qualified vegetable seeds through public private partnership. Enforcement on legislation of imported vegetable seeds according to the seed law is critical because lack of guarantee on quality and adaptability may cause high risk for farmers.

All urea fertilizers used were imported from China and some compound fertilizers were from Thailand illegally by mean of border trade. Lack of awareness on nutrient content of fertilizer by the sample farmer showed the necessity of extension training on fertilizer technology and application techniques in agricultural production. Enforcement on rules and regulations of imported fertilizer is also vital to protect the farmers from the fake product and undesired product utilization. Although there is recommended fertilizer application to vegetable production given by MoAI, research activities on rate of fertilizer application on improved cabbage and cauliflower varieties should be reinforced and fertilizer usage technology should be disseminated to farmers.

There is an essential need to be carefully following the application of pesticide dosage which is instructed on pesticide package label. Instruction or description should be in Myanmar or English language to read or understand by respective sale company and farmers. Moreover some pesticide brands were not mentioned label in Myanmar language. Using unregistered pesticides which are not mentioned instruction of usage in Myanmar language is very dangerous not only for the farmers but also for the consumers; strictly protection of unregistered pesticide importing is an urgent issue for the safety crop production.

The private sector increasingly participates in the sale of seed, agrochemical products and then enters into the transfer of knowledge on the use of their agrochemicals and improved seeds. About 80% of sample farmers accessed the information of pesticide spraying techniques from company sale agents, local dealers and other farmers. Only 7.5% farmers got information of pesticide application from extension agents. This is attributed to the limited availability of public extension services and training. Therefore the government should accelerate public extension services and training programs on pesticide application in vegetable production.

Lack of capital was one of the main constraints due to the limited access of farmers to credit facilities with favorable interest rates to benefit for the cabbage and cauliflower growing. All sample farmers did not receive agricultural credit from MADB for vegetable production. Most farmers got credit from cooperative society and local money lenders with a high interest rate of 2.5% and 6.7% per month respectively. This calls for improved access to credit for the farmers in the study area. The Government needs to increase and extend the rural credit programs to be ensured adequate credit for vegetable production. On the other hand, INGOs and NGOs should be participated to accelerate the improvement of rural credit program.

According to the cost and benefit analysis, the cost of production was high but the benefit-cost ratio of cabbage was 3.4 and the cauliflower was 1.3. The income of cabbage production was higher than that of cauliflower production. Cost of cultivation of cabbage was low because cabbage was sold standing crop and no harvesting cost and transportation cost. Regarding the marketing activities, reducing cost of harvesting and transportation would be merit for farmer’s income. Therefore, efficient and effectives marketing activities are very important for vegetable growers. It would be the key factor for increasing rural income.

As improved seed utilization was influenced by buying seed in credit transaction, MADB should strengthen the credit not only for rice production but also for vegetable production. As the demand of agricultural inputs such as compound fertilizer and pesticides were influenced by the current input prices, factors reducing the input prices such as relaxing the implicit tax, developing the market infrastructure and creating the competitive agrochemical market should be taken into account. In addition, since the demand of urea fertilizer was influenced by the lagged crop price, facilitating market infrastructure such as storage, transportation facilities, providing market information and enhancing marketing extension education are essential in order to reduce perishable crop price fluctuation suffered by vegetable growers.

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APPENDICES

Appendix 1 Sown area of vegetables in Myanmar (Hectare)

No.	Vegetable Names	2008-09	2009-10	2010-11	2011-12	2012-13
1	Cabbage	28,219	29,066	30,272	32,337	31,095
2	Cauliflower	24,303	25,185	26,698	26,609	27,154
3	Lettuce	8,481	9,180	9,565	10,655	11,893
4	Mustard	34,031	36,289	38,265	37,958	36,937
5	Tomato	110,277	110,450	111,899	107,457	110,391
6	Beet root	2,490	2,746	2,540	2,758	2,786
7	Radish	21,083	23,099	22,807	22,731	22,290
8	Water melon	17,186	18,217	18,960	16,571	15,267
9	Bottle gourd	19,715	22,894	22,295	22,767	23,302
10	Asparagus	349	526	527	502	508
11	Others	241,618	24,190	257,870	257,650	259,645

Source: MoAI 2013

Appendix 2 Map of Tatkon Township

Source: DoA 2013

Appendix 3 Enterprise budget for cabbage and cauliflower production (Ks/ha)

No.	Units	Cabbage (N=79)	Cauliflower (N=95)
1	**Total gross benefit**	**5,426,543**	**2,600,198**
2	**Variable costs**		
	(a) Material cost		
	Seed	63,068	169,014
	FYM	55,332	52,589
	Fertilizer (Urea)	171,456	156,262
	Fertilizer (Compound)	107,823	110,191
	Gypsum	55,046	49,509
	Hormone	16,417	15,457
	Pesticide	219,213	180,228
	Diesel	119,152	97,061
	Total material cost	**807,507**	**830,311**
	(b) Family labor cost		
	Plowing	59,195	53,582
	Harrowing	19,873	20,106
	Seeding	5,333	5,376
	Weeding	8,698	11,080
	Making planting holes	3,941	3,446
	Transplanting	1,908	1,821
	Watering (manual)	98,261	89,645
	Earthing up	2,337	1,665
	Inter-cultivation	2,930	2,602
	Making irrigation canal	6,924	7,205
	Irrigation	15,154	14,397
	Fertilizer application	13,495	14,059
	Pesticide application	32,029	33,306
	Harvesting	-	61,931
	Transportation	-	95,303
	Total family labor cost	**270,081**	**415,524**
	(c)Hired labor cost		
	Plowing	70,258	71,399
	Harrowing	6,131	7,231
	Seeding	1,001	1,014
	Weeding on manual	11,026	7,842
	Making planting holes	5,818	5,657
	Transplanting	27,212	25,425
	Watering (manual)	50,515	60,422
	Earthing up	44,415	44,075
	Inter-cultivation	35,517	35,023
	Making irrigation canal	60,621	60,613
	Irrigation	13,559	9,663
	Fertilizer application	6,897	7,725
	Pesticide application	25,992	19,209

	Harvesting	-	70,671
	Transportation	-	130,807
	Total hired labor cost	**358,962**	**556,776**
	(d)Interest on cash cost	**157,918**	**166,591**
	Material cost	129,201	99,778
	Haired labor cost	28,717	66,813
3	**Total variable cost**	**1,594,467**	**1,969,203**
4	**Return above variable cost**	**3,832,076**	**630,996**
5	**Return above cash cost**	**4,102,157**	**1,046,520**
6	**Benefit cost ratio (BCR)**	**3.4**	**1.3**

Appendix 4 Enterprise budget for cabbage and cauliflower production (Ks/ac)

No.	Units	Cabbage (N=79)	Cauliflower (N=95)
1	**Total gross benefit**	**2,196,092.0**	**1,052,285.9**
2	**Variable cost**		
	(a) Material cost		
	Seed	25,523.4	68,398.9
	FYM	22,392.4	21,282.6
	Fertilizer (Urea)	69,387.3	63,238.4
	Fertilizer (Compound)	43,635.6	44,593.8
	Gypsum	22,276.6	20,036.0
	Foliar	6,643.7	6,255.3
	Pesticide	88,714.2	72,937.3
	Diesel	48,220.3	39,280.0
	Total material cost (a)	**326,793.5**	**336,022.3**
	(b) Family labor cost		
	Plowing	23,955.7	21,684.2
	Harrowing	8,042.7	8,136.8
	Seeding	2,158.2	2,175.5
	Weeding	3,520.0	4,484.2
	Making planting holes	1,594.9	1,394.7
	Transplanting	772.2	736.8
	Watering on manual	39,765.8	36,278.9
	Earthing up	945.9	673.7
	Inter-cultivation	1,185.9	1,053.2
	Irrigation cannel making	1,360.8	1,557.9
	Plant population division	1,441.6	1,357.9
	Irrigation	6,132.9	5,826.3
	Fertilizer application	5,461.5	5,689.5
	Pesticide application	12,962.0	13,478.9
	Harvesting	-	25,063.2
	Transportation	-	38,568.4
	Total family labor cost (b)	**109,300.2**	**168,160.3**
	(c)Hired labor cost		
	Plowing with machine	28,433.0	28,894.7
	Harrowing with draft cattle	2,481.0	2,926.3
	Seeding	405.1	410.5
	Weeding	4,462.0	3,173.7
	Making planting holes	2,354.4	2,289.5
	Transplanting	11,012.7	10,289.5
	Watering on manual	20,443.0	24,452.6
	Earthing up	17,974.7	17,836.8
	Inter-cultivation	14,373.4	14,173.7
	Irrigation cannel making	7,502.5	7,230.7
	Plant population division	17,030.4	17,298.9
	Irrigation	5,487.3	3,910.5

	Fertilizer application	2,791.1	3,126.3
	Pesticide application	10,519.0	7,773.7
	Harvesting	-	28,600.0
	Transportation		52,936.8
	Total hired labor cost (c)	**145,269.7**	**225,324.4**
	(d)Interest on cash cost		
	Material cost	52,287.0	40,379.6
	Haired labor cost	11,621.6	27,038.9
	Interest on cash cost (d)	63,908.5	67,418.5
3	**Total variable cost (a+b+c+d)**	**645,272.0**	**796,925.5**
4	**Return above variable cost**	**1,550,820.0**	**255,360.4**
5	**Return above cash cost**	**1,660,120.1**	**423,520.7**
6	**Benefit cost ratio (BCR)**	**3.4**	**1.3**

Appendix 5 Summary demand functions of selected seed, fertilizer and pesticide for cabbage production

Independent variables \ Dependent variables	Seed	Urea	Compound	Pesticide
Household head's education level	ns (-)	ns (+)	ns (-)	ns (+)
Household head’s experience	* (+)	*** (+)	ns (-)	ns (+)
Total sown area	ns (-)	ns (-)	* (+)	ns (-)
Cropping intensity	ns (-)	ns (+)	** (+)	ns (-)
Total family labor	ns (-)	*** (+)	ns (-)	* (+)
Quantity of FYM	*** (-)	** (-)	ns (+)	ns (+)
Quantity of gypsum	ns (+)			ns (-)
Quantity of urea			** (+)	
lagged crop price		*** (+)		
Current input prices	*** (-)	*** (+)	*** (-)	*** (-)
Buying inputs in credit transaction	** (+)	ns (-)	ns (+)	ns (+)

N=79

Appendix 6 Summary demand functions of selected seed, fertilizer and pesticide for cauliflower production

Independent variables \ Dependent variables	Seed	Urea	Compound	Pesticide
Household head's education level	** (+)	ns (+)	ns (-)	ns (-)
household head's experience	ns (-)	ns (+)	ns (+)	* (+)
Total sown area	ns (+)	ns (-)	ns (+)	ns (+)
Cropping intensity	ns (+)	ns (-)	ns (-)	ns (-)
Total family labor	ns (+)	** (+)	ns (-)	ns (-)
Quantity of FYM	ns (-)	** (-)	** (+)	ns (-)
Quantity of gypsum	* (+)			ns (+)
Quantity of urea			** (+)	
lagged crop price		*** (+)		
Current input prices	*** (+)	ns (+)	*** (-)	*** (-)
Buying inputs in credit transaction	** (+)	ns (-)	ns (+)	ns (+)

N=95