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Assessment of fertilizers usage and cropping patterns in study area of Naypyitaw, Myanmar

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A study was conducted to observe the demographic characteristics of farmers, to assess the use of fertilizers application by farmer and to identify the current status of cropping pattern in the study area. The demographic profiles of 60 respondents stated that the age ranged from 30 to 78 years and land holding ranged from 0.10 to 2.80 ha. The majority of farmers (40%) had a primary educational level. Farmers utilized the different kinds of fertilizers (urea, NPK compound, phosphorous, special potash and foliar) depending on crops and time of applications, and 68% of respondents used cattle manure as basal. Response on farming experience indicated that six different levels of 3 to 60 years. The most cropping patterns observed in the study area were rice-black gram, rice-fallow, maize-tomato, maize-tomato and lablab bean intercropping, maize-lablab bean, okra-tomato. In addition, some of the farmers cultivated horticultural crops such as banana, guava and ambarella. There is a highly significant positive relationship on farm size with cropping pattern. This study suggested that farm size, inputs, market price, labors and farmer's willingness would influence the fertilizer usage and cropping patterns.

Key words: Demographic characteristics, fertilizer use, cropping patterns.

INTRODUCTION

Agriculture is mainly commercial; cultivated for profit in the developed countries, whereas in developing countries, like Myanmar, the objectives of agriculture are to maximize the production to meet the food requirements as well as to supply other financial obligations of the farmer's family and to export the agricultural products for foreign exchange of country. An ideal crops plan should not only fulfill requirement of the local people or food for the farmers and their families, but also meet fodder requirement of the farm animals. Moreover, the adoption of cropping pattern in any region is a product of varied factors, which includes the important role, such as physical, social and economic factors. Cropping patterns based on climate and land capability are sustainable but market forces and farmers' aspirations are forcing unsustainable systems (Shekara et al., 2016).

Fertilizer is critical in achieving higher yield needed to feed the rapidly growing population. Inorganic fertilizers

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Figure 1. Research Area in Sipintharyar village, Zeyarthiri township.

contain mineral nutrients which are easily available and absorbed by plants and the convenience and potency of fertilizers make them appeal strongly to traditional farmers who are major food producers in the humid tropics (Wilken, 1987). Soil fertility was depleted once inadequate fertilizer application that limits crop yield, results in nutrient mining. Conversely, the excessive or imbalanced application not only wastes a limited resource, but also pollutes the environment. Therefore, there is a direct link between farmers' fertilization practices and the resultant effects on soil quality status. The proper and efficient use of fertilizers is essential for increasing soil productivity. As a result, the best fertilizer management is a major consideration in agricultural production (Omari, 2017).

The different rate of nutrient application is possible only if experts can give correct site-specific recommendations, and result revealed that precise information about nutrient status of the soil is required (Godwin, 2001). However, Myanmar farmers have limited knowledge of modern agricultural technologies, including fertilizers. The linkages between the research and extension services to the farmers had not been underdeveloped, resulting in poor soil and fertilizer information dissemination. Farmer knowledge of integrated soil fertilizer management and 4Rs (right sources, right rate, right time, right place) concept has been low. Little or no improvement in research facility and skills and training of research and extension personnel was observed in my study area. Thus, the studies of soil productivity and soil fertility levels are required annually as time series information because they will change over time. In Zeyarthiri Township, most of the farmers in Sipintharyar village grow different crops in both wet and dry seasons and their income mainly depends on their crops yields and market prices. It is one of the intensive cropping zones which is dominated by small scale farming. The research aims to observe the demographic characteristics of farmers, to study the present status of different fertilizers application practices in farming and to identify the current status of cropping pattern in the study area.

Description of study area

The research area is located in the middle region of Myanmar, Naypyitaw, Zeyarthiri Township, Sipintharyar Village, situated between 19°44'43" N - 19°45'22" N and 96°17'42" E - 96°18'02" E (Figure 1) and a total study area of 60 ha. The study area receives a mean annual rainfall of about 1265 mm and the average temperature of 26.8°C. Farmers have practiced rice and maize in monsoon and tomato and lablab bean in winter, as dominant crops in the study area.

METHODOLOGY

Pilot survey was conducted in February 2020 with 10 farmers in the study area. The required secondary data were collected by interviewing the village-head, and meeting with township staff officers from the Department of Agriculture. The purposive random sampling technique was used for selection of farmers who included their field in the boundary area of the study area. Accordingly, 60 farmers were selected as sample respondents and interviewed with structured questionnaire at Sipintharyar village, Zeyarthiri Township, Naypyitaw, Myanmar during February 2020. The questionnaire consisted of social information, field and crop history information that includes soil fertility status, method of land preparation, cropping pattern; and soil management practices information such as fertilizer application (e.g. organic, inorganic or foliar), name and type of fertilizers, rate, time and frequency of fertilizer application, number of years for fertilizer application, use of herbicides, practices of crop residues incorporation, method of harvesting, income, cost and profit of farming.

Data analysis

The data were calculated using Statistical Package for Social Science, SPSS (version 17) software. The descriptive statistics was

Table 1. Demographic characteristics of farmers in Sipintharyar Village, Zeyarthiri Township (N=60).

	Minimum	Maximum	MSE	SD
Age (Years)	30	78	1.453	11.255
Education	2	5	0.119	0.918
Farm size (ha)	0.1	2.8	0.210	1.626
Farm experience (Years)	3	60	1.735	13.435
No. of years for fertilizer application (Years)	5	40	1.039	8.048

MSE= Mean Standard Error; SD= Standard Deviation.

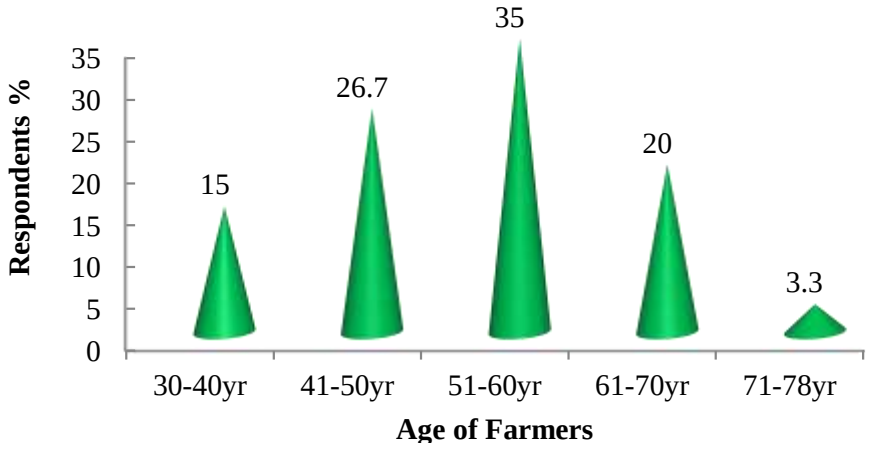

Figure 2. Age of Farmers in Sipintharyar village.

used for data analysis for all studied variables.

RESULTS AND DISCUSSION

Socio-demographic factors of the respondents in the study area

Distribution of the surveyed respondents according to their demographic characteristics is shown in Table 1. The age of the respondents ranged from 30 to 78 years with an average of 46 years. Of the total 60 respondents, about 82% respondents aged between 40 and 70 years, 3.3% of respondents are above 70 years while the rest 15% of respondents are below 40 years (Figure 2). Respondents' educational levels had 21% in read and write, 40% in Primary, 28% in Middle, and 10% in High School level in Sipintharyar village (Figure 3). The education status of the respondents in survey areas was found to be low. It showed that respondents could only read posters and magazines for more innovation and it could be weak to communicate their experiences among them. Thus, the finding of Omamo et al. (2002) also reported that education level of the household head may be taken as a proxy for enabling access to technical information on fertilizer use, and hence may be positively related with fertilizer use.

According to the findings, the respondents in survey areas possessed five groups of land-holding level ranging from 0.10 to 2.8 ha of farm size (Figure 4). About 65% of the respondents possessed the total sown area of 0.10-0.81 ha, 26.7% possessed in >0.81-2.02 ha, and 8.3% possessed in >2.02-2.8 ha. It indicated that the study area is occupied by the small-scale farmers. This finding is in agreement with those of Olayide et al. (1980) who classified small-scale farmers as those having 0.1 to 5.99 ha of farm size.

Most of the respondents started their farming activities at an early age and after getting married with varying wide ranged farming experience from 3 to 60 years (Table 1). Response on farming experience showed that 13% of the respondents had practiced in (<10) years, 20% in (>10-20) years, 33.4% in (>20-30) years, 21.6% in (>30-40) years, 6.7% in (>40-50) years and 5% in (>50-60) years, respectively (Figure 5). This implies that almost all of the respondents have been in the farming profession for quite some period of time and are not novices in farming activities that may enhance the better soil management practices. These are in line with those of Ridler and Hishamunda (2001) who reported that the experienced farmers were a lower risk compared to new farmers. In the survey area, all respondents except rice

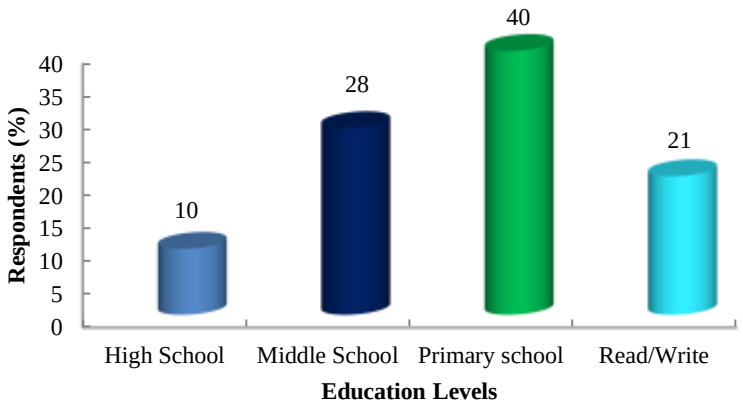

Figure 3. Education levels of respondents in Sipintharyar village.

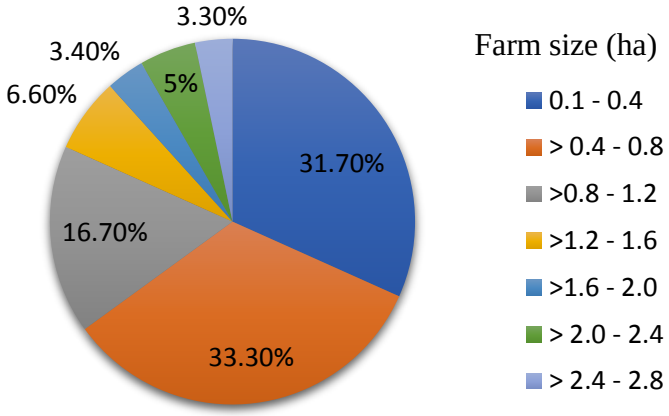

Figure 4. Different farm size levels of respondents.

growers practiced mixed cropping, crop rotation and intercropping systems for fertility management.

Crop management practices

The detailed information of crop management practices was presented in Table 3. The opinion of respondents for their soil fertility condition was found to be three classes in the study area (Figure 6). Most of respondents (68.3%) said that the fertility condition of their soils were medium while only 13.3% of respondents answered poor fertility condition. It might be the addition of cow dung, chemical fertilizers, and the cultivation of pulses in the study area. Machine was used in rice and black gram cultivation but it was used in ploughing while animal and human power were used for making bunds, planting rows, planting, weeding and harvesting for other crops in the study area. All of farmers have grown their seeds in lablab bean, black gram, chickpea, tomato (traditional varieties). They usually preferred to store their seeds or exchange with neighboring farms for the next crop season. However, farmers bought seeds from merchant for high yielding tomato varieties and maize (CP 888). Okra and Japanese mustard seeds were bought from Myanmar Agri Food Company. The horticultural crops such as banana, ambarella, mango and guava seedling were purchased from Private Farm. The seeding rate for broadcasting was 60 kg ha^{-1} in rice, 2.5 kg ha^{-1} in sesame and 20 kg ha^{-1} in green gram. The seed rates were 5-7.5 kg ha^{-1}, 5-7.5 kg ha^{-1} and 20 kg ha^{-1} for maize, okra and lablab bean, respectively. For plant density, 10000 -12000 plants per acre for tomato and 9000 plants per acre with lablab bean intercropping were used. Guava was grown as 6ft × 6ft, 20ft × 20ft for mango and 30ft × 30ft for ambarella and 10ft × 9ft for banana. With the availability of pump irrigation facilities, farmers have adopted different crops in their field (Table 2). Most of the cropping patterns were rice-black gram, rice–fallow, maize-tomato, maize- tomato and lablab bean intercropping, green gram- tomato, okra – tomato, okra-maize- tomato and sesame- lablab bean. The sowing and

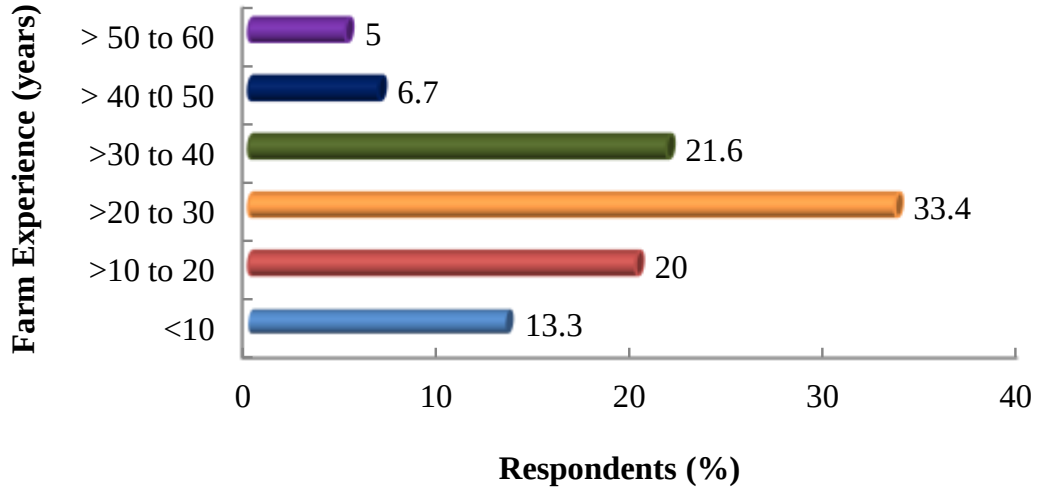

Figure 5. Farming experience levels of respondents.

Table 2. Name of crops and number of farmers grown in Sipintharyar village (N=60).

Season	Crops	Numbers of farmer
Rainy season	Maize	41
	Okra	22
	Rice	23
	Sesamum	2
	Sunflower	1
Summer season	Tomato and lablab bean	32
	Tomato	16
	Blackgram	14
	Japanese Amaranthus	7
	Lablab bean	4
	Onion	3
	Chickpea	2
	Chilli	1
Horticultural crops	Banana	3
	Ambarella	2
	Mango	1
	Guava	1

harvesting time of crops were shown in Table 3.

Fertilizer usage in crop cultivation

Conferring to the results, the 68% of respondents used cowdung manure at basal that was readily available from their cattle, and the quantity was not enough hence the farmers kept very few livestock. The rest 32% of respondents understood the benefit of cowdung for soil fertility but they have neither animal nor money to buy cowdung from others. Manure releases nutrients to the soil slowly and helps soils to build organic matter with long-term benefits (Place et al., 2003; Palm et al., 1997). All of the respondents knew how and when to apply manure to their crops. None of the respondents applied crop residues, because they piled the crop residues after harvesting in the fields and then burnt.

Among the respondents, the majority (95%) applied NPK compound fertilizers while growing their crops. They applied the rate of NPK (15:15:15) compound 125 kg ha^{-1} as basal application in tomato, maize and okra. Additional

Table 3. Crop management practices done by respondents in Sipintharyar Village, Zeyarthiri Township.

Season		Rainy Season					Winter Season						Horticultural Crops				
Crop	Management practices	Rice	Maize	Okra	Green Gram	Sesamum	Tomato	Tomato and lablabbean	Lablab bean	Black gram	Japanese Mustard	Chick pea	Onion	Mango	Guava	Banana	Ambarella
1	Seed source																
	Farmer seed	√				√		√	√	√		√	√			√	
	Merchant seed		√	√			√				√			√	√		√
	Experimental station				√												
2	Seed Rate (kg ha^{-1})	52-104	5 -7.5	5 - 7.5	20	2.5	12000 plant/ac	9000 plts/ac, 30	20	60	0.5	20	8 to 10	250plts	9000 plts	1200 plts	120plts
3	Land Preparation	Machine	Machine and Manual	Machine and Manual	Machine	Machine	Machine and Manual	Machine and Manual	Machine	Machine	Machine and Manual	Machine	Machine and Manual	Manual	Manual	Machine and Manual	Manual
4	Sowing Method																
	Brocasting	√				√				√	√	√					
	Line Sowing		√	√	√			√	√								
	Transplanting						√	√					√	√	√	√	√
5	Time of Sowing	June-July	May-June	April-May	April-May	April-May	Sept-Oct	Oct-Dec	December	Nov-Dec	Dec-Jan	Jan-Feb	Febraury	May-Jun	May-Jun	May-Jun	May-Jun
6	Fertilizer Applications																
NPK	compound (kg ha^{-1})	62	124	124		62	247	62					62		62	62	25
	Urea (kg ha^{-1})	247	247	62		6	124	124	10				3		30		
	Phosporous (kg ha^{-1})	0															
	Potassium (kg ha^{-1})	0					62										
	Foliar fertilizer			7-10 days intervals (Asifate, Biofoliar)	3 times		7-10 days intervals			3 times (cormas)	Asifate, Biofoliar						
7	Pesticide		Apply as need	Apply as need	3 times combined with foliar		3 times combined with foliar	Apply as need									
8	Weeding	weedicide	3 times (Manual and Animal)	Manual			Manual and Animal	Manual and Animal	Manual and Animal		Manual			Manual	Manual	Manual	Manual
9	Time of Harvesting	Nov - Dec	Sept-Octo	April-May	Aug	Aug	Dec-Feb	Jan-March	March	Jan-Feb	Nov-Dec	March	April	May-June	All year round		
10	Method of Harvesting	Machine	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual

use of NPK compound fertilizers for these crops at the rate of 124 kg ha^{-1} were applied two times, at flowering and fruiting times. Moreover, NPK compound fertilizer was used in horticultural crops but the rates for application depended on crop performance, market price and financial

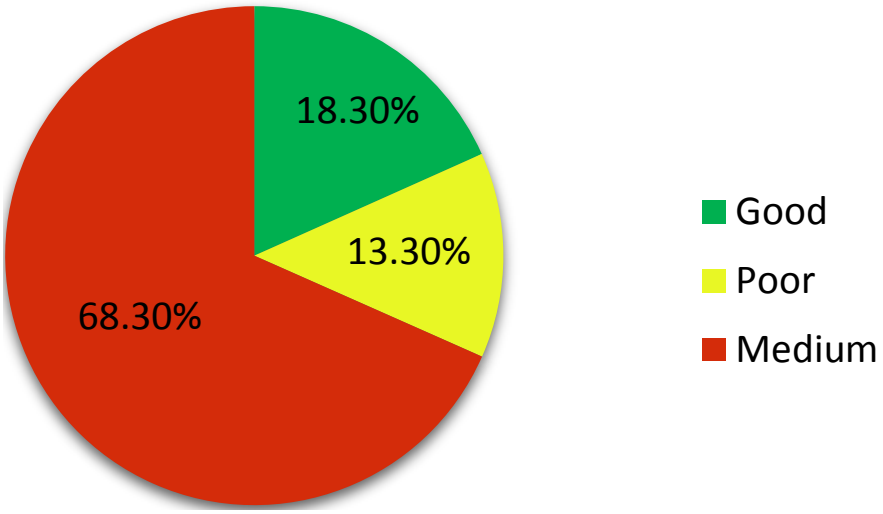

Figure 6. Opinion of respondents for their soil fertility status.

conditions. Some of the respondents had practiced in combined application of urea 247 kg ha^{-1} with 62 kg ha^{-1} triple super phosphate (TSP) after planting of tomato and okra for additional fruit setting. There was no application of fertilizer for lablab bean in tomato-lablab bean intercropping. Farmers responded that fertilizers used in tomato are still available to bean, and there was no need of further fertilizer application for lablab bean in this area. Farmers wanted to emphasize the use of nitrogen fertilizer (urea) but they did not know exactly the effects of phosphorous and potassium fertilizers in their cropping.

In addition, many kinds of foliar fertilizer are used at 10-15 days interval according to their crop performance and market demand in these cash crops. During crop seasons, farmers applied 4-5 times of foliar fertilizer together with pesticide or hormones in tomato and okra. Myanmar Agri Food Company sold the seeds (okra and Japanese mustard) to be grown by the farmers and also Blagate and Biofoliar to be used as foliar fertilizers for those crops, and then bought those products daily. The data observed in Figure 7 obviously showed the most common types of fertilizers used by the farmers in the study area. There was little knowledge for using phosphorus and potash fertilizers for crop production. The respondents stated that the fertilizer was always applied to the crops (tomato, okra) when needed by plant performance.

The results of this study showed that farmers' fertilization practice was just mainly determined by the availability of fertilizers by credit and crop performance, yield response and market price of products. The respondents had high awareness for using chemical fertilizers as they understood that it was needed for the crop to give the yield increase. In Sipintharyar village, the weed management in their field was done manually and by oxen for inter-cultivation between planting rows; however, only rice was managed by using weedicide. Weedicide was applied in rice field whereas other crops were done manually at 2 weeks intervals from 14 days after sowing to flowering time. According to survey data, 78% of respondents did not know about soil fertility test or analysis whereas the rest 22% were unaffordable for the soil analysis.

Correlation between demographic characters of farmers with cropping patterns

Age, educational level, farm size, incorporation of crop residue and farmers' opinion on soil fertility status had positive relationship with cropping pattern at 5% level of significance (Table 4). Among them, farm size was a highly significant positive relationship (p=0.003) than age, educational level, incorporate crop residue and opinion of soil fertility status. Conversely, farm experience was an insignificant negative relationship. As described in Table 4, R^2 value is 0.251 and indicates 25% of the variance of cropping pattern is explained by the selected demographic characteristics of farmers in the model. Table 4 indicates that farm size makes the highest contribution (β = 0.388) to explain respondents demographic characters on cropping pattern. It implies that the larger the farm size, the higher the possibility of growing diversity of crops or adopting more than one cropping pattern. Incorporate crop residue (β = 0.236) is the second most contributor on farmers' demographic characters followed by Age (β = 0.226), opinion of soil fertility status (β = 0.114), educational level (β = 0.105) and farm experience (β = -0.248) of farmers, respectively. This result indicates that farm experience was no contributor to cropping pattern. Therefore, farmers with a large farm size have to be depending more on cropping

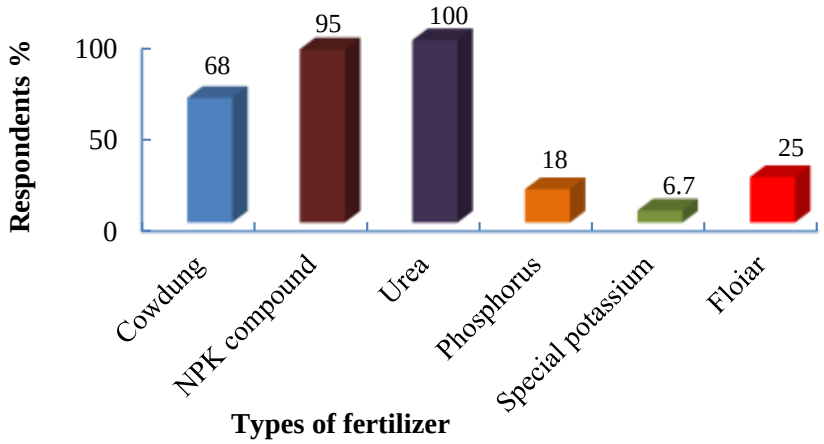

Figure 7. Common types of fertilizers used by farmers.

Table 4. Linear regression model showing coefficients of demographic characters of farmers with cropping patterns.

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	(Beta)		
(Constant)	0.401	0.604		0.663	0.51
Age (Years)	0.017	0.012	0.226	1.366	0.178
Educational level	0.098	0.114	0.105	0.857	0.395
Farm size (ha)	0.203	0.066	0.388	3.073	0.003
Farm Experience (Years)	-0.016	0.01	-0.248	-1.537	0.13
Incorporate Crop residue	0.662	0.352	0.236	1.878	0.066
Opinion of soil fertility status	0.172	0.185	0.114	0.927	0.358

R=0.501; R2= 0.251; Adjusted R2= 0.166; Std. Error of Estimate=0.776; F= 2.959; Sig.= 0.014.

pattern.

Conclusion

The study reveals that most of farmers (35%) fell under age group 51-60 years and 40% of respondents had primary educational level. Maximum number of respondents (65%) had small holding (0.10-0.81 ha) of cultivated land. One-third of respondents (33.4%) had farming experience of > 20-30 years. Most of the farmers grow maize in wet season and tomato in dry season while others grew rice in their fields. According to linear regression analysis results, age, educational level, farm size, incorporation of crop residue and opinion of soil fertility status of farmers had positive relationship with their cropping pattern but farm size was highly statistically significant and farm experience was negatively insignificant. During the study period, the major problem of farmers was the lower market price of tomato (one kyats per 1.5 kg). The income from selling of tomato could not yield tangible benefit; hence farmers were not picking up tomatoes from plants in the study area. In fertilizer usage, all farmers applied NPK compound and urea fertilizers in their farming. Most of the farmers challenged financial difficulties as well as the market price of products although the farmers are aware that fertilizer application is necessary for increased crop production. This study observed that the limited farmers' knowledge on fertilizer use and lack of information related to fertilizer management was according to their kind of crops. Thus, it is urgently necessary to project the soil fertility maps and to conduct soil fertility assessment to observe the appropriate use of fertilizer in their farming for the study area.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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