SUITABILITY OF AGRO-PHYSICAL ELEMENTS ON PADDY AND PULSES CULTIVATION IN THANLYIN TOWNSHIP

Ohnmar Myat Htoo[1], San San Khine[2]

Abstract

Southern District of Yangon is one of the largest crop producers especially paddy and pulses in Yangon Region. Thanlyin Township is included in the Southern District of Yangon, and contributes about 7.28 percent of the total paddy sown area of the district. Pulses are second important crop after paddy in the Thanlyin Township and it represents 12.02 percent of the total purses cultivated area of Southern District of Yangon. This paper highlights on the physical factors for assessing the suitability of crops. Generally, Thanlyin Township has suitable conditions for paddy and pulses cultivation such as favorable climate conditions with sufficient rainfall, large amount of meadow soil areas and level topographic condition. The spatial distributional pattern of crops cultivation and the potential suitable areas for crops cultivation are analyzed by using remote sensing technique and Arc Map GIS 10 software.

Keywords: *Paddy and pulses cultivation, physical elements, suitability, distribution pattern, Thanlyin Township*

Introduction

Agriculture is an important economic activity of Thanlyin Township. Among the agricultural crops paddy and pulses are grown in nearly whole of the township.

Paddy is a type of grass (*genus Oryza).* Paddy grain is rich in nutrients, vitamins, and minerals and is the staple food for more than 3 billion people in the world.

The green gram (*Vigna radiate),* (locally known as Pedisein) is a plant species in the legume family. Saline and alkaline soils are not suitable for green gram cultivation. It is very sensitive to water logging conditions.

To ensure continuing utility, productivity and stability of soils cultivation practices need may be developed and managed in an environmentally sustainable manner. Therefore it is necessary to develop effective and appropriate management techniques (ESCAP, 1997).

Recent researches suggest that productivity in the form of double cropping offer several economic and ecological advantages over mono cropping. When put under the plough on paddy lands in the post rainy season, soil nutrient losses will be its minimum.

Pulses contribute to sustainability of global food production system by enriching the soil through biological nitrogen fixing and improving soil physical conditions (Satyanarayana, 2001).

Although pulses are second important crops after paddy in Thanlyin Township, the Green gram (Pedisein) is the most economically important crop and in the township. Therefore, green gram is more emphasized than other pulses in this study.

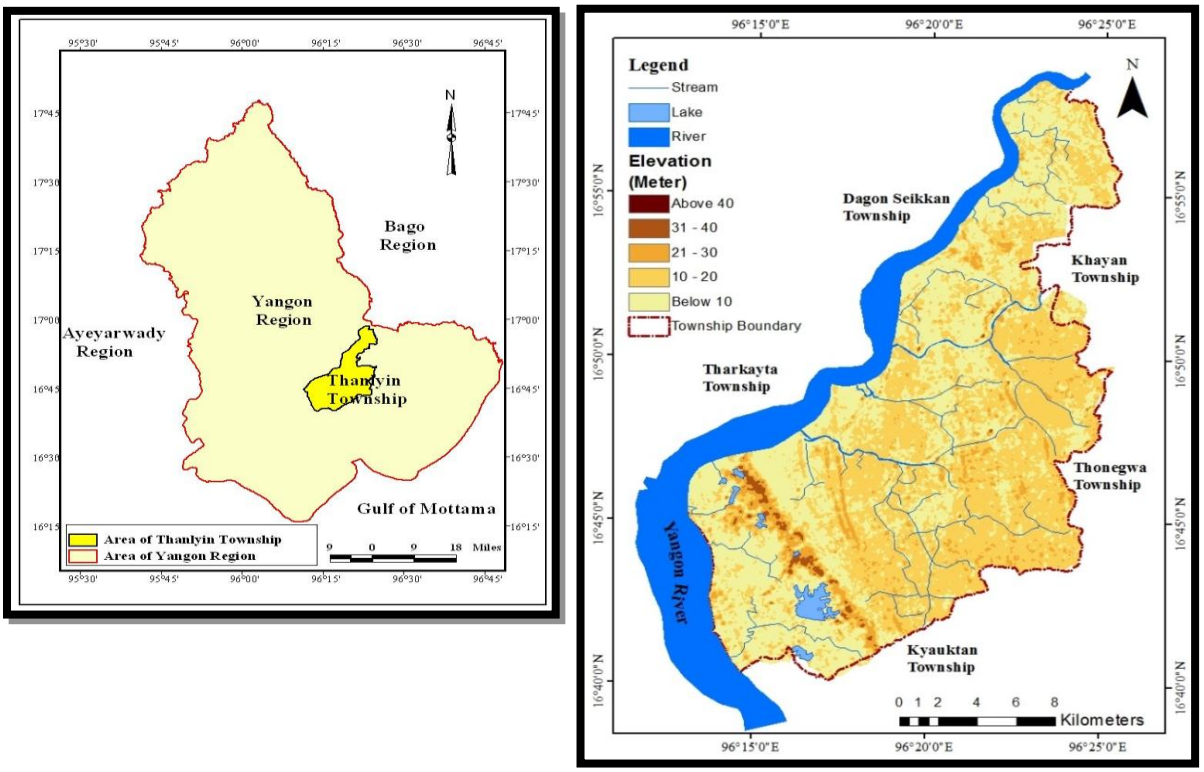
This study is a qualitative evaluation on paddy and green gram, considering mainly on the suitability of physical elements such as climate and soils of Thanlyin Township to the dominant crops.

[1] Dr, Associate Professor, Department of Geography, East Yangon University
[2] Dr, Associate Professor, Department of Geography, Bago University

The study area

Thanlyin Township is situated in the southern part of Yangon Region. It is latitudinally located between 16˚ 40′ and 16˚ 59′ north and longitudinally between 96˚ 13′ and 96˚ 25′ east. It has an area of 373 square kilometres (144 square miles) and composed of 17 wards and 28 village tracts.

Physiographically the township is a low land area (below 10 meters) except a narrow small ridge (41 metres) along the Kyauktan-Thanlyin Road. Figure (1)



Source: Department of Agricultural Land Management and Statistic (Thanlyin), based on DEM

Figure 1 (a and b) Location and Elevation of Thanlyin Township within Yangon Region

Bago River (before joining Yangon River), Khayan Creek and small streams are found in the study area. Major rock strata of shale, sand and silt are found.

The larger parts of the township are flood plain except lateritic ridge which trend from northwest to southeast. *Fluvie Gleysool*, *Gleysol*, *Gley Gleysol* and *Plinthic Ferrasol* soils are can be found.

Materials and Methods

In order to get the township boundary, ward, and village tract boundaries, the study area is digitized based on UTM (2000) and Google Earth Images (2018) and elevation data are obtained from Digital Elevation Model (DEM).

Soil type classification map is acquired from Land Use Department and soils data were obtain from laboratory analysis of soil samples collected during field work in February' 2019. Climate data are acquired from the Department of Meteorology and Hydrology, Yangon.

Department of Agricultural Land Management and Statistics in Thanlyin Township provided data the sown area and yield per acre of rice and green gram.

The information data of cultivating process of paddy and green gram are acquired through randomly interviews and discussion with local farmers. In order to know the perceptions of cultivators, cultivated farmers are randomly selected for interviews.

To examine the spatial distribution pattern of paddy and green gram, cultivated land areas are analyzed by using ArcMap GIS 10.1 software. Clay content ratio, thermal emission, slope gradient and land use and land cover data are acquired from prepared map by using ENVI Remote Sensing software.

Research problem

Paddy is cultivated in the whole Thanlyin Township except the town area and green gram is also grown as a second crop in the post monsoon season on the paddy land. Although monsoon paddy is grown in all village tracts, there is a problem on soil and land suitability for summer paddy and green gram cultivation in the summer period.

Aim

The main aim of the research paper is to provide information for agricultural land use planning on a sustainable long term basis.

Objectives

The main objectives of the paper are

- To assess the climatic factors affecting on the paddy and green gram cultivation
- To analyze the suitable types of soils for growing on paddy and green gram
- To examine the land suitability and spatial distribution pattern of paddy and green gram cultivation

Finding

Agro- Physical Elements

Agro-physics is defined as "a science that studies physical properties affecting plant production. The fundamentals of agro-physical investigations are mass (water, air, nutrients) and energy (light, heat) transport in the soil-plant-atmosphere" (Jan Glinski, 2013).

Crops – climate suitability

Climatic condition is a major factor influencing the plant growth. These related to the plant growth are temperature, precipitation, humidity, sunshine hours and winds. Among the climatic factors, temperature and rainfall are more significant for paddy and pulses growth and yield in the study area.

Paddy can be grown under a wide range of climatic conditions, both in temperate and hot tropical climate. The optimum temperature required for paddy is between 20˚ C and 37˚ C. When the paddy seeds germinate, the temperature requirement is between 10˚ C and 40˚ C. The irrigation water temperature for paddy growth is between 15˚ C and 30˚ C.

In paddy cultivation, rainfall requirement seems to be more important than temperature. The optimum rainfall for rainfed paddy is > 1600 mm/ year. Paddy is cultivated by means of broadcasting and transplanting. When the germinated paddy seeds are broadcasted, only a little amount of water is required. In transplanting method, nursery bed must be prepared first. The seeds are put into the nursery bed. After 15-20 days the seedlings in the nursery bed are picked out to transplant. At the initial stage of translating the amount of water required is 75 mm to 300 mm. Thanlyin Township has sufficient rainfall at this stage, usually in June. At the reproductive stage (July, August and September months), paddy needs 125 mm to 300 mm of rainfall. At the ripening stage (September to October), water need for paddy is 75 to 200 mm. Thus, the whole township is suitable to grow monsoon paddy in the rainy season. (Table 1)

In summer, water requirement for optimum growth of post monsoon paddy (summer paddy) is 75 mm to 300 mm at the beginning stage (November), 125 mm to 300 mm at the reproductive stage and flowering stage (December to February), and 75 mm to 200 mm at the ripening stage (March to April). In this period of summer paddy cultivation rainfall amount is only a little in the township. Thus, summer paddy cannot be cultivated successfully, unless sufficient irrigation water is available. Some villages have no reservoirs, diversion weir and streams therefore the acreage under summer paddy is rather limited or nil.

Nyaungthonepin, Ngapa, Kalawe, Ngapyama, Thanutpin, Bayet, Phayargonem Sitpinkwin, Kayinseik and Bawhthabyegan villages have access to irrigation water from the canal system of Bawh Creek and thus summer paddy can be grown successfully in large area with relatively high yield per acres.

Green gram is, the second most important crop in Thanlyin Township, grown in the post rainy season after the harvest of rain fed paddy from last week of October to first week of February, depending only on the soil moisture in the field. It enjoys hot dry climate. The optimum temperature for initial of stage green gram cultivation is between 24˚ C and 30˚ C, demanding mean temperatures between 30˚ C and 36˚ C during the growing cycle (FAO, 2003).

Average mean temperature in Thanlyin Township is 27.48˚ C. At the flowering stage, the optimum temperature requirement is 24˚ C. Thanlyin Township receives a mean temperature of 24.52˚ C in this period.

Crops water requirement assessment is essential for evaluation of the potential of an area, length of growing season, period of soil moisture excess or deficit and to evaluate the irrigation need (Jackson 1982).

At initial stage (October to November), crop water requirement for green gram is 173.6 mm (Calculation based on data of Department of Meteorology and Hydrology, Yangon). In addition to soil moisture frequent rains supplement the soil moisture. Thus the early stage of crop water requirement is small in the study area.

During the development stage (November to December), crop water requirement is 4.8 mm. More water requirement for green gram is acquired from residual soil moisture. Therefore, water is also sufficient in this stage of plant growth.

In the third stage or the mid-season (December to January) green gram plants release high rate of potential evapotranspiration. Therefore, more water is needed because the crop reaches

maturity. Crop water requirement at this stage is 8.1 mm. At the late season stage (January to February) i.e. ripening stage, crop water requirement is 26.4 mm.

The monthly rainfalls in this period are 5.6 mm in January and 0.47 mm in February. In mid-season stage and late season stage, there is little rainfall but **haze** fall provides some of the moisture required for the plant.

The village tracts with no access to irrigation water pulses are grown. Although green gram is resistant to dryness, certain amount of rainfall is needs to retain sufficient moisture in the soil during the growing period. It needs some irrigation water for high yields.

Day length hours influence the condition of chlorophyll and exerting effect on plant development and structure of plant. For growing cycle of rice sunshine is required from the initial stage to the ripening stage. In Thanlyin Township, the high yield of summer paddy than that of monsoon paddy is due to availability of more sunshine in the summer, and day length hours are over 10 hours in the growing cycle of green gram. It is quite sufficient for flowering and ripening of green gram.

Sunshine hour duration and intensity of light is an important factor of plant development. An area that gets full sun, a minimum of 6 to 8 hours of sunshine per day, is required to grow paddy. Green gram requires full sunshine or at least 8 to 10 hours of sunlight daily. In Thanlyin Township, sunshine hour is over 7 hours in November, December and January. This period is initial stage and development stage of summer paddy and green gram. In February and March, shine hours is over 8 hours sufficient for the late stage of growing cycle of crops. Therefore, it is suitable for summer crops.

Table 1 Climate data of Thanlyin Township (2003 – 2017)

Months	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Avg/Tot
Maxi-Temp ˚C	33.04	35.4	36.93	37.76	34.41	31.47	30.79	30.55	31.34	32.99	34.14	32.99	33.48
Mean-Temp ˚C	24.52	26.39	28.6	30.42	28.89	27.06	26.56	26.48	26.91	27.75	27.48	25.12	27.18
Mini-Temp ˚C	15.99	17.37	20.27	23.07	23.37	22.65	22.33	22.41	22.48	22.5	20.81	17.24	20.87
Rainfall mm	5.6	0.47	13.66	35.13	369.1	542.5	647.9	535.1	448.3	215.3	46.26	10.53	2869.81
Day length (Hours)	11.05	11.3	12.02	12.4	13.04	13.18	13.1	12.48	12.16	11.42	11.13	10.59	
Monthly shunshine (Hours)	7.88	8.64	8.4	7.82	5.6	1.92	1.22	1.56	3.2	4.28	7.44	7.98	

Source: Department of Meteorology and Hydrology, Yangon

Crops-soils suitability

Characteristics of soils depend upon relief, drainage condition and parent materials. Soil colour indicates the physical and chemical properties in the soil. In order to know the physical and chemical properties of soils, 24 sample soils are collected from the selected areas and tested in the soil laboratory of Land use Department. Essential nutrients for paddy and pulses are Nitrogen, Phosphorous and Potassium and other required nutrients are Calcium and Sulpha.

Seven different types of soil are found in Thanlyin Township (Figure 2, Plate 1)

Light brown meadow soils (*Gleysol*) samples are collected from Pharku (East), Pharku (West), Dayzat, Laharyet and Kayinseik villages.

The soil colour is light brown. Sample soils are collected at the depth of 0 – 9 inches from the topsoil and at 9 to 15 inches from the subsoil. The **pH** values range between 5.59 and 6.74, indicating a soil reaction of moderately acid or nearly neutral. Organic carbon content is low with

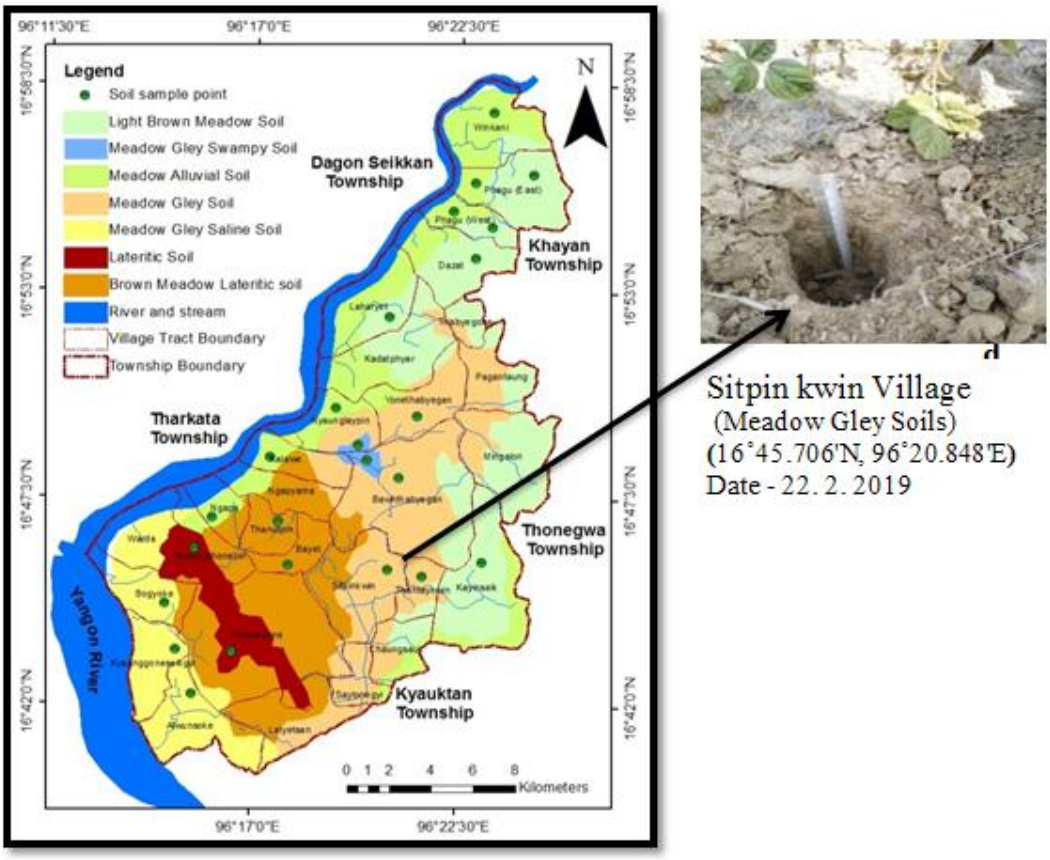
1.81 percent. C:N ratio is calculated to identify the ratio between organic matter and decomposition rate. As the resultant value is greater than 10, the rate of organic decomposition is rather low. Humus content is 3.13 percent. Cation exchange capacity is moderate with 14.95 milliequibalance /100g. Nitrogen (**N**) content is low with 0.15% and Phosphorous **(P)** content is also low with 4.54%, while Potassium oxide **(K_2O)** content is moderate with 19.58%. (Table 2)

The soil dominant texture is of silty clay. This soil is suitable for paddy and green gram cultivation. Ameliorative measures are high dose of organic matter application and more application of fertilizer.

Light brown meadow soil occupies 23 percent of the total soil area. It is found in Pharku (East and West), Dayzat, Laharyet, Thabyeygone, Mingalon, Bowthabyegan, Kayinseik and Chaungsauk village tracts.

Meadow alluvial soils (*Fluvic Gleysols)* samples are taken from Winkhani, Pharku (East), Pharku (West), Nyaunglaypin, Kalawe and Ngapa villages.

The colour of the soil is yellow brown. At lower layers pH may reach 5.50 to 6.67 or moderately acid. Organic carbon content is 1.56 percent and humus content is 2.69 percent.



Source: Land use Department, Myanmar Agriculture Services, Yangon

Figure 2 Soil types and collected soil sample points of Thanlyin Township

(a) Kayinseik Village
(Light Brown Meadow Soils)
(16˚45.707'N, 96˚22.891'E)
Date - 22. 2. 2019

(b) Ngapa Village
(Meadow Alluvial Soils)
(16˚46.613'N, 96˚16.324'E)
Date - 22. 2. 2019

(c) Thanutpin Village
(Brown Meadow Soils)
(16˚46.331'N, 96˚18.734'E)
Date - 22. 2. 2019

(d) Sitpin kwin Village
(Meadow Gley Soils)
(16˚45.706'N, 96˚20.848'E)
Date - 22. 2. 2019

(e) Kyaunggoneseikgyi Village
(Meadow Gely Saline Soils)
(16˚42.806'N, 96˚13.868'E)
Date - 22. 2. 2019

(f) Nyaunglaypin Village
(Meadow Gely Swampy Soils)
(16˚48.626'N, 96˚20.521'E)
Date - 22. 2. 2019

(g) Phayargone Village
(Lateritic Soils)
(16˚42.706'N, 96˚16.846'E)
Date - 22. 2. 2019

Source: Author observation

Plate 1 Seven types of soils in the study area

Cation exchange capacity (CEC) content is 14.46 milliequibalance /100g or moderate.

Decomposition rate of organic matter is relatively high. **N** content is moderate with 0. 29%. **P** content is low with 5.86% and K_2O content is moderate with 14.44%.

The soil is found in nearly the whole part of Winkhani, and others areas are Pharku (East and West), Dayzat, Laharyet Kadatphar, Nyaunglaypin, Kalawe, Ngapa, Kayinseik and Chaungsauk village tracts. It covers the 16 percent of the total soil area.

Meadow alluvial soils occur along the bank of rivers and creeks of Thanlyin Township and the disadvantages are low degree of moisture retention in the soil and salt water intrusion.

Soil texture is silty clay loam to silty clay. Although this soil is suitable for paddy and green gram, it is need to dig systematic drainage for irrigation and moderate dose of fertilizer application for successful yield per acre.

Brown meadow soils (*Gleysol)* are dug in Thanutpin and Bayet villages. Colour of the soil is brown. The pH value range is from 4.71 to 6.58, and it is strongly acid to slightly acid Decomposition rate of organic matter is low. Available nutrient content of **N** is low with 0.20 percent, **P** is also low with 1.37 percent and **K_2O** content is high with 37.50 percent.

Due to the soil texture of silty loam and high content of **K_2O**, the soil is suitable for paddy and green gram crops. But it is necessary to apply high dose of fertilizer of **N, P**, as well as systematic irrigation.

This soil type is found in the whole part of Thanutpin and Bayet villages and others are Ngapyayma, Ngapa, Sitpinkwin, Phayargone, Letyetsan, Bogyoke and Nyaungthonepin villages. It covers 20 percent of the total soil area.

Meadow gley soils (*Eutric Gleysol*) have dull brown colour. The soil sample is collected from Yonethapyaykan, Bawthabyegaan, Thahtaykwin, Sitpinkwin villages.

The pH value is moderately acid with 5.62 to 5.72. Decomposition rate of organic matter is fairly slow. **N** content is also low with 0.16 percent. **P** content of the soil is also low with 5.54 percent while $\mathbf{K_2O}$ content is high with 30.88 percent.

The soil textural composition is silty clay to clay loam. Structure of the soil is sub-angular blocky type. When the soil is dry, cracks features can be found. Permeability of **EC** soil salinity is fair with 0.44. Therefore the soil is suitable for paddy. It needs to systematic drainage and irrigation and application of fertilizer **N** for high yield per acre.

Meadow gley soil occupies 25percent of the total soil area. It is found in the nearly whole part of Yonethabyegan and Saylonegyi villages, and others are found in Nyaunglaypin, Pagantaung, Mingalon, Bowthabyegan, Thahtaykwin, Chaungsauk, and Letyetsan villages of Thanlyin Township.

Meadow gley saline soils (*Gley Gleysol*) sample are collected from Bogyoke, Kyaunggone seikgyi and Alwunsoke villages. Meadow gley saline soils have beige colour.

The soil pH varies from 5.90 to 6.75. Decomposition rate of organic matter in the soil is high. **N** content is also low with 0.15 percent, **P** content is low with 4.79 percent and $\mathbf{K_2O}$ content is high with 26.71 percent. Permeability of the soil is high (1.58) thus lower layers are wetter than upper layers.

Suitable crop in this soil is summer paddy due to salty tidal water from the Yangon River, only saltwater resistant paddy such as Manawthukha, Shwewarhtun and Yarkyaw varieties grown successfully.

Composition of soil texture varies from clay to clay loam. In order to get soil amelioration, it is necessary to remove salt in the soil and to prevent from the inversion of salty tidal water.

The meadow gley saline soils are found in low land of Bogyoke, Kyaunggone seikgyi, and Alwaunsoke villages. It covers 11 percent of the total soil area.

Meadow gley swampy soils (*Humic-Gleysol)* sample are taken from Nyaunglaypin and Bawthabyegan villages. When the soil depth is exceeded 8 inches, the lower layer is swampy.

The soil colour is bluish grey colour. The soil is strongly acid having a **pH** value of 4.88. Decomposition rate of organic matter in the soil is slow. Total **N** content is low with 0.18 percent. P content is also low with 1.94 percent. $\mathbf{K_2O}$ in the soil is moderate with 19.73 percent.

Textural composition is determined by silty clay. When dry it becomes very hard and crack. Therefore the soil is suitable for paddy. For successful yield per acre, it is necessary to systematic drainage, preparing the soil to reach a pH level of nearly neutral, by using lime and other application of more **N, P** fertilizers.

The meadow gley soil can be found at Nyaunglaypin, Kalawe, Bowthabyegan and Yonethabyegan villages. The soil occupies 1 percent of the total soil area.

Lateritic soils *(Plinthic Ferrasol*) samples are taken from Phayargon and Nyaungthonepin villages.

The soil is strongly acid with **pH** 4.06. Textural compositions vary from silty clay loam to silty clay. The range of carbon and nitrogen ratio (C: N) is less than 10. Therefore, decomposition rate of humus is so fast.

Total **N** content is low with 0.11 percent. **P** content and $\mathbf{K_2O}$ content are also low with 4.31 percent and 9.87 respectively. The soil colour changes from yellow to reddish yellow colour depending on ferrous iron concentration and mineral clay contents in the soil.

The lateritic soil is not suitable for paddy and green gram crops. The soils are found along the Thanlyin-Kyauktan Ridge, Nyaungthonepin, Phayargone, and Letyetsan villages. It occupies 4 percent of the total soil area.

The suitable pH value for growing green gram is 5.5 to 6.5. The soils should contain the moderate amount of **N, P, K** and other elements like Sulphur, Calcium and Magnesium, depending on the pH value.

Green gram (Pedisein) thrives best on lighter soils with good drainage, particularly deep loamy soils. It can be grown well on soils with pH 5.5 to 6.5. Although it is moderately tolerant to saline conditions, sensitive to soil with pH value of below 5.5. (FAO, Pulses Training Manual, 2003).

The suitable soils for obtaining higher yields depend on the soil texture. Four ranges of soil type suitability for paddy and green gram have been classified. The levels are defined as highly suitable (S1), suitable (S2), moderately suitable (S3), marginally suitable (S4) and not suitable (N). (Table 3)

In the study area, Green gram and is well suited to silty clay loam soils, but it can be grown on silty clay and clay loam soils. Thus silty clay loam textured Meadow alluvial soils *(Fluvic Gleysols)* with pH value 5.50 to 6.67 can be classified as highly suitable soils (S1) for green gram and paddy.

Green gram is also adapted to silty clay soils. It can also be grown on Light brown meadow soils (*Gleysol*) (pH 5.59 to 6.74). Therefore, it is classed as suitable soil (S2).

Silty clay to clay loam and moderately acid (pH 5.62 to 5.72) Meadow gley soils *(Eutric Gleysol*) are classified as moderately suitable soils (S3).

Brown meadow soils (*Gleysol*) with silty loam are strongly acid to slightly (pH 4.71 to 6.58). It is necessary to have a systematic irrigation, preparing the soil to reach a pH of nearly neutral. Thus the soil can be classed within the marginally suitable category (S4).

Table 2 Physical and chemical properties of soils in Thanlyin Township

Soil symbol	Soil depth	Soil PH	Organic Carbon %	Humus %	Texture	CEC meq/100g	Available Nutrients			EC Soil water 1.5
							N%	P	K2O	
Light Brown Meadow Soil	0″ - 9″ 9″ - 15″	5.59 - 6.74	1.81 Low	3.13	Sicl	14.95 Medium	0.15 Low	4.54 Low	19.58 Medium	0.48 Med
Meadow Alluvial Soil	0″ - 8″ 8″ - 15″	5.50 - 6.67	1.56 Low	2.69	Sicl L - Sicl	14.46 Medium	0.29 Medium	5.86 Low	14.44 Medium	-
Brown Meadow Soil	0″ - 6″ 6″ - 8″	4.71 - 6.58	2.45 Medium	4.23	Si L	15.93 Medium	0.2 Low	1.37 Low	37.50 High	-
Meadow Gley soil	0″ - 10″ 10″ - 15″	5.62 - 5.72	2.19 Medium	3.77	Sicl - C L	20.11 Medium	0.16 Low	5.54 Low	30.88 High	0.44 Med
Meadow Gley Saline Soil	0″ - 10″ 10″ - 15″	5.90 - 6.75	1.56 Low	2.68	C C L	19.64 Medium	0.15 Low	4.79 Low	26.71 High	1.58 High
Meadow Gley swampy Soil	0″ - 8″ 8″ - 15″	4.88 - 4.79	1.98 Low	3.14	Sicl	18.15 Medium	0.18 Low	1.94 Low	19.73 Medium	-
Lateritic soil	0″ - 8″ 8″ - 15″	4.06 - 4.94	0.81 Very Low	1.4	Sicl	10.08 Low	0.11 Low	0.11 Low	4.31 Low	-

Source: Results from author observation (Soils test by Land use Department, Yangon)
CEC = Cation Exchange Capacity, N = Nitrogen, P = Phosphorous, K_2 o = Potassium Oxide,
EC= Electrical conductivity (Soil water salinity), Sicl = silty clay, Si L = silty loam, CL=Clay loam,
C CL = clay to clay loam, Sicl L = silty clay loam,) meq = milliequibalance

Table 3 Suitable crops and soils in Thanlyin Township

Soil Type	pH	Texture	EC Soil water 1.5	Rating of suitable crop			Ameliorative measures required
				Green gram	Monsoon Rice	Summer Rice	
Meadow Alluvial Soil	5.50 - 6.67	Sicl L - Sicl	0.48 Medium	S1	S1	S1	Systematic drainage and irrigation, moderate dose of fertilizer application
Light Brown Meadow Soil	5.59 - 6.74	Sicl	-	S2	S2	S2	High dose of organic matter application and more application dose of fertilizer
Meadow Gley soil	5.62 - 5.72	Sicl - C L	-	S3	S3	S3	Systematic drainage and irrigation, dose of fertilizer **N_2** application
Brown Meadow Soil	4.71 - 6.58	Si L	0.44 Medium	S4	S4	S4	High dose of fertilizer **N, P** application, systematic drainage and irrigation
Meadow Gley Saline Soil	5.90 - 6.75	C C L	1.58 High	N	**S4 / N**	N	Soil amelioration, to remove salt in the soils and to prevent tide andsalt water
Meadow Gley swampy Soil	4.88 - 4.79	Sicl	-	N	**S4 / N**	N	Systematic drainage, lime and other application, more fertilizer **N,P** application
Lateritic Soil	4.06 - 4.94	Sicl	-	N	N	N	_

Source: Author observation

For paddy crop, Meadow gley saline soils and Meadow gley swampy soils are marginally suitable. They are located in the low land near the tidal stream. Paddy can be grown only when the water is drained away and preparing the soils.

Although the pH value Meadow gley saline soil is between 5.90 and 6.75 with clay to clay loam texture, **EC** soil salinity is high with 1.58. Unless necessary modifications are made green gram and summer paddy cannot be grown successfully.

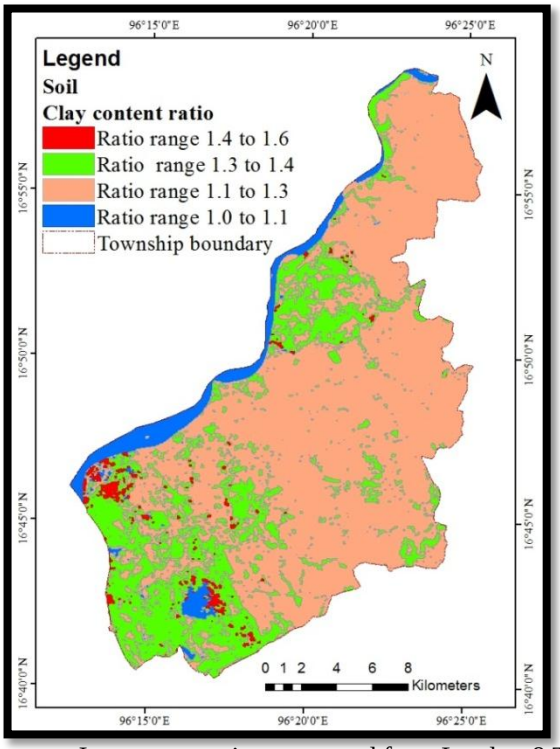
Land Suitability

Land suitability is a process for assessing the relative suitability of indicated areas of land for specified land uses (ESCAP, 1997). The cultivation of paddy and pulses was based on physical features of the land. Thus, land suitability classes are assessed and categorized considering clay content, thermal emission, slope gradient and land use and land cover of Thanlyin Township.

To acquire the clay content in the soil, Landsat 8 TM Clay ratio map was generated by band rationing of band 6 and band 7. Hydroxyl bearing minerals have a higher reflectance in band 6 and absorption in band 7. By rationing the two bands hydroxyl minerals (Clay minerals) can be discriminated. Figure 3 shows areas of higher clay content along the Kyauktan-Thanlyin Road including town area and, Phayaygone and Letyetsan village tracts. Moderately high clay contents are found in Alwunsoke, Kyaunggoneseikgyi, Bogyoke, Laharyet and Kadatphyar villages. Most of the crop lands on the low lands are moderately low clay content especially in Kayinseik, Mingalon, Bawhthabyegan, Pagantaung, Dazat and Phagu (East) villages. Lowest amount of clay occurs along the river and lakes.

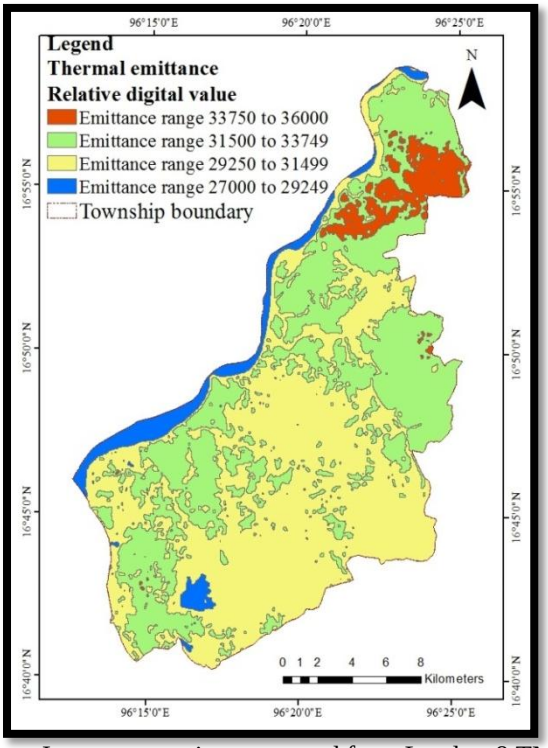
In Thanlyin Township, in order to know the classification of wetness for the discrimination of soil moisture conditions, Thermal infrared band 10 of Landsat 8 was used. The values of thermal emittance are relative digital values. Inverse relationship is found between emissivity and moisture condition. If the emission values are high, moisture content in the soil are low, vice versa. Small patches with **high emissivity** can be located on the lowlands, mainly in the north of Thanlyin Township with low moisture content. The area with **moderately high emissivity value,** and moderately moisture content, cover the northern and northeastern and western part of the lowland. Larger areas in the middle low lying of the township have **moderately low value** and moderately high moisture content. Small areas with **low emissive value** and high moisture content can be found along river courses and lakes (Figure 4).

The gradient condition of topography is also important for cultivation of the crops. Most of the crop lands occupy flat low land below 5 degrees of slope. Majority of the crop lands are found in the north, east and middle parts of the township. The Kyaikkhauk Pagoda Ridge is above 20 degrees of slope and it is the highest part in the township and located along the Thanlyin-Kyauktan Ranges (Figure 5).



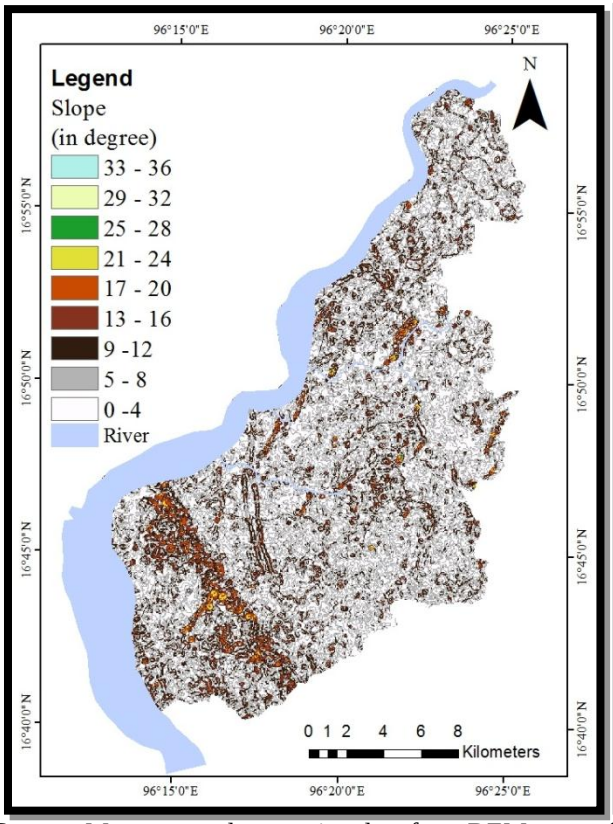
Source: Image processing generated from Landsat 8 TM

Figure 3 Clay content ratio of Thanlyin Township



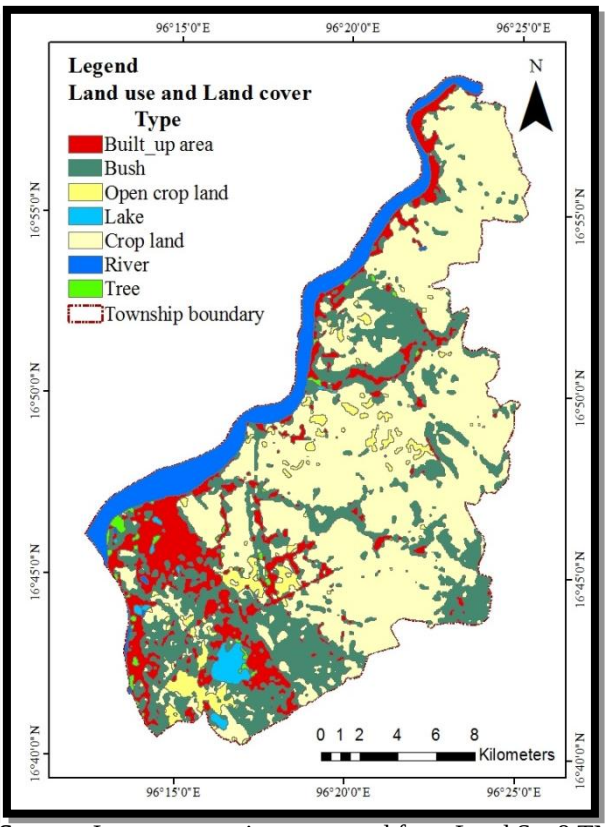
Source: Image processing generated from Landsat 8 TM

Figure 4 Thermal emittance of Thanlyin Township



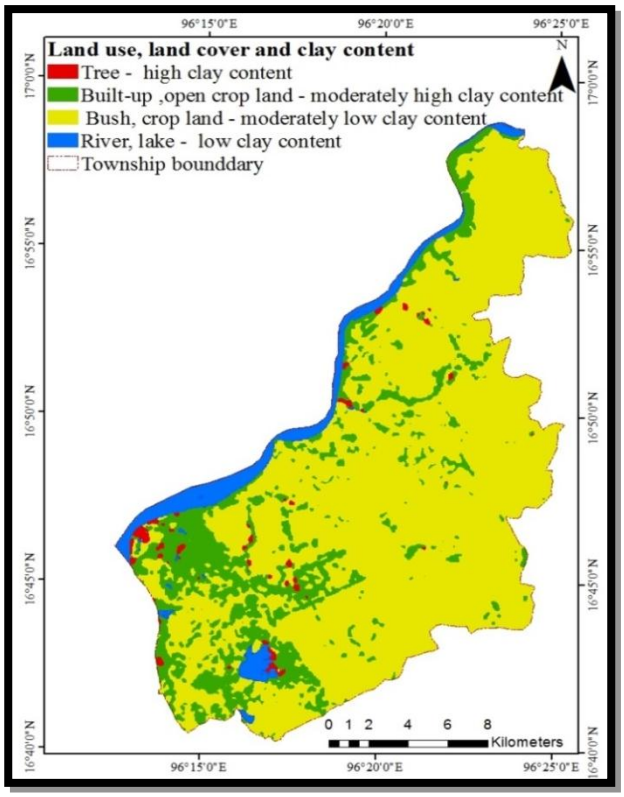
Source: Map prepared presenting data from DEM

Figure 5 Slope map of Thanlyin Township



Source: Image processing generated from Land Sat 8 TM

Figure 6 Land use & Land cover of Thanlyin Township



Source: Image processing generated from Landsat 8 TM

Figure 7 Correlation of Land use / cover and clay content

Table 4 Correlation of Land use & Land cover

Land use and land cover	Clay content (Area_hectare) From low to high				
	c1	**c2**	**c3**	**c4**	**Total**
Built_Up	18	1319	3001	208	4546
Bush	42	5317	3555	24	8938
Open Cropland	0	658	756	0	1414
Lake	325	39	38	10	412
Cropland	26	18052	2220	1	20299
River	1544	112	28	2	1686
Tree	3	8	77	156	244
Total	1958	25505	9675	401	37539

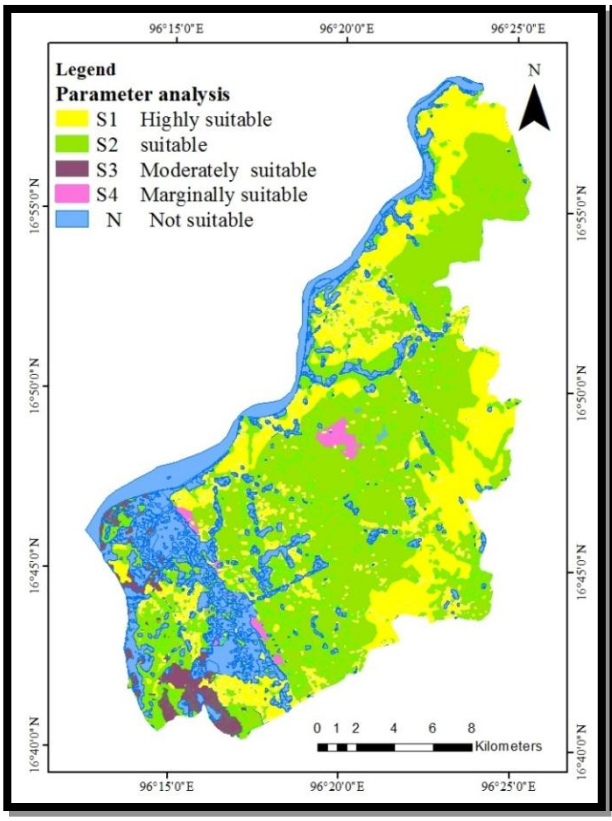
According to the map calculation, there is correlation between Land use and land cover and clay content. Tree possesses very high clay content value. Built-Up area and open-crop land areas made up with moderately high clay content and bush and crop land occupy the area with moderately low clay content. The areas with low clay content are located mainly along the river and lakes (Figure 6, 7 and table 4)

Land suitability map for paddy and green gram is produced by overlaying land use and land cover, clay content ratio and soil types.

The parameters for rice and green gram are

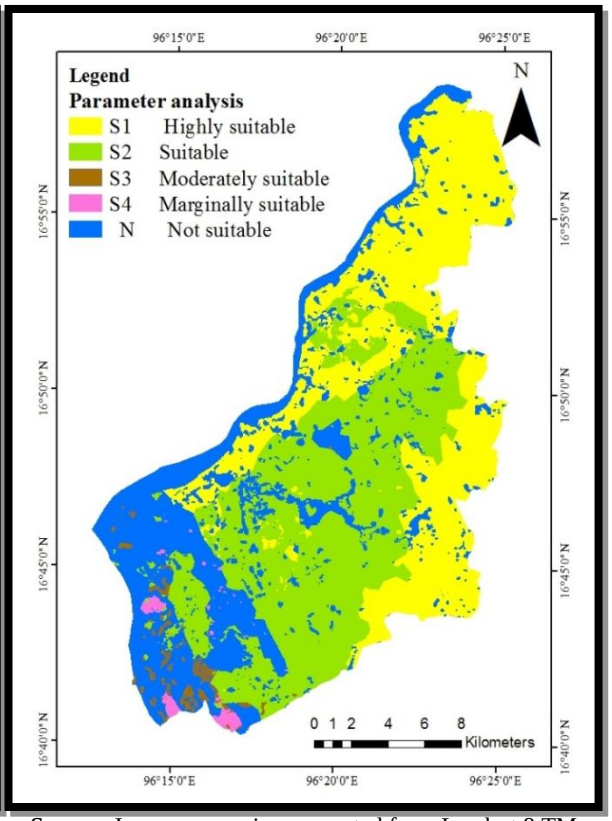
- low land
- high to moderate clay content for rice
- moderate to low clay content for green gram
- meadow alluvial soils, light brown meadow soil and meadow gley soils, brown meadow soils, meadow gley saline soils, meadow gley swampy soils
- crop lands, open crop land, bush or fallow lands

The classes are defined as highly suitable area (S1), suitable area (S2), moderately suitable area (S3), marginally suitable area (S4) and not suitable area (N). (Figure 8 and 9)



Source: Image processing generated from Landsat 8 TM

Figure 8 Land suitability for paddy



Source: Image processing generated from Landsat 8 TM

Figure 9 Land suitability for green gram

In practice, the farmers use the meadow gley saline soil and meadow gley swampy soil as cropland by modifying and applying chemical fertilizers and thus such land can be classified as marginally suitable category.

According to the calculation analysis, the result of land use and land cover, clay content and soil types, highly suitable (S1) areas for paddy crop are located in the north and east of the township comprising 9827 hectares (26%) of the township. The soil is meadow alluvial, with moderately low clay content which is ideal for paddy. (Table 5)

Suitable (S2) areas exist in the north and middle parts of the township. It covers 19042 hectares (51%) of the township area.

Moderately suitable (S3) areas are found in the southern portion of the township, covering 948 hectares (3%) of the township area.

Meadow gley saline soils and meadow gley swampy soils in some areas are classified as marginally suitable lands (S4), occupying 434 hectares (1%) in the township's areas.

Table 5 Suitable area (Hectares) of paddy and green gram in Thanlyin Township

Crops	Highly suitable	%	Suitable area	%	Moderately suitable	%	Marginally suitable	%	Non suitable	%	Total
Rice	9827	26	19042	51	948	3	434	1	7288	19	37539
Green gram	12971	35	14342	38	657	2	317	1	9252	24	37539

Source: Calculated on land suitability map

Highly suitable (S1) areas for green gram are found in the north and east of the township comprising 12971 hectares which represent 35 percent of the township area. The areas contain the well-drained meadow alluvial, light brown meadow soils with moderately low clay content. . These factors are suitable for green gram crop.

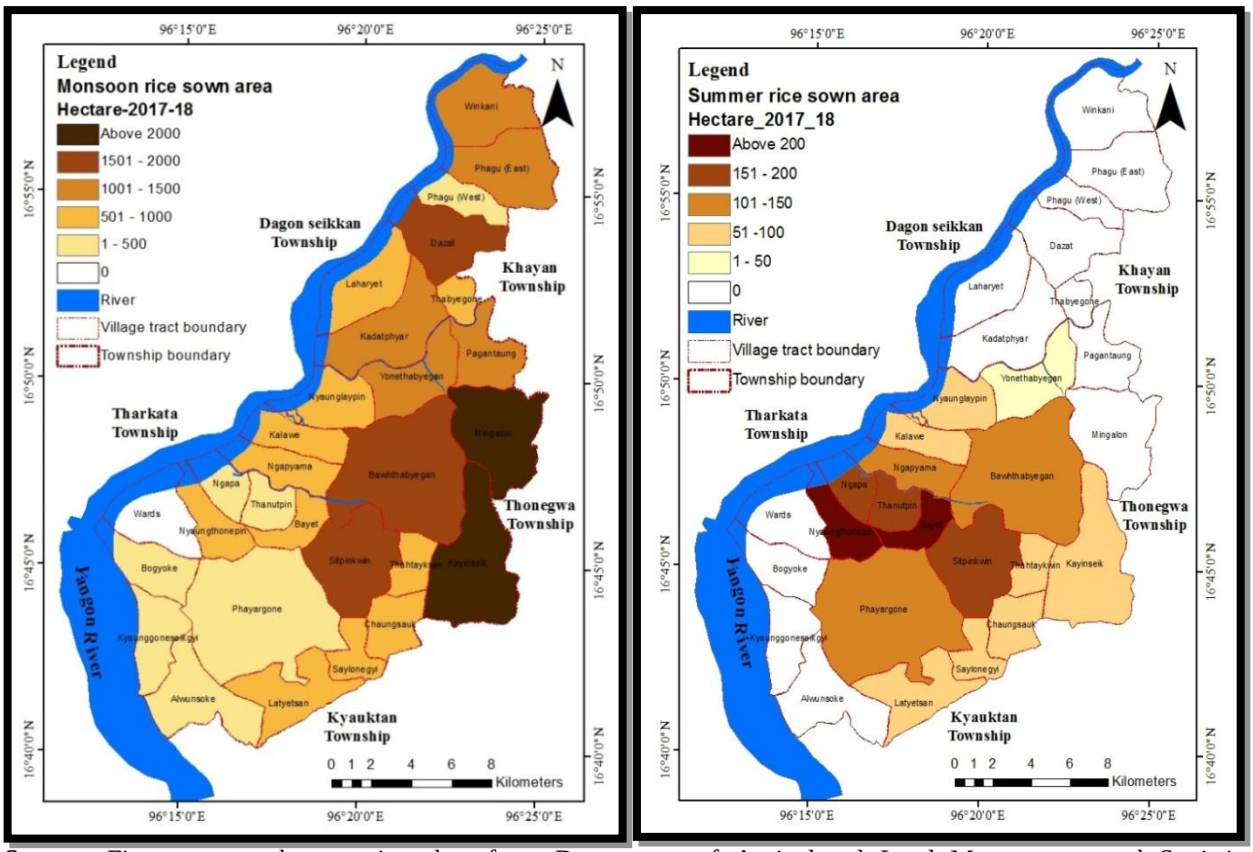
The area suitable (S2) for green gram is 14342 hectares (38%), located mostly in the middle portion of the township area. But moderately suitable area (S3) is only 657 hectares (2%) and marginally suitable area (S4) is even lower with 317 hectares (1%).

Discussion, Conclusion and Suggestion

The major crops of Thanlyin Township are monsoon paddy, summer paddy and pulses. Among the pulses, green gram (Pedisein) cultivated area is the most important in the total pulses cultivated area. Others pulses are grown only for local consumption.

Spatial distribution of sown area and yield of rice

In 2017 – 2018, total sown area of monsoon paddy was 24184 hectares (59760 acres). In that year, yield per acre was 69.42 baskets. The major growing areas are Winkani, Mingalon, Phagu (East), Dazat, Kayinseik, Sitpinkwin and Bawthabyegan village tracts.



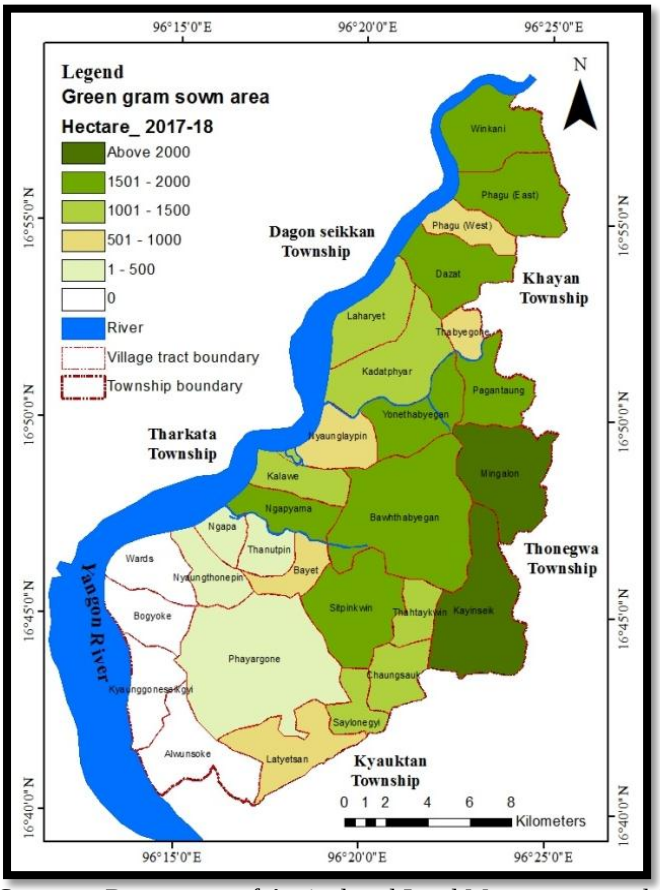
Source: Figure prepared presenting data from Department of Agricultural Land Management and Statistics (Thanlyin)

Figure10 Spatial distribution of monsoon & summer paddy sown area in Thanlyin Township (2017 - 2018)

Summer paddy cultivation depends largely on the availability of irrigation water. The local farmers obtain irrigation water from the small creeks, lakes and diversion weir by pumping. Therefore, sown acreage of summer rice has been very limited. The total sown acreage of summer rice was 954 hectares (2357 acres) in 2017 -2018. The yield per acre of summer paddy is 80.36 baskets. The village tracts with most cultivated summer paddy areas are Bayet, Nyaungthonepin, Thanutpin and Sitpinkwin, having access to irrigated water from Bawh Creek. (Figure10)

Spatial distribution of sown area and yield of green gram

Among pulses cultivated as a winter crop in the post monsoon period, green gram is more suitable crop in Thanlyin Township due to resistance climatic conditions and economically important. The covered area of green gram was 17442 hectares (43102 acres) in 2017 – 2018. It is represented 99.96 percent of the total cultivated area of pulses. (Figure 11)



Source: Department of Agricultural Land Management and Statistics (Thanlyin)

Figure11 Spatial distribution of green gram sown area in Thanlyin Township (2017 - 2018)

Socio-economic role of paddy and green gram farming

In 2018, the total number of population in Thanlyin Township was 280351 persons with total households of 62492. In the rural area, 7451 households and the rural people 11980 persons were engaged in agriculture sector. There were 8779 monsoon paddy cultivators representing (73%), 408 persons (3%) summer paddy cultivators, and 6149 green gram cultivators (52%) engaged in agriculture sector. The rural population expanded to197970 persons (70.62 %) and

urban population occupied 82381 persons (29.38%) in this year. Some farmers practice not only in monsoon paddy cultivation but also in green gram cultivation.

According to interview results with local cultivators,

- Although the soil fertility is low, yield per acre is high by applying more chemical
- fertilizers.
- Summer paddy can be grown only in areas where irrigation water is available.
- If the soil condition is good green gram can be successfully grown without access to irrigation source.
- In some places, farmers concentrate on the production of green gram although irrigation in available to cultivate summer paddy, because of low cost of cultivation and high economic return. The cost of the cultivation of one acre of summer paddy is Kyats 151500. If it is not encountered by plant disease, the yield would be 100 baskets which will bring in kyats 580000 at the current price and the profit is Kyats 428500.
- The cost of the cultivation of one acre of green gram is almost the same to that of paddy. If the yield is 15 baskets, the farmers will get Kyats 645000 at the price of Kyats 43000 per basket and the net profit will be Kyats 493500.
- Green gram needs only a little amount of water and it is more resistant to extreme climatic conditions. Before the cultivating, cost of soil preparing is also low.
- The study has 28 village tracts and all these village tracts grown monsoon paddy. Summer paddy is not grown in 11 village tracts because of no access to irrigation water. These are 9 village tracts that do not grow summer paddy, but green gram is cultivated, while 3 village tracts (Bogyoke, Alunsoke and Kyaunggoneseikgyi) grow neither summer paddy nor green gram because of unsuitability of soils.

To achieve the success of good production of paddy and green gram at the national, there are requirements for fully practicing the guidelines nationwide. In order to get suitable soil for cultivation, it is necessary to prepare the soils by adding the manual fertilizer. Water supply is an important factor for cultivation. Thus it should be projected to be able to irrigate the cropland with water from the existing streams.

Acknowledgement

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မြန်မာ့စိုက်ပျိုးရေးလုပ်ငန်း၊ စိုက်ပျိုးရေးပညာပေးဌာနခွဲ၊ ပဲစိုက်ပျိုးနည်း၊ လယ်ယာစိုက်ပျိုးရေးနှင့်ဆည်မြောင်းဝန်ကြီးဌာန၊ သန်လျင်မြို့နယ် ။

စိုက်ပျိုးရေးဦးစီးဌာန၊ မြေအသုံးချရေးဌာနခွဲ၊ စပါးစိုက်မြေဆီလွှာ၊ စိုက်ပျိုးရေး၊မွေးမြူရေးနှင့် နှင့်ဆည်မြောင်းဝန်ကြီးဌာန၊

သန်လျင်မြို့နယ် ပထဝီဝင်အနေအထား၊ သန်လျင်မြို့နယ် အုပ်ချုပ်ရေးမှူးရုံး။

ရာသီဥတုနှင့်ကောက်ပဲသီးနှံအစီရင်ခံစာများ၊လယ်ယာမြေစီမံခန့်ခွဲရေးနှင့်စာရင်းအင်းဦးစီးဌာန သန်လျင်မြို့နယ်။