Fachhochschule Köln

Institut für Tropentechnologie

Assessment of Socioeconomic Situations and Analysis of Farming Systems in Cyclone Affected Region, Case Study Bogale, Myanmar

Masterarbeit

Vorgelet von

May Phyoe Way

August,2009

Fachhochschule Köln
Cologne University of Applied Sciences

ITT

Fachhochschule Köln
Institut für Tropentechnologie

Master Arbeit

Vorgelegt von

May Phyoe Way

Matr. Number 11058534

Thema:

Assessment of Socioeconomic Situation and Analysis of Farming Systems in the Cyclone Affected Region, Case Study Bogale, Myanmar

Referent: Prof.Dr Hartmut Gaese

Co.Referent: Dr. Juan Carlos Torrico

Abgabe datum: 31st August 2009

Table of Content

Declaration **1**

Acknowledgement **1**

Abstract **2**

Zusammenfassung **3**

1. Introduction **4**

1.1. Problem Statement 5

1.2. Objective 7

1.3. Thesis Hypothesis 8

1.4. Thesis Outline 8

2. Literature Review **9**

2.1. Overview of Myanmar 9

2.1.1. Resources and Topography 9

2.1.2. Climate 9

2.1.3. Soil Types and Land Allocation 10

2.1.4. Role of Agriculture 10

2.2. Ayeyarwaddy Division in Brief 14

2.2.1. Seasonal Seawater Intrusion 15

2.2.2. Soil Types 15

2.3. Salinity Problem 16

2.3.1. Rice Cultivation in Saline Soil 17

2.3.2. Salt Tolerance of Crops 18

2.3.3. Management of Salinity 20

2.4. Soil Situation after Nargis in Study Area 20

2.4.1. Soil Analytical Status 20

2.5. Farm Management 23

2.5.1. Allocation of Land, Labors and Capital 23

2.5.2. Selection of Enterprises and Risk 23

3. Material and Methodology **24**

3.1. Study on Bogale 24

3.1.1. Water Resources 26

3.1.2. Rainfall Pattern 27
3.1.3. Transportation System 27
3.2. Agriculture Sector 27
3.2.1. Land Allocation 27
3.2.2. Soil Situation for Agriculture 28
3.2.3. Kinds of Crop, Cropping Area and Yield of each Crop 29
3.2.4. Data collections for soil salinity 30
3.3. Variables for Assessment of Cropping Practices and Income 30
3.4. Variables for Assessment of Yield of Rice before and after Nargis 31
4. Result and Discussion 32
4.1. Assessment of Socioeconomic Situation 32
4.1.1. Land Allocation for all crop in selected Area 32
4.1.2. Family member, labors and land ownership 34
4.1.3. Education Standard 34
4.1.4. Draught Animal 35
4.1.5. Machineries 36
4.1.6. Income Sources 37
4.1.7. Rice Sown Area and Yield in Northern Portion before and After Nargis 38
4.1.8. Price of Rice 41
4.1.9. Comparison of income before Nargis and after Nargis 42
4.1.10. General Descriptions on characteristics of farmers 45
4.2. Analyzing resources requirement and availability for farming system 47
4.2.1. Land 47
4.2.2. Land utilization in both portions 48
4.3. Capital 49
4.3.1. Comparison of Costs of Cultivation and Profits 49
4.4. Labor 50
4.4.1. Cropping activities and labor requirement for Traditional Rice Varieties 50
4.4.2. Cropping activities and labor requirement for High Yield Rice Varieties 51
4.4.3. Cropping activities and labor requirement for Winter Crops 52
4.4.4. Labor Availability 53
4.4.5. Calculation of Labor requirement and Labor availability 54
4.4.6. Monthly Labor requirement and Labor Availability 55
4.4.7. Labor efficiency and labor surplus 56
4.5. Estimation of resources requirements and income from secondary sources 58
4.5.1. Nipa palm 58
4.5.2. Duck Farming 58

4.6. Cropping Patterns and Crop Calendar 60
4.6.1. Crop Calendar in the northern Portion 61
4.6.2. Crop Calendar in the middle Portion 61
4.6.3. Crop Calendar in the southern Portion 62
4.7. Analysis of total income from each farming system 63
4.8. Estimation of labor availability in each farming system 64
4.8.1. Northern Portion 64
4.8.2. Middle portion 65
Conclusion 67
Reference i
Appendix i

List of tables

Table (2.1) Unfavorable Area for Rice Growing in Different State and Divisions……11
Table (2.2) Land ownership of farmers in Myanmar……12
Table (2.3) Nipa palm growing area in Myanmar State and Division in 2004-05……14
Table (2.4) Relative salt tolerance of various crops at emergence and during growth to maturity...19
Table (2.5) Soil Salinity Status in Northern Portion (Bogale) after Nargis Cyclone ……21
Table (2.6) Soil Salinity Status in middle portion (Bogale) after Nargis Cyclone ……22
Table (2.7) Soil Salinity Status in Southern Region (Bogale) after Nargis Cyclone……...22
Table (3.1) Area and yields of each crop in study area……29
Table (4.1) Area distribution of crops in selected village tracks in the northern portion…..……32
Table (4.2) Area distribution of crops in selected village tracks in the middle portion……33
Table (4.3) Distribution of land ownership of farmers in both portions……..34
Table (4.4) Distribution of draught animals in household in both portions……36
Table (4.5) correlation of land ownership groups and machineries owned in the northern portion..36
Table (4.6) different sources of income of different groups of farmers in northern portion……38
Table (4.7) different sources of income of different groups of farmers in middle portion……38
Table (4.8) Yields of Rice Before and After Nargis in the northern portion……...40
Table (4.9) Yields of Rice Before and After Nargis in the middle portion……..40
Table (4.10) Price of Rice of 100 baskets with respect to years……41
Table (4.11) Comparison of farmers' incomes before and After Nargis in Northern Portion…….43
Table (4.12) Comparison of farmers' incomes before and After Nargis in Middle Portion……44
Table (4.13) Characteristics of each farmers group in northern portion……46
Table (4.14) Characteristics of each farmers group in middle portion……...47
Table (4.15) Land utilization in each group in both portions……48
Table (4.16) Calculation of cost of monsoon rice including interest rate……...49
Table (4.17) Comparison of cost of cultivation and profits for each crop……..50
Table (4.18) Labor requirements per hectare of each growing period in each crop……53
Table (4.19) Labor availability respect to the each growing period of each crop……54
Table (4.20) Monthly labor requirement per hectare for each cropping pattern (manday)……55
Table (4.21) Labor Availability per ha in each group in every month……55
Table (4.22) monthly used labor and labor surplus in Northern Portion……57
Table (4.23) monthly used labor and labor surplus in middle Portion……57
Table (4.24) Calculation of income from Nipa (working in Dani production)……58
Table (4.25) Cost calculation of duck farming (100 numbers)……59
Table (4.26) Revenue and profit calculation of duck farming……..60
Table (4.27) Crop calendar in the northern portion……...61
Table (4.28) Crop calendar in the middle portion……..62
Table (4.29) Crop calendar in the southern portion……..62
Table (4.30) Possible combinations of alternative crops with monsoon rice……63

Table (4.31) Applied labors and surplus labor percentages in each farming system……..64
Table (4.32) Applied labor and surplus labor percentages in each farming system……65

List of Figure

Fig (2.1) map of Myanmar showing study area……10
Fig (2.2) Different types of crops in various regions……12
Fig (2.3) Working in Nipa palm in study area (Bogale townships)……..13
Fig (3.1) Map of Bogale showing three portions……..25
Fig (3.2) GDP of Bogale townships……26
Fig (3.3) Type of water harvesting during monsoon……26
Fig (3.4) Average monthly rainfall in 2003 to 2008……...27
Fig (3.5) Soil types in middle portions……28
Fig (4.1) Summer rice cultivation in northern portion……33
Fig (4.2) Fallow lands in middle portion in summer……..34
Fig (4.3) Education level of household head in Northern and Middle portion……..35
Fig (4.4) price of rice in regional market in the study area ……42
Fig (4.5) Comparison of Farm income before and after Nargis in northern portion……44
Fig (4.6) Comparison of farm income in middle portion before and after Nargis……...45
Fig (4.7) Labor Requirement of Rice (Traditional Varieties)……51
Fig (4.8) Labor requirement of Rice (High Yield Varieties)……..51
Fig (4.9) Labor requirement for winter crops……..52
Fig (4.10) monthly labor requirement and availability for each cropping pattern in northern portion……..56
Fig (4.11) Labor requirement and availability for each cropping pattern in middle portion……56
Fig (4.12) Duck farming in the northern portion, Bogale……..59

Declaration

TextTextText TextTextText

Acknowledgement

First of all, I would like to acknowledge to my professor, Dr. Hartmut Gaese, for supporting me all of my requirements especially for his grateful suggestion of this study. Secondly I would like to extend my thanks to Dr. Juan Carlos Torrico for his perfect supervision on writing scientific paper and structure of this paper and excellent advices.

Then, I really appreciate German Academic Exchange Service (DAAD) for funding not only for my study but for others as well. I thank to Institute of Technologies in Tropic and Subtropics for this programs and courses works.

I would like to express my thanks to responsible persons in Land Use Division, Myanmar Agriculture Services and Settlement and Land Record Department under Ministry of Agriculture and Irrigation, Myanmar for giving me opportunity and supporting secondary data which are very important for this study. I would like to acknowledge to FAO (Food and Agriculture Organization) Myanmar for supporting me very useful data and maps.

I would like to mention my gratitude to Daw Ni Ni Tun, Manager, Land Use Division, Myanma Agriculture Services, for her supporting of sources for literature review, suggestions and her encouragement for this study. Then I would like to acknowledge to all of my teachers in Yezin Agricultural University, Myanmar.

Special thanks to my husband and friends who were supporting and accompanying with me through my field trip for this study. I really appreciate all of farmers in Bogale townships for their patient, hospitality and their cooperation.

I would like to send many thanks to all of my friends, studying at ITT Germany and Myanmar, for their supporting academic works and sharing information.

Abstract

This study is concentrated on the farmers who were affected by cyclone Nargis in Myanmar 2nd May 2008. Besides infrastructures, farmers have lost their families, draught animals, machineries and other farms aids during cyclone. This study aims to assist them for their food security and later on development of their living standard. First of all, overview economic structure, land situation, soil situation, and constraints of crop production have been studied. The study area is divided into three portions, northern portion, middle portion and southern portion.

There are three steps in this study. Firstly, assessment of their family size, education standard, their income generation, resources availability and their cropping practices has been done with the aids of SPSS model and excel. Secondly, their resources availability, land, labor and capital, and percentages of these resources exploited presently have been analyzed. Finally, resources requirement for alternative farming systems and possible income from each have been estimated.

Due to sea water intrusion, yields of rice have been decreased severely. Amount of reduced crop productions for two growing seasons and price fluctuations of rice for 10 years have been mentioned. At the moment, farmers are suffering from both of reduced yields and decreased price of rice. According to the literature review, sea water affected soil should be washed out with fresh water. Crop rotation with pulses and utilization of salt tolerance varieties are recommended. In fact, some areas in the region can not be washed out flooded sea water because of low lands level. Crop rotation and using suitable varieties can be taken into consideration for particular situations.

.After analyzing data, it was found that lands were not being used full potential. In addition, labor requirement was high only in the harvesting time and seeding time. Apart from these periods, labors were surplus depending on their farm sizes and family labors sizes. Surplus labors and surplus land resources could be applied in other businesses.

Six alternative farming systems have been proposed in this study and estimated cost and benefit of each crop. Incomes from each farming system have been calculated. Crop rotations of monsoon rice with pulses, sunflower, groundnut or sesame are included in these farming systems. Among these cropping patterns rice - rice and rice - pulses are recommended for sea water affected region. From economic point of view, rice- rice or rice – pulses cropping patterns with duck farming can give higher income. In addition, labors are still surplus for some groups of farmers for these farming systems. These surplus labors can work in Dani production station as daily workers. It can provide some amount of money depending on the availability of family labors.

Zusammenfassung

Diese Studie konzentriert sich auf die Bauern, die durch den Zyklon `` Nargis´´ am 2. Mai 2008 in Myanmar, beeinträchtigt wurden. Durch den Zyklon haben die Bauern ihre Familien, Infrastruktur, Tiere, Maschinen usw. verloren. Das Ziel dieser Studie ist Bauern zu helfen eine Selbstversorgung mit Lebensmitteln zu schaffen und später ihren Lebensstandard zu verbessern. Zunächst wurde die ökonomische Struktur, geografische Lage, die Erdbodensituation und möglichen Probleme des Pflanzenanbaus geprüft. Der Bereich in dem die Studie durchgeführt wurde ist in drei weitere Teilbereiche gegliedert: Nord, Mitte und Süd.

Es gibt drei Schritte in dieser Studie. Die Studie beginnt mit der Bewertung von der Familiengröße, Bildungsstandard, Einkommen, für die Landwirtschaft benötigte, vorhandene Ressourcen und vorhandene Anbausysteme. Diese darstellende Analyse der Bewertung wurde mit Hilfe des SPSS Modells durchgeführt. Des Weitere wurde die Verfügbarkeit der Ressourcen(Land, Anzahl der Arbeitskräfte und Kapital) und die Prozentzahl der bereits benutzten Ressourcen analysiert.
Schließlich wurden die Bedürfnisse an Ressourcen für jedes einzelne Landwirtschaftssystem und das mögliches Einkommen abgeschätzt.

Aufgrund des Zyklons "Nargis" (2008) sind die Erträge von Reis stark zurückgegangen. In der Studie wird angesprochen, dass es für zwei Vegetationsperioden zu einer reduzierten Ernteproduktion und für 10 Jahre zu Preisschwankungen des Reis` kam. Zur Zeit leiden die Landwirte unter der reduzierten Produktion sowie unter der Preissenkung des Reis. Laut der Literaturrecherche sollte der mit Meerwasser verseuchte Boden mit frischem Wasser ausgewaschen werden und mit Hülsenfrüchten bepflanzt werden.

Aus der Analyse erhalten wir das Ergebnis, dass häufig das Potenzial des Landes nicht ausgeschöpft wird . Darüber hinaus ist der Bedarf an Arbeitskräften nur in der Zeit der Ernte und Aussaat hoch. Abgesehen von diesen Zeiten sind die vielen Arbeitskräfte überschüssig, je nach Betriebsgröße und Anzahl der in Familien bereits vorhandenen Arbeitskräften. Die überschüssigen Arbeitskräfte könnten für andere Aufgaben genutzt werden. Dadurch könnten die Landwirte das Einkommen erhöhen.

Sechs Landwirtschaftssysteme wurden in dieser Studie vorgeschlagen und deren Kosten und Gewinn abgeschätzt. Aus dieser Berechnung resultiert, dass das abwechselnde Beflanzen von Reis und Hülsenfrüchten oder das Beflanzen von Reis in zwei aufeinander folgenden Perioden und das Züchten von Enten das Einkommen erhöhen sollte.

1. Introduction

The numbers of natural disasters are increasing year after year over the world with an average growth rate of 8.4% in the year 2000 to 2007 period (Scheuren *et al.*2007). People who are vulnerable from disasters are increasing. Government, NGOs, Humanitarian agencies and international organizations are concentrating on early warning system and emergencies aid in order to reduce the victims. There are (5) kinds of natural disasters Geographical disasters, climatological disasters, hydrological disasters, meteorological disasters and biological disasters. Among these, hydrological disasters are the most serious one as according to the data reported by `` The Centre for Research on the Epidemiology of Disasters ´´ (CRED, 2007). In recent decades, the number of reported hydrological disasters has increased by 7.4% per year on average (Scheuren *et al.*2007).

In 2007, among the vulnerable countries, Asia is the most affected by the disasters with the rate of 37% of the year's reported disasters. It can be counted as 90% of all the reported victims and 46% of the economic damage due to natural disasters in the world. The 65 disasters reported in Europe and it means 27% of the world economic damages and only 1% of the world's victims. Asia was especially hard hit by the strong monsoon related events. In particular, India, China, and Bangladesh are the most affected countries in the region. The article of ``Potential Impacts of Sea-level Rise on Populations and Agriculture´´ said that global mean sea-level is expected to rise 95 cm by the year 2100 (Gommes *et al.*1998).

The impact of prolonged sea water flooding are cropping pattern changes, water management changes, social changes and migration.Indirect effect of the sea water rise is recorded with more difficulties than direct effects. These indirect effects are erosion patterns and damage to coastal infrastructure, salinization of wells, sub optimal functioning of the sewerages systems of coastal cities with resulting health impacts (WHO 1996, chapter 7). Conclusively, they assumed that accelerated sea-level rise seems to be the most serious consequent of global climate change (Gommes *et al.* 1998*).*

Among the main effects of the Tsunami that occurred on the 26th of December 2004 Indonesia were that it removed the top soil needed for crop production and soil texture was changed due to the introduction of large amount of sand or clay less fertile materials. Agricultural cropping patterns and varieties used have been changed in relation to the changed soil type and weather pattern. Soil reclamation has been done in the effected region (Bell 2005).

Another example of one of the biggest cyclones has been occurred in Bangladesh in 2007. The researchers discussed their observations at a series of meeting with the Secretary of the Ministry of Agriculture, the Bangladesh Agricultural Research Council, and the Bangladesh Rural advancement Committee. They decided to develop new salt tolerance high yield rice varieties and

apply crop management and crop intensification strategies which could help raise productivity to ensure higher and more stable income and food security (IRRI 2008).

Likewise, in Myanmar, there was a big cyclone in year 2008, which was the most devastating natural disaster in Myanmar history. The cyclone and resulting storm surge destroyed about 450,000 homes and damaged 350,000 others. 75 percent of health facilities in the affected areas were destroyed or severely damaged, together with around 4,000 schools. 783,220 hectares of agricultural land were flooded. 707,500 tonnes of stored paddy and milled rice are destroyed. Some 3,000 power tillers and thousand of tilling equipment were lost. And 227,420 draught animals were lost and other things of orchard crop and backyard gardening were damaged. The total economic losses amount to about 2.7% of the projected 2008 GDP, with effects of the cyclone concentrated on a region for agriculture and fishing in Myanmar (FAO 2009a). The risk of natural hazard in Myanmar is moderate to high because of frequent events even though they are ranging from small scale to medium scale. Since Agriculture is main economic sector in it, all the organizations and Government are concentrating on the Agriculture to rehabilitate the affected regions.

Study area is one of the most devastated areas and People are suffering from shortages of food, shelter and clothes. The other problem is that they lost their job opportunities due to the shortage of machines, labours, capital and left less fertility lands due to sea water intrusion. It is seriously needed for food security in the future in the effected regions.

1.1. Problem Statement

Study area is situated in Ayeyarwaddy division, delta region; it is so called rice pot in Myanmar. There are three main economic sectors in it, such as agriculture, livestock and fishery, among them GDP of agriculture in the region is the highest and main crop producing are rice, pulses, oilseeds crop, coconut rubber plantation and Nipa palm etc. When comparing to the yields of crops to that of other regions, it is above national average. The topography is flood plain. The area is always flooded during the raining season and some portions are flooded even in summer, almost whole year. Water levels in the fields are different from one portion to another. They are from 0.3 meter to 1 meter according to rainfall amount and topography during the raining season. All the fields are flooded while seeding monsoon rice. The farmers are use to practicing seed broadcasting with spout; after germination, seeds are broadcasted. After that, they usually do not do anything in their fields except in the harvesting time because fields are flooded whole growing season. During the harvesting and seeding, labor requirement is very high and it is very difficult to finish at the same time due to lacking of machine. In addition, farm distributions is not equal i.e. some own large farm acre and some owned few land area and most of the farmers are landless. Farmers who owned large amount of area could not manage their field harvesting in time and they have labor problem for preparation of next crops.

In order to mention specifically, there are three different portions in it i.e. fresh water region, fresh and sea water region and sea water region. Those are divided based on the fresh water availability and salinity line in the region. There are three different field-situations and different practices relying on field situation.

Northern portion is fresh water available portion and farmers in it can grow two crops per year. Their cropping pattern is double rice per year namely Monsoon rice and summer rice. All of farmers in it cultivate quality rice (traditional varieties) as monsoon crop and high yield varieties as summer rice. Although quality rice has low yield, price of it is relatively higher than high yield varieties. Rice is surplus in this region.

Farmers in the middle portion where fresh and sea water available. Fields are affected by sea water invasion in the middle of February to May every year. Fresh water is available in the rest of the whole year. It is possible to grow double crops per year by using the short period of crops. At present, farmers grow only rice per year and they do not use land resources and labor resources effectively and efficiently. Another reason is that labor requirement is not equally distributed since farmers grow same crop at the same time by using same cropping practices. Labor requirement is high in the seeding time and harvesting time. Apart from this time, most of the farmers are almost free and it is wasting labor resources.

In the south portion where fresh water is available from May to October, monsoon season, and rest months are sea water affected. It is most limited fresh water available region among three ones. The other problem is that their land topography is very low and farms are flooded whole year. It is not possible to grow other field crop as second crop after rice. Only monsoon rice is available to be grown in it. Fortunately, Fishery and Nipa palm growing is well developed in it as environment is favorable for nipa palm plantation and farmer could get some amount of income from it but income from rice growing is still main sources.

Most of the dead peoples lost during the cyclone are rural people and on the other hand, they are very useful labors for farming. Besides labor force, it also killed draft animals and almost all of the things that farmers owned previously. Presently, many organizations are supporting them until now and they have already finished their crop production for two seasons. For the first growing season, yield of rice has severely reduced due to the precipitation of sodium from sea water which was flooded for two week in their fields. In fact, there are not only sodium remaining contents in the soil but also seed problems. Since farmers lost their seeds during cyclone, seeds transported from another region are not adoptable in the region, some stored seeds are damaged during cyclone and some region used the grain as seed because of scarcity of seeds in order to grow plant in time.

Farmers in the region depend on farm income and secondly they get income from Nipa Palm growing, fishery and duck farming. Their secondary sources of income were also damaged.

Rehabilitation of rice growing is their main purpose. The cyclone occurred in the beginning of raining season. Since farmers have lack of information and knowledge, they broadcast more than two times rice seed to the fields. They lost their money and affords again. If they have knowledge of salinity problem and technology of how to remedy it, they could save their money. In the fresh water portion, it was slightly damaged and topography in it is relatively higher than other and it is possible to remove sea water from their fields and rice yield in it reduced but relatively lower than other regions. Sea water region, southern most part, was severely damaged and yield reduction was higher than others. This region is not able to leach the sea water from their fields. All the farmers in this region are suffering from impacts of sea water flooding.

1.2. Objective

The main objective of the present study is to assist the farmers to improve their living standard and food security by holistic consideration of their main income sources, secondary income sources, resources, risks and problems. Specifically,

1. To assess the socioeconomic situations of farmers in the cyclone affected region
2. To analyse the requirement and availability of resources for farming systems
3. To estimate income from each farming system
4. To suggest better practices for sustainable productions in sea water affected soil

1.3. Thesis Hypothesis

Study area was highly damaged by the cyclone Nargis in the year 2008 and there was sea water flooding in the fields. Additionally, there is regular sea water intrusion in the area depending on different locations. Farmers in the area face high risk of their crop production.

1. *Sea water intrusion in the coastal zone is one of the salinity problems for the agriculture purposes (Akbar and Ponnamperuma, 1982). When salt concentration in the soil solution is higher than the concentration in the plants, plant will become water stress due to osmosis potential. If the rice fields are flooded with sea water, germination and yield of rice will reduce.*

2. *As to their cropping practices, farmers are not using their resources effectively and efficiently. Family labours and land resources are in surplus condition. If farmers change their cropping patterns and crop varieties wisely suitable to the salinized soil situation, it can increase not only their land and labor used efficiency but also recover the yield losses due to sea water intrusion for sustaining long term productions.*

3. *Main income source of the farmers in the study area is from farming and their secondary income varies with the locations. Farmers always face the risk of disasters for their livelihood and crop production. Farmers' income can be maximized by including secondary income sources into the possible combination of rice based cropping patterns.*

1.4. Thesis Outline

This study is composed of four chapters. The first chapter will present the evolution of the study and objectives. Second chapter will be about overview of Myanmar and Ayeyarwaddy division concentrating on the role of Agriculture and current problem in the study area. Third chapter is the material and methodology approaching to the problem of the study area. Fourth chapter is composted of two portions of socioeconomic assessment of study area by using the primary data of interview with farmers and analysing the resources requirements and availabilities for farming systems.

2. Literature Review

2.1. Overview of Myanmar

Myanmar is situated in South East Asia between 9° 58 to 28° 31 N and 92° 29 to 101° 10' E. It is one of the tropical countries and total land area is 678,500 sq km. Myanmar is bounded by Bangladesh and India in the west, China, Laos and Thailand in the east and Bay of Bengal in southwest. Coastline is 1,930 km long. Population is 48,137,741 inhabitants with the growth rate of 0.78% and population density is 202 persons per square mile. 75% of total populations are living in the rural area and the rest in urban area. It is composed of 8 divisions and 9 states for effective administrative purposes.

GDP per capita in 2007 is USD 234. Economy of Myanmar depends on the agriculture and the other sectors are developed based on it. In year 2008, GDP of agriculture sector is (40.9%) and 19.7% and 39.3% occupied by industry and services respectively (DAP 2009). Agricultural policies have been laid out to get self sufficiency first and later on to improve foreign exchange by exporting agricultural products. Export products are rice, maize, black gram, green gram, other pulses, sesame seed, niger seeds, onion, tamarind, oil cake, raw rubber (DAP 2006).

2.1.1. Resources and Topography

Myanmar is rich in many kinds of resources of petroleum, timber, tin, antimony, zinc, copper, tungsten, lead, coal, marble, limestone, precious stone, natural gas, hydropower and etc. As water resources, there are four major rivers such as Ayeyawaddy, Chindwin, Sittaung and Thanlwin. The basin of first three rivers is Ayeyawaddy delta, the largest one in Myanmar whereas the river Thanlwin creates small delta for crop productions.

There are plateaus, valleys and plain and rain forest in Myanmar. Myanmar is bounded by plateau Shan in the east, Rakhine and Chin Hills in the west, Bago Yoma, low range of hill, in the central Myanmar and Tanintharyi plateau is in the southern most portions. Myanmar used to have forth largest mangrove forests in the Asia Pacific region but about 50% have already disappeared. It was counted 119,000 ha and 21,000 ha out of it were damaged during the cyclone Nargis in 2008 (FAO 2009a). There is plain in central zone and it is also called dry zone where water scarcity is always occurred even in raining season. There is salinity problem in it due to rainfall is much lower than evaporation.

2.1.2. Climate

There are three seasons in Myanmar namely summer, monsoon and winter. Myanmar receives annual rainfall from North West monsoon from mid May to mid October. However, amount of precipitation varies depending on the altitude. The agro- climatic factors of temperature, rainfall, relative humidity and other factors are different in various regions. Annual rainfall is ranging from

1016 mm to 2032 mm in most of the regions and very heavy rainfall from 2540 to 5080 mm can be found in the Rakhine, part of Kayin, Kachin, Tanintharyi, and Mon. Rainfall is less than 1016 mm in the dry zone area of central Myanmar. Temperature varies widely in the different regions; northern part is cooler and ranging from 7.3℃ to 29.4℃, in the central plain zone is hot and reaches to the 40.6 to 43.3 ℃ in the summer. Temperature in the southern part is similar in the different seasons. Therefore, many kinds of crops could be adopted in Myanmar (MOAI 2009).

2.1.3. Soil Types and Land Allocation

There are three main groups of soil found in Myanmar so called alluvial, black soil and red literatic soil. Alluvial (50% of total) soil is mostly occupied in Ayeyarwaddy, Chindwin and Thanlwin river basin. Black soil can be found in the region where the rain fall is ranging from 508 to 1016 mm. The rest red literatic soil is in the region where rainfall is 1016 to 3048 mm and land form is undulated. Net sown acreage of crop land is constituted about 11.67 million hectares, forest area is approximately 34 million hectares and the rest are fallow land, waste land and unclassified which is not suitable for crop (MOAI 2009).

Fig (2.1) map of Myanmar showing study area

2.1.4. Role of Agriculture

As an agricultural country, since it has different climate zone from temperate to tropic, more than 60 different crops are cultivated in it, mainly cereal, pulses, industrial, oil seed and etc. Among them

cereal crops are the most important crop and occupied 44 % of total sown area. Concentrating on the most important cereal rice, sown area of it is 5.66 million hectares in monsoon and 0.8 million hectare in summer. Rice production was reached approximately 3.0 million ton in the year 2007.

However, some of the rice growing areas do not have favorable environments. There are flood prone area, drought prone area, salt affected area and upland area. (See Table 2.1)There is an undergoing research by IRRI consortium rice unfavorable environment (CURE). Suitable varieties with respect to the specific unfavorable environment have been developed such as submerged tolerance variety e.g. swarnar sub 1 and Meekauk Du Me. Suitable varieties for drought prone area is already developed namely, Yezin 9, Kone Myint 3 and Kone Myint 4 etc. Again, as a unfavourable environment of rice growing, salt affected areas occupied with respect data mentioned this table (2.1) DAR (Myanmar) collaborating with BIOTECH (Thailand) improved the salt tolerance variety called ``Sin Thwe Lett´´ (local variety).

Table (2.1) Unfavorable Area for Rice Growing in Different States and Divisions

State and Division	Flood Area		Drought Area		Salt-affected Area	
	Area (ha)	% of total	Area (ha)	% of total	Ares(ha)	%of total
Kayin	19583	3.26	0	0	0	0
Sagaing	3328	5.54	45,741	7.0	5735	1.2
Tanintheryi	30102	5.00	0	0	2041	1.6
Bago (East)	154164	25.6	35,985	5.7	1852	0.3
Bago (west)	48168	8.00	28,956	7.1	0	0
Magwe	2200	0.004	448,638	18.7	0	0
Mandalay	5549	0.92	58,482	21.2	1595	0.6
Mon	52672	8.80	0	0	4193	1.5
Yakhine	36884	6.14	39,854	9.8	23505	5.8
Yangon	1055718	17.6	0	0	5735	1.2
Shan (East)	117	0.02	0	0	0	0
Ayeyarwaddy	111998	18.7	0	0	5735	1.2
Total	600443	0	253,886	0	57502	0

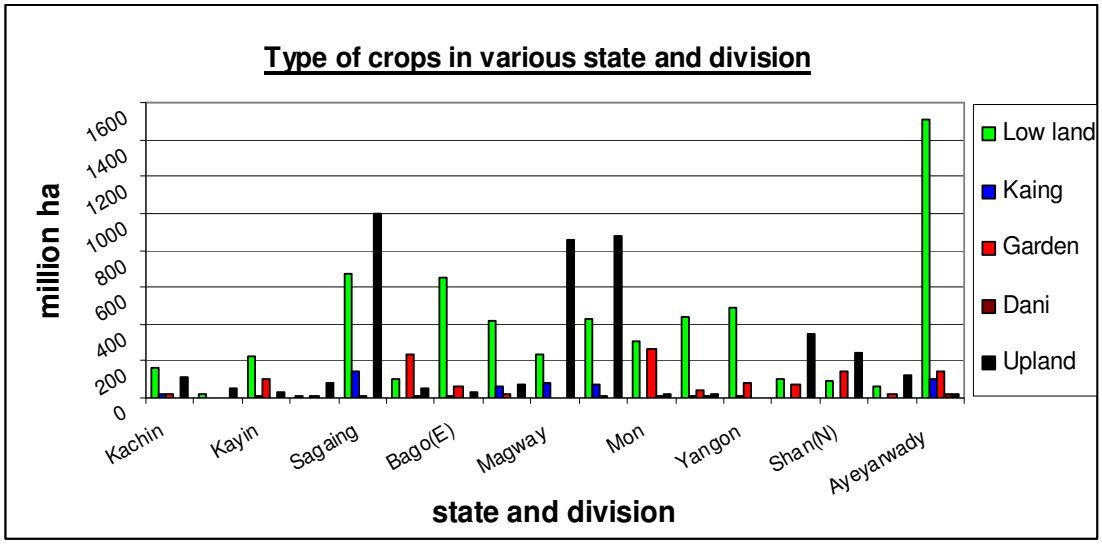
Source: Than Aye 2006.

Cropping System

Multiple cropping systems was driven and expanded significantly in the year 1960 to 1980. Rice is the main crop as monsoon crop and Jute, cotton, and sesame etc, are sown as pre monsoon crop. After rice, sesame, peas and beans and maize, etc are used to be sown as dry land by using residue moisture. Mix cropping is also practiced in some area. Cropping intensity increases to 167.2% in 2007-08. The main piller crops are paddy, pulses, cotton and sugarcane due to their foreign income generation and domestic consumptions.

Different Types of Crop in Various Regions

There are more than 60 kinds of crops currently grown in Myanmar and based on these, 5 groups of crop have been divided in the different regions. Ayeyarwaddy division, where study area is belongs to, has highest low land area and it has the highest Nipa palm (Dani) plantation area.



Sources: MOAI 2009.

Fig (2.2) Different types of crop in various regions

Landownership of Farmers

Most of the farmers in Myanmar are very poor and they own lass then 2.02 hectare, only few farmers have more than 40 hectares. Following table shows land distribution in the whole Myanmar. It was based on the household family in 2007-08.

Table (2.2) Land ownership of farmers in Myanmar

Size of Holding	No. of Farmers (,000)	Total Million hectare
Below 2.02 hectare	3528	3.73
2.02 to 4.05 hectare	1403	4.07
4.05 to 8.09 hectare	534	3.11
8.09 to 20.23 hectare	129	1.54
20.23 to 40.47 hectare	5	0.15
above 40.47 hectare	3	0.22
Total	**5602**	**12.82**

Sources: MOAI 2009.

Nipa plantation in Myanmar

Nipa palm could be found in the Asia and Oceania e.g. Australia, Indonesia, Papua New Guinea, Philippines, Thailand, Malaysia, India, Bangladesh, Vietnam, Sri Lanka, Burma, Carolinas, Ryukyus, Solomons, etc and it has been introduced to Africa since 1906 (Sawnger *et al*. 1983 cited Hamilton and Murphy 1988). Hamilton and Murphy reviewed the Nipa plantation in (1988) as followings. Its leaves, juice or sap from inflorescence stalk and fruit are useful for many purposes. Leaves could be used for the roof thatching and wall of the dwelling. In addition, it could be used for making weave hats, umbrella, raincoats, baskets, mats and bags while the young leaflets are used as cigarette wrappers (Burkill 1935 and Robinson 1911). Leave is also useful as insulation board but it is unsuitable for the paper pulp (Hossain and Siddique 1969). Yong seeds are eaten as raw and preserved foods (Hamilton, pers. Obs). Furthermore, young shoots, decayed wood, and burned roots or leaves can be used as medicinal purposes (Burkill 1935). The sap or juice contains approximately 14 to 17 % of sucrose (Halos 1981) and been used to produce vinegar, alcohol and later on it was considered to produce sugar (Hinchy 1938b and Roxas 1929 cited Hamilton and Murphy 1988).

Pictures: Author 2009.

Fig (2.3) Working in Dani production station and Nipa transportion in study area

Myanmar is one of the tropical countries which produce Nipa. There is a regional market for Nipa palm. Lower Myanmar of Ayeyarwaddy division, southern and northern part of Yangon, some part of Bago Division are mainly depend on the Dani, final product of Nipa palm, from delta region. The rest Nipa growing area are producing only for their local uses. Branches of Nipa palm are cut and made Dani, which is used for roof materials and walls of dwellings. Dani is seasonal product and starts from end of winter season to before monsoon season. Generally, it is after the harvesting to monsoon rice. Using labors in Nipa plantation are not sharing of labors with monsoon rice growing. There was a study on market of Nipa palm in Myanmar provided by CARE (Myanmar). Nipa palms are highly demanded after Nargis. Cyclone effected area are needed to reconstruct dwellings. Due to some of the Nipa palm planting areas were destroyed by cyclone, 30% of Dani production has been reduced in quantity and quality is also reduced (Moe Aung 2008)

As a secondary income source, Nipa plantation plays main role in the study area. According to the farmer interview, some farmers are working in the Dani production station as daily worker and Nipa growers sell their products as raw material to the Dani production station. Working duration for Nipa palm is from January to April, so that it does not compete with monsoon rice growing in the regards of the labor forces. Even though Nipa palm is used in various purposes in other countries, only producing alcohol and roofing are common in Myanmar.

Nipa palm can produce 8000 to 10000 pieces per acre of Dani for one circle of production. Depends on the location, there are different units of Nipa palm. Nipa producing areas are as shown in the table (2.3).

Table (2.3) Nipa palm growing area in Myanmar State and Division in 2004-05

Sr.	Location	Area (Thousand hectares)
1	Ayeyarwady Division*	16
2	Tanintharyi Division	9
3	Rakhine State	6
4	Mon State	6
5	Yangon Division	2

* In the study area

Source: Moe Aung 2008.

2.2. Ayeyarwaddy Division in Brief

It is situated in the southern part of Myanmar and many rivers including the Ayeyarwaddy River, which is 2710 km long, and their tributaries are located in the region. Population is around 10 million and 20% of total and population density is the highest in Myanmar. Government-UNDP Poverty Assessment of 2005 estimated that 29% of people in delta are poor. Out of which, poverty is relatively higher in the coastal region, where people could cultivate only one crop per year due to saline content brackish water environment (FAO 2009a).

Economic sectors of it are occupied by agriculture, fishery, Industry and forestry. Among them agriculture is the largest sector and almost 50 to 60 % of the families are engaging agriculture. It is main rice supporting region for whole country even though rice are grown in almost every region of the country. Rice grown areas for monsoon rice and summer rice account for 1.5 million ha and 0.5 million ha respectively. It occupies 25% of national rice growing of 8.05 million ha (FAO 2008). Besides rice, pulses, oilseeds crop, coconut, rubber plantation, nipa palm are mainly cultivated whereas fishery and livestock farming are second economic sectors in it. Although the region has

high agricultural production, 31 % of farmers are landless and they are working as renter and sharecroppers and permanent/seasonal agricultural workers meanwhile national averages is 26%. It means it is above national average. 44% of landless are under poverty line (FAO 2008).

Although it is considered as main rice production region among any other rice produced regions in Myanmar, risk of disaster is high such as sea water flooding, storms and luck of enough maintenance of embankment to avoid sea water intrusion into the fields. In addition, increasing of cropping area causes reduction of mangrove forest, consequently it causes environmental damages. Finally, risk of disaster is getting higher and higher.

After Nargis cyclone, there was a report on damage and loss rapid assessment team participated by FAO collaborating with ministries concerned in Myanmar. As agriculture is main economic sector, it concentrated in agriculture and made the interview with farmers, traders, stakeholders, fishery men, livestock producers and government organization. They said southern part was severely affected than the northern parts. Besides rice, coconut, mango, nipa palm, betel nut and rubber plantations were damaged. A number of livestock including cattle which are important for farming have been killed during the cyclone. In addition, the embankment which was funded by World Bank was damaged and it was important for prevention of sea water intrusion.

Generally, farmers in the region usually grow traditional varieties and high quality rice which is also one of the traditional varieties but its cooking quality is high and it is quite famous in Myanmar. According to the nature of traditional variety which are photoperiods sensitive and they do not response fertilizer comparing to the high yield varieties. Therefore farmers usually do not use fertilizers in the monsoon rice production but in the summer rice which are high yield varieties. Fertilizer application for the HYV is ranging from 100 to 250 kg per hectare and for the traditional varieties 50 kg to 100 kg per hectare (FAO 2009b)

2.2.1. Seasonal Seawater Intrusion

In delta region, it has more than enough water and there are many rivers and their tributaries in it. The water in the rivers is replaced by seawater seasonally from February to until the monsoon of May. During the Monsoon, the water becomes fresh and able to be used for all purposes. Salinity level of water and time of salinity depend on the locations. Time of salinity is ranging from beginning of Feb to 15th of Feb. Fresh water is available for the whole year in the northern portion and therefore the portion is free from suffering of salinity. Following map mentioned that the sea water intrusion times and levels of salinity respect to the regions. Study area is one of the effected sea water areas. (see appendix salinity isogenic line map 1,2,3)

2.2.2. Soil Types

As to the book of `` Soil type and Land Classification of Myanmar´´ by ministry of agriculture and irrigation, 12 type of soils could be found in Ayeyarwady division out of total 24 types of soil in

whole Myanmar. This classification was based on the classification system of FAO UNESCO. They are Alluvial soils, Meadow and Meadow alluvial soils, Gley and Gley swampy soils, Swampy soils, lateritic soils, Red brown forest soils, yellow brown forest soils, Dune forest and beach sand, saline swampy meadow gley soils, yellow brown dry forest and indaing soils and water body. Gley and Gley swampy soil occupied 3,105688 ac (1257363.56) ha i.e. 35% of total 8,656,564 ac (3504681.78) ha, and 997585 ac (403,880) ha, 11 % and 865,828 ac (350537.65) ha, 10% of total saline swampy meadow gley and alluvial soil respectively. Some types of soil that can be found in study area are mentioned as follow;

1) **Gley and gley swampy soil** can be found in the different parts of Myanmar in river plains, delta and low coastal plains and valleys. It is clay and has thick solum. They are most suitable for paddy cultivation. Medow soils found in lower Myanmar have yellow brown color with acid to neutral soil reaction. They are non carbonate and contain large amount of salts and contain plant nutrients. Although it contain large amount of iron, it is useful for rice growing and vegetable. In addition, groundnut, sesame, sunflower, jute, sugarcane can be grown in it.

2) **Alluvial soil** which contain large portion of silt can be found in Ayeyarwady division and soil reaction in it is usual neutral and being young soils, developed from recent alluvial deposits of the river plains, they are rich in plant nutrients. Therefore, it is very important of agriculture especially it is suitable for rice, vegetables, pulses and beans, chili, sugarcane and maize and etc as to the recommendation of Ministry of Agriculture and Irrigation.

3) **Saline Swampy Meadow Gley** (Gley-Gleysol)
It is influenced by tidal sea water and it is always salty. It is should be utilized for prawn breeding and mangrove firewood forests as salinity is high.

2.3. Salinity Problem

Salinity is world wide problem and it is counted 380 million ha on the earth's land surface, fortunately 240 million ha are not strongly saline (Massond 1974 cited Akbar and Ponnamperuma 1982), the rest land could be assumed as strongly saline soil. 54 million ha out of strongly saline soil are in South and Southeast Asia and 27 million ha are coastal saline soil (Akbar and Ponnamperuma 1982). There are many influencing factors for causing salinity in soil. Depending upon these factors, physical and chemical characteristics of salinities will be different. Accordingly, remedy practices should be also different from each other. The main causes of salinity problems are irrigation of poor quality water, amount of precipitation and evaporation; this is usually occurred in dry zone area, increases salinity level in ground water and intrusion of saline sea water; this is usually occurred in coastal zone (Dobermann and Fairhurst 2000).
Soils with soluble salt or exchangeable sodium or both are defined as saline soil and those are problematic for Agriculture. Soluble salt is mostly composed of cation sodium, calcium and magnesium, and the anions chloride and sulphate. Ocean in the low lying area and coastal region,

irrigation water, ground water are the source of salt for plant cultivation. Sea water is mainly composed of 55.2% of Chloride and 30.33% of sodium cation and with few accounts of other anion and cation.

Saline soils are divided into three groups according to its component as follow.

Sr	Type of Soil	EC	ESP	PH
1	Saline soil	4 dS m^{-1}	<15%	<8.5
2	Saline-sodic soils	4 dS m^{-1}	>15%	~8.5
3	Sodic soils	<4 dS m^{-1}	>15% SAR>15	>8.5

Source: Dobermann and Fairhurst 2000.

The correlation between the measured value of ECe and ESP of soil and yield reductions are estimated as shown in the table.

Sr	Measured Value	Optimum	Slight Reduction	Moderate Reduction	Severely Redution
1	ECe	<2 dS m^{-1}	>4 dS m^{-1}	>6 dS m^{-1}	>10 dS m^{-1}
2	ESP	<20%	>20-40%	40-80%	>80%

Source: Dobermann and Fairhurst 2000.

Quality of irrigation water is as important as soil measured value. It is limited EC value between 0.5 dS m^{-1} and 2 dS m^{-1} and PH value between 6.5 to 8.4 and SAR between 15 and 25 (Dobermann and Fairhurst 2000).

Na is the beneficial mineral element which means it is essential only for certain species of under specific conditions. Brownell 1965 said that Na is essential element for halophyte which becomes chlorotic and necrotic and its growth is retarded in the situation of without Na. Marschner (1995) proved that Na is essential for some C4 plants but not for C3 plants.

The accumulation of Na in the plant tissues may somehow lead to the yield losses. But the point to be considered is that there is no critical concentration of Na in leaf tissue in order to show salinity injury symptoms. It depends on the type of varieties (Dobermann and Fairhurst 2000).

2.3.1. Rice Cultivation in Saline Soil

Rice is recommended as potential plant for the coastal saline of humid tropic region since there have enough rainfall to leach out salt content in the soil and they are climatically, physiologically, and hydrologically suited with rice growing (Akbar and Ponnamperuma 1982). Nevertheless, the tolerances of rice varieties vary from one to another. Selection of right variety and selection of best practices play important role in the saline soil cultivation. When salinity is high in rice growing soil, the plant will absorb much amount of sodium and chloride from the soil solution and it will cause the toxicity to plant growth. Besides this problem, plant will suffer from water stress due to effects of osmotic potential and many deficiencies problems, particularly potassium and calcium.

Consequently, it can also inhibit the other essential activities of rice plant such as nitrate reductase and photosynthesis rate and chlorophyll content in soil meanwhile it can increase the activities of respiration rate and nitrogen contents in the soil. Tolerance cultivar has narrow Na: K ratio i.e. it can take K rather than Na and Ca content in leaf is higher than that in susceptible cultivars (Dobermann and Fairhurst 2000).

Not only the varities and cultivars, salt tolerance varies with the growth stages. It is very sensitive in the beginning of vegetative stage and flowering stages and relatively more tolerant in the germination stage. Some symptoms are leaf tip become white, stunting plant high, reduce tillering and etc. Accordingly, it cause the yield reduction by reducing the factors of germination, tillering, poor root growth, 1000 grain weight and increase spikelet sterility. Furthermore, when plants suffer from salt injury, leaf burn or drying out and browning of leaves, premature abscission of leaves, and die-back of twigs will appear on the leaves. The plant becomes stunted and deep blue green leaves will occur.

2.3.2. Salt Tolerance of Crops

Degree of salt tolerance of plants is much depend on soil, water in which the plant grown and other environmental factors of temperature, air pollution, relative humidity, soil fertility, water stress, and etc. It is difficult to predict plant responses to known salt concentration but it can be only known relatively. Besides this difficulty, there are variability of salt tolerance of plant even among the cultivars of rice, Bermuda grass, brome grass, birdsfoot trefoil, creeping bentgrass, barley, wheat, soybean, and berseem clover, etc.

Salt tolerance of plant is considered based on these criteria:

`` 1) the ability of a plant to survive on saline soils

2) the absolute plant growth of yield, and

3) the relative growth of yield on saline soil as compared with that on non saline soil´´(Maas1986).

Following table mentioned the relative tolerance of plant to salinity in the stage of emergence, based on survival, and later growth stages, based on growth or yield. 50% of yield and 50% of emergence will be reduced in the amount of salinity mentioned in the table.

Table (2.4) Relative salt tolerance of various crops at emergence and during growth to maturity

Crop		Electrical conductivity of saturated soil extract				
Common Name	Botanical Name	50% Yield	50% Emergence	Threshold level	Slope	Rating
		dS/m	dS/m	dS/m	% per dS/m	
Barley	*Hordeum vulgare*	18	16-24	8	5	T
Cotton	*Gossypium hirsutum*	17	15	7.7	5.2	T
Sugarbeet	*Beta vulgaris*	15	12-Jun	7	5.9	T
Sorghum	*Sorghum bicolor*	15	13	6.8	16	MT
Saffflower	*Carthamuch tinctorius*	14	12			MT
Wheat	*Triticum aestivum*	13	14-16	8.6	3	T
Beet,red	*Beta vulgaris*	9.6	13.8	4	9	MT
Cowpea	*Vigna unguiculta*	9.1	16	2.5	11	MS
Alfafa	*Medicago sativa*	8.9	13-Aug	2	7.3	MS
Tomato	*Lycopersicon Lycopersicum*	7.6	7.6	2.5	9.9	MS
Cabbage	*Brassica oleracea capitata*	7	13	1.8	9.7	MS
Corn	*Zea Mays*	5.9	21-24	1.7	12	MS
Lettuce	*Lactuca sativa*	5.2	11	1.3	13	MS
Onion	*Allium Cepa*	4.3	5.6-7.5	1.2	16	S
Rice	*Oriza sativa*	3.6	18	3	12	S
Bean	*Phaseolus vulgaris*	3.6	8	1	19	S

Source: Maas 1986.

T = tolerance MS= moderate sensitive

MT = moderate tolerance S= sensitive

Understanding this table, plant resistant to salinity is vary with its growth stages. Most of the crops have more ability to resist salt in their emergence stage than in growth stages. Concentrating on rice, its yield will reduce 50% when the soil electrical conductivity is 3.6 dS/m and rice in the germination stage can resist until 18.0 dS/m of ECe of soil. Threshold level refers to the maximum amount of salt contents without reduction of yield and slope % mentioned yield decreases per unit increase in salinity beyond the threshold.

2.3.3. Management of Salinity

After finding out causes of salinity, reclamation management is necessary to be considered. Rice is the best crop for reclamation of both sodic and saline soil. There are many available ways to recover the salinity. Salt tolerance varieties have been produced (e.g. Pobboli, Indonesia; IR2151, Vietnam; AC69-1, Sri Lanka; IR6, Pakistan; CSR10, India; Bicol, Philippines). Cultivating salt tolerance varieties is only for the short term solution but not enough for long term since it is very difficult to get perfect variety to prevent the increasing of salt content in soil. Double rice cropping pattern or rotation with legumes; clover or Sesbania for several years is best practices to cover the soil salinity. Coating seed with oxidants (e.g. Ca peroxide at 100% of seed weight) can improve seed germination. Submerge the field for two weeks before planting and let the salt content to leach is also one of the solutions. Fertilizer application of Zinc (5-10 kg Zn ha^{-1}) is recommended and K fertilization is also important. Organic matter can increase the partial CO_2 pressure and decrease pH. Therefore, application of organic matter and farm yard manure should be practiced (Dobermann and Fairhurst 2000).

The salt in soil can be eradicated by the leaching and drainage. Depends on the type of salt e.g. calcium, magnesium, sodium, etc, if the soil is rich with calcium and magnesium, leaching method would be effective. If the soil is rich with sodium salt, application of gypsum and sulfur into soil before leaching is strongly recommended. In both case, the washing water must be free from salt contents.

When gypsum is added to the salty soil, carbonate forms are changed into the sulphate form which is soluble and harmful salt could be drained out with water. Cultivation of salt resistant crops such as sugar beet, cotton, sorghum, barley, rye, sweet clover and alfafa are also suggested to manage the saline and alkaline soil (Brady 1984).

2.4. Soil Situation after Nargis in Study Area

2.4.1. Soil Analytical Status

Following tables mentioned about soil situation of Nargis cyclone affected area in Bogale. All of these data have been analyzed after cyclone Nargis intending to identify soil salinity condition for the purpose of Agriculture. Flooding occurs only in raining season. This portion has favorable

situation for double crops per year if they have enough labors, machineries etc. The flooded sea water stayed in the field for more than one week and it was drained out and washed to have good soil condition for rice farming. Nevertheless, according to the soil analytical data, it is still remain soil sodium high and soil EC is still high after 10 months of Nargis event, soil PH is from acid to extremely acid, soil texture is clay and silty clay. As to the soil nutrients status in the region and expertise in Myanma Agriculture Service suggested possible affects and recommended the some practices to over come the serious situation in it. They mentioned that it can cause reduction of germination and dead of seedlings if farmers practiced direct seeding method. Furthermore, they recommended that farmers should practice transplanting method, to wash salt with fresh water, to use salt tolerance varieties.

Comparing to soil salinity status in all portions, northern portion has better situation than other two. Farms in the northern portion have been washed out more than two times after Nargis event according to farmers' interviews but that of in the other portion have not.

Table (2.5) mentioned that soil salinity status in northern portion and following data were taken in and analyzed after 10 months of Cyclone Nargis. Soil pH is acid to extreme acid, ECe and Na contents are still high and it is not optimum situation for rice growing. Soil texture is clay and silty clay.

Table (2.5) Soil Salinity Status in northren portion (Bogale) after Nargis Cyclone

Sr	location	soil PH	EC e	Texture				Total Nitrogen	Available P	Available K	Exchangeable cation				Water soluble Na (me/100gm)
				Sand	Silt	Clay	Total				Ca	Mg	k	Na	
2	Thapay kone	3.9	6.9	1.2	25	72.5	98.7	0.63	0.8	26	3.86	0.55	0.6	6	2.8
3	Dama thu kha	4.5	6.3	1.35	44.5	52	97.9	0.61	20	39.4	3.33	0.84	0.8	8	3.4
4	Pyin bo Lay	4	11.3	1.15	36.9	60.5	98.6	0.61	19.2	48.6	3.91	1.05	1.1	9.8	4.8
5	Ba Wa Thit	4.3	2.52	1	24.8	71.5	97.3	0.67	6.4	31.2	3.95	0.68	0.7	5.4	1.6
6	Kwin Sa Khan	3.9	10.7	1.05	54.5	42.5	98.1	0.44	16.8	42	2.99	0.91	0.9	11	5.2

Table (2.6) mentioned that soil salinity status in middle portion. Soil PH is strongly acid, soil ECe is very high and soil texture is clay and silty clay. It is recommended that this soil is also not optimum situation for rice growing. It is discovered that, ECe value is too high to grow rice as to literature review. (see table 2.4)

Table (2.6) Soil Salinity Status in Middle Portion Region (Bogale) after Nargis Cyclone

Sr.	location	soil PH	ECe	Texture				Total N	Available P	Available K	Exchangeable cation				Water soluble Na (me/100gm)
				Sand	Silt	Clay	Total				Ca	Mg	k	Na	
1	patpel	5.0	7.5	1.0	31.7	65.0	97.7	0.5	7.2	50.7	4.7	1.4	1.1	9.4	4.9
2	Pyin bo Gyi	4.9	8.2	1.25	27.6	70	98.9	0.53	22.4	110	4.08	1.33	2.3	11	4.5
3	Tharyar kone	4.2	13.2	1.15	50.8	47	99	0.49	8	37.7	3.66	0.8	0.8	12	6.6
4	Tharphyan (thazinkone)	4	18.9	1	35.5	60.5	97	0.49	13.6	36.8	4.96	0.78	0.8	13	6.5
5	Tharphyan (Gayan)	4.8	5.0	1.5	43.8	53	98.3	0.46	23.2	38.3	2.91	0.81	0.8	8.4	2.7
6	Thone Htat	4.4	16.4	1.35	34.6	62	98	0.44	7.2	56.1	3.91	1.2	1.2	16	6.7

Table (2.7) mentioned that soil salinity status in southern portion. These soil analytical data were collected and analyzed as soon as after Cyclone Nargis. Soil EC is also very high and it can reduce the yield of rice referring to literature review. The region is very low land level and it is not possible to drain out of wash sea water for rice growing.

. Table (2.7) Soil Salinity Status in Southern Region (Bogale) after Nargis Cyclone

Sr.	Location	Soil PH	Soil EC	Soil ECe
1	Kadonkani	5.53	2.79	17.8
2	ApyinpadeGaw	5.12	1.75	11.5
3	GawychaungGyi	5.15	2.53	16.2
4	HngetGyiTaung	5.24	2.06	13.2
5	Taik Sein Kone	5.3	1.43	9.2
6	MakyinMyaingKyun	5.58	3.77	24.1
7	KyainchaungKyi	5.6	2.15	13.8
8	ApyinBoatChaung	5.56	2.37	15.2
9	KyinchaungGyi	4.4	0.6	4.1
10	Kyuntharyar	5.2	0.8	5.2

Sources: Myanma Agriculture Services, MOAI, 2009

2.5. Farm Management

Since all the people in the region are suffering from bad situation of soil, shortage of labors during harvesting period, machineries and capital, it is seriously needed to have best management by wise use of scare resources. Farm management plays important role in the farm enterprises. The best management is maximizing the net return by minimizing input and resource use. Farmers' decisions should be wise by consideration of all around factors of limited resources, net return, market and risks. Following factors have been introduced to consider and give suggestion to farmer to sustain and increase the farmers' income.

- Enterprise selection
- Allocating land, family labour and capital in a better way
- Better selection of technologies and practices and
- How to manage the risks of farming (Kaham 2004).

There are three kinds of enterprises, competitive enterprise, supplementary enterprise and complementary enterprises. A competitive enterprise is one that competes to other in the uses of land, labor and capital. Increasing use of resources in one enterprise could reduce the other. A supplementary enterprise is that one enterprise uses resources which are not used by others. It can reduce the waste of resources and increase the efficiency of resources use. A complementary enterprise is one enterprise that provides the needs of other. For example, animal farming could provide the manure to the field crop farming (Kaham 2004). Supplementary and competitive enterprises should be engaged by farmers in the region where resources are not fully utilized.

2.5.1. Allocation of Land, Labors and Capital

Land, labor and capital are resources for the farming and allocation of these and effective use of them are very important to maximize the farm income. They all are linked each other. When one is limited, the other two could not be used efficiently. For example when labor resource is scare, land and capital could not reach their maximum productivity. Farmers need to consider the optimum combination of two resources to minimize the cost and maximize the profit. In addition, when one resource is scare, proficiency of it should be calculated to select the best enterprise (Kaham, 2004).

2.5.2. Selection of Enterprises and Risk

There are many options of technologies and practices in the farm enterprise. Among them, farmers need to select the best one which could give optimum rate of return. New technologies and practices could change the input and out put and then maximize the profit. Farmers' adaptability to technologies is important for decision making for their farms. Farming is full of risk. In fact, risk of weather is high in farming and the other risks of pest and diseases, fluctuation of price of input, out put are also important and have to be considered in the farming. Farmers need to adapt the risk eduction strategies. Product diversifying is one of the strategies to overcome the risk. (D.Kaham, 2004).

3. Material and Methodology

The present paper is based on the literature review, secondary data from relevant ministries in Myanmar and primary data by making interview with farmers in the villages in the study area. Responsible officers in the related departments have been interviewed before meeting with farmers. After getting data, these data have been analyzed by using SPSS model and excel.

3.1. Study on Bogale

It was officially divided into there portions such as fresh water region, fresh and sea water region and sea water region depending on occurrence of seasonal sea water intrusion. Northern portion is defined as fresh water region. Fresh and sea water region and sea water region are defined as middle portion and southern portion respectively. In order to cover current situation of the study area, following parameters have been studied;

Area
Number of village tracks
Demography
Climate
Transportation system
GDP
Soil Type
Agricultural Sector

After general study on the whole area of Bogale and detail study has been done in the selected villages. There are 14 village tracks out of the total 71 villages tracks. 91 farmers have been interviewed which covered northern portion and middle portion, unfortunately it could not cover southern portion since it is very difficult access to go there.

For case of cyclone Nargis, many organizations including FAO, UNDP have been assessed the damages and losses of people, draught animals etc. These assessments have been referred in the study.

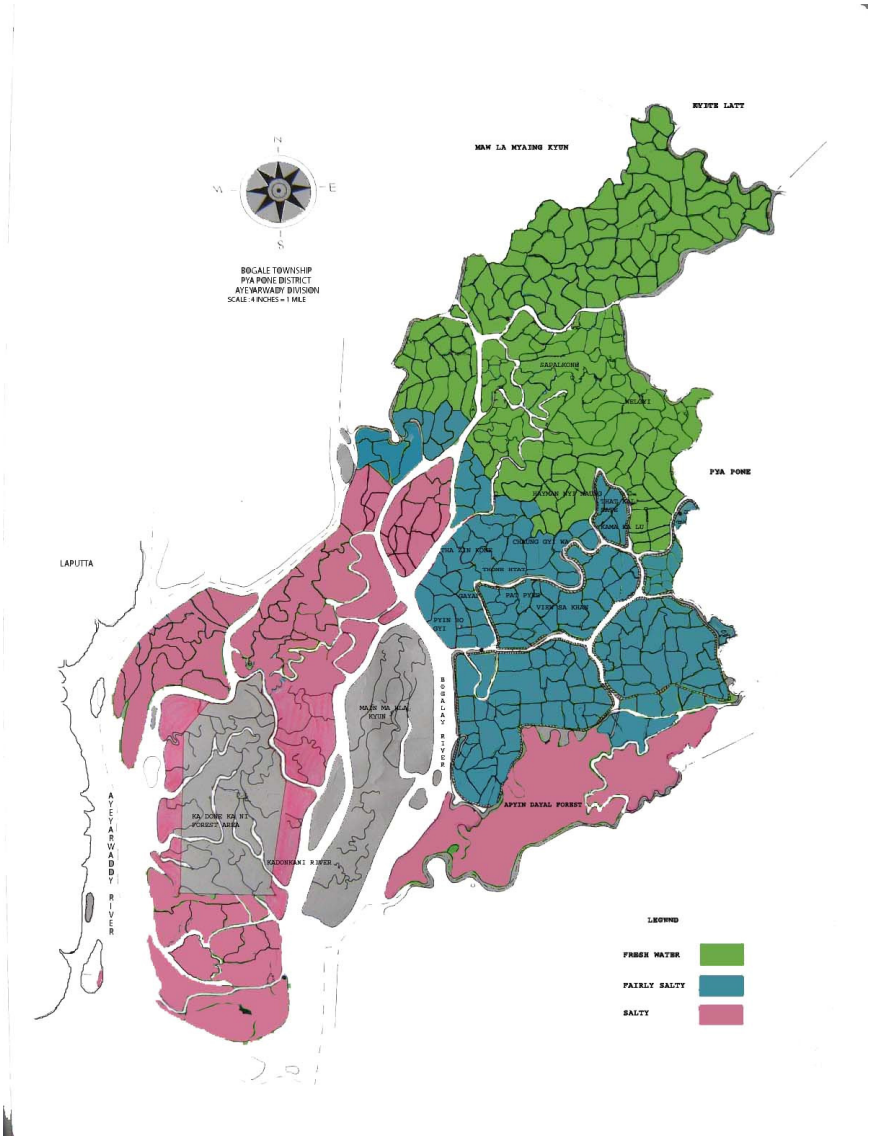


Fig (3.1) Map of Bogale showing three portions
Source: SLRD 2009.

Study Area is situated in Ayeyarwaddy division in Myanmar between north latitude (15:46:30) and (16:30:00), between east longitude (95:05:04) and (95:36:09). Total area of it is 2,250.36 square kilometer. It lies in southern part of Myanmar. . Total population in the whole region is 253,223. Out of them 45,429 are urban people and 207,794 are rural people. Total numbers of households who are engaging farming are about 28,279 and 36% of total 76,845 households.

There are (71) number of villages tracks in the rural area. Agriculture, fishery and forestry are main economic in it. According to data of GDP shown below, Agriculture is the main income sources of the people and especially main rice producing area (SLRD, 2008).

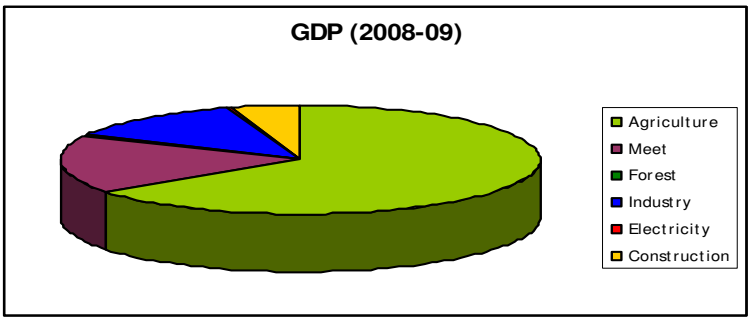


Fig (3.2) GDP of Bogale townships

3.1.1. Water Resources

Rainfall during raining season is stored for domestic consumption in dry seasons. Irrigation water can be obtained from rivers and their tributaries. Fresh water availability is not equality distributed. North portion of Bogale get fresh water whole year for irrigation and middle portion gets from May to Feb. Intrusion of sea water occurs yearly in the middle of February to May and fresh water in rivers and tributaries mixes with sea water and then fresh water is no longer available for agriculture purposes. Villagers store fresh water (rainfall) in the ponds and it is just sufficient for home consumptions. There are no enough infrastructures for storages of water for irrigation. In the southern portion, fresh water is mixed by sea water from end of Jan to May. All villages in this portion face fresh water scarcity two weeks earlier than in the middle portion. Some villages have wells which can provide subsistence amount of fresh water. International organizations such as UNDP, FAO and International Non Governmental organizations are currently supporting in digging wells in the whole Bogale rural areas after Nargis 2008. Wells could be expected as good sources of fresh water but they are needed to be dig until 180 meters in everywhere of Bogale townships. Cost of digging wells is quite expensive for villagers.

Fig (3.3) Type of water harvesting during monsoon

3.1.2. Rainfall Pattern

Raining season starts from May to October every year. Average annual rainfall is about 2756 mm in the last 6 years. Annual average temperature is around 25℃. Amount of rainfall in every month is shown in diagram (SLRD, 2008).

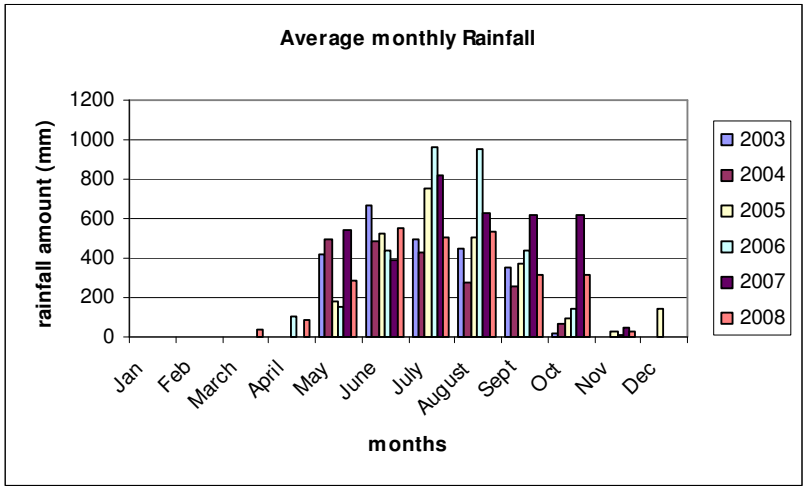


Fig (3.4) Average monthly rainfall in 2003 to 2008
Sources: SLRD 2008.

3.1.3. Transportation System

Transportation by means of water is very common in it as there are a lot of tributaries of river. Rural people are using small boat for transportation even in the summer. There is a high way road which is not well developed from Yangon (former city of Myanmar) to Bogale. Transportation system is less developed and it much depends on the water current in tributary. It takes time and people in it face some difficulties to transport their commodities to the market. There is no road transportation within villages in Bogale townships.

3.2. Agriculture Sector

After general study on the whole area, detail assessment has been concentrated on the crop productions and resources availability for farming. All of followed assessments are situation of the region after Nargis, 2008.

3.2.1. Land Allocation

Cultivated lands are defined as flooding land, deep lands, drainage accessible lands, sandy land and sea water flooding lands. According to these land situations, cultivable crops and cultivable areas are shown below. Among them, paddy lands are the largest and the others are mentioned as;

Paddy land	87754.25 ha
Horticultural land	314.17 ha
Nipa land	2419.0 ha
Forest land	102,045.74 ha
Wild land	21.86 ha
Uncultivated land	32450.60 ha

Source: (SLRD, 2009)

3.2.2. Soil Situation for Agriculture

Among paddy land, drainage accessible lands occupied 56,162.72 hectares (64% of total) and the rests are flooded land, deep water lands, sea water flooded lands and sandy lands. Flooded land is defined as the land which is flooded during the raining season and it could not be drained out unwanted water. Deep water land is defined as the land which is flooded not only in monsoon but also in the summer.

Soil type is grey and grey swampy and soil texture is clay as to the literature review. Soil PH is less than 7 so called acid soil. For the case of Nargis, there was very heavy rain and most of the lands have been flooded with sea water and it reached to 1.52 to 4.57 meters. After Nargis, some of the areas have been covered with sand but not in the study area said by Ministry of Agriculture and Irrigation, Myanmar, 2008.

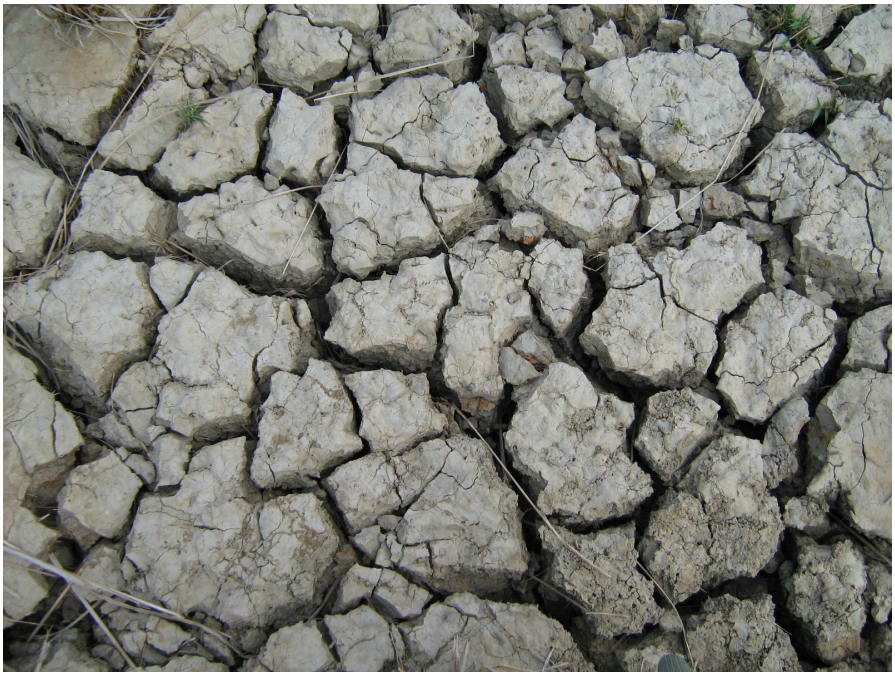


Fig (3.5) Soil types in middle portions

3.2.3. Kinds of Crop, Cropping Area and Yield of each Crop

There are eight main crops in study area. Total number of acres and their yields are shown in the following table (3.2). The table said, monsoon rice is the main crop since it can be grown in every portion while summer rice can be grown about 30% of the total monsoon rice sown area. The growing areas of other crops are significantly very low when they are compared to the rice area. It is very obvious that cropping patterns and used varieties are homogeneous. Certainly, Rice-Rice cropping pattern are practiced, only Rice in middle portion and southern Portion. Winter crops, peanut, sesame and etc, after monsoon rice are cultivated in very few farms in the northern portion and middle portion. Southern portion is unable to grow second crop after rice. All the farmers in the whole region grow traditional varieties for the monsoon rice and high yield varieties for the summer crop. In addition, almost all of the farmers are cultivating same cultivar e.g. Be Jar, traditional varieties, as monsoon rice and Thee Htat Yin, high yield varieties, as the summer rice.

Most of the farmers are used to broadcasting but only few farmers are transplanting rice. The reasons are scarcity of labors, capitals and lack of knowledge. Although Myanma Agriculture Service introduced transplanting method by using low seed rate, it could not be applied because of high labor requirements in very specific time.

Most of the farmers hardly apply fertilizers in monsoon rice but only in the summer rice. Cropping practices for monsoon rice in the region are very simple since they do not need transplanting, inter-cultivation, fertilization and irrigation etc. Labor requirement for monsoon rice is very high only in seeding time and harvesting time.

Table (3.1) Area and yields of each crop in study area

Sr.	Crops	Area (ha)	Yield (kg/ha)	Total production (kg)
1	Monsoon Rice	128321.1	3836.2	492,267,970.2
2	Summer Rice	39276.9	5003.1	196,506,358.4
3	Corn	23.4	2257.2	53,000.4
4	Peanut	200.4	2555.1	512,042.0
5	Sesame	167.61	602.3	100,953.1
6	Sunflower	1056.6	1621.8	1,713,723.6
7	Black gram	938.0	614.5	576,478.6
8	Green gram	1060.7	639.54	678,372.8

Sources: MAS 2009.

3.2.4. Data collections for soil salinity

This portion is based much on the literature review. There are many causal factors of salinity in the soil. Depends on the causes, salt contents and types of salts are different which in turn cause different remedy processes. According to the literature review, Na is important element among the other type of salt such as Ca, Mg and etc. Na content is high in sea water. Therefore, Na content has been analyzed as exchangeable form and available form. If sodium is much in the exchange site, this soil is needed to be applied Gypsum to exchange sodium in the soil particles. If not, it is possible to wash out the soil with fresh water.

The parameters of soil sample to analyze;
Electrical Conductivity,
Soil PH,
Available sodium,
Exchangeable sodium,
Exchangeable calcium,
Exchangeable magnesium,
Soil texture (sand, silt, clay)
Land Use Division under Ministry of Agriculture and Irrigation has collected the soil samples after Nargis and interpreted the result data and recommended the practices. All analyzed data have been collected as secondary sources.
Moreover, farmers have been interviewed concerned with sea water intrusion.
Variable questions are as follow;

How many days did sea water flood in your fields?
Did you wash out your fields when you start growing?
If yes, how many times?
If not, why?
Is there any other problem during growing period? E.g. pest, fertilizer, seed, weed
What is your opinion of reduced yields?

3.3. Variables for Assessment of Cropping Practices and Income

After the study assessment of serious situation in the region, following questionnaires have been set up to get detail information from farmers. These questions could cover almost their entire current socioeconomic situation, their income, their living standards, their cropping practices, labor requirements and payments of labor.

Family member
Family labors

Household head Education
Household member Education
Land ownership
Land Situation (low or high)
Main Income
Secondary income (rating)
Cropping Pattern
Crop cultivar
Farm Aids (Tractor, power tiller)
Draught Animal
Time of seeding and harvesting
Labor requirement
Payments for labors

3.4. Variables for Assessment of Yield of Rice before and after Nargis

Before setting up questionnaires, cropping activities which are currently used in the region have been studied. It is discovered that cropping practices in the regions are different from each others.

Questionnaires are as follow;
Times of Seeding
If more than once, why? (Sea water problem, delay seeding time, impurities of seed, pest problem, fertilizer problem)
Amount of Seed used
Fertilizer used
Pesticide used
The lowest yield of rice within 10 years before Nargis
The highest yield of rice within 10 years before Nargis
Yield of Rice after Nargis (monsoon rice)
Yield of Rice after Nargis (summer rice)
Experiences for growing other crop apart from monsoon rice

If yes, which crop?
What are the problems to grow next crop after monsoon rice?
Do you have willingness to grow next crop?

4. Result and Discussion

This chapter is composed of two portions, assessment of socioeconomic situation of farmers in the study area and analysis of resources availabilities and requirements of alternative farming systems. Possible income from each farming system has been estimated.

4.1. Assessment of Socioeconomic Situation

14 village tracks out of 71 were selected as survey area in the Bogale townships. Total numbers of 91 farmers in 58 villages have been interviewed. Selected villages and village tracks are in northern portion and middle portion. There are no primary data for southern portion due to difficult access to go there. Moreover, this portion is mainly occupied by forest area and it is not possible to cultivate second crop after monsoon rice. For these reasons, only two portions have been concentrated in this study.

4.1.1. Land Allocation for all crop in selected Area

Following table (4.1) mentioned that land allocation for monsoon rice, summer rice and winter crops in selected village tracks of 14 out of 71 total village tracks. Apparently, the upper portion has favorable environment for summer crop since there are higher summer rice cultivated area than in the middle portion.

Table (4.1) Area distribution of crops in selected village tracks in northern portion

Sr	Village Track	Monsoon Rice (ha)	Summer Rice (ha)	Winter crop (ha)
1	Sape Kone	1395.1	1395.1	98.78
2	Wel Gyi	1511.7	431.2	234.8
3	Phayar thone su	1283.4	1240.5	5.3
4	Thatkal sate	1032.8	904.8	8.9
5	Hayman Nyi Naung	1013.4	917.4	21.9
6	Sakhan Gyi	1066.4	261.1	31.2

Source: SLRD 2008/2009.

(May, March 2009)

Fig (4.1) Summer rice cultivation in northern portion

Table (4.2) Area distribution of crops in selected village tracks in middle portion

Sr	Village Track	Monsoon Rice (ha)	Summer Rice (ha)	Winter Crop (ha)
1	Thone Htat	1171.3	0	75.3
2	Thazin kone	1970.0	226.7	75.3
3	Gayan	2035.2	101.2	25.5
4	Patpye	1483.8	0	43.3
5	View Sa Khan	1596.4	0	61.1
6	Pyin Bo Gyi	1745.3	0	49.4
7	Chaung Gyi Wa	1049.4	351.0	80.2
8	KamaKalu	1011.3	0	25.9

Source: SLRD 2009.

Fig (4.2) Fallow lands in middle portion in summer

4.1.2. Family member, labors and land ownership

There are average 5.32 family members in northern and average 5.05 members in the middle portion. Very few members are not taking part in farming activities and they are working in the other places as food sellers, teachers, tailor and etc. Consideration of the labor availability, people in the villages has been reduced 15% from 245,204 to 207,794 after Nargis. As to the survey, 3.71 family members involve in farming activities in northern portion and 3.36 family members in middle portion at present. It can be said on the other way that 69% of family members are working in the northern portion and 66% of members in the middle portion.

As mentioned in the table (4.3) below, apparently, farmers in the middle portion own relatively larger farm areas than farmer in the northern portion have.

Table (4.3) Distribution of land ownership of farmers in both portions

Portion	<2.02 ha	2.42 to 4.04 ha	4.45 – 8.09 ha	>8.09 ha
Northern portion	35.5%	25.8%	25.8%	12.9%
Middle portion	5.5%	23.6%	40%	30.9%

4.1.3. Education Standard

As to the farmers interview, almost all of the farmers are in primary standard of education. There is only primary school in every village but middle schools are located in some of the villages. Therefore, villagers need to go to other villages to attend middle school education. For high school education, they need to go to cities. Farmers said all the family members are needed to work in the

fields. Moreover, it is very difficult to go to other villages for studying since transportation access is not developed within the villages. Most of the villagers stop their education after primary school and work in the various kinds of fields. Few of them are attending middle and high school education.

Following graph (fig 4.4) mentioned that percentages of education level of household heads. Primary education level is the highest and takes part 48.4% in the northern portion and 72.7% of total in the middle portion.

Comparing to these two portions, household head education level is higher in northern portion than those in the middle portion. It could be assumed that people in the northern portion can invest much more money in their education than those in the middle portion. There are very few percentages of household heads who have higher education level in both portions.

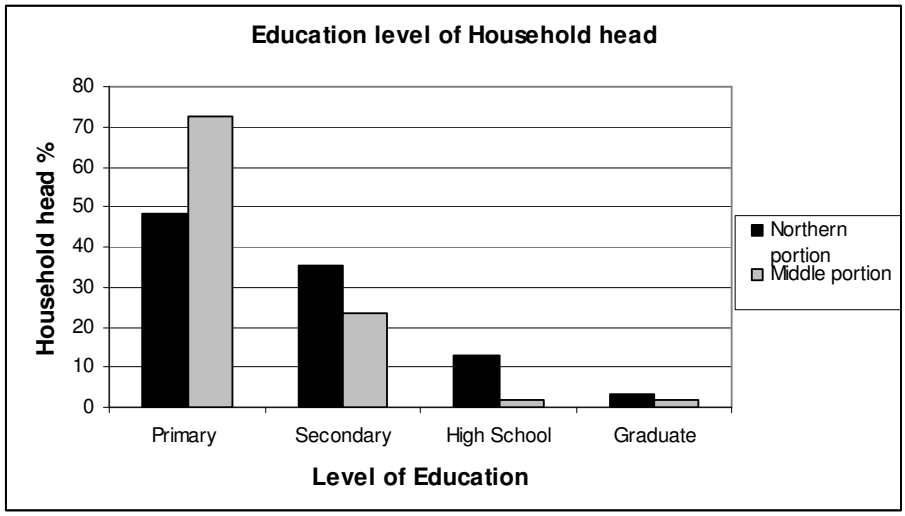


Fig (4.3) Education level of household head in Northern and Middle portion

4.1.4. Draught Animal

About 26,408 out of total 62,916 draught animals have been killed during cyclone and it contributes 41.97% of total. In the northern portion 25% of farmers have no draught animal and 22% of people have 2 draught animals while 32 % of farmers have no draught animal and 11% have only one draught animal in the middle portion. When the situation of labor and draught animal availability in the middle portion compares with that of in northern portion, middle portion has very less draught animal and less labor than in northern portion.

Table (4.4) Distribution of draught animals in household in both portions

No. of draught animals	Northern portion (Household)	Middle portion (Household)
0 unit	25.80%	59.30%
1 unit	12.90%	20.40%
2 unit	22.60%	7.40%
3 unit	12.90%	9.30%
4 unit	9.70%	0%
5 unit	3.20%	3.60%
6 unit	3.20%	0%
7 unit	0%	0%
8 unit	6.50%	0%
9 unit	0%	0%
10 unit	3.20%	0%

4.1.5. Machineries

Machineries were damaged during the cyclone. After Nargis, it was counted as primary interview that 16.1 % of respondents in the northern portion possess power tiller and 45.2 % possess tractors. In the middle portion 25 % have power tillers and 10.9 % have tractors. In the northern portion the highest farms size owned farmers have 100% of machineries but in the middle portion, those have only 70% (see table 4.4).

Household group who has less than 2.02 ha has only 18.8% of power tillers. These power tillers are donated by German Agro Action (GAA), German non Governmental Organization. There was no donation of power tillers to farmers who have more than 2.02 ha. Previously, the smallest farms size owned farmers have no tractor and no power tiller.

Lack of machineries is one of the constraints for the farmers to start the next crop in time after monsoon rice. Therefore, farmers in the middle portion have not only problem of sea water intrusion but also lack of machineries and less draught animals than northern portion.

Table (4.5) correlation of land ownership groups and machineries owned in the northern portion

Sr.	Land owned group	Northern portion		Middle portion	
		Power tiller	Tractor	Power tiller	Tractor
1	less than 2.02 ha	18.8%*	0%	0%	0%
2	Between 2.42 and 4.04 ha	37.50%	50%	7.6%	0%
3	Between 4.45 and 8.09 ha	0	75%	27%	9%
4	more than 8.09 ha	50%	50%	47%	23%

*These percentage of power tillers were donated after Nargis by GAA (German Agro Action) German Non Government Organization.

4.1.6. Income Sources

Their main income is from farm but they have different secondary income sources of fishery, duck farming, pork farming, Nipa palm coconut, betel nut and etc. Among the secondary sources of income, animal farming, coconut and betel nut plantation are the least labor requirement. Nipa palm plantation and working in the Dani making station as daily workers could give some amount of extra income. Nevertheless, accessible working time on Nipa palm business is limited only for 4 months from (Jan to April) per year. The smallest farms size owned farmers are more likely very poor and working in the farms as worker during the planting time and in Dani production station or fishery as daily workers.

Almost all of the people grow coconut, betel nut and home gardening in their resident compound for their own consuming and they sell extra products but there are only very few people are producing commercially coconut and betel nut. Although there is a market for the betel leave, people could not cultivate well because it needs intensive care and high investment.

Animal farming is also subsistence and it was wild farming. Anyway it can provide some amount of money for their daily needs. After Nargis, most of the organizations were delivering the animals to the affected regions. Very few people are making commercial duck farming.

In this assessment, farming of monsoon rice and summer rice were assumed as main income. Secondary income sources data were collected base on rate. Fishery, Nipa palm and animal farming were found as main secondary income sources and some of the respondents are working either one secondary or two or all of three. In that case, highest income source was selected as secondary. Some farmers have no secondary income especially in the northern portion. Working as teachers, tailors, food seller and etc were belong to others group. Almost all of the farmers have coconut plants, betel nut plants in the resident compounds. The incomes from them were also defined as other groups. Duck, pork and chicken farming were grouped into the animal farming. Among them, duck farming was common for the commercial productions but the others were mostly for home consumption. Since environment is plenty of water, rich in small fishes and other foods for ducks, it is favorable for duck farming.

Two different secondary income sources can be seen in two different regions rely on their different land situation. In the northern portion locally called fresh water region has secondary income source of animal farming as showed in table (4.5). The other reason is that farmers have not much time since they are producing double rice per year.

Table (4.6) different sources of income of different groups of farmers in northern portion

Land Ownership groups	Main Income	Sources of Secondary Income				
		Nothing HH %	Fishery HH %	Nipa HH %	Animal Farming HH%	Others HH %
less than 2.02 ha	Farm	36	9	0	18	36
Between 2.42 and 4.04 ha	Farm	12	0	25	12	50
Between 4.45 and 8.09 ha	Farm	25	0	12	37	25
more than 8.09 ha	Farm	0	0	25	50	25

HH = Households

Secondary income sources in the middle portion are mentioned in the table (4.6) and it is clearly seen that their secondary income is from working on Dani making station and Nipa palm productions. Some farmers who have large farm sizes do not have any source of secondary income. They can survive on their main income source of crop productions.

Table (4.6) different sources of income of different groups of farmers in middle portion

Land Ownership groups	Main Income	Sources of Secondary Income				
		Nothing %	Fishery %	Nipa %	Animal Farming %	Others %
less than 2.02 ha	Farm	0	33	0	0	66
Between 2.42 and 4.04 ha	Farm	0	23	38	30	7
Between 4.45 and 8.09 ha	Farm	4	22	22	31	18
more than 8.09 ha	Farm	5	0	47	29	17

HH = Households

4.1.7. Rice Sown Area and Yield in Northern Portion before and After Nargis

After Nargis, farmers have started their farming activities with the aids of government and a numbers of international and regional organizations. They started cultivation end of June, normally they cultivate monsoon rice middle of June it was more or less two weeks delay than usual. All the farms have been started simultaneously. Unfortunately, all farmers have broadcasted seeds for more than two times. . As to their land situation, some fields are always flooding with the depth of 30.4 cm even in the summer but some are not. During the raining season, all the fields are flooded with the depth of 30.4 cm to 91.4 cm ft. In the region, farmers usually grow traditional varieties

which are taller than high yield varieties, in the raining season and very few farmers used high yield varieties during monsoon.

Concerned with yield reduction, there was a mission team of FAO/WEP crop and food assessment mission team (CFSAM). FAO said yield of rice has been reduced 37% in the 7 township in Ayeyarwaddy division and by 35% in 3 affected townships of Yangon Division. FAO concluded that it was for the reasons of poor quality seed, salinity and iron toxicity and lack of agricultural labor and draught animals. FAO assumed that Ayeyarwaddy division will be continuously suffered from consequences of cyclone Nargis in their food supply and income generation.

Table (4.7) expressed that yields of rice before Nargis and after Nargis situation in northern portion. As to literature review, high yield are more sensitive to salinity than traditional varieties. The surveyed data of farmer interviews can be concluded that yield of the monsoon rice, immediately after cyclone, was reduced to 19% in traditional varieties and 23% in high yield varieties as summer rice. After Nargis, farmers in this portion have washed out flooded sea water from their farms more than two times and then they broadcasted seeds to the fields.

After Nargis, the situation of soil become worse than usual and their income have been reduced due to the yield reduction of rice and damages of their secondary income sources. Farmers have to reclaim their field to reach their normal yield. Rice yield was still decreasing until after twp rice growing seasons. Causes of yield reduction have been studied by using secondary data, literature review and primary data of farmers' interview. Sea water flooding in the fields resulted from cyclone Nargis was very obvious. However, there might have other problems that can cause the yield reduction for example less fertilizer application, pest problem, delay seeding time, purity of seed, poor quality seed and etc. According to the report from Myanma Agriculture Services, MOAI after Nargis, salt affects, delay seeding time, less fertilizer use and low adaptability of seed were pointed out as important factors. Farmers in the middle portion have answered their experiences for the yield reduction that sea water flooding problem was main factor and pest problem was second problem as a result of cyclone. After cyclone, crabs destroyed the rice fields more than usual. Farmers assumed that previously the crabs were not a serious problem, only after cyclone it becomes serious problem in their region.

Farmers said seeding time was not delay and it was in the range from last week of May to middle of June. Farmers hardly use fertilizer for the monsoon rice so that fertilizer was not a problem to get their normal yields and the varieties are traditional and it can not respond to fertilizers. For the summer rice, fertilizer was main problem for the yield reduction, the amount of fertilizer used after Nargis was lesser than that of the usual amount.

Farmers in the northern portion have answered different from the farmers in the southern portion that there was no pest problem in their fields and they thought that it was only because of

sea water for the monsoon rice and sea water and fertilizers problems reduced the yields of summer rice.

Table (4.8) Yields of Rice Before and After Nargis in the northern portion

Groups	Before Nargis			After Nargis		
	Traditional Varieties			High Yield Varieties		
	Yield (kg/ha)	Yield (kg/ha)	Reduced yield (%)	Before Nargis (kg/ha)	After Nargis (kg/ha)	Reduced yield (%)
less than 2.02 ha	2268.5	1796.1	21%	4032.8	3253.5	20%
Between 2.42 and 4.04 ha	2107.1	1669.6	21%	4347.9	3465.7	21%
Between 4.45 and 8.09 ha	2457.5	2016.4	18%	4410.9	3591.7	19%
more than 8.09 ha	2268.5	1890.4	17%	4473.9	3087.6	31%

Table (4.8) mentioned that yield of rice in the middle portion, 48% of yield of traditional varieties was reduced after Nargis. Comparing to the northern portion, yields of the rice have been more reduced. It was because of the land level. Most of the fields in the portion have not been washed out the flooded sea water after cyclone like farms in northern portion.

Table (4.9) Yields of Rice Before and After Nargis in the middle portion

Groups	Yield of Traditional Varieties		% of yield reduction
	Before Nargis (kg/ha)	After Nargis (kg/ha)	
less than 2.02 ha	1890.3	907.4	52%
Between 2.42 and 4.04 ha	2093.5	1275.4	40%
Between 4.45 and 8.09 ha	2104.6	1053.6	50%
more than 8.09 ha	2051.7	1393.3	33%

4.1.8. Price of Rice

The farmers are used to selling their products, rice, at the mills near in their villages. Following prices were collected from the rice mill in the Bogale city. Different crop varieties have different price depending on their qualities. Prices have dramatically fallen downed in the year 2008 after Nargis because there was an economic crisis over the world in the year 2008. At that time, farmers have been suffered from not only reduced yield but from low price of rice as well.

The article of Daily Time `` Fall in Rice Price hit Myanmar Exporter, Farmers´´ said that farmers were selling their rice with price below cost of cultivation after Nargis. The food and agriculture organization mentioned an article of ``Rice Market Monitor, June 2009´´ that revealed about world rice production and rice price trends from 2001 up to presents. World rice production is increased and it was 688 million tons in the year 2008. FAO expected rice production will be 698 million tons in the year 2009. International rice price has been started to decline since beginning of this year 2009. Low quality rice (Indica varieties) has been more reflected comparing to the other high quality rice. Rice price is estimated that it will be under pressure in coming months (FAO 2009b).

Table (4.9) Price of Rice of 100 baskets with respect to years

Year	Price of Quality Rice (TV)	Price of High Yield Varieties
1999/2000	350,000	200,000
2000/01	350,000	200,000
2001/02	350,000	200,000
2002/03	370,000	230,000
2003/04	400,000	250,000
2004/05	400,000	250,000
2005/06	400,000	300,000
2006/07	480,000	320,000
2007/08	520,000	390,000
2008/09	370,000	240,000

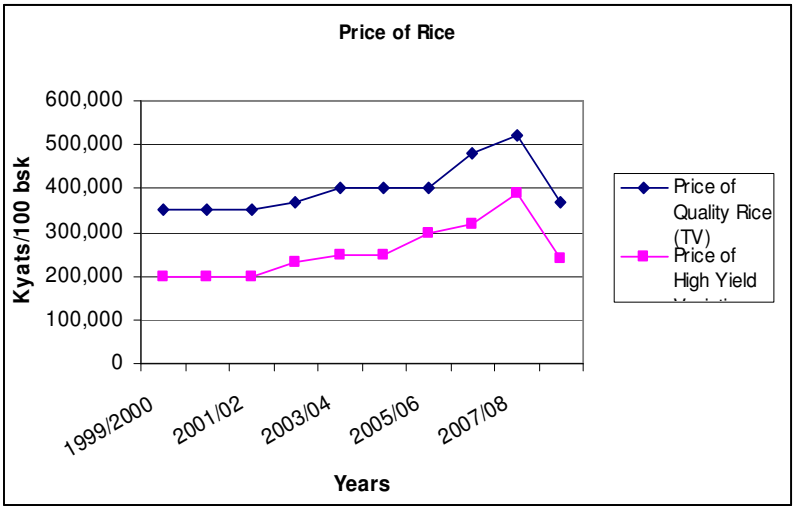


Fig (4.4) price of rice in regional market in the study area

4.1.9. Comparison of income before Nargis and after Nargis

Farmers were divided rely on their farm size ownership as follow;

GI = less than 2.02 ha

GII = between 2.42 and 4.04 ha

GIII = between 4.45 and 8.09 ha

GIV = more than 8.09 ha

After Nargis, farmers were suffered from not only yield reduction price reduction as well. Table (4.9) mentions that 68% of GI, GII and GIV farmers' incomes are reduced after Nargis and 63% of GIII is reduced after Nargis.

Table (4.11) Comparison of farmers' incomes before and After Nargis with respect to the groups in Northern Portion

	Before Nargis				After Nargis			
Items	GI	GII	GIII	GIV	GI	GII	GIII	GIV
Monsoon Rice								
Cultivated area (acre)	4.19	7.6	15.73	32.72	4.19	7.6	15.73	32.72
Yield (Monsoon rice) bsk/ac	45.0	41.8	48.8	45.8	35.63	33.1	40.0	37.5
Total production (basket)	188.5	317.7	767.6	1498.6	149.3	251.6	629.2	1227.0
Unit price (Kyat)	5,200	5,200	5,200	5,200	3,700	3,700	3,700	3,700
Revenue/ac (Kyat) (,000)	234	217	253	238	131	122	148	138
Cost of production/ac (,000)	65	65	65	65	65	65	65	65
Profit/ac (Kyat) (,000)	168	151	188	172	66	56	82	73
Sub Total Income (Kyat) (,000)	706	1,154	2,961	5,649	277	432	1,297	2,396
Summer Rice								
Cultivated area (acre)	3.95	5.87	10.49	17.53	3.95	5.87	10.49	17.53
Yield of summer rice (bsk/ac)	80	86.3	87.5	88.8	64.5	68.8	71.3	61.3
Total production (basket)	316.0	506.6	917.8	1556.7	254.8	403.8	747.9	1074.6
Unit Price (Kyat)	3,900	3,900	3,900	3,900	2,400	2,400	2,400	2,400
Revenue/ac (Kyat)	312	336	341	346	154	165	171	147
Cost of production/ac (,000)	96	96	96	96	96	96	96	96
Profit/ac (Kyat) (,000)	215	240	244	249	58	68	74	50
Sub Total Income (Kyat) (,000)	851	1,409	2,567	4,379	230	402	782	887
Total Income (Kyat) (,000)	1,557	2,563	5,528	10,028	508	836	2,080	3,284

1 $ = 1040 Kyat

1 hectare = 2.47 acres

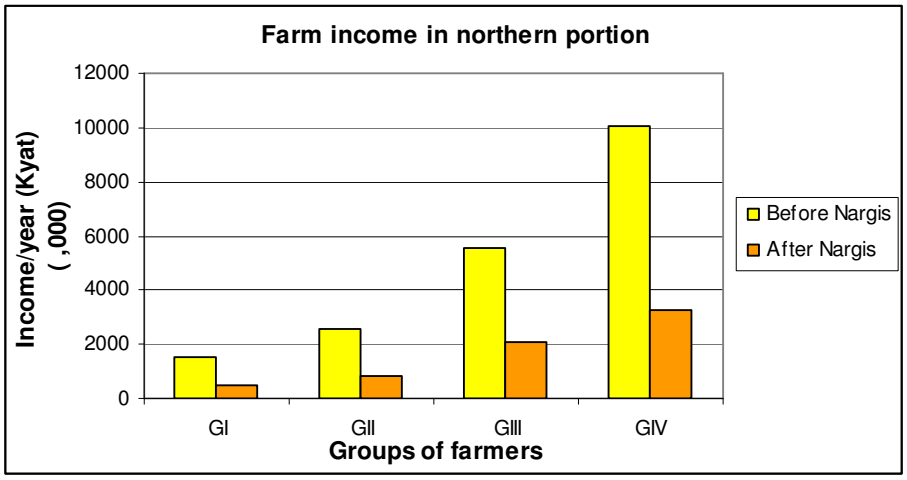


Fig (4.5) Comparison of Farm income before and after Nargis in northern portion

Yields of monsoon rice reduced higher than that of in northern portion and they cultivate only monsoon rice per year, farmers in the middle portion have suffered income reduction more than those in northern portion. Table (4.10) stated that incomes of farmers in middle portion before Nargis and after Nargis. GII, GIII and GIV farmers' income were reduced more than 75% and GI farmers lost almost 100%.

Table (4.12) Comparison of farmers' incomes before and After Nargis in Middle Portion

Items	Monsoon Rice							
	Before Nargis				After Nargis			
	GI	GII	GIII	GIV	GI	GII	GIII	GIV
Cultivated area (acre)	3.97	7.73	13.18	32.99	3.97	7.73	13.18	32.99
Yield (Monsoon rice) bsk/ac	37.5	41.5	41.75	40.7	18	25.3	20.9	27.64
Total production (basket)	148.9	320.8	550.3	1342.7	71.5	1955.7	275.5	911.8
Unit price (Kyat)	5,200	5,200	5,200	5,200	3,700	3,700	3,700	3,700
Revenue/ac (Kyat) (,000)	195	215	217	211	66	93	77	102
Cost of production/ac (,000)	65	65	65	65	65	65	65	65
Profit/ac (,000)	129	150	151	146	1	28	11	36
Total Income (Kyat) (,000)	514	1,161	1,998	4,821	4	217	155	1,212

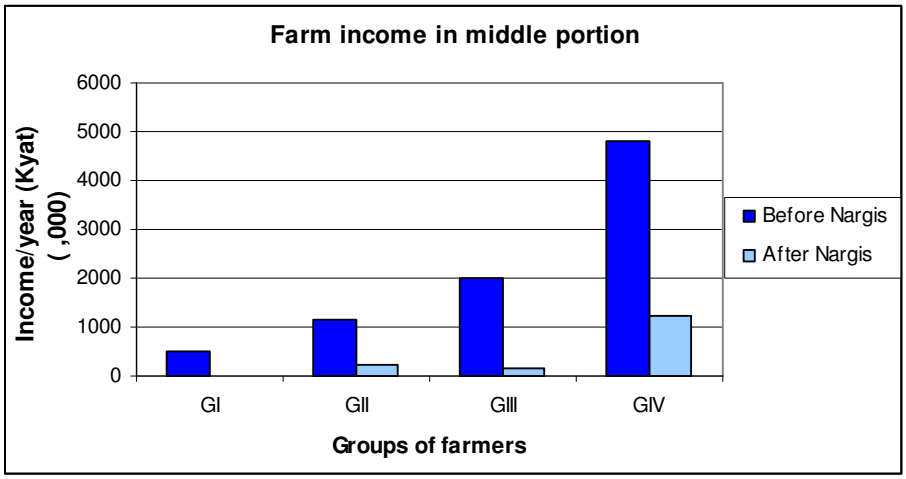


Fig (4.6) Comparison of farm income in middle portion before and after Nargis

4.1.10. General Descriptions on characteristics of farmers

General characteristics of farmers in the northern portion have been mentioned in the table (4.11) in groups. It is discovered that fertilizer usages for summer rice in the GIV farmers are lower than GII and GIII groups but it is higher than use of GI. Yield of rice per ha in GIV group is the lowest among four groups. But the production of GIV is highest because of its land size. As to farmers interview, they used more fertilizer previously, before Nargis, than present amount due to high price of fertilizers. Moreover, GIV farmers can cultivate summer rice 78% of monsoon rice even though other groups could cultivate more than 80% of monsoon rice area.

All groups need to hire labors in seeding time and harvesting time but GI farmers need to hire labor only in the harvesting time.

Table (4.13) Characteristics of each group of farmers in northern portion

Descriptions	Northern Portion			
	GI	GII	GIII	GIV
Distribution of groups	35%	25%	25%	12%
No. of family members	5.5	4.25	5.6	6.25
No. of family labors	3.7	3.0	4.0	4.5
Land ownership (ha)	1.7	3.08	6.37	13.25
Machineries (power tiller)	18%	37%	0	50%
Machineries (Tractors)	0%	50%	75%	50%
Draught Animal (number)	0.63	2.0	4.6	4.7
Cultivated area of monsoon rice (ha)	1.6	2.98	5.23	9.0
Cultivated area of summer rice (ha)	1.6	2.38	4.25	7.1
Cultivated area of winter rice (ha)	0	0.08	0.08	0.55
Urea Fertilizer used for summer rice kg/ha	101.75	185.15	192.9	138.9
T Super fertilizer used for summer rice kg/ha	87.0	77.0	131.2	77.2
Yield of monsoon rice (kg/ha)	35.63	33.1	40.0	37.5
Yield of summer rice (kg/ha)	64.5	68.8	71.3	61.3
Hire Labors	Yes*	Yes	Yes	Yes
Income from Monsoon rice	277,926	432,972	1,297,725	2,396,740
Income from summer rice	230,285	402,799	782,763	887,368
Winter crops cultivated area	0	0.08	0.08	0.55
Income from winter crops	0	3,952	3,952	27,170
Total income/ha	508,211	839,723	2,084,440	3,311,278
Highest Secondary income sources	Animal farming	Animal farming	Animal farming	Animal farming

* only in the harvesting time

GIII and GIV farmers distribute largest percentages in this portion. Due to their farm size, labor demand is high during harvesting time and they could not start next crop in time after monsoon rice in case of lack of labors. GI farmers cultivate very few area of summer rice and GII farmers have very few areas of winter crops as shown in the table (4.12). All the groups in it need to hire labors during seeding time and harvesting time like the farmers in the northern portion but GI farmers need to hire labor only in the harvesting period. In the middle portion, nominal amount of fertilizers are used for monsoon rice.

Table (4.14) Characteristics of each group of farmers in middle portion

Descriptions	Middle portion			
	GI	GII	GIII	GIV
Distributions of groups	5%	23%	40%	30%
No. of family members	5.3	4.61	5.0	5.3
No. of family labors	3.0	3.2	3.18	3.7
Land ownership (ha)	1.61	3.31	5.66	13.64
Machineries (power tiller)	0	7%	22%	0%
Machineries (tractors)	0%	0%	9%	23%
Draught Animal (number)	0.66	0.76	0.80	0.88
Cultivated area of monsoon rice (ha)	1.61	3.13	5.34	13.36
Cultivated area of summer rice (ha)	0.32	0	0	0
Cultivated area of winter rice (ha)	0	0.08	0.03	0.003
Fertilizer used for monsoon rice	0	0	0	0
Yield of monsoon rice (kg/ha)	18	25.3	20.9	27.64
Hire Labors	Yes*	Yes	Yes	Yes
Income from Monsoon rice	4,367	217,290	155,919	1,212,976
Summer rice cultivated area	0.32	0	0	0
Yield of summer rice (kg/ha)	60	0	0	0
Income from summer rice	42,992	0	0	0
Winter crop cultivated area	0.08	0.03	0	0
Income from winter crops	3,952	1,482	0	0
Total income	51311	218,772	155,919	1,212,976
Secondary income sources	Fishery	Nipa	Animal	Nipa

* only in the harvesting time

4.2. Analyzing resources requirement and availability for farming system

4.2.1. Land

Myanmar is agricultural based country and staple food is rice. Government have been concentrated on the rice cropping and aimed to increase rice production not only for domestic consumption but for export as well. Government policy for agricultural commodities has changed from government controlled marketing system to market oriented system. All agricultural commodities have been liberalized for export and import in year 2003. However, rice is national product and production of rice is still under government. Monsoon rice is compulsory crop for farmers and summer rice is forced everywhere in which there is a good irrigation system. Before trade liberalization 2003,

government provides the inputs of fertilizer with lower price than in the free market, loan with 12% interest rate, technologies via extension workers but farmers have to sell fixed amount of rice to Government with fixed price (below market price). At present, Government provides loans and technologies and farmers do not need to sell any amount of rice to Government.

Concerning with land ownership, all lands are defined as state owned and farmers have `` right to work´´. Farmers are not allowed to sell, buy, mortgaging and transferring lands to others. Farmer can transfer or partition their lands only under the permission of authorities regarding to the `` Land Nationalization Act, 1953´´. Agricultural lands have been taxed with nominal amount annually (U Win Htoon Nee, U Thein Win, 2004). Nevertheless, as long as farmers are working on farms as to government instructions, farmers may not loose the advantages of their efforts on farms.

4.2.2. Land utilization in both portions

Farmers in the both portions could not cultivate all of their farms in the monsoon due to the limitation of resources. Summer rice growing has more limitation than monsoon rice growing. It accounts only 30% of the monsoon rice growing area for whole Bogale region.

In the northern portion, as to the farmers' interview, average total land ownership of farmers is 4.89 ha; average monsoon rice growing area is 4.05 ha. Therefore it is 84% of total land is under used in monsoon but 3.65 ha, 74% of total, is used for summer rice, 0.12 ha, 0.02% of total, is used for winter crops. Cropping intensity of GIV group is the lowest, it is probable for requirements of labor resource within short time in order to start next crop after monsoon rice.

In the middle portion, they can cultivate almost all of their farms in monsoon but they have very few areas of next crop after monsoon rice. Therefore, although monsoon rice cropping intensity is higher than that of in the northern portion, total crop intensity is lower than that of northern portion as shown in the table (4.13).

Table (4.15) Land utilization in each group in both portions

Items	Northern Portion				Middle Portion			
	GI	GII	GIII	GIV	GI	GII	GIII	GIV
Average landownership (ha)	1.7	3.1	6.3	13.2	1.6	3.3	5.66	13.64
Average Monsoon rice area (ha)	1.6	2.9	5.0	9.0	1.6	3.1	5.34	13.36
Cropping intensity %	94	96	82	67	100	94	94	97
Average summer rice area (ha)	1.6	2.38	4.25	7.1	0.3	-	-	-
Cropping intensity %	94	77	66	53	20	-	-	-
Average winter crop area (ha)	-	0.1	0.1	0.6	0.1	0.03	0.003	-
Cropping intensity %	-	2	1	4	5	1	0.3	-
Total cropping intensity %	188	175	149	124	125	95	94.3	97

4.3. Capital

Agricultural Development Bank under Ministry of Agriculture and Irrigation provides loan by means of various types; short term, long term and development loans with interest rate of 12% per annum. Comparing it to the interest rate of borrowing from other owner illegally, that is about 10% per months. Short term loan is for seasonal crop productions. Medium term and long term loans are for the investment of farms e.g. buying cattle, machineries and others. Short term loan is per acre basis and it is 7000 Kyat per acre. The loan is distributed equally to the each acre through Agriculture Bank under supervision of Agriculture staffs. If the farmers break the rule or absence on the payment of interest rate in time, they have to be fined some extra amount.

4.3.1. Comparison of Costs of Cultivation and Profits

Farmers could have loan from Government 17,290 Kyat per ha cropping for any kinds of crop for every growing season such as monsoon, winter and summer. The loan could not cover the total production cost of any crop. Farmers who have large farm size can have more advantages than farmers with small farm size since the larger the farm size, the lower the total production cost. Large farm size owned farmers could save some amount of money in their production.

After the growing season 6 months for monsoon rice, farmers have to pay loan to government, it cost 18,327.4 kyat per ha. If farmers who do not have enough money for cost of cultivation, they need to borrow from other private owner illegally with interest rate of 10% per month. Detail calculation is shown in the table (4.14).

E.g. for monsoon rice,

Table (4.16) Calculation of cost of monsoon rice including interest rate

Items	Value (Kyat)
Government loan per ha	17,290
Interest rate for 6 months	1037.4
Amount of payment end of season	18,327.4
Cost of cultivation per ha	161,785
Amount of money for a hectare they need to borrow from private owner	144,495
Interest rate for 6 months	86,697
Amount of money at the end of season	231,192
Total amount of payment	249,519
Revenue per ha	319,865
Therefore, Cost of cultivation including interest rate	249,519
Profit per ha for growing season of 6 months	70,346

Following table (4.15) mentioned about comparisons of cost of cultivation of all crops and their profits. If farmers need to borrow money from private and government, they need to pay some amount of interest. For that situation, farmers could not have amount of profits shown in the table (4.15). Their profit will reduce 40 to 50% of its amount. In case of bad weather or pest problem or other bad situation like cyclone Nargis farmers could not have their target yields, farmers will have problem to give this borrowed money back.

Table (4.17) Comparison of cost of cultivation and profits for each crop

Sr.	Crops	Total cost/ac (Kyat)	Yield (bsk/ac)	Price per bsk (Kyat)	Revenue (Kyat)	Profit/ac (Kyat)	Profit/ha (Kyat)
1	Rice (traditional)	65,500	35	4000	140,000	74,500	184,015
2	Rice (HYV)	148,500	90	2500	225,000	76,500	188,955
3	Pulses	79,000	10	12000	120,000	41,000	101,270
4	Sesame	88,000	5	25000	125000	37,000	91,390
5	Groundnut	89,000	20	6000	120,000	31,000	76,570
6	Sunflower	74,000	15	8000	108,000	46,000	113,620

(see appendix for detail calculations)

4.4. Labor

4.4.1. Cropping activities and labor requirement for Traditional Rice Varieties

Direct seeding method is very common in the region. Before seeding, all the seed have been germinated and then broadcasted into the fields. Seeding is usually started middle of May and harvested in the middle of December. It lasts 6 months. During the germination time, farmers need to prepare the land, removing debris, bank making, harrowing and ploughings. Farmers usually use large amount of seeds that is 3 time higher than national seed rate, to the fields in order to depress the weeds. After broadcasting seed, farmers need fertilization and pesticide application once for each activity during the growing period to harvesting time. Fertilizer application is not common because these varieties are not responding to fertilizer unlikely to high yield varieties. After being harvesting, transporting and winnowing and threshing are carried out by using family labors. Finally, they send it to the mill and sell their product. Labor demands is showed in the fig (4.7).

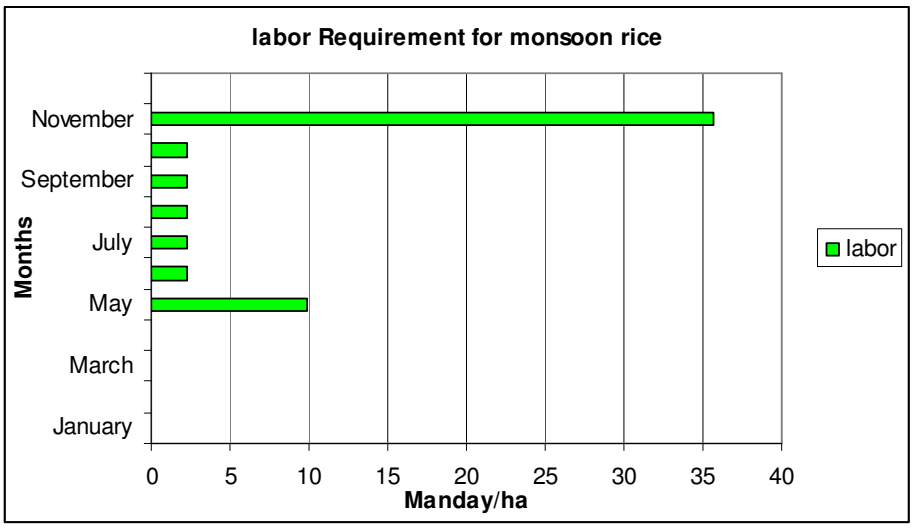


Fig (4.7) Labor Requirement of Rice (Traditional Varieties)

4.4.2. Cropping activities and labor requirement for High Yield Rice Varieties

Summer rice growing is started from mid December to until end of March and it lasts approximately 110 days. It needs intensive care during the growing season such as irrigation, fertilizer application and etc. Farmers use broadcasting practices due to shortage of labors and high rate of seeds to depress weed. Amount of fertilizers application is relatively higher than those used for monsoon rice. Labor demand for high yield varieties is shown in the fig (4.7)

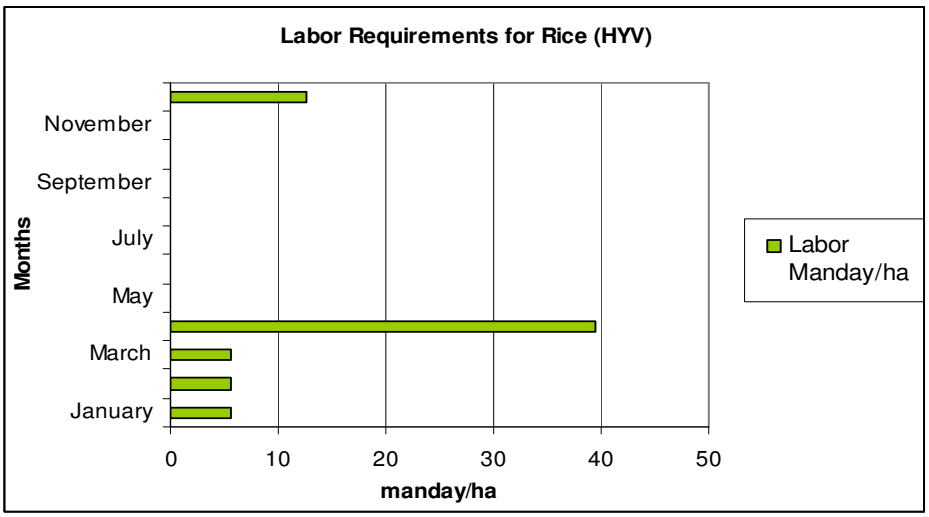


Fig (4.8) Labor requirement of Rice (High Yield Varieties)

4.4.3. Cropping activities and labor requirement for Winter Crops

Pulses, sunflower and sesame are defined as winter crops and these are used to being grown in the northern and middle portion. Considering to the middle portion, land preparation should be started in mid December, harvested in end of March until mid April. Farmers should use short duration cultivars which are around 90 days. When salinity is getting high due to sea water intrusion in the middle portion, all the plants are grown enough and can survive in high saline situation.

First of all, lands have to be irrigated once and then needed to be ploughed and harrowed for two times. Debris removing, fertilizers and pesticide applications have to be done during the growing period. Labor requirement is concentrated in the harvesting periods and land preparation periods.

The point to be considered is that monsoon rice growing will finish end of Nov and farmers have to start land preparation as soon as the harvesting of rice is finished. Labor requirement reaches to peak during this time. Winter crops should be started not later than mid December. It is not able to prepare for next crop for all acreages without aids of machine and draught animals. However, farmers could extend acres for their winter crop production gradually. All of these proposed winter crops are based on farmers' experiences and literature reviews. Among these crops, rice- rice and rice- pulses are recommended by literature review. Labor demands for each crop can be found in the fig (4.8).

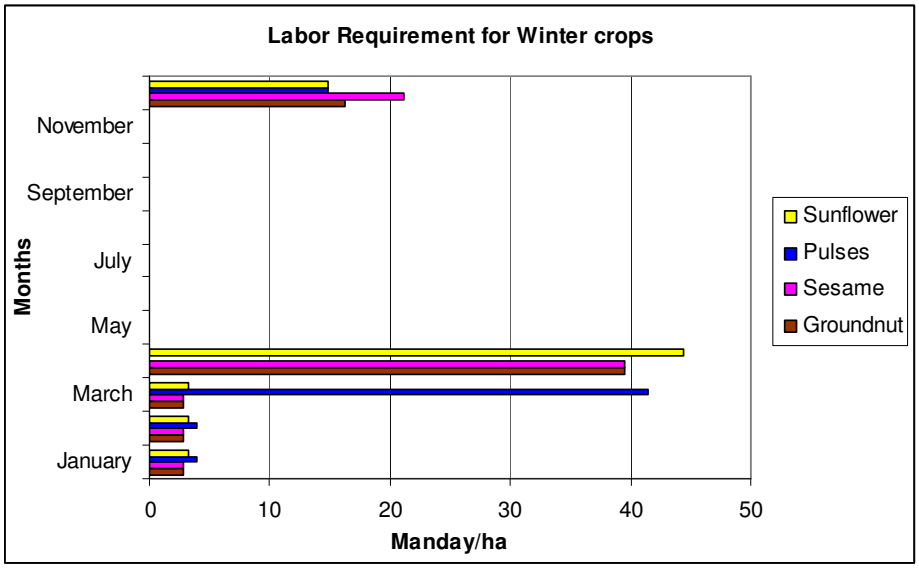


Fig (4.9) Labor requirement for winter crops

Labor requirement in each growing period for each crop is calculated as shown in the table (4.15). Since the harvesting time of second crop is fixed due to sea water intrusion. Labor demand in summer rice growing is peak in April unlikely to pulses production where labor demand is peak in

March. There is no labor demand for rice-pulses cropping pattern in April. Some crops such as sunflower and pulses can be started on 15th December. So that, land can be fallowed for 15 days and farmers can have 15 days to prepare for next crops. Again, pulses are the shortest life periods among these proposed crops and they can be harvested in the end of March. So, lands can be fallowed for one month before monsoon rice is started.

Man day = labors * numbers of days

Table (4.18) Labor requirements per hectare of each growing period in each crop

Sr.	Crop	Period	Duration	Days	Man	Man day/ac	Man day / hectare
1	Rice (TV)	L. preparation	15th May to 1st June	4	1	4	9.88
		Growing period	1st June to 15th Nov	5	1	5	12.35
		Harvesting	15th Nov to 30th Nov	2	7	14	34.58
2	Rice (HYV)	L. preparation	1st Dec to 15th Dec	4	1	4	9.88
		Growing period	15th Dec to 30th Mar	8	1	8	19.76
		Harvesting	1st April to 15th April	2	8	16	39.52
3	Sunflower	L. Preparation	15th Dec to 30th Dec	3	2	6	14.82
		Growing period	1st Jan to 30th Mar	4	1	4	9.88
		Harvesting	30th Mar to 15th April	3	6	18	44.46
4	Pulses	L. Preparation	15th Dec to 30th Dec	2	3	6	14.82
		Growing period	1st Jan to 15th Mar	4	1	4	9.88
		Harvesting	15th Mar to 30th Mar	2	8	16	39.52
5	Goundnut	L. Preparation	1st Dec to 15th Dec	2	3	6	14.82
		Growing period	15th Dec to 30th March	4	1	4	9.88
		Harvesting	1st April to 15th April	2	8	16	39.52
6	Sesame	L. Preparation	1st Dec to 15th Dec	4	2	8	19.76
		Growing period	15th Dec to 30th March	4	1	4	9.88
		Harvesting	1st April to 15th April	2	8	16	39.52

4.4.4. Labor Availability

As to the assessment, average family labors 3.71 are working in the farms in the northern portion and 3.36 family labors in the middle portion. There are many kinds of local payments for hiring labor in farming. According to the primary data, farmers hire labors as

- Seasonal workers, workers have to work daily in his farms through growing season,
- Daily workers, workers have to work only on the respected days and
- Contract workers, during the harvesting time, farmers hire labor payment of per acre basis, e.g. it cost 12000 kyat per acre it does not matter how much labors they used. If ten workers work on it, every worker can get 1200 Kyat.

Small farmers, GI, said that they can manage their field by using their own family labors except in the harvesting time.

4.4.5. Calculation of Labor requirement and Labor availability

Land preparation and harvesting periods are fixed 15 days for each crop. Again, family labors have to share according to their farm sizes. Following table (4.16) mentioned that labor requirements and family labor availability in each period. Since GIII and GIV groups have large farm sizes, they need to hire labors in the land preparation period in both portions. Every group has to hire labor in harvesting periods. There are labor surplus in all groups in the growing period.

Table (4.19) Labor availability respect to the each growing period of each crop

Crop	Period	L.req. Man day/ha	F. availability man day/ha (N. portion)				F. Labor Availability man day/ha (M. Portion)			
			GI	GII	GIII	GIV	GI	GII	GIII	GIV
Rice (T.V)	L. preparation	9.88	27.5	17.2	8.87	6.87	24.9	15.6	8.03	6.22
	Growing period	12.35	303	189	97.6	75.7	274.4	172	88.4	68.52
	Harvesting	34.58	27.5	17.2	8.87	6.87	24.9	15.6	8.03	6.22
Rice (HYV)	L. preparation	9.88	27.5	17.2	8.87	6.87	24.9	15.6	8.03	6.22
	Growing period	19.76	193	121	62.12	48.15	175	109	56.26	43.60
	Harvesting	39.52	27.5	17.2	8.87	6.87	24.9	15.6	8.03	6.22
Sunflower	L. Preparation	14.82	27.5	17.2	8.87	6.87	24.9	15.6	8.03	6.22
	Growing period	9.88	165	103	53.25	41.27	149.7	93.6	48.22	37.37
	Harvesting	44.46	27.5	17.2	8.87	6.87	24.9	15.6	8.03	6.22
Pulses	L. Preparation	12.35	27.5	17.2	8.87	6.87	24.9	15.6	8.03	6.22
	Growing period	9.88	137	86.1	44.37	34.39	124.7	78.0	40.19	31.14
	Harvesting	39.52	27.5	17.2	8.87	6.87	24.9	15.6	8.03	6.22
Groundnut	L. Preparation	14.82	27.5	17.2	8.87	6.87	24.9	15.6	8.03	6.22
	Growing period	9.88	193	121	62.1	48.2	174.6	109	56.26	43.60
	Harvesting	39.52	27.5	17.2	8.87	6.87	24.9	15.6	8.03	6.22
Sesame	L. Preparation	19.76	27.5	17.2	8.87	6.87	24.9	15.6	8.03	6.22
	Growing period	9.88	193	121	62.12	48.15	174.6	109	56.26	43.60
	Harvesting	39.52	27.5	17.2	8.87	6.87	24.9	15.6	8.03	6.22

In fact, labor requirement is high in the land preparation and harvesting periods which are 15 days on each. Apart from these periods, there are labor surplus. On the other hands, labor used in each month is still under surplus condition. Table (4.17) explained that labor used condition in each month.

Table (4.20) Monthly labor requirement per hectare for each cropping pattern (manday)

Months	Rice& pulses	Rice& Rice	Rice& Sunflower	Rice& Groundnut	Rice& Sesame
January	3.9	5.6	3.29	2.82	2.82
February	3.9	5.6	3.29	2.82	2.82
March	41.49	5.6	3.29	2.82	2.82
April	0	39.52	44.46	39.52	39.52
May	9.88	9.88	9.88	9.88	9.88
June	2.24	2.24	2.24	2.24	2.24
July	2.24	2.24	2.24	2.24	2.24
August	2..24	2.24	2.24	2.24	2.24
September	2.24	2.24	2.24	2.24	2.24
October	2.24	2.24	2.24	2.24	2.24
November	35.7	35.7	35.7	35.7	35.7
December	14.82	12.5	14.82	16.23	21.17
Total	118.65	125.6	125.93	120.99	125.93

Table (4.21) Labor Availability per ha in each group in every month

Groups	Northern Portion				Middle Portion			
	GI	GII	GIII	GIV	GI	GII	GIII	GIV
Labor manday	55.09	34.45	17.75	13.75	49.09	31.2	16.07	12.45

4.4.6. Monthly Labor requirement and Labor Availability

Labor availability per hectare is different from one group to another according to their land ownership. Then, durations of land preparation and harvesting are fixed, 15 days for each crop. Fig (4.9) shows that situation in northern portion where labor demand is very high in March, April and November but only for GIV is high in December. There is high Labor surplus in GI group. During growing period labors are surplus even in GIV group.

In the middle portion, Labors are surplus like in northern portion. This fig (4.10) shows about labor situation for two crops per year. In reality, farmers are cultivating only monsoon rice and very few farmers are growing summer rice and winter crops at present. If farmers do not grow next crops after monsoon rice, all of labors will be surplus from January to April. On the other hand, lands are not in applied situation.

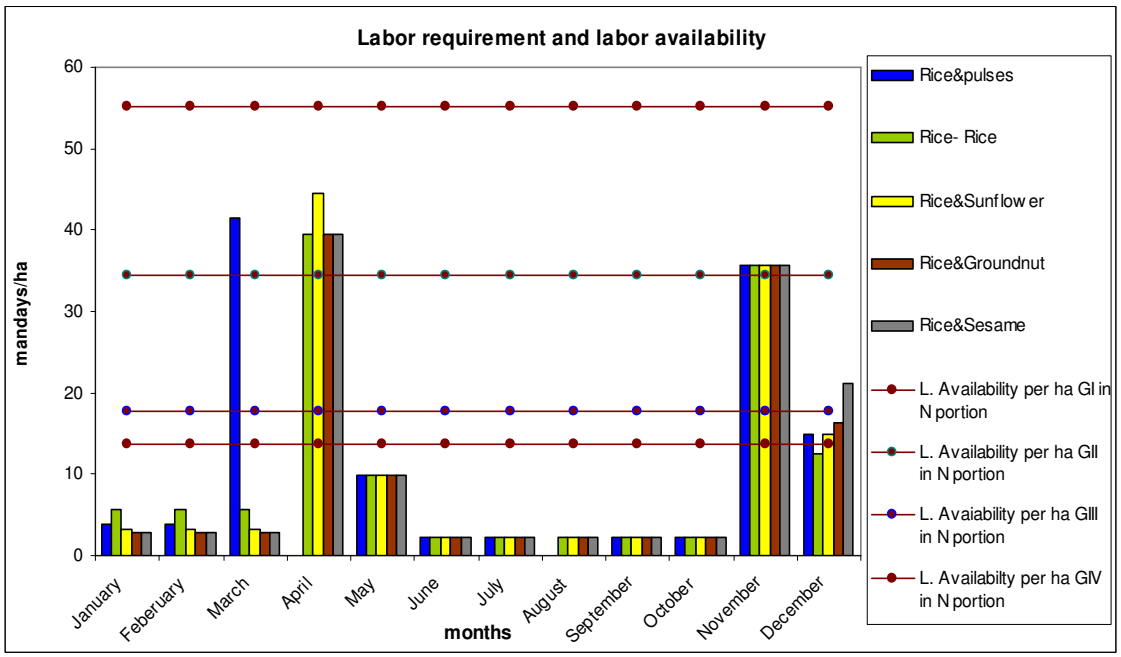


Fig (4.9) monthly labor requirement and availability for each cropping pattern in northern portion

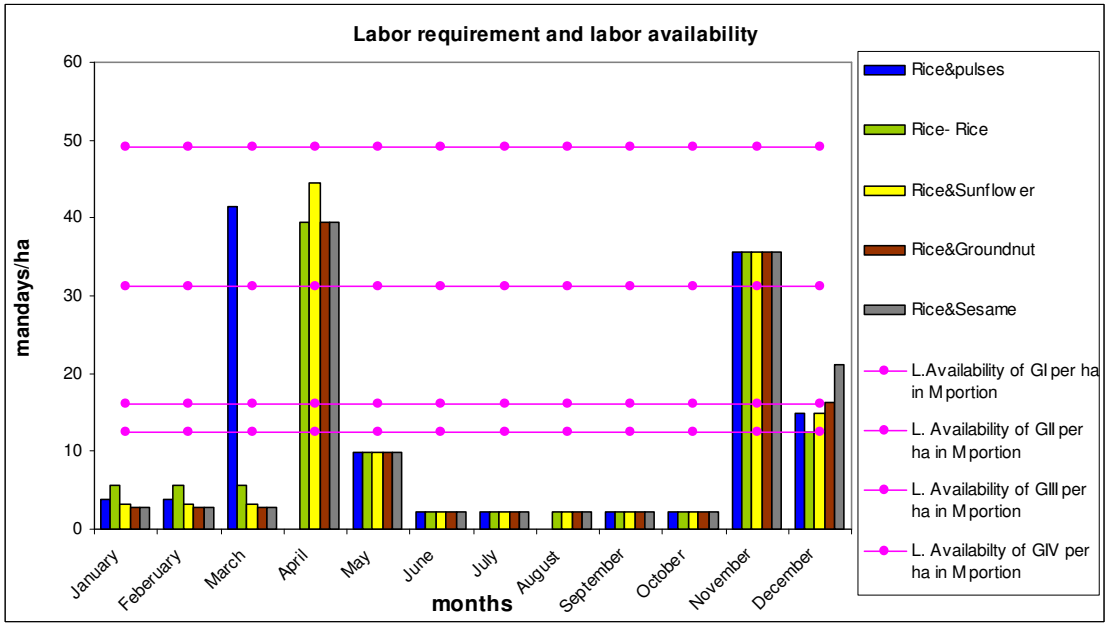


Fig (4.11) Labor requirement and availability for each cropping pattern in middle portion

4.4.7. Labor efficiency and labor surplus

Depending upon the family labor availability in each group, labor surplus has been calculated in the table (4.20). Labor requirements can be seen in April and November. Farmers have to hire the labor during these months in both portions. On the other way, yearly used labor efficiencies are

18% in GI, 30% in GII, 58% in GIII and 76% in GIV in northern portion. 21% in GI, 33% in GII, 65% in GIII and 84% in GIV of family labors are used in the middle portion.

Table (4.20) monthly used labor and labor surplus in Northern Portion

Months	Labor used for M Rice& S Rice				Available labor in N portion	Labor surplus in N portion			
	GI	GII	GIII	GIV		GI	GII	GIII	GIV
January	11.3	18.0	35.1	45.3	111.3	100	93.3	76.2	66.0
February	11.3	18.0	35.1	45.3	111.3	100	93.3	76.2	66.0
March	11.3	18.0	35.1	45.3	111.3	100	93.3	76.2	66.0
April	78.8	127.6	247.7	319.6	111.3	32.5	-16.3	-136.4	-208.3
May	19.9	31.9	61.9	79.9	111.3	91.4	79.4	49.4	31.4
June	4.5	7.23	14.0	18.1	111.3	106.8	104.0	97.3	93.2
July	4.5	7.23	14.0	18.1	111.3	106.8	104.0	97.3	93.2
August	4.5	7.23	14.0	18.1	111.3	106.8	104.0	97.3	93.2
September	4.5	7.23	14.0	18.1	111.3	106.8	104.0	97.3	93.2
October	4.5	7.23	14.0	18.1	111.3	106.8	104.0	97.3	93.2
November	72.1	115.3	223.8	288.8	111.3	39.2	-4	-112.5	-177.5
December	25.3	40.37	78.4	101.1	111.3	86	70.9	32.9	10.2
Total	252.5	403.7	783.7	1015.8	1335.6				

Table (4.23) monthly used labor and labor surplus in middle Portion

Months	Labor used for M Rice& S Rice (manday)				A. labor in N portion (manday)	Labor surplus in N portion (manday)			
	GI	GII	GIII	GIV		GI	GII	GIII	GIV
January	11.3	18.0	35.1	45.3	100.8	89.5	82.8	65.7	55.5
February	11.3	18.0	35.1	45.3	100.8	89.5	82.8	65.7	55.5
March	11.3	18.0	35.1	45.3	100.8	89.5	82.8	65.7	55.5
April	78.8	127.6	247.7	319.6	100.8	22.0	-26.8	-146.9	-218.8
May	19.9	31.9	61.9	79.9	100.8	80.9	68.9	38.9	20.9
June	4.5	7.23	14.0	18.1	100.8	96.3	93.57	86.8	82.7
July	4.5	7.23	14.0	18.1	100.8	96.3	93.57	86.8	82.7
August	4.5	7.23	14.0	18.1	100.8	96.3	93.57	86.8	82.7
September	4.5	7.23	14.0	18.1	100.8	96.3	93.57	86.8	82.7
October	4.5	7.23	14.0	18.1	100.8	96.3	93.57	86.8	82.7
November	72.1	115.3	223.8	288.8	100.8	28.7	-14.5	-123.0	-188.0
December	25.3	40.37	78.4	101.1	100.8	75.5	60.4	22.4	-0.3
Total	252.5	403.7	783.7	1015.8	1209.6				

4.5. Estimation of resources requirements and income from secondary sources

4.5.1. Nipa palm

As to farmers' interviews, very few farmers have some area of Nipa palm. Most of the farmers are working in the Dani production station as daily workers. Yield of Nipa palm per ac is 200 to 300 binds of Dani. One bind contains 18 to 19 leave branches. The price of each bind is approximately 500 to 900 Kyats (local currency). Therefore income from Nipa plantation per acre is 175,000 Kyat per year.

Income for the labors who are working in the Dani production station as daily workers is calculated in the following table (4.19). It is assumed that all family labors are working on the Dani production station in limited period. If farmers are working on Nipa as competitive enterprise i.e. farmers do not cultivate next crop after monsoon rice, all family labors are available for Nipa.

If farmers work on Nipa business as supplementary enterprise, surplus family labors from January to April are calculated as following. Cropping pattern of rice and pulses and GI group family members is taken as an example for labor surplus calculation.

E.g. Pulses / GI group farmers
Total labors requirement for pulses from Jan to April = 99.56 manday
Total labor availability in GI group farmers = 445.2 manday
Labor surplus for GI farmers = 345.64 manday
Income per manday = 250 Kyat
Total income = 86,410.0Kyat

Table (4.24) Calculation of income from Nipa (working in Dani production)

Portion	Available F. Labors (manday)	Duration of work (days)	Total labors (manday)	Wages/manday (Kyat)	Total income/season (Kyat)
N. Portion	3.71	120	445.2	250.0	111,300.0
M. Portion	3.36	120	403.2	250.0	100,800.0

N. portion = Northern portion
M. portion = Middle portion
1$ = 1040 Kyats

4.5.2. Duck Farming

Few numbers of Ducks are used to being kept by a household in the region. They can survive by eating available foods in their surrounding such as green plants, snail, insects, scraps, etc. If

farmers want to raise commercially, hut is needed for them. Ducks are needed to leave outdoor daily for food and for their health. Farmers have to look after them when they are outside and have to feed them daily. Types of foods for duck have to change at the age of 4 months. Cost of foods increases after 4 months. At the age of 4 months, they start laying eggs until 2 years. The rate of laying eggs is 80% per day between at the age of 4 to 10 months, and it is reduced to 50% per day after 10 month until 2 years. After 2 years, ducks are sold to be slaughtered. Only one labor is needed to look after 100 duck farm. Hut has to been repaired yearly. Deterioration rate of duck is 10%. Duck are used to laying eggs at night and the rate of laying eggs is usually low during the raining season. Duck should be raised during the raining season June to July, then after 4 months, they become old enough and good time to lay eggs during the winter (September, October). Farmers could earn 520,500 kyat within 2 years from 100 duck farming. If the farmer continues farming next year, repairing cost of hut is 20,000 kyat.

If farmer use family labor, he could earn 480,000 kyat within 2 years. If farmer raises ducks 100 to 500 numbers, labor charges will be the same. As to the farmers interview, they need two labors for 1000 duck farming. Labor requirement for 100 duck farming is 360 manday per year. Labor requirement per month is 30 manday. Duck farming can increase labor used efficiency 27% in northern portion and 29% in middle portion.

Fig (4.12) Duck farming in the northern portion, Bogale

Table (4.25) Cost calculation of duck farming (100 numbers)

Sr.	Items	Units	Units cost	Value
1	Hut	1no.	39,000.0	39,000
2	Duck	100 no.	350.0	35,000
3	Foods for first month	1 month	37,500.0	37,500
4	Foods for 2nd to 4th month	3 months	83,333.0	250,000
5	Foods for 5th to 2 Years	20 months	33,000.0	660,000
6	Labor	24 months	40,000.0	480,000
7	Total cost			1,501,500

Table (4.26) Revenue and profit calculation of duck farming

Sr.	Items	No. of days	No. of Eggs/day	Value/egg (kyat)	Value
1	Eggs from 5th to 10th months	180	80	60	864,000
2	Eggs from 11th to 24th months	420	40	60	1,008,000
3	Sold as meet		100	1500	150,000
4	Revenue				2,022,000
5	Profit after 2 years				520,500
6	Profit after 1 years				260,250

4.6. Cropping Patterns and Crop Calendar

All cropping patterns have to be rice based because monsoon rice is compulsory crop in whole Myanmar. Regarding the selection of varieties, there are only two type of rice varieties photoperiod sensitive and photoperiod insensitive (Wada, 1954; Oka, 1954; Vergara et.al., 1965) (B.S.Vergara, 1976). Almost all of the traditional varieties are strongly and weakly photoperiod sensitive (Oka, 1954a; Oka and Chang,1960; Katayama,1964: Vergara et.al., 1965) (B.S.Vergara,1976).

Traditional varieties are photoperiod sensitive i.e. time of flowering is fixed. It is long growth duration varieties; especially it has long vegetative growth stages and has no response to fertilizer. It can resists to water logging and suitable in very low land. Photoperiod sensitive varieties are necessary for floating rice area. Cultivation of these varieties is common in flooding area of some countries such as Thailand, Bangladesh, Vietnam and Myanmar etc. These varieties have to be cultivated in April, May and harvested in November to December. It lasts more than 180 days. Flowering time depends on day length; therefore flowering time may not be similar in the different latitude. From economic point of view, traditional varieties are less risky than high yield varieties. (B.S. Vergara, 1976)

High yield variety is different from traditional one. It has short duration growth and it is photoperiod insensitive and it is best variety for the area where improved irrigation system and it could be grown anytime of year if water is available. There are many kinds of traditional varieties which are grown in study area presently. Those are fairly tolerance to salinity, tall enough to grow in flooded fields and good in quality and their price is relatively higher comparing to other varieties. For many reasons, traditional varieties should be selected as monsoon crop in the region. Next crop after rice should be diversified as to the soil situation and resources. These calendars mentioned below are options of cropping patterns in study area with respected to the regions. Blue color is for fresh water availability and red color means seasonal sea water intrusion.

4.6.1. Crop Calendar in the northern Portion

There is no intrusion of sea water in the northern portion and fresh water is available for the whole year. Pulses, sunflower, sesame, groundnut can be grown as second crops. Crop durations and working periods of Dani production station and duck farming can be seen in the table (4.22).

Table (4.27) Crop calendar in the northern portion

Sr.	Crop	May		June		July		Augt		Sept		Oct		Nov		Dec		Jan		Feb		Mar		April	
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1.	M-Rice																								
2.	S-Rice																								
3.	Pulses																								
4.	Sunflower																								
5.	Sesame																								
6	G. nut																								
7.	Nipa																								
8.	DFarming																								

Sea water intrusion

Fresh water

M-Rice = monsoon rice

S-Rice = Summer rice

G.nut = Groundnut

Dfarming = Duck farming

4.6.2. Crop Calendar in the middle Portion

In the middle portion, farmers usually cultivate only monsoon rice per year. This region is able to grow next crop after rice such as short duration cultivar of sunflower, sesame, vegetable, pulses and etc. Among the variable of crops, pulses are shortest period crop. Sea water intrusion always occurs from 2nd week of February to end of May as shown in the table (4.23)

Table (4.28) Crop calendar in the middle portion

Sr.	Crop	May		Jun e		July		Au gt		Sept		Oct		Nov		Dec		Jan		Feb		Mar		April	
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1.	M-Rice																								
2.	S-Rice																								
3.	Pulses																								
4.	Sunflower																								
5.	Sesame																								
6	G. nut																								
7.	Nipa																								
8.	DFarming																								

Sea water intrusion

Fresh water

4.6.3. Crop Calendar in the southern Portion

In the southern portion, seasonal sea water intrusion is about one week earlier than in the middle portion. The region is not favorable for summer rice cultivation and winter crops too. Nipa palm plantation, working on the Dani production station and duck farming should be practiced to increase farmers' income generation.

Table (4.29) Crop calendar in the southern portion

Sr.	Crop	May		Jun e		July		Au gt		Sept		Oct		Nov		Dec		Jan		Feb		Mar		April	
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
1.	M-Rice																								
2.	S-Rice																								
3.	Pulses																								
4.	Sunflower																								
5.	Sesame																								
6	G. nut																								
7.	Nipa																								
8.	DFarming																								

Sea water intrusion

Fresh water

4.7. Analysis of total income from each farming system

Considering to the selection of next crop after rice, suitable crops are short period cultivar of summer rice, sesame, pulses and groundnut. Literature review recommended that double rice and rice follow pulses cropping patterns especially for the sea water affected area. In addition, farmers have had experiences to cultivating these crops and these crops are currently growing in the some of the area in the region, Bogale townships. Opportunity costs of these crops are calculated. Summer rice, pulses and Nipa palm are taken as examples in table (4.22).

Working as a daily worker in Nipa palm business can be taken as not only competitive and it is also possible to be supplementary as well. Duck farming can be assumed as supplementary. From the economic point of view, summer rice can give highest income. Rice- Rice and Rice- Pulses cropping patterns are recommended by literature review.

Second crops are competitive in resource use. However, working in the Dani production and duck farming can be assumed as supplementary business.

Alternative Farming systems are proposed as follow:
Farming system I = Monsoon rice
Farming system 2 = Monsoon rice and summer rice
Farming system 3 = Monsoon rice and pulses
Farming system 4 = Monsoon rice, Nipa (Dani production)
Farming system 5 = Monsoon rice, pulses, duck farming
Farming system 6 = Monsoon rice, pulses and Nipa (Dani production)

Table (4.30) Possible combinations of alternative crops with monsoon rice

Farming system	Monsoon rice (Kyat/ha)	Summer rice (Kyat/ha)	Pulses (Kyat/ha)	Duck farming (Kyat/year)	Nipa (Kyat/ season)	Total Income (Kyat)
Farming system 1	161,370.0					161,370.0
Farming system 2	161,370.0	133,330.6				294,700.0
Farming system 3	161,370.0		101,270			262,640.0
Farming system 4	161,370.0				111,300.0*	272,670.0
Farming system 5	161,370.0		101,270	260,250		522,890.0
Farming system 6	161,370.0			260,250		421,620.0

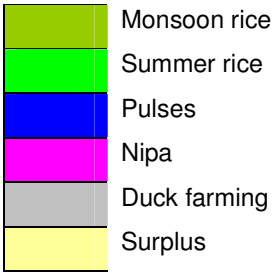
*Working as a daily worker in Nipa palm business can be taken as competitive. However, it is also possible to be supplementary.

4.8. Estimation of labor availability in each farming system

Regarding labor availability, all kinds of farming system could be done by all groups of farmers. But only GIV group in the middle portion does not have enough labors for farming system 5. Labor used efficiency is highest in farming system 5. Nevertheless, available family labor will be less than usual for harvesting period. Farmers have to hire labors for that period more than usual. According to their family labor availability, applied labors percentage is different from one portion to another.

4.8.1. Northern Portion

Table (4.26) Applied labors and surplus labor percentages in each farming system



Farming system 1 (monsoon rice)

GI	8.1%	91.9%
GII	12.9%	87.1%
GIII	22.24%	77.76%
GIV	32.36%	67.64%

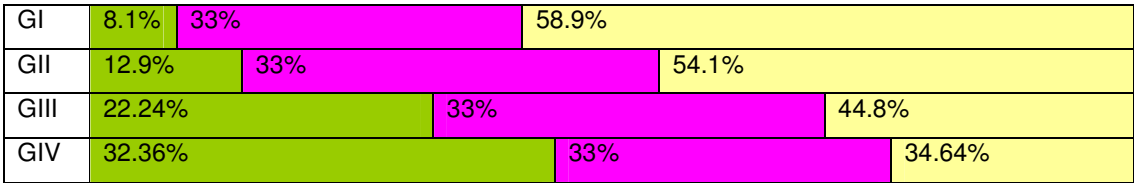
Farming system 2 (monsoon rice and summer rice)

GI	8.1%	10.1%	81.8%
GII	12.9%	16.1%	71%
GIII	22.24%	27.8%	49.9%
GIV	32.36%	40.45%	27.2%

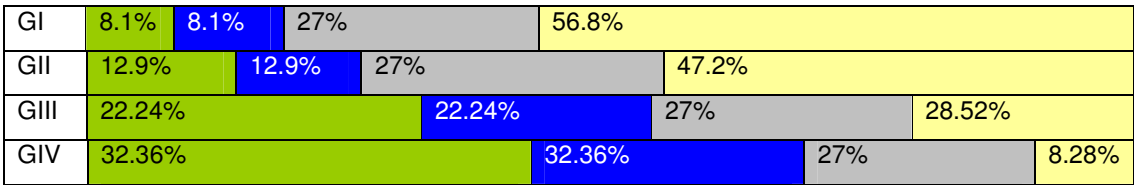
Farming system 3 (monsoon rice and pulses)

GI	8.1%	8.1%	83.8%
GII	12.9%	12.9%	74.2%
GIII	22.24%	22.24%	55.5%
GIV	32.36%	32.36%	35.28%

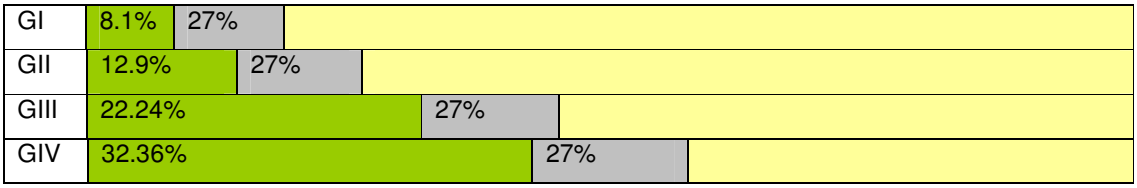
Farming system 4 (monsoon rice and Nipa)



Farming system 5 (monsoon rice, pulses, duck farming)



Farming system 6 (monsoon rice and duck farming)

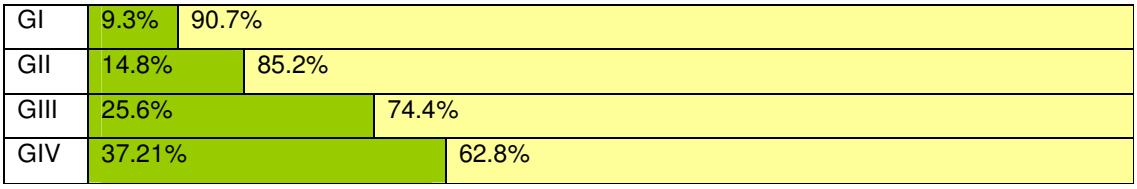


4.8.2. Middle portion

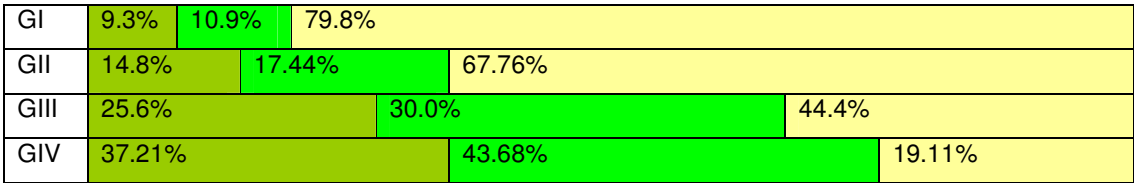
Farmers in this portion are cultivating only one crop per year. If farming system is changed to double crop per year, cropping intensity will increase and labor use efficiency will increase. Farming system 5 is the best for this portion too. The problem is that labors can not be enough for GIV farmers. GIV farmers will need to hire labors.

Table (4.27) Applied labor and surplus labor percentages in each farming system

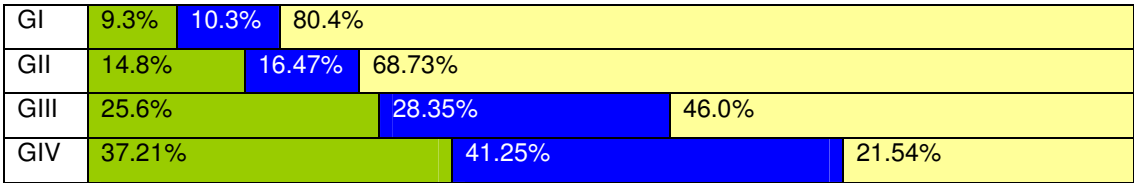
Farming system 1 (monsoon rice)



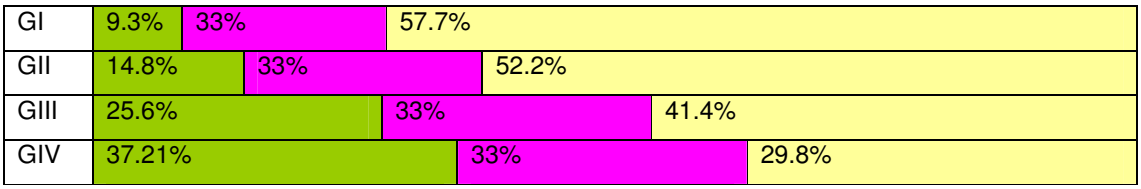
Farming system 2 (monsoon rice and summer rice)



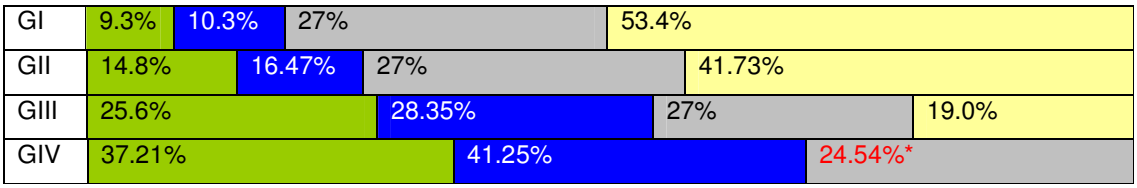
Farming system 3 (monsoon rice and pulses)



Farming system 4 (monsoon rice and nipa palm)

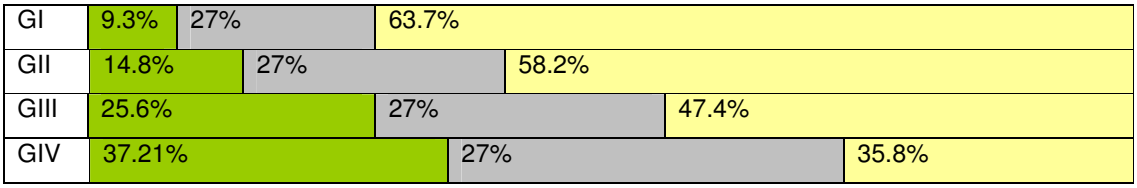


Farming system 5 (monsoon rice, pulses and duck farming)



* There are no enough labors in GIV group for this farming system

Farming system 6 (monsoon rice and duck farming)



Conclusion

After assessment of situation of the region, there are three different regions with different situations. Northern portion is relatively more favorable than other two. Farmers are growing double crops per year. Apparently, farmers in this portion have better situations than in the other two. As to the primary data, they have higher education and more farm aids than others. This is not only because of fresh water availability but also its location. It is the closest portion to the urban of Bogale. Therefore, the portion has an easy access of transports for their farm products. As to the primary data, they have not reached the maximum efficiency of resources uses. They can still increase their land, labor and capital efficiencies.

Middle portion has potential for two crops in some parts. Their main problems are labor scarcity and lack of knowledge. Farming in the region is risky due to sea water intrusion. Intensive care and attention are needed for their second crop. Farmers have to start growing second crop as early as possible after monsoon rice. Labor requirement is peak between harvesting time and land preparation for the next crops. If farmer have more machineries, it could reduce the labor requirement. Nevertheless, farmers could decide the area of second crop depending on resources availabilities. Later on, farmers could increase cropping area gradually.

Southern portion is the poorest among three. There is very little potential to have double crops per years. Fortunately, fishery, prawn farming, Nipa plantation, Dani production and duck farming are options for their additional incomes. Improving secondary income sources is very important for this region.

- *Hypothesis 1 Sea water intrusion in the coastal zone is one of the salinity problems for the agriculture purposes (Akbar and Ponnamperuma, 1982). When salt concentration in the soil solution is higher than that in the plants, plant will become water stress due to osmosis potential. If the rice fields are flooded with sea water, germination and yield of rice will reduce.*

Before monsoon rice growing is started, farmers in the northern portion washed out fields with fresh water more than two times but farmers in the middle portion could not washed out their fields. According to survey, farmers in both potions have broadcasted seeds more than three times. Monsoon rice growing was started in both portions at the same time. As to result, in the northern portion, yield of traditional varieties of rice have reduced 19% than previous yield whereas 22.7% of high yield varieties have been decreased. In the middle portion, yield of traditional varieties have been decreased 43.7% of previous yield.

- *Hypothesis 2 As to their cropping practices, farmers are not using their resources effectively and efficiently. Family labours and land resources are in surplus condition. If farmers change their cropping patterns and crop varieties wisely suitable to the salinized soil situation, it can increase not only their land and labor used efficiency but also recover the yield losses due to sea water intrusion for sustaining long term productions.*

As to the suvey, double rice is practiced in northern portion and only monsoon rice in the middle portion. It can be clearly seen that family labours re surplus especially in the middle portion. Labour requirement is peak only in the harvesting time and land preparation time for some of farmers groups. If farmers practice pulses after rice, or double rice per year can increase crop intensity and labour used efficiency. Again, pulses are short period plants, therefore it can reduce labour requirement during peak period of harvesting.

On the other hand, yield of rice is still decreasing after two seasons of rice growing. The most important thing is to concentrate to have their normal yields. Literature review recommended that rice- rice, rice- pulses should be practiced in the salinized soil in order to recover the damage of soil. From the economic point of view, cultivation of pulses after rice could increase their income from farms. The common problem in the whole region is that all farmers have to grow simultaneously in order to maintain soil moisture and control pest problem. Otherwise, irrigation water for second crop will lost in the soil crashes since soil type is heavy clay soil and big earth crash will appear when it is dry.

- *Hypothesis 3 Main income source of the farmers in the study area is from farming and their secondary income varies with the locations. Farmers always face the risk of disasters for their livelihood and crop production. Farmers' income can be maximized by including secondary income sources into combination of rice based cropping patterns.*

As to the assessment, Nipa and duck farming are main sources of secondary income. Duck farming is common in the northern portion and Nipa is common in the middle portion related to their favorable environment. Family labors' availability is different from one group to others and one portion to another. However, all groups have enough labors for proposed farming systems, except only GIV group in middle portion does not have enough labors only for farming system 5 (monsoon rice, pulses and duck farming). Adding of these secondary income sources in the cropping pattern of rice-pulses increases not only resource use efficiencies but income as well.

Reference

Action contre la Faim, 2008 ``Food Security and Water Sanitation Rapid Assessment´´ Bogale Township, Ayeyarwaddy Division, Myanmar.

AKBAR, M. AND PONNAMPERUMA, F.N., 1982. Saline soil of south and southeast Asia as potential rice lands. *In: Rice research strategies for the future.* Philippines: International Rice Research Institute, 265-281.

ASLAM, M., QURESHI, R.H. AND AHMED, N., March 1993. A rapid screening technique for salt tolerance in rice (*Oryza sativa* L.). *Plant and Soil*, 150, 99-107

BRADY, NC., 1984. The Nature and Properties of Soil. 9th ed. New York: Macmillan Publishing Company.

DEPARTMENT OF AGRICULTURAL PLANNING, 2006. *Mynamar Agriculture at a glance,* Yangon: Ministry of Agriculture and Irrigation

DEPARTMENT OF AGRICULTURAL PLANNING, 2009. *Myanma Agriculture in Brief*. Yangon: Ministry of Agriculture and Irrigation.

DOBERMANN, A AND FAIRHURST, T., 2000, `` Nutrient Disorder and Nutrient Management´´, Potash and Phosphate Institute (PPI), Potash and Phosphate Institute of Canada (PPIC) and International Rice Research Institute (IRRI).

FAO, 2008. *Damage and Loss Rapid Assessment Team,* Yangon, Food and Agriculture Organization of United Nations.

FAO, 2009 *Salinity isogenic line,* map available from www.fao.org/giews/humanitarianinfo (accessed 01/04/2009).

FAO, 2009. Rice Market Monitor Trade and Market, 12(2). 8.8.09.FAO

FAO, 2009a. *Post Nargis Recovery and rehabilitation program strategy*. Yangon: Food and Agriculture Organization of United Nations.

GERGORIO, G.B. AND SENADHIRA, D., April, 1993. Genetic analysis of salinity tolerance in rice (*Oryza sativa* L.). *TAG Theoretical and Applied Genetics*, 86 (2-3), 333-338.

GOMMES, R.; GURENY, J.D.; NACHTERGAELE, F.; BRINKMAN, R., 1998. Potential impacts of sea- level rise on population and agriculture.*SD-Dimension* [online], FAO of United Nations. Available from: http://www.fao.org/sd/Eldirect/Elre0045.htm (accessed 12/05/2009)

GREGORIO, G.B.; SENADHIRA, D.; MENDOZA, R.D.; MANIGBAS, N.L.; ROXAS, J.P.; GUERTA, C.Q., 2002. Progress in breeding for salinity tolerance and associated abiotic stresses in rice. *Field Crops Research*, 76, 91-101.

HAMILTON, L.S. AND MURPHY, D.H., 1988. Use and Management of Nipa Palm (*Nypa fruticans*, Arecaceae): a Review. *Economic Botany*, 42 (2), 206-213.

HUNT, P.G.; CAMPBELL, R.B.; SOJKA, R.E.; PARSONS, J.E., 2005. Flooding Induced soil and plant ethylene accumulation and water status response of field grown tobacco. *Plant and Soil*, 59 (3), 427-439.

JUGSUJINDA, A. AND PATRICK, W.H., 1993. Evaluation of toxic conditions associated with granging symptoms of rice in a flooded Oxisol in Sumatra, Indonesia. *Plant and Soil*, 152, 237-243.

KAHAN, D., 2004. Farm Economics Handbook: Working with market oriented farmers. Rome: Food and Agriculture Organization of the United Nation.

KHATUN, S.; RIZZO, C.A.; FLOWERS, T.J., 1995. Genotypic variation in the effect of salinity on fertility in rice. *Plant and Soil*, 173, 239-250.

KYAW, K.Z., 2005. *Cropping pattern assessment and policy advice for semiarid region of Myanmar*. Thesis(M.Sc), Cologne University of Applied Science.

Land Use Division, 2000. *Soil Type and Characteristics of Myanmar*. Myanmar: Ministry of Agriculture and Irrigation.

LUTTS, S., KINET, J.M, AND BOUHARMONT, J.,1995. Changes in plant response to NaCl during development of rice (*Oryza sativa* L.) varieties differing in salinity resistance. *Experimental Botany*, 46 (293), 1843-1852.

LYN, N.N., 2004. *Profitability and Risk in Rice-based Farming Systems in Pyinmana Township, Myanmar*. Thesis(M.Sc), Cologne University of Applied Science.

MAAS, E.V., 1986. Salt tolerance of Plant. *Applied Agricultural Research*, 1(1), 12-26.

MARSCHNER, H., 1995. Mineral Nutrition of Higher Plants. 2nd ed. Institute of Plant Nutrition, University of Hohenheim Germany.

MAS, 2009. *Annual report of Myanma Agriculture Service*. Bogale, Myanmar.

MOE AUNG, 2008. Nipa palm sourcing and Market Analysis. Myanmar: CARE

MOONS, A.; BAUW, J.; MONTAGU, M.V.; STRAEDEN, D.V.D., 1995. Molecular and physiological responses to abscisic acid and salts in roots of salt- sensitive and salt-tolerant indica rice varieties*. Plant Physiology*, 107,177-186.

NEILL, C., 1993. Seasonal flooding, soil salinity and primary production in northern prairie marshes. *Oecologia*, 95, 499-505.

REDDY, M.D. AND MITTRA, B.N., January 1985. Effects of complete plant submergence on vegetative growth, grain yield and some biochemical changes in rice plants. *Plant and Soil,* 87, 365-374.

SASEENDRAN, S.A., SINGH, K.K., RATHORE, L.S., SINGH,S.V. AND SINHA, S.K., Nov 2004. Effects of Climate Change on Rice Production in the Tropical Humid Climate of Kerala, India. *Climate Change*, 44 (849), 495-514.

SCHEUREN, J.M, and et.al. 2008. Annual Disaster Statistical Review´´ United Nation, International Strategy for Disaster Reduction, Belgium

SETTLEMENT AND LAND RECORD DEPARTMENT, 2009 *Annual report of settlement and land record department* Bogale: Myanmar

SETTLEMENT AND LAND RECORD DEPARTMENT, 2009. Map of Bogaletownship, scale 4inches :1 mile. Myanmar.

THAN AYE, Oct 2008. Post Nargis Recovery and livelihood Opportunity in Agricultural Sector. *ESCAP/ASEAN Regional Expert Group Meeting,,27th to 28th October 2008, Bangkok, Thailand.*

U WIN HTOON NEE AND U THEIN WIN, 2004. Land Administration of Union of Myanmar Report on `` Meeting of heads of land administration of the ASEAN heads´´ Malaysia

VERGARA, B.S., 1976. Physiological and morphological adaptability of Rice Varieties to Climate. *In: Proceeding of the Symposium on Climate and Rice*. Philippines: International Rice Research Institute, 67-86.

WILLETT, I.R., 1979. The effects of flooding for rice culture on soil chemical properties and subsequent growth. *Plant and Soil*, 52, 373-383.

Appendix

Cost of Sunflower Cultivation and profit per hectare

Sr.	Description	unit	Qty	Unit price	Value
1	Land Preparation				19,500
1.1	Debris removing	man	3	1500	4,500
1.2	Irrigation	Man&machine	1	5000	5,000
1.3	Plowing&harrowing	Man&machine	2	5000	10,000
2	Growing Period				6,000
2.1	Seeding	Man	1	1500	1,500
2.2	Fertilizer application	Man	1	1500	1,500
2.3	Pesticide application	Man	2	1500	3,000
3	Harvesting period				29,000
3.1	Harvesting	man	10	1500	15,000
3.2	Winnowing	Man	6	1500	9,000
3.3	Transporting	Man&machine	1	5000	5,000
4	Input uses				19,500
4.1	Seed	bsk	0.25	10,000	2,500
4.2	Fertilizer	Bag (50 kg)	0.5	25,000	125,00
4.3	Pesticide	Lit	1	4,500	4,500
5	Total cost				74,000
5.1	Revenue	Bsk	15	8,000	120,000
5.2	Profit/ac				46,000
5.3	Profit/ha				113,620

Cost of Rice Cultivation and profit per hectare (Quality Rice, Traditional Variety)

Sr.	Item	Unit	Qty	Unit price	Value
1.	Land preparation				9,500
1.1	Bank preparation	man	1	1500	1500
1.2	Harrowing and plowing	Man&machine	1	5000	5000
1.3	Removing Debris	Man	2	1500	3000
2	Growing period				7,500
2.1	Broadcasting	man	1	1500	1500
2.2	Transplanting	labor	2	1500	3000
2.3	Fertilization	labor	1	1500	1500
2.4	Pesticide spraying	labor	1	1500	1500
3	Harvesting				21,000
3.1	Harvesting	man	10	15000	15000
3.2	Transporting cost	man	2	1500	3000
3.3	Winnowing	man	2	1500	3000
4	Input Used				27,500
4.1	Seed	bsk	4	3000	12000
4.2	Urea	bag	0.5	22000	11000
4.3	Pesticide	lit	1	4500	4500
5	Total cost				65,500.0
5.1	Revenue	bsk	3,700	35	129,500.0
5.2	Profit (Kyat)/ac				64,000.0
7.	Profit (Kyat)/ha				158,080.0

Cost of Pulses Cultivation and profit per hectare

Sr.	Description	Unit	Qty	Unit price	Value
1	Land preparation				19,500
1.1	Debris removing	Man	3	1500	4500
1.2	Harrowing	Man&machine	2	5000	10,000
1.3	Irrigation	Man&machine	1	5000	5000
2	Growing period				6,000
2.1	Seeding	Man	1	1500	1500
2.2	Fertilizer application	Man	1	1500	1500
2.3	Pesticide application	Man	2	1500	3000
3	Harvesting				29,000
3.1	Harvesting	Man	10	1500	15000
3.2	Winnowing	Man	6	1500	9,000
3.2	Transporting	Man&machine	1	5000	5000
4	Input				24,500
4.1	Seed	Bsk	0.5	15000	7500
4.2	Fertilizer	Bsk (50 kg)	0.5	25000	12500
4.3	Pesticide	Lit	1	4500	4500
5	Total cost				79,000
5.1	Revenue	Bsk	10	12000	120,000
5.2	Profit per ac				41,000
5.3	Profit per ha				101,270

Cost of Rice Cultivation and profit per hectare (HYV)

Sr.	Description	Unit	Qty	Unit Price	Value
1	Land preparation				13,000
1.1	Bank preparation	man	1	1500	1500
1.2	Plowing	Man&machine	1	5000	5000
1.3	Harrowing	Man&machine	1	5000	5000
1.4	Debris removing	Man	1	1500	1500
2	During Growing season				15,500
2.1	Seeding	man	1	1500	1500
2.2	Transplanting	Man	2	1500	3000
2.2	Fertilizer application	man	3	1500	4500
2.3	Irrigation	Man&machine	1	5000	5000
2.4	Pesticide application	man	1	1500	1500
3	Harvesting				29,500
3.1	Harvesting	Man	10	1500	15000
3.2	Transporting	man	3	1500	4500
3.3	Winnowing (machine)	Man&machine	2	5000	10000
4	Inputs				102,500
.1	Urea	Bag (50 kg)	1	22000	22000
4.2	T Super	bag	0.5	24000	12000
4.3	Pesticide	lit	1	4500	4500
4.4	Seed	bsk	4	5000	20000
5	Total cost				96,500
5.1	Revenue	bsk	62.7	2400	150,480
5.2	Profit/ac				53,980.0
5.3	Profit/ha				133,333.6

Cost of Groundnut Cultivation and profit per hectare

Sr.	Description	Unit	Qty	Unit price	Value
1	Land preparation				24,500
1.1	Debris removing	Man	3	1500	4500
1.2	Harrowing	Man&machine	3	5000	15,000
1.3	Irrigation	Man&machine	1	5000	5000
2	Growing period				6,000
2.1	Seeding	Man	1	1500	1500
2.2	Fertilizer application	Man	1	1500	1500
2.3	Pesticide application	Man	2	1500	3000
3	Harvesting				29,000
3.1	Harvesting	Man	10	1500	15000
3.2	Winnowing	Man	6	1500	9,000
3.2	Transporting	Man&machine	1	5000	5000
4	Input				29,500
4.1	Seed	Bsk	1	8000	8000
4.2	Fertilizer	Bsk (50 kg)	0.5	25000	12500
4.3	Pesticide	Lit	2	4500	9000
5	Total cost				89,000
5.1	Revenue	Bsk	20	6000	120,000
5.2	Profit per ac				31,000
5.3	Profit per ha				76,570

Cost of Sesame Cultivation and profit per hectare

Sr.	Description	Unit	Qty	Unit price	Value
1	Land preparation				24,500
1.1	Debris removing	Man	3	1500	4500
1.2	Harrowing	Man&machine	3	5000	15,000
1.3	Irrigation	Man&machine	1	5000	5000
2	Growing period				6,000
2.1	Seeding	Man	1	1500	1500
2.2	Fertilizer application	Man	1	1500	1500
2.3	Pesticide application	Man	2	1500	3000
3	Harvesting				29,000
3.1	Harvesting	Man	10	1500	15000
3.2	Winnowing	Man	6	1500	9,000
3.2	Transporting	Man&machine	1	5000	5000
4	Input				28,500
4.1	Seed	Bsk	0.25	28000	7000
4.2	Fertilizer	Bsk (50 kg)	0.5	25000	12500
4.3	Pesticide	Lit	2	4500	9000
5	Total cost				88,000
5.1	Revenue	Bsk	5	25000	125,000
5.2	Profit per ac				37,000
5.3	Profit per ha				91,390

Questionnaire

Type 1

Farmer's Name ---------- Date----------

Village Track ----------

Village ----------

Family Information

Sr.	Names	Age	Relation to head	Education	Occupation
1. 2. 3. 4. 5.					

Occupation

1= Farm

2= Non farm

Education

1= Primary

2= Secondary

3= High School

4= Graduate

Farm Information

Items	Land owned		Cropping system	Power tiller	Tractor	Draught animal	Main income	Secondary income
	Low land	High land						
Numbers								

Main Income

Rating

1=

2=

3=

Secondary Income

Rating

1=

2=

3=

Sr.	Crop	Varieties	Cropping Practices	Amount of fertilizer used	Duration of growing
1					
2					
3					

Varieties

Cropping practices

1= Traditional Varieties
2=High yield varieties

1= Direct seeding
2= Transplanting

Other Question

Do you get the loan from government? ----------

Do you need to hire the labor and how many? ----------

Which kinds of payment did you use for hiring labor? ----------

Type 2

Season crops	Sown Acre		Yields after Nargis		Minimum yield before Nargis		Maximum yield before Nargis		Price of Rice/bsk After Nargis		Price of Rice/bsk Before Nargis	
Monsoon Rice	HYV	TV	HYV	TV	HYV	TV	HYV	TV	HYV	TV	HYV	TV
Summer Rice												
Winter crop												

Other Questions

How many days did the sea water stay in your fields? ----------

Can you guess the depth of water in the field due to sea water? ----------

Do you know the depth of water in your field in normal situation?

In monsoon ----------

In summer ----------

What do you think about the yield reduction? ----------

Do you have any experience of growing winter crop?

If yes, which crop? ----------

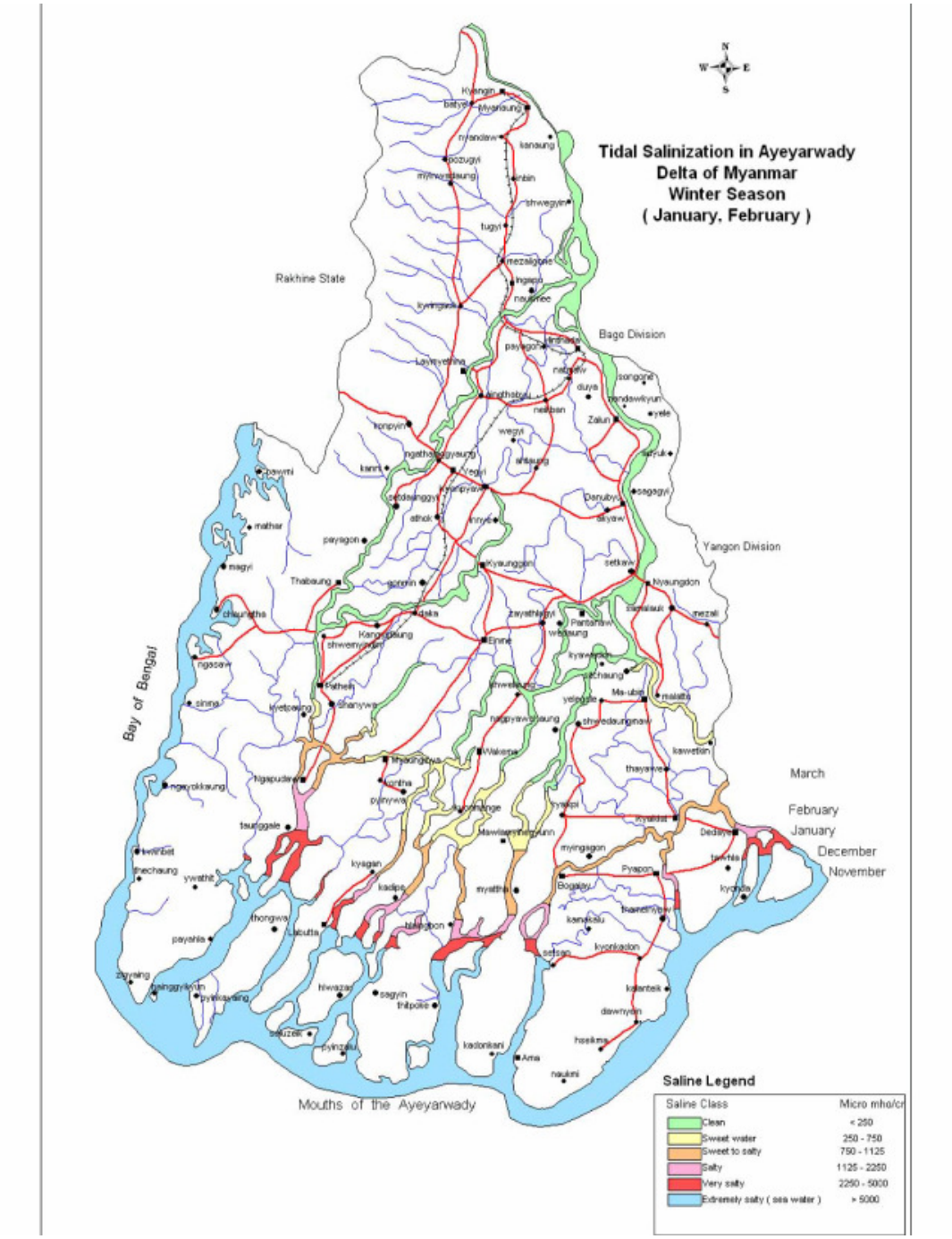
Did you get success in growing winter crop? ----------

What are the problems when you grow the winter crop? ----------

Do you have wiliness to grow next crop after rice? ----------

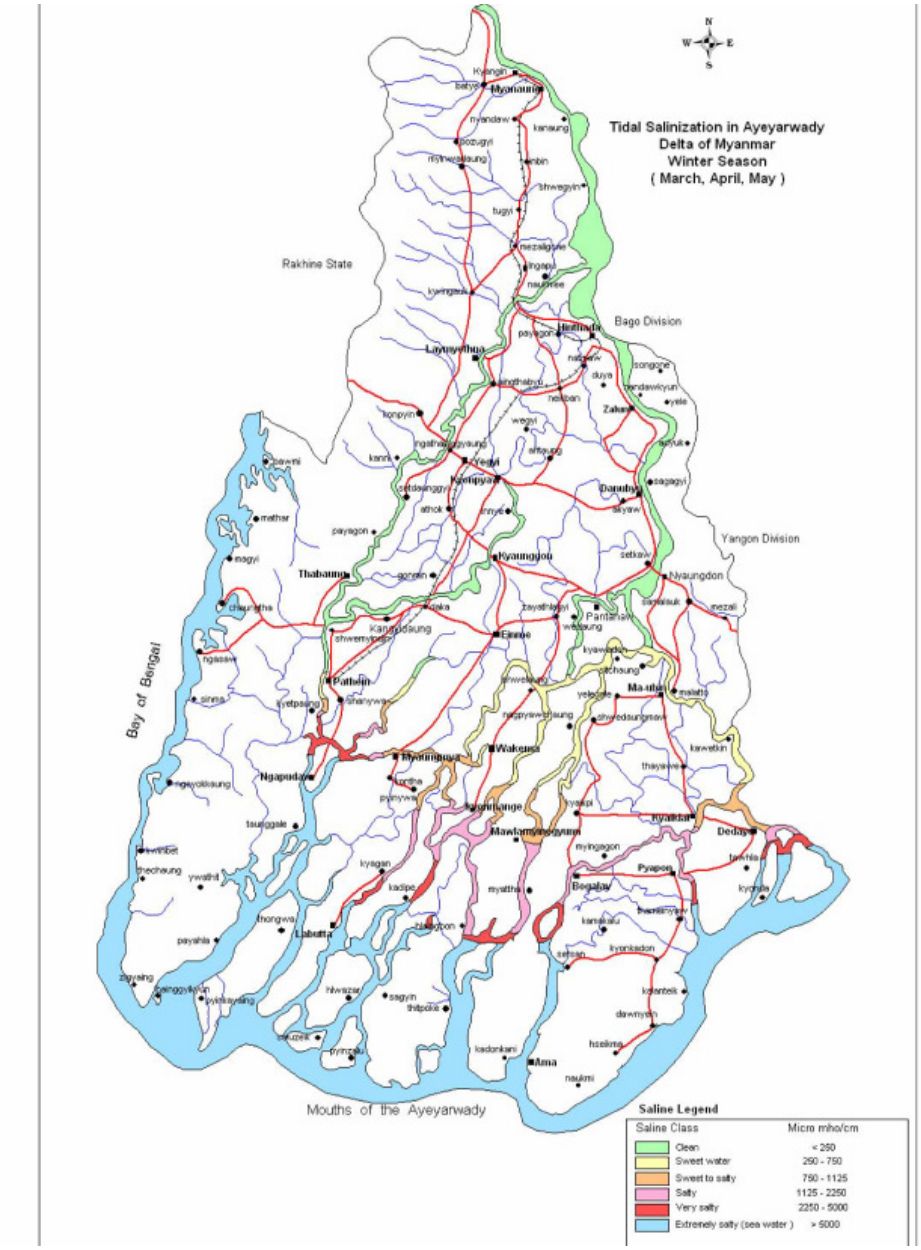
What do you need to grow next crop? ----------

1. Salinity isogenic line in January, February in Ayeyarwaddy division



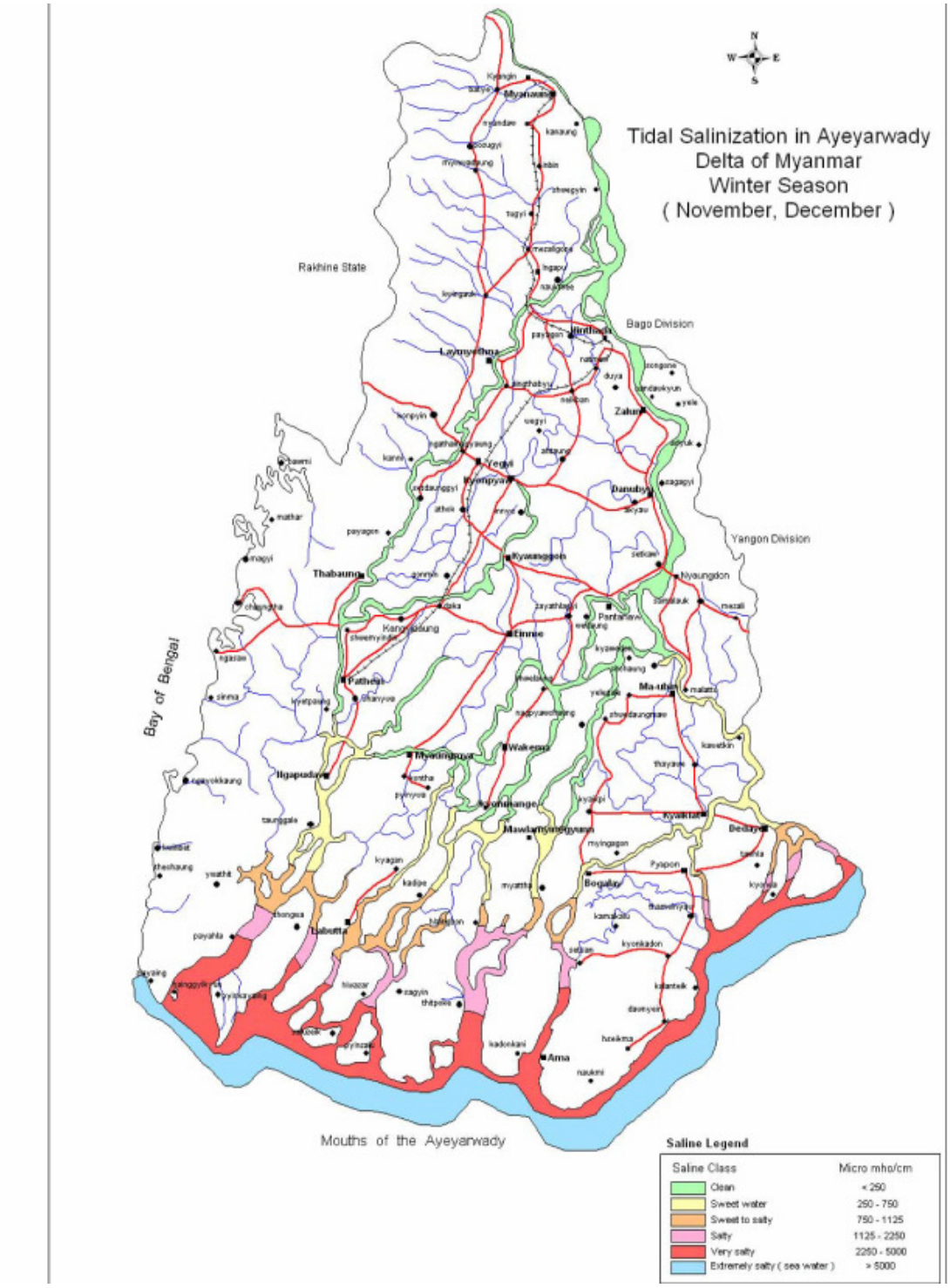
Source: FAO, 2009

2. Salinity isogenic line in March, April, May in Ayeyarwaddy Division



Source FAO,2009

3. Salinity isogenic line in November, December in Ayeyarwaddy Division



Source FAO,2009