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An Assessment of Soil Fertility Management Practices in Central Dry Zone of Myanmar

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Abstract

This study was carried out in two villages in central dry zone of Myanmar to assess farmers' soil fertility management strategies and practices and their influencing factors. Kanswe village had irrigation water availability due to dam constructed by the governmetn and the Inganet village had reservor built by the villagers themselves which are reffered in this study as government irrigation project (GIP) and local irrigation project (LIP) respectively. Excel spreadsheet and SPSS were used for analyzing data. Qualitative techniques were used for descriptive data. Independent sample t-test was carried out where comparison was needed for dependent and independent variables. The main locally adopted soil fertility management practices (SFMPs) include the application of farmyard manure (FYM), green manuring, the use of chemical fertilizers, crop rotations, crop residues management and water saving techniques. Study found that inorganic fertilizer application has increased. Critical issues for soil fertility management in the areas were water scarcity, soil salinity, soil erosion, high price of chemical fertilizer and financial problems. There is a need to promote integrated plant nutrient management systems (IPNMS) in both the project areas.

Keywords : soil fertility, dry zone, agriculture, farmyard manure, Myanmar.

1. Introduction

Dry zone is one of the most important agricultural zones in Myanmar with most of the residense in this region are small scale farmers. As a result of natural and human factors, household food security in this area has been adversely affected. Decline in agricultural productivity and income in dry zone of Myanmar was due to low rainfall, poor soil fertility, and insufficient inputs used for agriculture and unsatisfactory farming practices (FAO 2014). The adoption of intensive agriculture through increased use of fertilizers, pesticides and other inputs, directly or indirectly has brought some adverse impacts to farmlands. Low soil fertility is a major impediment to intensive agriculture (Vanlauwe et al. 2017). The low level of annual perecipitation (700 mm per year) in the region is a particular challenge for the farmers leading to droughts and other severe difficulties for agricultural production, a situation that is likely to be aggravated by climate change. In the upland areas in dry zones, land degradation is a major issue which is a consequence of increased population combined with unsuitable land use and shifting cultivation. Because population pressure and climate change impacts are very significant in this region, soil degradation and soil erosion process are becoming more prominent (FAO 2014). Naing (2004) reported that over 25% of the total production costs for rice cultivation is the cost for fertilizers in Myanmar. Because of low inputs of mineral fertilizers and manure (Hossain and Singh 2000; Naing 2004), low nitrogen recovery (<40%) of urea fertilizer in lowland rice ecosystems (De Datta 1985; Freney et al. 1996) and due to some other factors, rice yields in Myanmar have declined at about 3.3 ton per hectare since 1985.

The farmer's perceptions about soil fertility are mostly related to the whole system to produce better yield (Hedlund et al. 2004). Chambers (1991) stated that the main reasons for low production are unsuccessful technology transfer, expensive inorganic fertilizers and lack of farmers' awareness on conservation measures. Lwin et al. (2013) reported that in the context of ecological and socioeconomic factors in this region, soil fertility management technologies were still not accepted. Consideration of conservation practices are still poor because crop cultivation is mostly under the traditional farming systmes in this region. In developing countries such as Myanmar, the challenge of agricultural development is that production should be improved to feed the growing population. Therefore, more efficient, economic and integrated system of nutrient management is needed to develop for achieving higher yield without causing decline in soil fertility. Improving soil fertility would lead to rural and nationwide economic development, attain enduring food security and consequently farmers' living standards would be higher. Therefore the objectives of the study were to 1) compare current farming practices in soil fertility management in two different irrigation projects in the dry zone of Myanmar, 2) to find out the factors that influence farmer's choices of the different soil fertility improvement practices in the context of local initiated large reservoir and government dam irrigated areas in dry zone of Myanmar, and 3) to find out the constraints on SFMPs.

2. Conceptual framework

The conceptual framework of the study is shown in figure 1. The framework show that high population density has strongly pressurized the environment through cropping intensity such as deforestation, shortened fallow, land degradation, and soil erosion. The dry zone in Myanmar is strongly influenced by its climate resulting into semi-arid conditions restricting agricultural potential in the absence of irrigation. Moreover, the high cost of imported chemical fertilizers and low rice prices reduced fertilizer consumption and constrained rice production. Therefore, efficient nutrient management is essential to sustain the productivity. More efficient, economic and integrated system of nurtient management is necessary to attain high crop yield withoud reducing soil fertility. Soil fertility improvement could creat rural and national economic development and consequently higher standard of living can be occurred which can bring about environmental degradation reduction and lesser rural migration. On the other hand, there are many factors influencing sustainable soil fertility management such as soil nutrient status, soil structure, education of the farmers, their farming experience, land holdings, livestock holdings, cropping pattern, labor availability, fertilizer application (organic/inorganic), residues utilization, income, availability of credit/incentive and training programs etc.

3. Methodology

3.1 Selection of the study area

Selection of the study area was done by both purposive sampling and random sampling. Survey method was used to collect the primary data in this study. The key sources of information in this study were household level questionnaires, key informant interviews and focus group discussion. Moreover, published and no-published government and non-government reports, records, books, paper articles and papers were collected as secondary source of data.

The precipitation in dry zone area is totally dependent on monsoon circulation system. According to NCEA (2009), average annual precipitation is <600 mm in the Dry Zone. Erratic rainfall pattern can be found with high intensities of rainfall up to 250 mm/day and over 100 mm/hour. Mid-May to October is the period that the precipitation occurs in this area. Between mid-October and mid-February, there is a dry cool spell. The dry period usually starts from mid-February to mid-May (FAO 2003). April and May are the hottest months of the whole year with the average mean temperature of about 27˚C.

Annual humidity on an average is about 63%. Lower level of potassium can be found in all soil types in this region. Rice is the main crop if irrigation water is available, but otherwise pulses such as chickpea, grams and pigeon pea, oilseeds such as sesame, groundnut and sunflower and sorghum are mainly cultivated (FAO 2014). Production of economic crops such as onion, potato, tomato and pulses can also be found in this region (Ministry of Forestry, 2005).

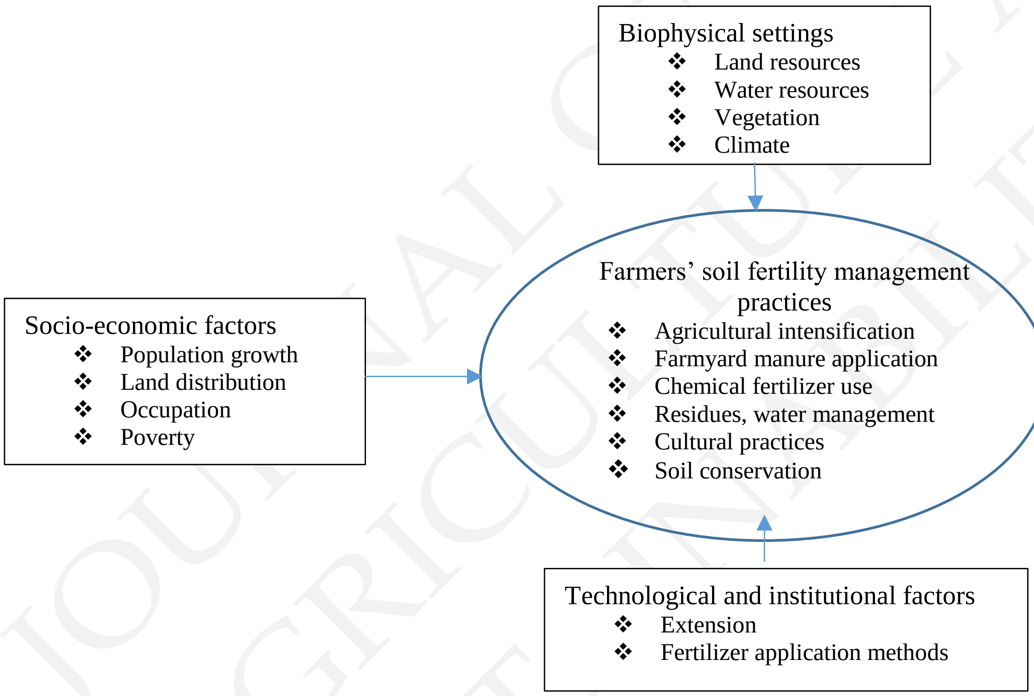

Figure 1: Conceptual Framework

Both Thazi township and Wundwin township are situated in Meiktila District, located in Mandalay region of the dry zone region of Myanmar. Thazi township lies on 21°50′ N 95°39′ E. It is composed of 79 village tracts. Among them, Ingannet village from Man Kyee Kwa village tract was selected as study village. Wundwin township is located on 21°5′ N and 96°2′ E. It contains 69 village tracts. From them, Kanswe village from Sue Pan village tract was selected as study village. Meikhtila district was selected to represent the general production situation of dry zone region. Among the townships of Meikhtila, Thazi township and Wundwin township were purposively selected. Then, two villages were selected according to the above criteria. The difference between the two villages was irrigation source. Inganet village from Thazi township has irrigated rice production but the irrigation water was provided by a large reservoir built by the villagers themselves in the year 1985. Therefore, this village was named as local irrigation project (LIP) area. On the other hand, Kanswe village from Wundwin township received irrigation water for rice production from government initiated dam, Kinda dam, built in 1986 and was called as government irrigation project (GIP) area in this study.

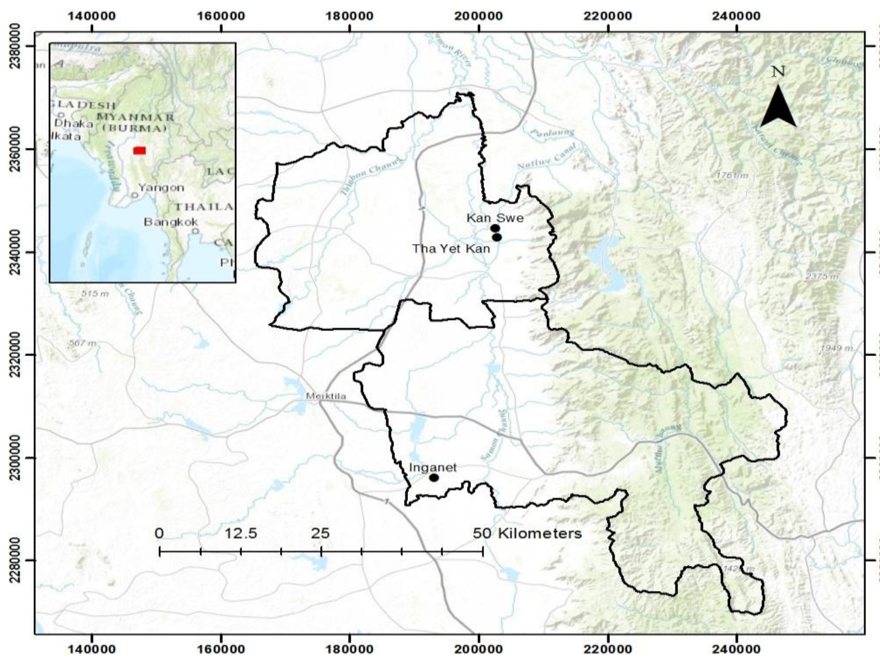

Figure 2: Study Area

3.2 Sample Size

The sample size for each village was calculated by using Yamane's Formula (Yamane 1967) with 10% error of acceptance and 90% confidence level. The total households in the selected villages were 336. The total sample size was based on the number of households who practice rice based farming from the selected villages. By using the formula, the resulted sample size was 125 households. However, the study covered 154 total respondent households (83 from Inganet and 71 from Kanswe villages) due to the availability and willingness of the respondents. Stratified random sampling was used for the selection of the respondents at household level. And then, farmers from each category were randomly selected to carry out questionnaire survey, key informant interview and focus group discussions.

3.3 Data Collection and analysis

This study use primary and secondary sources of data from different organizations. Both qualitative data and quantitative data were collected for the analysis of the factors influencing farmers' SFMPs. The qualitative data were ranked with numerical value before entering in datasheet. In qualitative techniques, descriptive statistics like charts, tables, graphs, frequency, percentage, mean, etc. were used. The secondary data were preprocessed before compiling with tabulated field data. Processing and analyzing data were done using Microsoft excel and SPSS. In addition, independent sample t-test was carried out to compare application rate and cost of organic and inorganic fertilizer and income of study area. In this study, the cost of the fertilizer was calculated by multiplying the quantity of a particular type of fertilizer (kg/ha) and the price of the fertilizer (Kyats/50 kg) as one bag of fertilizer weighs 50 kg. For calculating the cost of FYM that was produced on-farm, the amount of FYM applied to the field (cartloads/ha) was multiplied by the market price that the farmers usually sell to others (Kyats/500 kg) as one cartload of FYM has 500 kg.

4. Results and discussions

4.1 Respondents' demographic and socio-economic information

The average age was 49-year-old in both local irrigated area and government irrigated area. The majority of the respondents from both the study area were male. Average family size of both study villages was 5. The average year of experience of respondents in both villages was about 23 years. About 86% of respondents from local irrigated area and 73% from GIP had primary and middle school education. Agriculture was the main occupation for the farmers in both the study areas. However, the income sources of farmers in LIP area were more diverse than those from GIP area. Average land holding size of household at LIP area was 1.13 ha for lowland and 1.52 ha for upland. GIP area had the average land holding size of 1.51 ha for lowland and 2.88 ha for upland. Over 80% of households in both the areas owned cattle that were used in land preparation and post-harvest activities. Most of the farmers from both study villages have more number of animal operated farm equipment than farm machine. This indicated that mechanization has not yet developed in this area although they have started using hand tractor in field preparations since 10 years ago.

4.2 Cropping pattern in the study area for the year 2013-2014

Crops were cultivated in three seasons, pre-monsoon rice or sesame, monsoon rice and post-monsoon chickpea. The cropping calendar of the study villages was totally dependent on the onset of monsoon rains and the irrigation water accessibility. If the onset of monsoon was early, cultivation usually starts in the third week of April. If the onset of monsoon is late, it usually starts in second week of May. In LIP area, sesame is grown as a pre-monsoon crop in lowland before monsoon rice because of not enough water supplies for growing summer rice. Meanwhile, similar cropping calendar could also be occurred in the village with government dam irrigation but the reason that have made the difference from local reservoir is the irrigation water available for summer rice. The cropping calendar has covered almost the whole year in both study areas.

4.3 Farming practices used for soil fertility management

Average numbers of field preparation practices used for summer and monsoon rice are shown in table 1. The t-test results showed that there were no significant different between the two villages in average number of plowing times, harrowing times, irrigation times and weeding times for summer rice cultivation. For monsoon rice cultivation, farmers from GIP area had significantly higher number of irrigation water application than those from LIP area. Likewise, significantly more number of weeding was done by the farmers from GIP area than from LIP area. The average number of harrowing for monsoon rice production in LIP area was higher than the average number of harrowing in GIP area at 95% confidence level. However, the average numbers of plowing times between the two study villages were not significantly different. Crops residues were mainly used for the livestock feed due to feed shortages. However, what remained in the fields e.g. stubble and weeds were incorporated into the soils. Most frequently the residues were burned. Some farmers burned the stubble also because they believed that this would help to reduce weeds and insect pest population for the next crop.

Table 1: Agronomic practices for summer and monsoon rice

Agronomic Practices (No. of times applied)	Summer rice			Monsson rice		
	LIP (n=6)	GIP (n=71)	t-test	LIP (n=83)	GIP (n=69)	t-test
	Mean (Time)			Mean (Time)		
Plowing	1.33	1.28	*p*=0.861	1.13	1.30	*p*=0.081
Harrowing	0.86	1.94	*p*=0.012	2.46	1.94	*p*=0.004
Irrigation	4.29	7.69	*p*=0.220	4.08	7.31	*p*=0.000
Weeding	0.71	0.83	*p*=0.731	0.37	0.81	*p*=0.000

Source: Field Survey, 2015. Note: *Significant at 0.05 confidence level; **Significant at 0.01 confidence level

4.4 Soil Fertility Improvement Practices

Table 2 shows that in LIP area, the amount of FYM used for major crops exceeded the average amount produced year round. The study found that the farmers from this area bought manure from their neighboring villages to apply to their major crops. Almost all farmers relied on organic fertilizer such as FYM, mixture of cow dung and crop residues for crop production because inorganic fertilizers were expensive. The amount of FYM and inorganic fertilizer such as Urea, T-super, Potash, compound fertilizer and Gypsum used for summer rice were not significantly different from each other. Farmers from LIP area did not apply T-super and Potash for summer rice.

The amount of FYM used in both study villages was higher than the amount of inorganic fertilizers. However, the farmers from LIP area used significantly higher amount of FYM for monsoon rice than those from GIP area. It can be realized that the farmers from LIP area had their focus only on monsoon rice production and they used more amount of FYM than other inorganic fertilizers for that season. In contrast, the farmers from GIP area grew rice in both summer and monsoon seasons. Urea application in GIP area was significantly higher than those in local reservoir irrigated monsoon rice. Likewise, the farmers from GIP area used significantly more amount of Compound fertilizer and Gypsum than those from LIP area for monsoon rice. Results showed that the amount of FYM used for sesame production was significantly higher in LIP as compared to GIP area. Because no irrigation water was needed for sesame, farmers from LIP area with less water availability, focused on sesame production. Farmers from LIP area used more amount of cheap and long-lasting FYM than other chemical fertilizers. In contrast, farmers from GIP area applied Urea, T-super (1.19 kg/ha) and Compound but no application of FYM was reported.

Regarding fertilizer cost, results show that there was no significant difference between the two study villages in the cost of FYM and inorganic fertilizer for summer rice cultivation. A highly significant difference in the cost of FYM, Urea, Compound fertilizer and Gypsum were occurred between the two study villages. Farmers from GIP area spent more amount of money to buy Urea, Compound fertilizer and Gypsum than those from LIP area. However, in GIP area, respondents spent significantly less amount of money for FYM than those from LIP area. The cost for other fertilizer such as T-super and Potash were not much different between two study villages. Farmers from LIP area used only Urea for sesame cultivation whereas those from GIP area spent their money on Urea, T-super and Compound fertilizer for sesame production. However, there were no significant difference in the cost of Urea, T-super and Compound fertilizer for sesame production between the two study villages.

Table 2: Fertilizer application and its cost for major crops

Fertilizer type	Summer rice			Monsoon rice			Sesame		
	LIP (n=6)	GIP (n=71)	t-test	LIP (n=83)	GIP (n=69)	t-test	LIP (n=50)	GIP (n=1)	t-test
	Amount (kg/ha)								
FYM	4,492.71	5,435.90	*p*=0.749	4,484.01	1,118.36	*p*=0.000	1,659.60	0.00	*p*=0.000
Urea	135.53	229.89	*p*=0.078	65.48	211.09	*p*=0.000	0.55	9.50	*p*=0.042
T-super	0.00	20.10	*p*=0.452	3.14	14.11	*p*=0.081	0.00	1.19	*p*=0.049
Potash	0.00	0.92	*p*=0.773	0.00	0.94	*p*=0.274	-	-	-
Compound	149.36	147.80	*p*=0.977	39.26	132.97	*p*=0.000	0.00	27.44	*p*=0.000
Gypsum	2.20	7.03	*p*=0.346	0.19	5.03	*P=0.000*	-	-	-
	Cost in USD/ha								
FYM	36.32	52.16	*p*=0.538	46.47	11.04	*p*=0.000	-	-	-
Urea	46.74	91.89	*p*=0.212	25.07	79.59	*p*=0.000	0.54	1.63	*p*=0.418
T-super	0.00	5.03	*p*=0.443	1.50	7.12	*p*=0.083	0.00	2.37	*p*=0.146
Potash	0.00	0.53	*p*=0.756	0.00	0.54	*p*=0.277	-	-	-
Compound	38.20	51.43	*p*=0.451	19.48	52.09	*p*=0.000	0.00	23.70	*p*=0.146
Gypsum	0.00	0.48	*p*=0.756	0.20	5.99	*p*=0.000	-	-	-

Source: Field Survey, 2015, Note: 1 USD = 1216.30 Myanmar kyats, *Significant at 0.05 confidence level; **Significant at 0.01 confidence level

4.5 Yield and income of major crops

Average yield of monsoon rice in GIP area was significantly higher than the LIP area (Table 3). This may be because of availability of irrigation water from Dam and use of significantly higher amounts of inorganic fertilizers for crop production. However, the yield of monsoon rice in the study villages is still under the targeted yield of 5.2 t/ha set by the Ministry of Agriculture and Irrigation (MOAI, 2012). Similarly, the average amount of chickpea yield in GIP area was significantly higher than the yield of chickpea in LIP area. Although no application of fertilizer and irrigation for chickpea was found in both study areas, the yield of chickpea was different between the two study villages. This could be because of the residual moisture left after the monsoon rice cultivation as more irrigation water was available for monsoon rice cultivation in GIP area. Nevertheless, there was no significant difference in the yield of summer rice and sesame between the two study villages. This could be because of more irrigation times in this area for monsoon rice production. Regarding income, farmers from GIP area got significantly higher income from monsoon rice and Chickpea production than farmers from LIP area. However, income from summer rice and sesame were not significantly different from each other.

Table 3: Yield and income of major crops

Crops	LIP	GIP	t-test
	Yield (t/ha)		
Summer rice	3.85	4.63	*p*=0.096
Monsoon rice	2.62	4.11	*p*=0.000
Chickpea	0.57	1.01	*p*=0.001
Sesame	0.28	0.20	*p*=0.187
	Income (USD/ha)		
Summer rice	587.39 (58.02)	703.78(37.06)	*p*=0.315
Monsoon rice	125.27(12.37)	636.84(33.54)	*p*=0.000
Chickpea	197.39(19.50)	440.59(23.20)	*p*=0.000
Sesame	102.38(10.11)	117.74(6.20)	*p*=0.784

Source: Field Survey, 2015 Note: 1 USD = 1216.30 Myanmar kyats, *Significant at 0.05 confidence level; **Significant at 0.01 confidence level

4.6 Farmers' opinion on trend of fertilizer, crop residues and soil fertility over the past 10 years

Over 50% of the respondents answered that the application of both organic and inorganic fertilizer has the same trend over the past 10 years in both study villages (Figure 3). Over 80% of respondents in both study areas used the same amount of crop residues that they have been using over the past 10 years. The application of FYM was increased by 39.8% of respondents in LIP area and by 35.2% in GIP area. Only 15.7% of farmers from LIP area and 19.7% of respondents from GIP used more amount of crop residue over the past 10 year. The trend of chemical fertilizer usage was increased by 37.3% in LIP area and 46.5% in GIP area. About 52% of respondents from LIP area thought that increased soil fertility occurred in lowland whereas 38.6% of respondents answered that no change in soil fertility in their lowland. However, 66.3% of respondents responded that their upland soil fertility status was the same over the past 10 years in LIP area. Likewise, most of the farmers from GIP area thought that their upland soil fertility was not changed over the past 10 years. 43.7% of respondents from GIP area replied that there was an increase in their lowland soil fertility whereas another 43.7% of respondents thought that the soil fertility status of their lowland has not changed during the past 10 years.

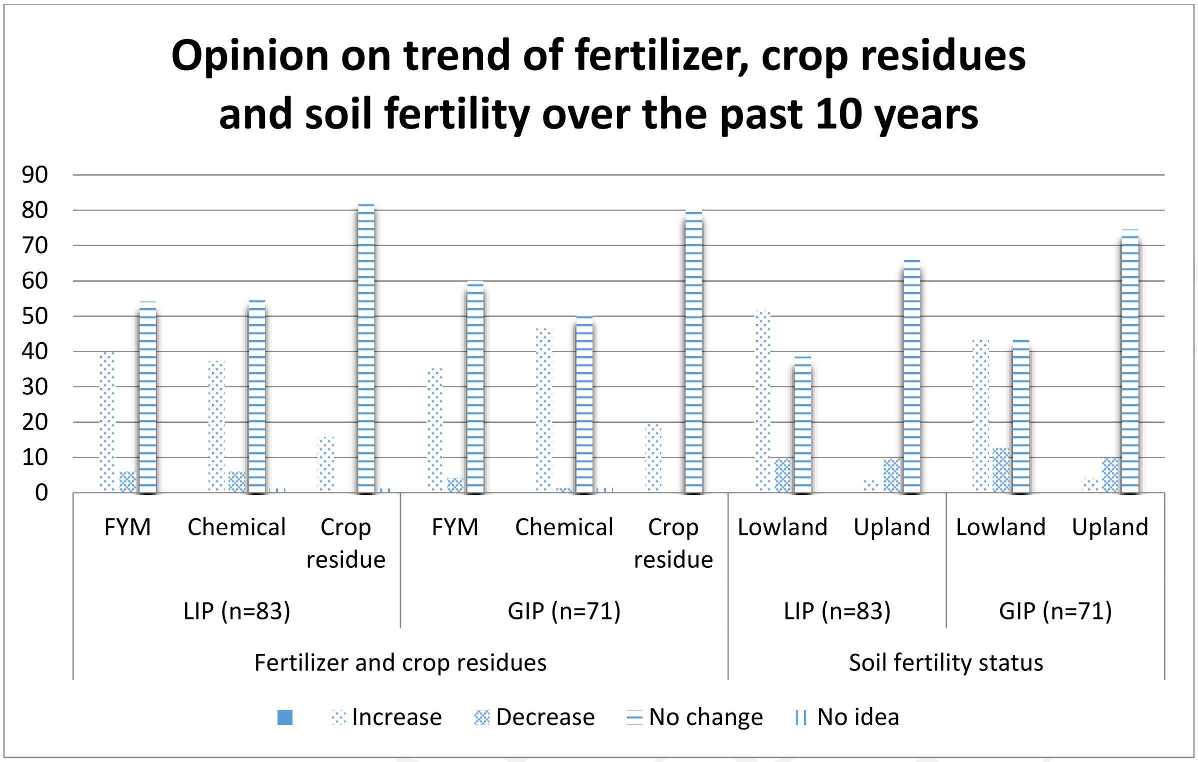

Figure 3: Farmer's opinion on trend of fertilizer, crop residues and soil fertility over the past 10 years

4.7 Credit for Agriculture

Table 4 shows the credit sources of the farmers in the study area. Farmer's access to credit was based on the land area sown and land holding. The amount of credits ranged from 25 USD to 1661 USD for the whole year. In both study villages, there were three kinds of credit sources i.e., Myanmar Agricultural Development Bank (MADB), Cooperatives and NGOs (OXFAM and IRRI in LIP area and IRRI in GIP area). All the credit sources were aimed for lowland cultivation. The amount of credits gained from MADB differed significantly between the two study villages at 95% level of confidence. Farmers from GIP area got higher amount of credits from MADB than those from LIP area. There was less summer rice production in LIP area because of incapability of restoring rain water in their reservoir. Therefore, the total area of lowland for both summer rice and monsoon rice in

LIP area were less than those in GIP area. The average amount of credits gained from cooperatives and NGOs were not significantly different between the two study areas. However, OXFAM supported chickpea production and the credits were aimed for chickpea production only in LIP area. The interest rates were 1.5% and 2.5% depending on the organizations. The duration of the credits was 6 months in both study villages.

Table 4: Credit sources for Agriculture

Credit sources	LIP	GIP	t-test
	USD/household		
MADB	285.04	454.36	*p*=0.002
Cooperatives	074.84	155.50	*p*=0.143
NGOs	082.12	098.68	*p*=0.735

Source: Field Survey, 2015 Note: 1 USD = 1216.30 Myanmar kyats. Note: *Significant at 0.05 confidence level; **Significant at 0.01 confidence level

4.8 Constraints on conducting SFMPs

Constraints on conducting soil fertilility management practices in the study area are shown in table 5. Concerning environmental constraints, farmers are facing different problems. However, most of the farmers from both the areas stated that insufficient water for irrigation was the most important problem in both study areas. Flooding and water logging were also important factors for SFMPs in LIP area. In GIP area, farmers stated that soil salinity, soil erosion due to rainwater and water logging were important problems in soil fertility management. Regarding the technical and socioeconomic constraints, 80.7% of respondents from LIP area and 67.6% of respondents from GIP area confirmed that the most important problem of soil fertility management was financial problem.

Table 5: Constraints to managing soil fertility

Constraints	LIP (n=83)	GIP (n=71)
	% of Respondents	
1. Environmental constraints		
Erosion	15.70	19.70
Soil salinity	6.00	21.10
Flooding	26.50	18.30
Water logging	24.10	19.70
Water scarcity	72.30	53.50
2. Technical and socio-economic constraints		
Limited access to fertilizer	48.20	39.40
Labor unavailability	37.30	39.40
High price of fertilizer	68.70	56.30
Financial problem	80.70	67.60
Low technical knowledge	48.20	36.60
Incorrect management practices	7.20	21.10

Source: Field Survey, 2015

The farmers stated that they cannot do agronomic practices as many times as they want because of higher lobour wages. Moreover, the higher price of inorganic fertilizer made it difficult for them to use soil fertility management. Limited access to fertililzer was one of the other constraints for soil fertility management as reported by 48.2% and 39.4% farmers from LIP and GIP areas respectively. Farmers stated that they have difficulty in accessing organic fertilizer especially when they do not have their own livestocks. Moreover, technical problems were reported by about 48% and 36% farmers from LIP and GIP areas respectively. They do not know the fertilizer rate per unit area of land and fertilizer application methods etc. Labor unavailability was aslo an important issue in soil fertility management in both the areas. Incorrect management practices such as pesticide and fertilizer overdoses were also reported (21.1%) in GIP area.

4.9 Information sources for fertilizer application

Results showed that most of the information for fertilizer application came from fellow-farmers, followed by extension agent and input dealers in LIP area. In GIP area, major information sources for the amount of fertilizer per unit area were reported from input dealers followed by extension agent and printed materials. The percentage of the respondents that had been attended any training given by any organization was the lowest in both the areas. This indicates that the number of farmers who received the agricultural extension and training is very low.

4.10 Training provided by DOA (Department of Agriculture) Township office

According to the DOA Township office data, both the number of training and attendance in Thazi township were higher than those in Wundwin township. However, in study townships, the number of training provided by the DOA township office and the number of people who received the Agricultural training showed an increasing trend starting from 2010-11 to 2013-14. Good Agricultural Practices (GAP) are provided mainly by the DOA township offices. DOA conducted demonstration fields in the villages. In order to use GAP methods and farm machine systematically, trainings, field visit and discussions with the farmers were being conducted. Nevertheless, such kind of trainings and services from township offices did not reach to the farmers from both study areas. However, there were trainings and education activities provided by the OXFAM in LIP area. OXFAM provided seeds, fertilizers and pesticides to the respondents who grew chickpea in the

LIP area. This project lasted for 3 years in this study village. OXFAM also played a substantial role in developing financial services such as microfinance for the respondents who do not own land for doing agriculture in this study village. IRRI conducted demonstration fields in order to understand the suitable rice varieties with respective to the ecological conditions and provided material supports (seeds, fertilizers) to the farmers. Both study villages received those kind of supports from IRRI.

5. Conclusion and recommendations

The cropping pattern in both study areas was dominantly rice based. Major crops were rice, sesame and chickpea. Soil fertility improvement was the most crucial factor for farmers in order to get higher yield in the long term. However, it was found that farmers focused on lowland for SFMPs. Upland cultivation was totally dependent on the rainfall and because of low rainfall. The use of FYM would get decreased because of constant reduction in number of livestock. Inorganic fertilizer usage was high in area with dam irrigation. Soil fertility management constraints include water scarcity, soil salinity, financial issues and high price of fertilizers. Although training programs provided by the Township DOA office, the study areas did not get the training services and most of the information was derived from input dealers, fellow farmers, extension agents and printed materials.

Farmers practiced SFMPs in their traditional ways. Training on farmyard manure and compost making technology will be useful for enhancing organic manure application. Dam irrigation should be provided in area with reservoir irrigation. Renovation of reservoir and canals should be done in order to ensure a good drainage. Farmers usually buy inorganic fertilizers with the credit. However, the amount of the credit was low and farmers had to borrow money with high interest rate from private sectors. Therefore, more amount of credit for agriculture should be provided to the farmers. Knowledge dissemination in the study areas was very weak. Farmers need information concerning SFMPs and per unit fertilizer rate for major crop productions. Green manuring should be promoted in order to increase production. Moreover, livestock production should be promoted in order to gain secondary income as well as increased manure. Crop residues management should be improved so that more efficient nutrient management can be done.

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