CONSTRAINTS AND OPPORTUNITIES OF RICE-BASED FARMING SYSTEM IN THE AYEYARWADY DELTA: A CASE OF PANTANAW TOWNSHIP, AYEYARWADY REGION, MYANMAR

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Abstract

Myanmar's economy is predominantly based on agriculture. The study area is located in Ayeyarwady Delta, the rice bowl of Myanmar which produces most of the rice requirements of the country. This area is naturally provided with deltaic alluvial soil and abundant monsoon rainfall. Thus, rice-based farming system in the study area is the most important farming system covering about 40000 hectares. Rice in the study area has reached self-sufficiency for local consumption and surplus is being exported. However rice-based farming system faces a number of constraints at the farm level due to yearly flooding. Opportunities exist for one or more new rice cultivation techniques and varieties to be adopted in farming system. The objectives of this study are to present rice cultivation practices and farming system employed by the local farmers and to present the constraints encountered in their rice-based farming system and opportunities resulted from RBFS. Focus group discussion, in-depth interviews, and field observations are the key techniques for this research. Deep water field is the largest sown area with 57.92 percent of the total rice cultivated area in the township. The results show that constraints encountered in RBFS of study area is related to flooding. Opportunities can be also resulted for this farming system in future.

Key wards: *Farming System, Constraints, and Opportunities*

Introduction

The Ayeyarwady Delta is a key agricultural production zone located on the southern part of Myanmar. The Delta as a large flat alluvial plain is uniquely suitable for rice cultivation. Ayeyarwady Delta known as the rice bowl of Myanmar is naturally provided with deltaic alluvial soil and abundant monsoon rainfall. This region produces most of the rice requirements of the country. However, the delta is flooded each year from July to October by flow

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from the Ayeyarwady river system. Therefore, most areas are favourable for rice cultivation while some are prone to flooding in the monsoon. As the study area is located in this region, rice-based farming system (RBFS) in the study area faces a number of constraints at the farm level. Opportunities exist for one or more new rice cultivation techniques and varieties to be adopted in farming system. This paper presents constraints and opportunities of rice-based farming system in the study area. Therefore this study will focus on the research question "how do constraints faced in rice cultivation affect the high productivity of rice and what are the opportunities involved in RBFS for local farmers?" Based on these research questions the objectives of this study are to present rice cultivation types and farming system employed by the local farmers and to present the constraints encountered in their rice farming system and opportunities resulted from RBFS.

Sources of Data and Methodology

Pantanaw Township is included in Maubin District of Ayeyarwady Region. It lies in the central part of Ayeyarwady Delta which is known as the rice bowl. It extends from north latitudes 16° 48' to 17° 13' and from east longitudes 95°16' to 95° 34'.The neighbouring townships are Danubyu in north and northeast, Nyaungdon in east and northeast, Maubin in east and south east, Wakema in south, Einme in southwest and Kyaunggon and Kyonepyaw in west and northwest.

Most of the boundaries are rivers and creeks. Southern boundary is defined by Shwelaung and Ayeyarwady rivers. Southeast boundary is also formed by Ayeyarwady River (24.1 kilometres or 15 miles long). Eastern boundary (27.4 kilometres or 17 miles long) is limited by Ayeyarwady River. The northeast boundary which is demarcated along Danubyu for 17.9 kilometres (8 miles) is defined by Bawdichaung. The western boundary is 16 miles long and it is demarcated along the paddy fields. The northwest boundary is formed by Kawthaline creek. The western boundary serve as boundary of Pantanaw and Kyaunggon (32.2 kilometres or 20 miles long). Southwest boundary serve as boundary between Patanaw and Einme Township (19.3 kilometres or 12 miles long). Nearly all the boundaries are made of rivers and creeks.

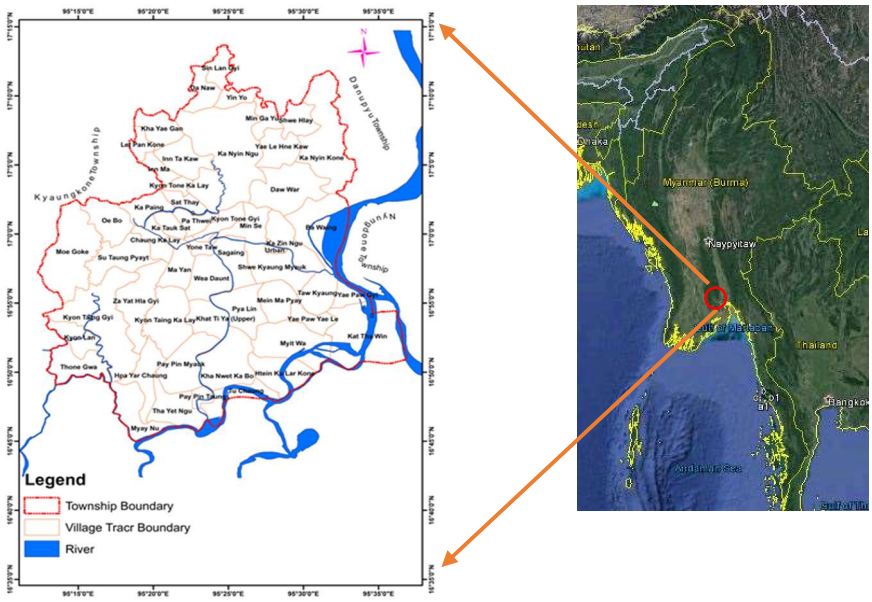

Figure 1 . Location of Pantanaw Township in Ayeyarwady Region
Source : Settlement and Land Records Department, Pantanaw

Data Collection

Primary data was conducted from the duration of fieldwork through data-gathering methods such as interviews and group discussions with key persons and local farmers. In order to investigate the responses of local people to farming system and practices, floods, irrigation, several kinds of data and information needed to be collected as methodologies. Both qualitative and quantitative data comprise information on the impacts of flood conditions, cultivation practices, local experiences and knowledge on their rice farming systems, their adaptive strategies to reduce flood damage, and the attitudes of different groups of farmers to dyke construction.

Secondary data includes the various published and unpublished documents from governmental concerned, and research institutes. Historical documents concerning with the history of the township, land use, farming system and water management from the annual reports. Besides, official records are collected. The statistical data about area, land use, and production were also collected. The interview was supplementary to the group discussion.

Selected households did not follow statistics samples but households represented based on the different farm size.

Results and Findings

Physical Factors affecting rice farming

The study area is a flat region of central part of Ayeyarwady delta. There is regular flooding in the township during the monsoon season. Thus, the cropping cultivation protected is from flooding by dyke construction. Rivers and creeks are frequently crossed by bridge of new highway roads namely Pathein-Yangon roads and Wakema-Yangon road. As a series of branches of Ayeyarwady River, small rivers and creeks flow from north to south. The general elevation of the study area is under 15m (50 feet) above sea-level and the land is flat, favourable for the cultivation of rice crops.

Pantanaw Townshiup is covered by flood water during the monsoon period. But those water retreat back into the river in summer season. So, this region gains good fertilizer from the deposition of silt. They are much suitable for crop cultivation. But the banks are frequently broken by floods and it leads to the loss of agricultural lands and villages.

The township records an average annual rainfall of 2000mm-3 000mm. The major precipitation occurs between June and September but rainy season commences from May onwards. From this, long dry period (November-April) inhibits efficient cultivation. This situation can overcome through irrigation. The average annual temperature is about 27.11° C°(80.8°F) which is the optimum condition for the growth of rice. This land receives tropical monsoon type of climate. The climate is governed by the monsoon and dry seasons according to rice growing period.

The three main soil groups that are important for rice cultivation in the township are meadow alluvial soils, brown meadow soils and meadow gley soils. The general characteristic soil types of this township are meadow gley soils. These soil types are most suited for the rice cultivation.

Socio-economic factors affecting rice farming

As the study area is located in Ayeyarwady deltaic region, the township has broad tract of flat alluvial land suitable for successful growing of rice. Moreover, the township lies on Yangon-Pathein Highway. Combined with easy accessibility, it has become an area of moderately dense population, particularly rice based farming. In 2016, total population was 168561 persons which represented 2.7 percent of the Ayeyarwady Region's total. Of these, 45188 persons are farmers with 27 percent of township's total population. Land use is one of the important factors for agricultural development in any area. The areal extent of the township is 1291.16 sq km (129116 hectares or 498.52 sq mi), taking up 3.68 percent of Ayeyarwady Region. There are five types of land use in the study area. Of these, agricultural land is largest land use type in the township. After 1995, government reclaimed deep water areas and extended as the agricultural land.

Table 1. General Land Use of Study Area (2016)

Type of Land Use	Area (square kilometer)	Percent of township areas
Agricultural Land	933.61	72.31
Fallow Land	3.44	0.27
Pasture	73.25	5.67
Waste Land	43.48	3.37
Uncultivated Land	237.38	18.39
Township Total	**1291.16**	**100**

Source : Settlement and Land Records Department, Pantanaw Township

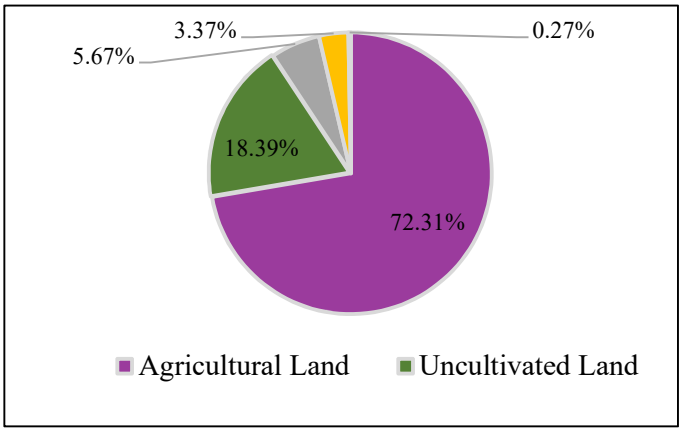

Figure 2. Type of Land Use in Study Area (2016)
Source : Based on table (1)

Rice is grown in the study area during the monsoon (June to November) and summer (November to March) seasons. As the study area enjoys a monsoon climate with abundant rainfall, rice is grown throughout the year. There are two dominant rice production systems in the study area: rainfed rice in monsoon season and irrigated rice in summer season. During the monsoon season, study area's rainfall is sufficient for growing rice without supplemental irrigation from dams, river and stream. On the basis of rainfall, flooding patterns and topography, rice cultivated fields in monsoon season can be categorized further into suitable water and rain field, flood water field and deep water field. Of these, deep water field is the largest sown area with 57.92 percent of the total rice cultivated area in the township (Table 3). Matured area is decreased over 1500 hect (3706.5 acres) due to the effect of flooding in 2016-17.

Farmers in deep water and flood-prone areas cope with the high risk of production by using dry seeding. Direct seed broadcasting is a common practice in areas where the accumulated water level can reach more than 100 cm, since the water in these areas is not likely to subside to a level suitable for transplanting during the monsoon period. Rice establishment by direct seed broadcasting, however, requires dry land preparation before the monsoon.

Deep water and flood water rice are cultivated in the same areas as suitable water and rain rice, but is found mainly near the rivers and streams where the water is deep or flooded. As the study area is located in Ayeyarwady Delta, most of the rice field are subject to flooding ranging in duration from a few days to 2 or 3 months, resulting for significant risks to farmers. More frequent and prolonged submergence events may be a consequence of climate change. Therefore, some areas are suitable only for deep water rice and flood water rice, a low yielding rice type that elongates to stay above the rising water. Therefore, these types of rice are called floating rice in other word. Rice cultivated in these area are the same varieties such as Taunghti, Sitpwar, and Thaiyenet. In 2016-17, rainfed rice in monsoon season account for 40.67 percent of total agricultural land in the township and 19.59 percent of irrigated rice in summer. According to interview monsoon season rice are grown mainly during June to November. Summer season rice is cultivated in the main cropping period of November to March with full or supplementary irrigation or in receding floodwaters.

Table 2. Cropping Calendar of Rice Farming System in the Study Area

Production System	June	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Rainfed rice												
Irrigated rice												

Source: Based on Interview Survey, July 2017

Table 3. Types of rice cultivated field in monsoon season (2016-17)

Types of Rice Field	**Sown Area (Hect)**	**Matured Area(Hect)**	**Yield/ Hect(Ton)**
Suitable water and rain field	12307	12307	4.71
Deep water field	22638	21104	3.11
Flood water field	3024	3024	3.22
Total/Avg	**37970**	**36435**	**3.68**

Source : Based on Data of Agricultural Department, Pantanaw Township

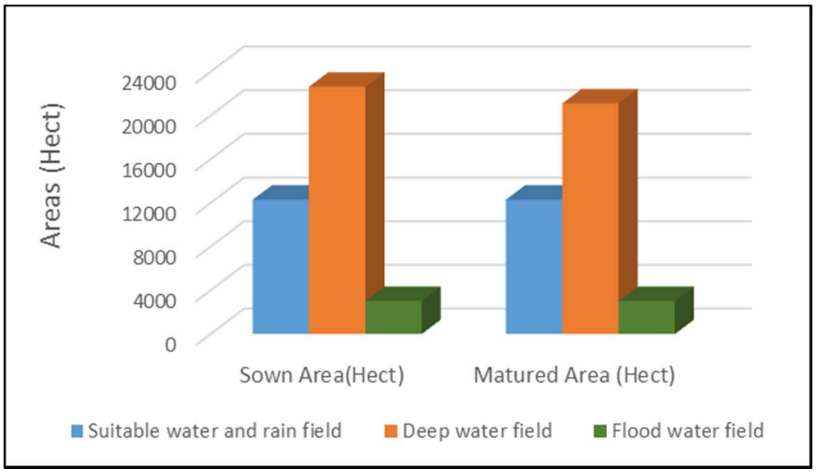

Figure 3. Types of Rice Field in the Study Area (2016-17)
Source: Based on table (3)

Western part of the township was highest in monsoon rice area with more than 1000 hectares (over 2500 acres). Small areas (under 500 hectares) of monsoon rice in that year are found in eastern part of the township. In the study area, rainfed rice is cultivated in the whole township.

More than 2,000 different rice varieties have been used in Myanmar. Many varieties are identical although they are called various names in different areas of the country (Young et al, 1998).Young, 1998). Likewise, many varieties of rice in the monsoon season were cultivated in the study area (table 4). Of these varieties, Sinthukha is the largest cultivated area and yield (except Palethwe) in the study area with 16904.49 hectares in 2016-17. Palethwe are costly to cultivate due to high input cost and labour charges. On the other hand, climate is not adaptable to this variety because of their early maturity and existing harvesting and drying methods.

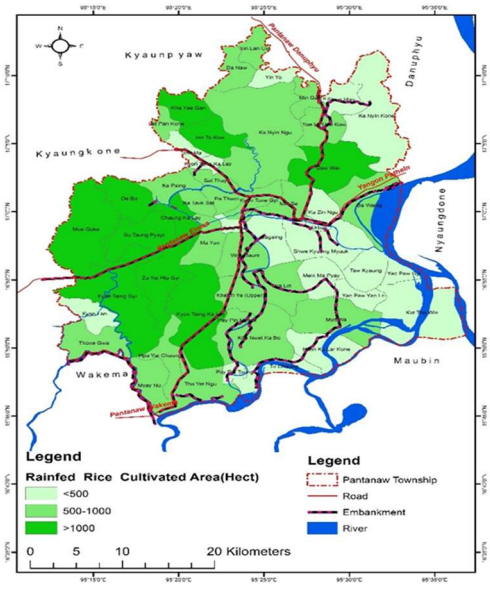

Figure 4. Rainfed Rice Cultivated Areas of the Study Area (2016-17)
Source : Based on Data of Agricultural Department, Pantanaw Township

Therefore, this variety is not highly cultivated area in the township. Taungti and Sitpwer are very low yield with 1.65 to 1.67 ton/hect and cultivated in flooded area. There are risks of submergence and stagnant water, both of which can sharply reduce yields. The average yield in rainfed rice ranges from 1 to 6 mt /hect. Therefore, Maung et al., (1990) also mentioned that the major production constraint in deep-water areas and poorly drained, rain-fed lowlands is the excessive floodwater during the monsoon season.

After the monsoon crop rice was irrigated as second crops in the dry season with 18296.24 ha in 2016-17. Some deep water and flood water rice areas in the monsoon season were used to produce a dry-season crop as the water level receded. As rainfall is highly seasonal in the study area, the dry period lasts for about six months. Rice grow only in flooded field and thus, rice cultivation in the dry period cannot be done successfully without irrigation water sources.

Table 4. Rice Varieties Cultivated in Study Area

Varieties	Matured Area (Hect)	Yield/Hect(Ton)
Parlethwe	48.16	5.95
Manawthuka	4864.02	4.24
Sinthukha	16904.49	4.39
Yatanatoe	1342.78	4.40
Sinthwelat	619.99	4.51
Thihtatyin	1312.02	3.42
Ayeyarmin	2277.22	3.42
Kyauknyin	97.94	2.87
Yatanawin	743.02	2.55
Taungti	4062.32	1.67
Sitpwer	4163.09	1.65

Source : Based on Data of Agricultural Department, Pantanaw Township

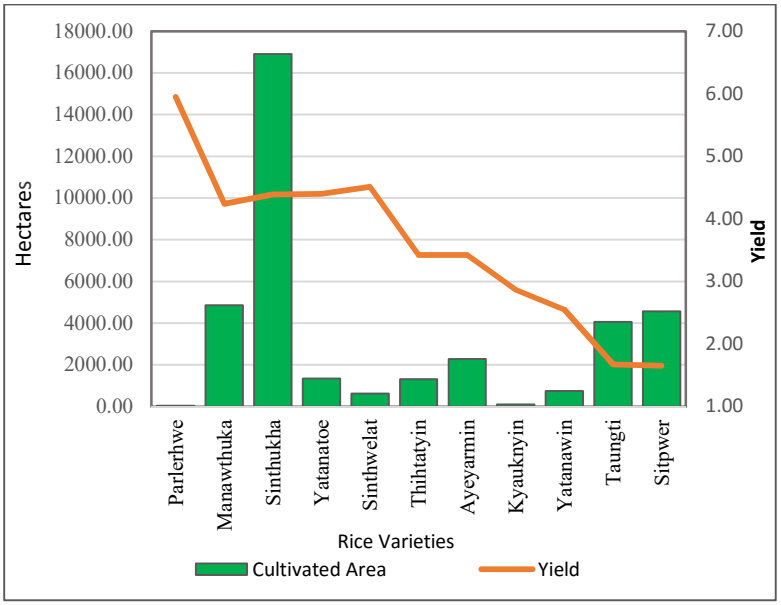

Figure 5. Matured Area and Yield/Hect by Varieties
Source: Based on table (3)

In 2016-17, irrigated rice was mostly grown in the northern part of the township, as they are located near the Ayeyarwady River, and its tributries from which water is pumped into the fields. For the southeastern part of the township, irrrigated rice is slightly cultivated owing to lack of canal that can deliver large amount of irrigation water. However, Naing (2005) reported that there are high potential for groundwater development in the Ayeyarwady River Basin. Therefore, the freshwater from these sources also is pumped by some farmers into the fields to grow summer rice. Rice yields in summer season are more than monsoon season that cultivated traditional varieties with low yield are more suitable to tolerate flooding. This point largely affected the total production of rice farming in the study area.

Prior to the 1995, the majority of the area was cultivated for one crop of long-term floating rice over the monsoon season from June to November in a year. Since the introduction of high yield variety rice at some sections in the country have been modified to provide flood protection by the construction of high embankments exceeding peak flood levels.

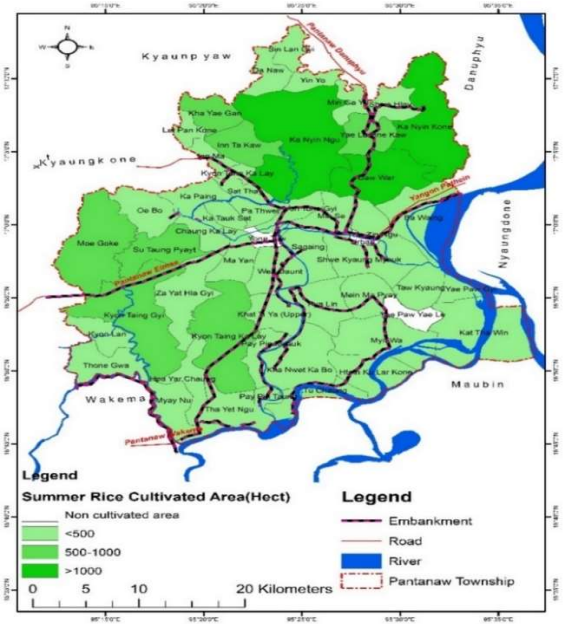

Figure 6. Irrigated Rice Cultivated Areas of the Study Area (2016-17)
Source : Based on Data of Agricultural Department, Pantanaw Township

Embankments are essential to prevent agricultural land and settlement area. Then these are joined to form compartments with sluice gates installed to exclude floodwater but allow water in and out of the compartment as required. In 1995, there are four embankments in the township and beneficial area is 14381.63 hectares (35537 acres). Currently, there are 11 embankments to protect flooded water in the study area and beneficial areas of 42355.32 hectares (104660 acres).

Table 5. Varieties cultivated and Yield/Hectare in Summer Season

Varieties	Cultivated Areas(hect)	Yield/Hect(Ton)
Sinthukha	7588.02	4.89
Thihtatyin	7918.25	5.03
Manawthuka	2316.88	4.93
Yatanatoe	382.44	5.08
90 days	91.06	5.07
Total/Avg	**18296.64**	**5.00**

Source : Based on Data of Agricultural Department, Pantanaw Township

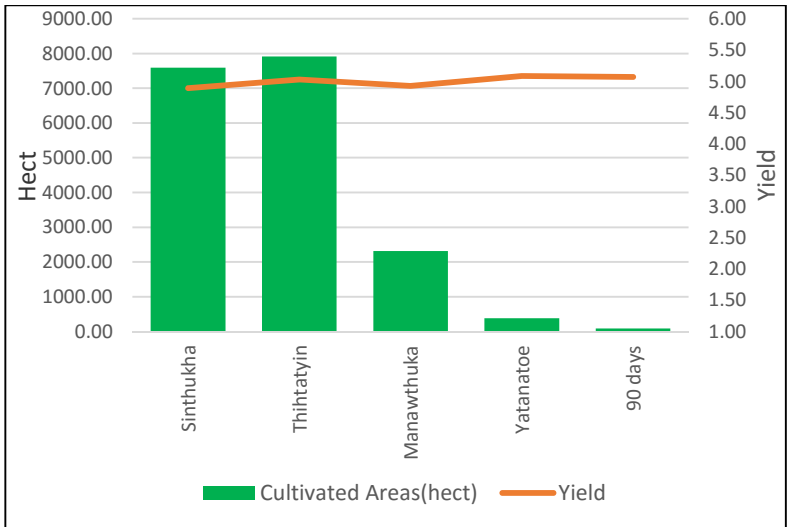

Figure 7. Yield /Hect by Varieties Cultivated in Summer Season
Source: Based on table(5)

Constraints and Opportunities related to Rice Farming

Flood

According to interviews with key informants and group discussion with farmers, the major constraints to rice production in the study area are flooding in monsoon season. The increased productivity of rice-based farming systems remains the primary goals of the national plan, with a focus on short duration varieties for irrigated areas.

Water in the monsoon season cannot usually be controlled due to poor drainage and insufficient embankments along the river banks. As the rainfall during six months of monsoon is heavy, the accumulated water level can rise gradually or abruptly, depending on the drainage system, location and amount of rainfall received. The cultivated rice crop can be lost in some deep water and flood water areas due to an abrupt rise of water and lasting. Communication and transport facilities are often hampered during flood periods, preventing the timely application of inputs, such as fertilizer especially in suitable water and rain rice field.

The rice system that would be best adapted to climate conditions projected for the coming decades is to utilize floating rice varieties, which are able to withstand prolonged inundations and floods. Most rice varieties can survive complete submergence for only 3 or 4 days, but submergence-tolerant varieties can survive for about 12 days. Deepwater and floating rice are sown before the floodwaters rise and flower about the time of maximum water depth. Deepwater rice varieties can grow in maximum water depths of around 100 cm. Floating rice are those that grow very rapidly under submergence.

Despite its relatively low yield compared to high yielding varieties (HYV), floating rice (FR) has been seen to have a range of other advantages. According to interview survey, farmers in the study area have not applied to chemical fertilizers in FR cultivation. FR fields have abundant biodiversity compared with other rice field and contain substantial fish and other aquatic animals which can be harvested as valuable food protein sources for local peoples.

The floating rice yields are low at only 1.6 t/ha compared to HYV of rice at over 4 t/ha. There is significant variation in productivity from different

farming systems, reflected in differences in yield. Moreover, the price of floating rice is low at only 4000 kyats in 20.86 kg (one basket) compared to HYV of rice at over 6000 kyats.

Although summer season needs irrigated water available to cultivate rice, generally, crops are rarely fully irrigated. In most areas, they are planted to take advantage of the receding floodwaters or of residual soil moisture. For the central part of the township, rice is cultivated very low owing to lack of canals, and other water avalivible conditions. Therefore, farmers are more willing to irrigate into their fields by canals.

Groundwater provides significant advantages over formal surface water irrigation systems in terms of lower infrastructure costs. The potential for expansion of groundwater use is high in the study area particularly in the large alluvial systems of the region's major rivers. Groundwater is seasonally recharged by the annual flood. Therefore, the study area has opportunities for enhancing surface water and groundwater availability through managed irrigation system.

Yield during the dry season can be increased more than during the wet season because farmers potentially have control of the water input. Yield can be increased by up to over 5 t/ha. The Government and local people have placed a strong emphasis on irrigation development.

Varieties

Rice varieties cultivated in the study area are mainly controlled by cost of cultivation and adaptation to local. Farmers want commonly to cultivate their own seed that do not require to buy from year to year. Varieties cultivated in the township are used up to 3 or 4 generations by farmer. After these generations the seeds are no longer usable because of low yield and quality. Then, farmers bought new seeds from local agricultural department or other farmers. Sinthukha as high yield varieties (HYV) is the most cultivated variety in the township. Farmers do not gain potential yield from the cultivation of these varieties due to flooding, low inputs and weak effort in cultivation. Yield per ha has not improved since the early days due to restrictions on chemical fertilizer supply. The yield currently under rice varieties in monsoon and summer season has fairly high, but the floating rice

yields are low under 2 t/ha compared to HYV varieties of rice over 3 t/ha. Currently, rice researchers in Myanmar noted that they need a floating rice variety that can elongate more than 50 centimetres/day. They expected to exchange floating rice seed as in Cambodia (Nguyen and Pittock, 2016). Therefore, local farmer's seed selection and genetic exchange is one of the key components for gaining high yield and conserving floating rice systems.

Fertilizer

Rice cultivation in the township used only a small amount of fertilizer due to the high cost. According to interview survey, the current fertilizer use in rice cultivation by farmers is low the quantity actually used for one hectare than township agriculture department standard. For example, instead of three and half bag of Urea fertilizer for one hectare (2.471 acres) in rice cultivation, farmer commonly use two and half bag/hectare. Therefore, insufficient use of chemical fertilizer is one of the low yield production factors in the study area. Fertilizer supply has improved since the government has allowed private imports, but the private market price has been steeply higher. Most of the chemical fertilizer use is for HYVs and in irrigated areas.

Labour

Labour is an important factor in any type of cultivation. Farm labourers are indispensable for the high productivity of rice. Today, the young adults of working age take little interest in the local work to enhance the agriculture activities such as rice farming. The considerably working age-group migrate to other region such as Yangon and the neighbouring countries, mostly to Thailand to get better job opportunities and earn more money. Therefore, labour shortage is also a major constraint in rice cultivation of the township. However, the wages of a worker/day is between 3500 and 4000 kyats in the township. This rate is very expensive for farmer.

Agricultural Loan, Land Tenure and Machinery

According to interview survey poor farmers with a small land holding of less than 2 ha want to maximize the output of his land. It is this category of farmers who are most inspired by the marvels of HYV rice. The most essential

input they need is some money to start with. Most of the available money was used in paying compensation to former lenders, instead of being used for agricultural credits. In 2017, farmers are able to borrow a total amount of K 150000/ acres (0.404 hectares) from the Agricultural Bank. However, farmers do not have sufficient amount in cultivation. In study area, some farmers are land tenure. Such farmers do not get agriculture loan. Therefore. They want to get it. Such farmers are not willing to invest in machinery because they do not have secure land tenure.

Lack of domestic and international markets for floating rice (FR)

Although HYV rice has a domestic and international market acceptability, FR has no market. FR can available low prices due to low quality. It is also perceived as hard to eat. Farmers grow floating rice for home consumption or animal feed. Nguyen and Pittock (2016) reported that floating rice is perceived as safe, chemical free and nutritious. Therefore, FR may be market acceptability due to contribute the health of people in the future.

Conclusion

As the study area is located in a flat region of central part of Ayeyarwady delta, there is regular flooding in the township during the monsoon season. Thus, rice farming system of the study area largely affected flooding. The yield currently under rice varieties in monsoon and summer season has fairly high, but the floating rice yields are low under 2 t/ha. The variety that would be best adapted to flood affected areas projected for the coming decades is to utilize floating rice varieties, which are able to withstand prolonged inundations and floods. Some varieties can survive complete submergence for only 3 or 4 days, but floating rice varieties can survive for about 12 days. The floating rice must be improved for changed conditions to increase yield and quality, as they are currently quite low. There is little public policy for recognizing the importance of climate change in rice cultivation in the study area. Therefore, there is no emphasis on developing higher yield floating rice varieties.

Farmers must keep up with the adoption new technologies as they become commercially available. The costs and benefits of rice based farming system in the study area remain an important aspect for further research.

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