# IMPACT OF LAND CONSOLIDATION ON PROFITABILITY OF RICE PRODUCTION IN THE SELECTED TOWNSHIPS, NAY PYI TAW

**MOH MOH**

**NOVEMBER 2015**

# IMPACT OF LAND CONSOLIDATION ON PROFITABILITY OF RICE PRODUCTION IN THE SELECTED TOWNSHIPS, NAY PYI TAW

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**A Thesis Submitted to the Post-Graduate Committee of the Yezin Agricultural University in Partial Fulfillment of the Requirements for the Degree of Master of Agricultural Science (Agricultural Economics)**

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The thesis attached here to, entitled **"Impact of Land Consolidation on Profitability of Rice Production in the Selected Townships, Nay Pyi Taw"** was prepared and submitted by Moh Moh under the direction of the chairperson of the candidate supervisory committee and has been approved by all members of that committee and the board of examiners as a partial fulfillment of the requirements for the degree of **Master of Agricultural Science (Agricultural Economics).**

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## DECLARATION OF ORIGINALITY

This thesis represents the original work of the author, except where otherwise stated. It has not been submitted previously for a degree at any other University.

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**DEDICATED TO MY BELOVED PARENTS,**

**U SHWE HTOO AND DAW LEI LEI WIN**

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## ABSTRACT

This study was an attempt to explore current circumstances and socio-economic status of participant and non-participant households in land consolidation program. In addition, this study analyzed the profitability of rice production, investigated the determinants of rice production and assessed the major constraints of rice production. The survey was conducted by personal interviewing with 60 participant households who participated in land consolidation program and 60 non-participant households who did not participate in that program from Pyinmana and Zeyarthiri Townships, Nay Pyi Taw during the period of November to December, 2014. Descriptive analysis, cost and return analysis and production function analysis were used for data analysis.

The descriptive analysis indicated that the majority of both participant and non-participant households were male headed households and nearly half of household heads were at the primary education level. Participant households possessed more traditional farm implements and machineries than those of non-participant households. In the evaluation of the profitability of monsoon rice production, the benefit-cost ratios of participant and non-participant households were 1.10 and 1.21, respectively. Moreover, the benefit-cost ratios of summer rice production were 1.30 in participant households and 1.45 in non-participant households.

In the production function analysis, monsoon rice production was positively and significantly influenced by seed rate, total fertilizer amount, pesticide amount, herbicide amount, total machine day and total man day. In summer rice production, summer rice production was positively and significantly influenced by household head's age, seed rate, total fertilizer amount, total machine day, total animal day, total man day and Pearlthwe variety. Rice production was negatively and significantly related to participant households. Majority of participant and non-participant households faced with constraints of high labor cost, high fertilizer application, high production and transportation cost. Moreover, most of participant households described constraints in labor scarcity and poor irrigation and drainage system after land consolidation.

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| ac | = Acre |
| Amd | = Animal day |
| AMD | = Agricultural Mechanization Department |
| BCR | = Benefit-Cost Ratio |
| DoA | = Department of Agriculture |
| FAO | = Food and Agriculture Organization |
| FYM | = Farm yard manure |
| ha | = Hectare |
| kg | = Kilogram |
| L | = Liter |
| Mad | = Machine day |
| MADB | = Myanma Agricultural Development Bank |
| Md | = Man day |
| MMK | = Myanmar Kyat |
| MOAI | = Ministry of Agriculture and Irrigation |
| MT | = Metric Ton |

## LIST OF CONVERSION FACTORS

| | |
|---|---|
| 1 basket of paddy | = 20.86 kilograms |
| 1 hectare | = 2.471 acres |
| 1 metric ton | = 1000 kilograms |
| 1 metric ton | = 2 cartloads of cow dung |

# CHAPTER I
# INTRODUCTION

## 1.1 Background of the Study

Nowadays, land consolidation is often understood in a much broader sense. Land consolidation can promote management of natural resources and support better land use planning and land management, including solving potential conflicts over changes to the use of land (Lisec et al. 2012). In transition countries, land consolidation is one of the most important fundamentals for helping to resolve the structural problems in agriculture and agricultural production (Sadegh et al. 2012).

Traditionally, land consolidation means a comprehensive reallocation procedure in a rural area consisting of fragmented agricultural or forest holdings or their parts. In addition to land exchange aiming to form land plots that are better adapted to their proper use, improvement of the road and drainage network, landscaping, environmental management, conservation projects and other functions may be implemented in land consolidation (Vitikainen 2004). The classical form of farmland consolidation involves changing the land tenure structure and providing the necessary infrastructure such as roads and irrigation networks, for efficient agricultural development (Demetriou et al. 2012).

The main objective of land consolidation is to improve the land holdings of farmers by concentrating their farms in as few plots as possible and to support the farms with roads and infrastructure, when needed. Generally, land consolidation has some negative impacts such as decreasing biodiversity in rural areas and change in the long-established habitats of animals around the villages (Lisec and Pintar 2005). Positive impacts of land consolidation are increasing community participation, improving technical knowledge, increasing cultivated area, decreasing conflict between farmers, mechanized agriculture, improving irrigation and drainage systems, better roads, increasing land and labor productivity, decreasing migration from rural areas, better farm management and finally, decreasing costs (Mirandaa et al. 2006).

Moreover, land consolidation is a very important tool for rural development which improves rural peoples' lives through improving the natural resources management and protecting environment, providing services and infrastructure, providing job opportunities and boosting life situation in rural areas (FAO 2003). The lack of land consolidation can be considered as an obstacle to efficient farm management, as it leads to smaller parcels over time as well as the physical dispersion of parcels owned or worked by the same farmer (Hristov 2009).

## 1.2 The Status of Land Consolidation in Myanmar

Farmland consolidation is very often accompanied with farm mechanization. In fact, to fully and effectively utilize farm machineries, rugged farmlands should be leveled and regularly shaped. Also, when equipped with irrigation canal, drainage canal and farm road, highly efficient farm management can be realized, leading to ideal intensive agriculture.

To promote intensive agriculture, farm mechanization is one of the musts. Farm casual labors and also farm workforce are expected to decline according to the migration of workers to construction sector and decline young generations. It means that agriculture sector should accelerate the farm mechanization. Farm mechanization is currently mandated by Agricultural Mechanization Department (AMD) under Ministry of Agriculture and Irrigation (MOAI) and this area shall involve private sector participation a lot.

Farmland consolidation in Myanmar had started in mid 1990s as pilot basis. During the previous government era (1995-1996 to 2010-2011), a total of 9,969 ha farmland has been consolidated. Then, under the present government, an annual plan is formulated and according to the budget availability, land consolidation has been put into implementation. By April 2015, a total of 24,258 ha farmland has been consolidated including the area implemented by the previous government (Table 1.1).

In Myanmar, policy makers pointed out that agricultural reform would be made in five ways to develop the agricultural sector as follows;

(1) Create the incentives for active participation and cooperation by the farmers along with the new mind-set in their farming activities.

(2) Replacing the traditional varieties with improved quality and high yielding seeds.

(3) Application of modern pre-harvest and post-harvest technologies in place of conventional farming methods.

(4) Transforming the rain-fed farming into systematic irrigated farming.

(5) Converting conventional small-scale farms into mechanized farms in the form of acre-plots or hectare-plots in order to change manual farming into mechanized farming (MOAI 2014).

In addition, according to AMD (2014), there are four objectives in land consolidation program.

(1) To become agricultural farm plots for widely utilization of farm machineries and equipment,
(2) To become continuous cultivated expansion farm plots by reducing boundaries area among farm plots,
(3) To enhance and produce good quality products by implementing agricultural systematic farm plots with proper irrigation and drainage and farm roads and
(4) To enhance the agricultural and irrigation sector development, the implementation of systematic land consolidated program is the ideal demonstration for farmers to exchange to the systematic agricultural system in Myanmar.

## 1.3 The Status of Land Consolidation in Nay Pyi Taw

In Nay Pyi Taw, land consolidation programs were initiated in 2011-2012. Farmland consolidation status in Nay Pyi Taw was described in Table 1.2. According to that table, the total farmland consolidation area was 577 ha in 2011-2012, 1,708 ha in 2012-2013, 1,310 ha in 2013-2014 and 219 ha in April, 2014-2015. Among the townships, the maximum farmland consolidation area was 1,453 ha in Dekkhinathiri Township and minimum farmland consolidation area was 23 ha in Ottarathiri Township from 2011-2012 to April, 2014-2015.

Implementation area led by AMD and private companies in Nay Pyi Taw (2011-2012 to April, 2014-2015) was indicated in Table 1.3. In 2011-2012, farmland consolidation area was 577 ha in which 316 ha were implemented by AMD and 261 ha were implemented by private companies. In 2012-2013, in total area of 1,708 ha, 1,389 ha was implemented by AMD and 319 ha was implemented by private companies. In 2013-2014, 1,310 ha and in April, 2014-2015, 219 ha was implemented by only AMD (AMD, Nay Pyi Taw April 2015).

**Table 1.1 Farmland consolidation work implemented in Myanmar as in April 2015**

| Regions/States | Implemented area (ha) | | | | | |
|---|---|---|---|---|---|---|
| | 1995-2011 | 2011-2012 | 2012-2013 | 2013-2014 | 2014-2015 | Total |
| Kachin | 0 | 0 | 0 | 226 | 325 | 551 |
| Kayah | 0 | 0 | 4 | 44 | 127 | 175 |
| Kayin | 0 | 0 | 61 | 47 | 427 | 535 |
| Sagaing | 54 | 32 | 233 | 57 | 247 | 623 |
| Tanintharyi | 0 | 0 | 0 | 40 | 40 | 80 |
| Nay Pyi Taw | 0 | 577 | 1,708 | 1,310 | 219 | 3,814 |
| Bago | 32 | 1,115 | 739 | 623 | 501 | 3,010 |
| Magway | 11 | 85 | 49 | 62 | 190 | 397 |
| Mandalay | 707 | 170 | 338 | 170 | 356 | 1,741 |
| Mon | 0 | 40 | 57 | 42 | 162 | 301 |
| Rakhine | 0 | 40 | 40 | 40 | 299 | 419 |
| Yangon | 9,075 | 1,118 | 404 | 147 | 69 | 10,813 |
| Shan | 0 | 0 | 0 | 40 | 141 | 181 |
| Ayeyarwaddy | 90 | 112 | 145 | 84 | 1,187 | 1,618 |
| Union total | 9,969 | 3,289 | 3,778 | 2,932 | 4,290 | 24,258 |

Source: AMD, Nay Pyi Taw (April 2015)

**Table 1.2 Farmland consolidation status in Nay Pyi Taw**

| Townships | Implemented area (ha) | | | | |
|---|---|---|---|---|---|
| | 2011-2012 | 2012-2013 | 2013-2014 | 2014-2015 | Total |
| Dekkhinathiri | 143 | 1,292 | 18 | 0 | 1,453 |
| Pobbathiri | 202 | 0 | 397 | 0 | 599 |
| Pyinmana | 178 | 0 | 357 | 0 | 535 |
| Zabuthiri | 34 | 117 | 140 | 140 | 431 |
| Lewe | 0 | 283 | 0 | 0 | 283 |
| Tatkon | 0 | 0 | 237 | 40 | 277 |
| Zeyarthiri | 20 | 16 | 138 | 39 | 213 |
| Ottarathiri | 0 | 0 | 23 | 0 | 23 |
| Total | 577 | 1,708 | 1,310 | 219 | 3,814 |

Source: AMD, Nay Pyi Taw (April 2015)

**Table 1.3 Implementation area led by AMD and private companies in Nay Pyi Taw**

| Particulars | Implemented area (ha) | | | | |
|---|---|---|---|---|---|
| | 2011-2012 | 2012-2013 | 2013-2014 | 2014-2015 | Total |
| Agricultural Mechanization Department | 316 | 1,389 | 1,310 | 219 | 3,234 |
| Private companies | 261 | 319 | 0 | 0 | 580 |
| Total | 577 | 1,708 | 1,310 | 219 | 3,814 |

Source: AMD, Nay Pyi Taw (April 2015)

### 1.4 Sown Area, Yield and Production of Rice

Rice (*Oryza sativa.* L.) is the staple food crop in our country and it is also grown throughout the country. The most major rice growing areas are Ayeyarwaddy, Yangon and Bago Regions. Rice is traditionally grown as summer rice (February-July) and monsoon rice (July-December) in our country.

Rice production has been increasing (60%) during the period of 1996-1997 to 2013-2014 and rice production is self-sufficiency and surplus has been exported to the other countries. Out of total rice production 27.9 million metric tons, 1.09 million metric tons was exported (MOAI 2014).

Total rice sown area and yield in Myanmar during the period of 1995-1996 to 2013-2014 were presented in Figure 1.1. The total sown area of rice increased from 6,138 thousand hectares to 8,047 thousand hectares between 1995-1996 and 2010-2011. However, the total sown area of rice was decreased from 8,047 thousand hectares to 7,284 thousand hectares between 2010-2011 and 2013-2014.

The average yield of rice was also increasing at a low rate from 3.08 MT/ha to 4.07 MT/ha during the period of 1995-1996 to 2010-2011. Average yield per hectare also decreased from 4.07 MT in 2010-2011 to 3.90 MT in 2013-2014. Therefore, the sown area and yield of rice were fluctuated within the period of 1995-1996 to 2013-2014.

Table 1.4 indicates the comparison of rice productions between Myanmar and other main Asian rice producing countries. The world's rice production was 676.50 million metric tons and production of Asia was 612.21 million metric tons in 2013. According to the situation of rice production in Myanmar, total harvested area of rice was 7.50 million hectares, total production was 25.40 million metric tons and yield per hectare was 3.73 MT. Rice productivity of Myanmar remains low in comparison with its international competitors and neighbors.

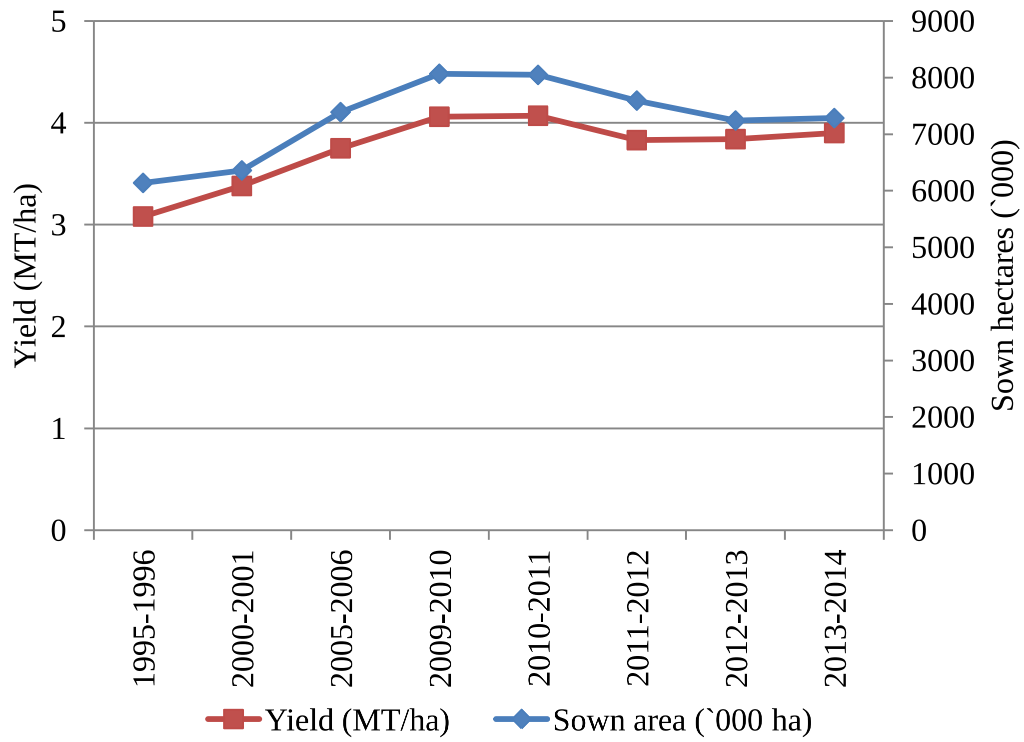


**Figure 1.1 Sown area and yield of rice in Myanmar (1995-1996 to 2013-2014)**

Source: MOAI (2014)

**Table 1.4 Rice productions in Myanmar and neighboring countries (2013)**

| Country | Harvested area (million ha) | Yield (MT/ha) | Production (million MT) |
|---|---|---|---|
| World | 164.72 | 4.53 | 676.50 |
| Asia | 146.46 | 4.61 | 612.21 |
| China | 30.23 | 6.73 | 184.42 |
| India | 43.50 | 3.66 | 144.43 |
| Indonesia | 13.84 | 5.15 | 64.66 |
| Bangladesh | 11.77 | 4.38 | 46.72 |
| Vietnam | 7.90 | 5.57 | 39.95 |
| Thailand | 12.37 | 3.13 | 35.19 |
| Myanmar | 7.50 | 3.73 | 25.40 |
| Philippines | 4.75 | 3.89 | 16.73 |
| Cambodia | 3.10 | 3.01 | 8.47 |
| Malaysia | 0.69 | 3.82 | 2.38 |
| Lao PDR | 0.88 | 3.75 | 2.99 |

Source: FAO (2014)

## 1.5 Rationale of the Study

Myanmar agriculture sector is still affected by land fragmentation. According to agricultural census 1993, there were 2.7 million landholdings comprising over 6.1 million plots of land. The average farm size was 2.35 ha (5.8 ac) with the average number of plots 2.2 per holding. The average farm size slightly increased to 2.52 ha (6.2 ac) in 2003 agricultural census (Lon et al. 2010). Land fragmentation where a single farm has a number of parcels of land, is one of the important features of agriculture in many countries, especially in developing countries (Hung et al. 2007). The agricultural land in Myanmar including Nay Pyi Taw has led to too small fragmented parcels, too many field ridges, low or unsustainable productivity, incomplete farm road and irrigation systems and lots of unused marginal land or wasteland. Land consolidation is generally as the most favorable approach for solving land fragmentation problem and also reduces the number of irregular parcels. The politicians recommended integration of land use to solve the problem of land distribution.

Because of the extensive nature of fragmentation and the growing importance of rural space for non-agricultural purposes, land consolidation has remained an important instrument in strategies. Farmland consolidation in Myanmar was launched with 369 ha by government subsidy since the period of 1984-1985. During the period of 1995-1996 to April, 2014-2015, Yangon Region was the most farmland consolidation area which was about 10,813 ha and the second largest farmland consolidation area was Nay Pyi Taw about 3,814 ha. Moreover, in Nay Pyi Taw, land consolidation program was implemented since 2011-2012. Therefore, it is necessary to study and analyze impact of land consolidation on production and profitability of rice cultivation in the selected households, Nay Pyi Taw.

## 1.6 Objectives of the Study

The overall objective of the study was to observe the impact of land consolidation on production and profitability of rice cultivation in the study area. The specific objectives were

(1) To study the demographic and socio-economic characteristics of participant and non-participant households in the study area,

(2) To analyze the profitability of rice production between participant and non-participant households in the study area,

(3) To investigate the determinants of rice production of the sample farm households and

(4) To assess the major constraints of rice production between these two groups.

# CHAPTER II
# LITERATURE REVIEW

## 2.1 The Concept of Land Consolidation

Land consolidation is generally considered as putting together small plots with the aim of making them viable and more productive per unit of investment, through economies of scale. These need not change the amount of land controlled by individuals and is therefore not necessarily an instrument for social justice (Zhou 1999). Lindenmaier et al. (2003) considered that land consolidation as a process which includes structural changes in farm land and providing the required infrastructures including irrigation system, drainage network and roads for agricultural development.

According to Pasakarnis and Maliene (2010), land consolidation can be described as the planned readjustment of the pattern of the ownership of land parcels with the aim of forming larger and more rational land holdings. Land consolidation has a close relationship with the four main function of land management: land tenure, land value, land use and land development (Williamson et al. 2010).

Also the land consolidation can be described in two different types as narrow and broad sense. The land consolidation in narrow meaning is; combining the fragmented properties without any infrastructure work. The land consolidation in broad meaning includes the irrigation, drainage, transportation, soil and water conservation measures and the measures required by the rural habitation as well as combining the fragmented properties (Cevik and Tekinel 1987).

The land consolidation in broad meaning includes the following issues:

- Integrating fragmented land
- Doing the necessary works for land leveling and reclamation of other soil properties
- The reorganization of the villages and the planning of environmental management
- Arrangement of roads in the village, improvement of farm buildings
- Providing the necessary land allocation for dams, roads, railways, airports, industry and tourism facilities afore (Takka 1993)

FAO (2003) argued that policymakers in different countries use four approaches for land consolidation. The first approach is comprehensive land consolidation which is the reallocation or exchange of land plots with an extensive renovating activities and social infrastructures. The second approach is simplified land consolidation which is the reallocation or exchange of land plots along with some renovating activities and some facilities. The third approach is voluntary group consolidation which is the reallocation or exchange of land plots on the basis of volunteers' participation. The last approach is individual consolidation is the reallocation or exchange of land plots in an informal and individual process without the government intervention. Based on these approaches, a number of land consolidation projects are executed in different countries.

## 2.2 Land Consolidation Program

Land fragmentation is a major problem in agriculture. The fragmentation of agricultural lands has been seen more or less in all countries. Land fragmentation is regarded as a feature of less developed agricultural systems (Hristov 2009). The main problems associated with land fragmentation can be outlined as follows: distance between parcels and the farmstead, many boundary lines, small size and irregular shape of parcels and lack of access. In particular, when parcels are spatially dispersed, travel time and hence costs in moving labor, machines etc. from one parcel to another, are increased (Niroula and Thapa 2005).

In addition, land fragmentation involves a complicated boundary network among parcels (hedges, stone walls, ditches, etc.) which cause land wastage because a part of a holding (especially in small parcels) remains uncultivated at the margins of the parcels (Burton 1988). Furthermore, the small size and irregular shape of parcels is another dominant problem associated with land fragmentation (Yates 1960). The use of modern machinery is difficult or may be impossible in tiny parcels and may require an excessive amount of manual work in the corners and along the boundaries (Bentley 1987). Therefore, land fragmentation can be a major obstacle to agricultural development because it hinders agricultural mechanization. As a result of these problems, productivity decreases and hence the income of farmers also declines. Thus, this situation emphasizes the need for agricultural commercialization via large farm sizes to attain the economies of scale.

Policy makers often propose land consolidation programs as a solution to the costs associated with land fragmentation. Most consolidation programs are results of government policies, ranging from large-scale mandatory programs to decentralized small programs encouraging consolidation on a more voluntary basis. The interventions vary in levels of formality and government involvement. Programs often include new roads, irrigation systems, settlement schemes and related services (Rose and Richard. 2002).

The main costs for a land consolidation program are:

- investigation of the composition and size of every owner's farm
- individual talks with the land owners at "days of wishes"
- elaboration of the design of the new consolidated properties
- valuation of all properties
- mediation and negotiation with all participating land owners
- surveying of the new boundaries

The costs for a land consolidation program are influenced by:

- degree of fragmentation
- number of real properties/parcels
- number of landowners and their attitude
- size of the consolidation area
- the length of all boundaries (Backman 2010)

## 2.3 Compensation Principles

Land consolidation will enhance agriculture production by means of uniformly leveled farmlands equipped with agricultural infrastructure such as irrigation and drainage canals and farm roads. However, necessary lands to be occupied by the infrastructure shall be availed out of the farmland presently owned by the beneficiary farmers. It means that the beneficiary farmers shall surrender a part of their farm land, in which no compensation can be made on conditions that the following are met;

(1) It has been confirmed that the productivity of the project area will increase more than the rate of the area to be discounted to the total area for securing the land necessary for the construction of agricultural infrastructure. Further, the lands shall be reallocated to each landowner with the discount of equal rate less than, in principle, 10% from each of their original areas before the land consolidation.

(2) The areas to be reallocated to the landowners upon completion of the land consolidation project should be equivalent to the areas they used to own before the land consolidation excluding the area acquired for the agriculture infrastructure construction, e.g. construction of farm roads, irrigation canals and drainage canals.

(3) Sufficient discussions among the concerned stakeholders including the whole beneficiary farmers on the project implementation have been carried out and the contents of the project, policy for compensations and supports have been agreed upon among the concerned beneficiary farmers.

(4) A complaint handling mechanism in order to deal with claims from not only the beneficiary farmers but also nearby inhabitants during and after the implementation period has been established prior to the project commencement (JICA 2014).

Otherwise, the following compensations or supports against the effects shall be undertaken by the responsible organizations according to the contents of dissatisfaction;

(1) On the loss of land (jointly contributed land), which is eliminated from the original farmland for the sake of agriculture infrastructure construction, provision of alternative land or compensation with the value for the reacquisition of equivalent land shall be arranged,

(2) On the land to be lost apart from the ones contributed for the sake of agriculture infrastructure construction, provision of alternative land or compensation with the value for the reacquisition of equivalent land shall be arranged,

(3) On the loss of income generation opportunity incurred by the temporal seizure of the land for land consolidation work, compensation for the loss of the opportunity and/or supports to livelihood recovery shall be provided and

(4) On structures such as houses and trees existing on the land for the project, compensation with the value for the requisition and/or supports for reconstruction in case removing and reconstructing the structures shall be arranged.

## 2.4 Analysis of Land Consolidation

Sadegh et al. (2011) mentioned that analysis of paddy-field consolidation effects for Iranian rice farmers. The most important targets of land consolidation projects are reducing expense generation and increasing rice farmers' income. The data for this research was collected from 176 farmers cultivating traditional rice fields and 188 farmers participating in a farm-development program in Guilan Province. The farmers were sampled by using a stratified random sampling method. The results showed that there are positive and significant relationships between rice farmer's satisfaction and variants such as rice farmer's education, rice farmer's income, eliminate drainage problem, eliminate the problems of irrigation and eliminate the problems of access to farm. The mean contrast results showed that there are significant differences between variants such as rice farmer's satisfaction, toxicity usage and number of parcels between the rice farmers with traditional and developed lands.

Sadegh et al. (2012) identified factor analysis of paddy-field consolidation: case study of Iran. Land consolidation is a strategy for the development of Iranian rice-growing regions. The most important targets of the program are reducing rice farmers' expenses and increasing their income. The objective of this article is to conduct a factor analysis of Iranian paddy-field consolidation. The survey data was collected from 188 farmers participating in a farm-development program in Guilan province by using stratified random sampling method. Factor analysis for farmers with rice fields in projects showed that five factors explained 63.92% of total variance. These factors were: (1) social, (2) instructional, (3) environmental, (4) economic and (5) institutional effects. Among these factors, only social effect was the greatest effect which explained 34.84% of total variance.

Ahmadpour et al. (2013) examined about factors affecting farmers' resistance to adoption of land consolidation case study: paddy farmers in Mazandaran province, Iran. This study was carried out to identify factors which contribute to the farmers' resistance to the adoption of land consolidation by farmers in Mazandaran province, Iran. In this study, 259 paddy farmers were interviewed by using cluster sampling method. Results from factor analysis show that ten factors discourage farmers to adopt land consolidation in Mazandaran Province including heritage law and conflict among farmers, being accustomed to traditions, rural population increase, land downsizing after consolidation, difference in lands' location, high costs for farmers, delay in provision of consolidated lands, lack of trust to government and finally land tenure system. These factors explained 62 percent of the total variance of the factors which contribute to the resistance of farmers to the adoption of land consolidation plan. The study suggested that to raise farmers' awareness on the advantages of land consolidation and to collaborate with agricultural bank for providing farmers with loans for land consolidation.

Dinpanah and Zand (2012) studied effective factors on the paddies' attitude of Sari County toward land consolidation. The goal of this research was to study the effective factors on the paddies attitude of Sari County towards land consolidation. In this study, 329 paddies were selected as sample by using the stratified random sampling method. Results showed that 83.6% of responders have had a good attitude and 16.4% have had a very good attitude toward Land consolidation. As well as, the results of step-by-step regression indicated that variables such as education level, informative resources usage, cultivation background, social participation, social permeability, the influence of the training-extension activities, using mass media, area under cultivation and age which explained 51.6% of changing the attitude toward land consolidation.

Bizoza and Havugimana (2013) reported that about land use consolidation in Rwanda: a case study of Nyanza District, Southern Province. The study assessed the adoption of land use consolidation and its determinants in Nyanza District of Southern Province, Rwanda. A sample of 132 households was randomly selected for the interviews. The analysis focused on farm, household and institutional factors to investigate how these determine household's decision to adopt land use consolidation. The findings showed that gender, family size, trust, distance, cropping/farming practices are important determinants of a farmer's decision to adopt land use consolidation in Nyanza District, Southern Rwanda.

Abdollahzadeh et al. (2012) analyzed that farmland fragmentation and consolidation issues in Iran; an investigation from landholder's viewpoint. The study showed that Iran is one of the countries facing the most severe farmland fragmentation (FF) in rural areas and farmland consolidation (FC) is generally regarded as being a suitable instrument to solve this problem. A case study in the central area of Iran was conducted to explore landholder's attitudes towards issues related to FF and FC. Randomized stratified sampling frame was used to select 146 landholders in 10 villages. The results showed that increasing production input costs (labor, fuel and machinery) is the most severe predicament caused by FF. Physical investments by government and access to credit and loan operate as promoter factors of FC according to landholders' view. Their most preferred options of FC are the government sponsored farming in rural production cooperative units including traditional cooperatives and informal peasantry societies to facilitate voluntary land consolidation**.**

Keikha and Keikha (2012) analyzed land consolidation and its economic effects on the city district of Loutak Zabol. The purpose was to increase agricultural production and mechanization, ultimately increasing productivity and improving the economic status of farmers in Loutak Zabol. In this study, two consolidation villages (Loutak and Islamabad) and two non-consolidation villages (Kalati Mosafer and Varmal) for comparison were examined. Methods were descriptive-analytical in the form of adaptive. The results showed that the land consolidation, reducing the number of parts, increasing acreage, increasing land values, reduced water consumption, increased use of agricultural machinery, agricultural products and ultimately increase the income of farmers had a significant effect. The study indicated that there is a direct relationship between the land consolidation and mechanization of the agricultural products.

## 2.5 Analysis of Production Function

Bhujel and Ghimire (2006) reported that estimation of production function of Hiunde (Boro) rice. Hiunde (Boro) rice had not been popularized due to least attention given to this crop in Nepal. In this study, to estimate the production function of this crop, a field survey in Morang district by using a semi-structured questionnaire. The result of the empirical model of Cobb-Douglas production function revealed the model significant at 1% level and defined 95% variation in Hiunde rice production due to variation in independent variables included in the model. The coefficient of area, nitrogen, phosphorous and tractor hour were found significant at 1% level while the dummy for more than 10 times of irrigation was significant at 5% level and up to 10 times of irrigation and potash was significant at 10% level. The effect of human and bullock labor was found non-significant. Among the sample farmers, the average cropping intensity was 194% and average yield of Hiunde rice was 4803 kg/ha and the benefit cost ratio was 1.73. About 31% cost was incurred in land preparation and transplanting which was highest among the operations. It was followed by the costs incurred in fertilizers and agrochemicals which counted 23%.

Ingabire et al. (2013) examined determinants and profitability of rice production in Cyabayaga Watershed, Eastern Province, Rwanda. The aim of this study was to analyze the determinants of rice production and its financial profitability. The study was composed of a stratified sample of 46 rice growers. In this study, Cobb-Douglas production function was adapted and estimated to indicate individual effects of land, labor and capital on rice production. In addition, Cost-Benefit Analysis (CBA) approach was opted to compute the financial profitability of rice growing in the study area. Results from the analysis substantiated that cultivated area (land) and labor had significant (5% significance level) contribution to rice yield. However, capital investment in form of inputs (seeds and fertilizers) was not statistically significant even at 15% significance level. Some farmers reported insufficient income to invest in rice production thus making the overall contribution of the investment factor insignificant for this case study. It is recommended to support these farmers to have access to inputs and agricultural trainings. These constitute the major area of their investments and constraints for improved and well sustained rice production in the study area.

Hussain (2013) studied on economic analysis of rice crop cultivation in District Swat was done in the year 2013. The purpose was to analyze input-output relationship and cost-revenue comparison of different rice varieties in district Swat. Three tehsils namely Kabal, Matta and Barikot were selected on the basis of purposive sampling technique. From each tehsil, three villages were selected and seven rice varieties (JP-5, Basmati-385, Sara Saila, Swat-1, Swat-2, Dil Rosh-97 and Fakhr-e-Malakand) were grown. Primary data were collected from 100 respondents randomly selected through structured questionnaire. For data analysis, benefit cost ratios, log-linear Cobb-Douglas production function, Wald test and marginal rate of substitutions were estimated. According to the results maximum benefit cost ratio was noted for variety Fakhr-e-Malakand (3.41) followed by Basmati-385 (3.37). The output elasticity of area, tractor hours, fertilizer, seed, labor and pesticides were observed as 0.3112, 0.0012, 0.5924, 0.6212, 0.5124 and 0.0013, respectively. It showed that rice input-output relationship holds increasing returns to scale. The farmers should be advised to cultivate high yielding varieties like Fakhr-e-Malakand and also use improved seed.

Abdullahi (2012) mentioned that comparative economic analysis of rice production by adopters and non-adopters of improved varieties among farmer in Paikoro local government area of Niger State. This study was on the Comparative Economic Analysis of Adopters and Non-adopters of improved rice varieties among farmers in Paikoro Local Area of Niger State. Primary data were collected using a structured questionnaire administered to 90 respondents, which consist of 45 adopters of improved rice variety and 45 non-adopters of improved rice variety using stratified random sampling technique. Descriptive statistics, gross margin and production function were used in analyzing the data. The results revealed that 68.9% of adopters were male, while for the non-adopters, 53.3% were male. Costs and returns analysis showed that adopters had the highest mean gross margin compared to non-adopters. Farm Size and fertilizer were significant at 1% and improved seed was significant at 5% level for the adopters, while only farm size and quantity of agro-chemicals were significant at 1% and 10% respectively for the non-adopters. Some of the problems encountered by both categories of farmers in the study area include; pests and diseases, high cost of seed, fertilizer and labor. It is recommended that policy should be designed to ensure adequate supply of inputs to farmers at subsidized rates and extension packages should also be extended to non-adopters.

Chidi et al. (2015) studied analysis of socio-economic factors and profitability of rice production among small-scale farmers in Ebonyi State. This study investigated on socio-economic factors and profitability of rice production among small-scale farmers in Ebonyi state. Multi-stage random sampling technique was employed to select a total of 120 rice farmers. The primary data were collected for the study through structured questionnaire. Analytical tool adopted for the study include; frequency, percentages, and multiple regression analysis and factor analysis. In the result of multiple regression analysis, it was observed that coefficient of determination was 87% and all the variables used were positively signed and some statistically insignificant such as age, marital status, household size, educational level, farming experience and annual income. The statistically significant ones were occupation, gender and farm size. The major constraints limiting the rice production were identified as economic problem, infrastructural issue and unfavorable government policies.

# CHAPTER III
# RESEARCH METHODOLOGY

## 3.1 Conceptual Framework of the Study

The conceptual framework of the study was shown in Figure 3.1. It included four variables such as social indicators, economic indicators, institutional indicators and perceptions of farmers. The general conceptual framework of this study is framed on the participation or not in land consolidation program. In this framework, farmers whether participation or not in land consolidation program which impacts on agricultural productivity. Agricultural productivity would be correlated by their social indicators such as age, education level, farm experience, family size and assets. Not only social indicators of farmers but also economic indicators would be related to agricultural production at farm level. The availability of extension service, credit and infrastructure of participant and non-participant households can influence on agricultural productivity. In addition, farmers' perceptions based on general constraints of production can impact on agricultural production.

## 3.2 Study Area

### 3.2.1 General description of the study area

Nay Pyi Taw is located between the Bago Yoma and Shan Yoma mountain ranges as well as lies between 1.9 miles West of Pyinmana Township and approximately 200 miles North of Yangon. It is also at the Southern tip of the central dry zone. It stands at 19˚ 45′ North latitude and 96˚ 6′ East longitude and has an area of 7,054.37 $km^2$. It is situated at 400 ft elevation above the sea level. It is more centrally and strategically located than the old capital, Yangon. It is also a transportation hub located adjacent to the Shan, Kayah and Kayin states.

Nay Pyi Taw Union Territory consists of eight administrative townships: Pyinmana, Lewe, Tatkon, Ottarathiri, Dekkhinathiri, Pobbathiri, Zabuthiri and Zeyarthiri Townships. There were about 1,558,367 populations in these townships of Nay Pyi Taw (Department of population 2014).

The study area, Pyinmana Township, there was 29 village tracts consisting of 140 villages and total population of 180,966. The number of household was 36,450 and the number of farm household was 7,659. In Zeyarthiri Township, it was comprised of 13 village tracts with total of 65 villages. There were 23,956 households with population of 97,415 and the number of farm household was 7,168 (Table 3.1). The maps of Pyinmana and Zeyarthiri Townships showing selected village tracts were presented in Appendix 1 and 2 (DoA, Pyinmana and Zeyarthiri Townships 2014).

The selected village tract, Nutthaye village tract occupied the total land area of 1,127 ha in which the cultivated area was 964 ha and farmland consolidation area was 189 ha. In Mautaw village tract, the total land area was 529 ha, the cultivated area was 497 ha and farmland consolidation area was 60 ha (Table 3.2). The household level survey was carried out in four villages from Pyinmana Township and two villages from Zeyarthiri Township. The data of studied villages were described in Table 3.3.

### 3.2.2 Climate

There are tropical and sub-tropical climates with three general seasons; namely the hot season, rainy season and winter season in Myanmar. The hot season from mid February to mid May, the rainy season during the south west monsoons from mid May to mid October and the winter season from mid October to mid February. The climate of Nay Pyi Taw is tropical. In winter, there is much less rainfall than in summer. The average temperature was 26.8$^{\circ}$ C and the average precipitation was 1,167 mm.

For Pyinmana Township, Figure 3.2 shows a maximum precipitation of 403 mm was found in August and a minimum precipitation of 21.8 mm was found in November. There was no precipitation from January to March and December in year 2014. For Zeyarthiri Township, Figure 3.3 shows a maximum precipitation of 369 mm was found in August and a minimum precipitation of 6.86 mm was found in November. There was no precipitation from January to April, October and December in year 2014 (DoA, Pyinmana and Zeyarthiri Townships 2014).

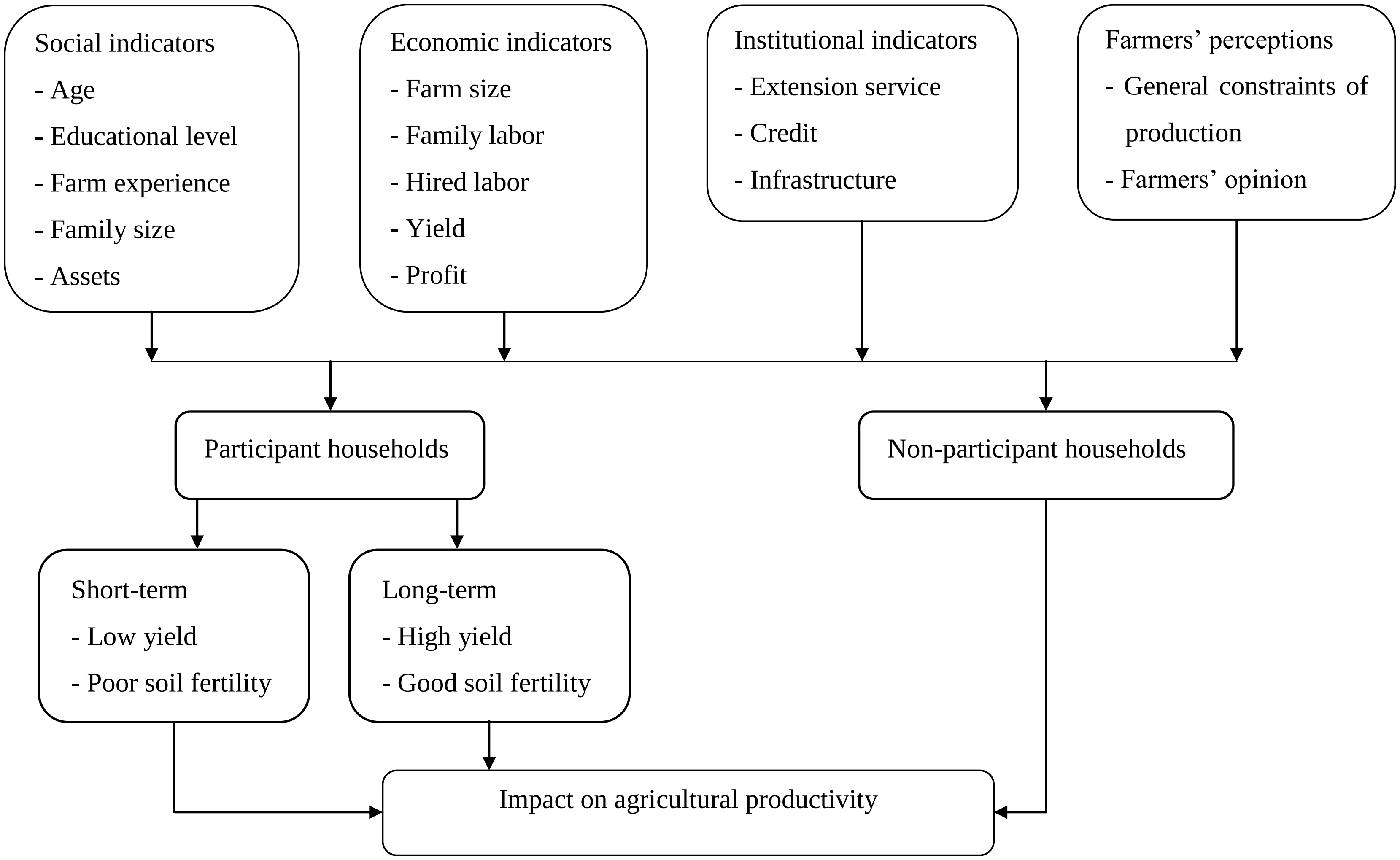


**Figure 3.1 Conceptual framework of the study**

**Table 3.1 General descriptions of Pyinmana and Zeyarthiri Townships**

| Items | Pyinmana | Zeyarthiri |
|---|---|---|
| No. of village tract | 29 | 13 |
| No. of village | 140 | 65 |
| Population | 180,966 | 97,415 |
| No. of household | 36,450 | 23,956 |
| No. of farm household | 7,659 | 7,168 |

Source: DoA, Pyinmana and Zeyarthiri Townships (2014)

**Table 3.2 General descriptions of the selected village tracts**

| Items | Nutthaye | Mautaw |
|---|---|---|
| No. of village | 5 | 4 |
| Population | 5,469 | 4,807 |
| No. of household | 1,194 | 1,338 |
| No. of farm household | 817 | 325 |
| Land area (ha) | 1,127 | 529 |
| Cultivated area (ha) | 964 | 497 |
| Consolidated farmland area (ha) | 189 | 60 |

Source: DoA, Pyinmana and Zeyarthiri Townships (2014)

**Table 3.3 Total population and household of the studied villages**

| Items | Nutthaye | | | Mautaw | | |
|---|---|---|---|---|---|---|
| | Nutthaye | Tartikone | Panpaesu | Kyanpho | Mautaw | Seinsarpin |
| Population | 2,122 | 914 | 624 | 407 | 1,001 | 1,855 |
| No. of HH | 492 | 186 | 140 | 97 | 277 | 503 |
| No. of farm HH | 300 | 53 | 32 | 30 | 34 | 77 |

Note: HH = Household

Source: Field survey (2014)

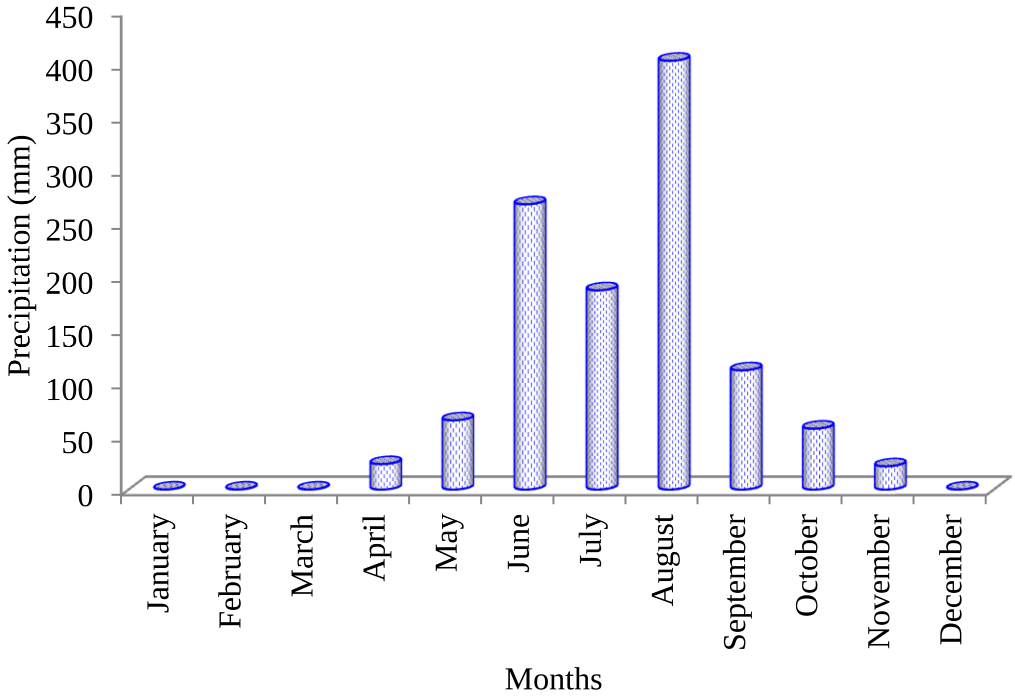


**Figure 3.2 Precipitations (mm) in Pyinmana Township (2014)**

Source**:** DoA, Pyinmana Township (2014)

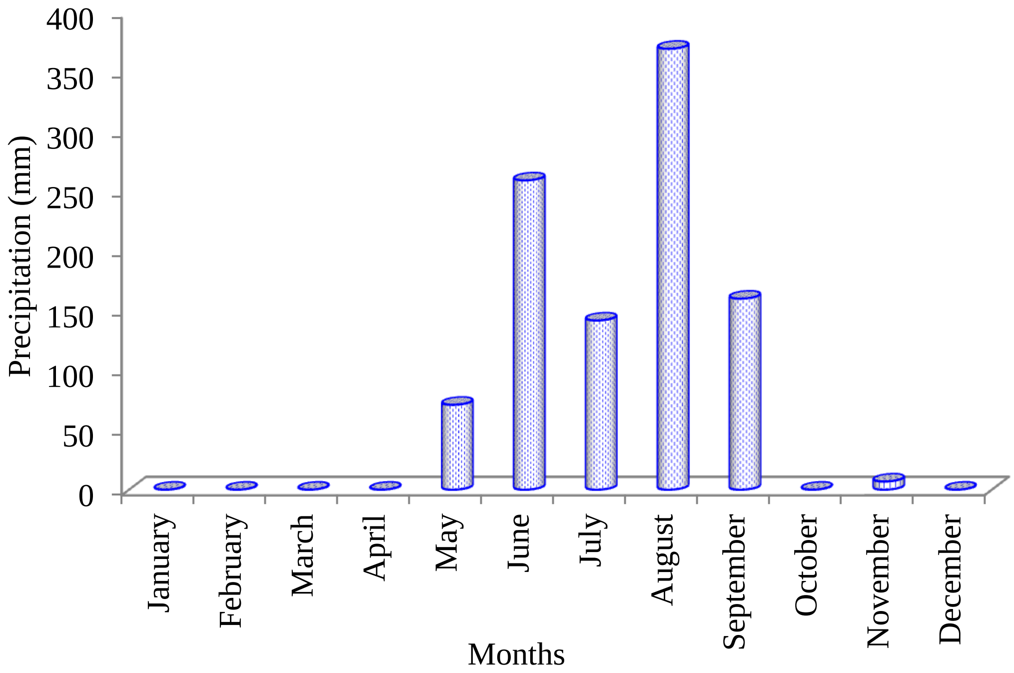


**Figure 3.3 Precipitations (mm) in Zeyarthiri Township (2014)**

Source**:** DoA, Zeyarthiri Township (2014)

### 3.2.3 Land utilization and rice production of Pyinmana and Zeyarthiri Townships

The study area, Pyinmana Township occupied the land area of 110.28 thousand hectares and the total cultivated land area of 11.02 thousand hectares (9.99%). Total cultivated land area was classified as 6.51 thousand hectares of lowland, 1.79 thousand hectares of upland and 2.72 thousand hectares of horticultural land in 2013-2014 growing season. On the other hand, there were reserved forest land of 10.22 thousand hectares, wild land of 75.07 thousand hectares, arable wild land of 0.06 thousand hectares and others of 13.91 thousand hectares in total land area.

Zeyarthiri Township occupied the land area 59.77 thousand hectares and the total cultivated land area 9.47 thousand hectares (15.84%). Total cultivated land area was divided into 5.34 thousand hectares of lowland, 4.13 thousand hectares of upland in 2013-2014 growing season. On the other hand, there were wild land of 10.70 thousand hectares and others of 39.60 thousand hectares in total land area (Table 3.4).

Table 3.5 indicates rice production of the Pyinmana and Zeyarthiri Townships during the period of 2011-2012 to 2013-2014. In Pyinmana Township, the harvested area of monsoon rice was 6.39 thousand hectares and the yield and production was 4.81 MT/ha and 30.37 thousand metric tons, respectively in 2013-2014. In summer rice, the harvested area of summer rice was 0.97 thousand hectares, the yield was 6.58 MT/ha and the production was 6.33 thousand metric tons in 2013-2014.

In Zeyyarthiri Township, the harvested area, yield and production of monsoon rice were 4.87 thousand hectares, 4.88 MT/ha and 23.48 thousand metric tons, respectively in 2013-2014. In summer rice production, there were about 1.67 thousand hectares of harvested area, 5.49 MT/ha of yield and 9.04 thousand metric tons of total production in 2013-2014.

**Table 3.4 Land utilization in Pyinmana and Zeyarthiri Townships (2013-2014)**

| No. | Types of land | Pyinmana | | Zeyarthiri | |
|---|---|---|---|---|---|
| | | Area (`000 ha) | Percentage | Area (`000 ha) | Percentage |
| 1. | (a) Lowland | 6.51 | 59.09 | 5.34 | 56.37 |
| | (b) Upland | 1.79 | 16.21 | 4.13 | 43.63 |
| | (c) Horticultural land | 2.72 | 24.70 | - | - |
| | **Total cultivated land** | **11.02** | **9.99** | **9.47** | **15.84** |
| 2. | Reserved forest land | 10.22 | 9.27 | - | - |
| 3. | Wild land | 75.07 | 68.07 | 10.70 | 17.90 |
| 4. | Arable wild land | 0.06 | 0.05 | - | - |
| 5. | Others | 13.91 | 12.62 | 39.60 | 66.26 |
| | Total | 110.28 | 100.00 | 59.77 | 100.00 |

Source: DoA, Pyinmana and Zeyarthiri Townships (2014)

**Table 3.5 Rice productions in Pyinmana and Zeyarthiri Townships**

| Items | Pyinmana | | | | | | Zeyarthiri | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Monsoon rice | | | Summer rice | | | Monsoon rice | | | Summer rice | | |
| | 2011-2012 | 2012-2013 | 2013-2014 | 2011-2012 | 2012-2013 | 2013-2014 | 2011-2012 | 2012-2013 | 2013-2014 | 2011-2012 | 2012-2013 | 2013-2014 |
| Sown area (`000 ha) | 6.39 | 6.48 | 6.69 | 0.86 | 0.35 | 0.97 | 4.86 | 4.86 | 4.87 | 1.60 | 1.64 | 1.67 |
| Harvested area (`000 ha) | 6.35 | 6.43 | 6.39 | 0.86 | 0.35 | 0.97 | 4.86 | 4.86 | 4.87 | 1.60 | 1.64 | 1.67 |
| Yield (MT/ha) | 4.70 | 4.72 | 4.81 | 6.12 | 6.58 | 6.58 | 4.80 | 4.84 | 4.88 | 5.31 | 5.38 | 5.49 |
| Production (`000 MT) | 29.51 | 29.98 | 30.37 | 5.18 | 2.27 | 6.33 | 23.04 | 23.26 | 23.48 | 8.41 | 8.71 | 9.04 |

Source: DoA, Pyinmana and Zeyarthiri Townships (2014)

### 3.3 Data Collection and Sampling Method

Both primary and secondary data were used in this study. The survey was conducted during the period of November to December, 2014. A combination of multi-stage and purposive sampling methods was used to select the sample farm households for the study. Firstly, Pyinmana and Zeyarthiri Townships in Nay Pyi Taw were purposively selected as the study area based on farmland consolidation area. Within the selected townships, Nutthaye village tract from Pyinmana Township and Mautaw village tract from Zeyarthiri Township were purposively selected. Afterward, four villages (Nutthaye, Tartikone, Panpaesu and Kyanpho) from Nutthaye village tract of Pyinmana Township and two villages (Mautaw and Seinsarpin) from Mautaw village tract of Zeyarthiri Township were randomly selected. The primary data were collected by interviewing 60 participant households who participated in land consolidation program and 60 non-participant households who did not participate in that program from Pyinmana and Zeyarthiri Townships. They were randomly selected and interviewed with well structural questionnaires.

Demographic and socio-economic characteristics of rice farmers such as age, education level as well as farm experience, family size and labor, annual household income, household assets and farm implements were collected. And also cultural practices of rice production such as land owned, rice production area, varieties used, cropping patterns, utilization of seed, fertilizer, insecticide and farm yard manure were collected. Moreover, cost and return of rice production, general constraints of participant and non-participant households in land consolidation program were collected.

The secondary data were obtained from different government agencies including Ministry of Agriculture and Irrigation (MOAI), Department of Agriculture (DoA), Agricultural Mechanization Department (AMD) and other relevant data sources.

### 3.4 Data Analysis Methods

Data entry for both qualitative and quantitative data was done by using the Microsoft Excel program. These data were analyzed by Excel Software and Statistical Packages for Social Science (SPSS) version 16.0 software. The analytical techniques used in this study were descriptive analysis, cost and return analysis and production function analysis using the Ordinary Least Square (OLS) criterion to estimate the parameters of the production function.

### 3.4.1 Descriptive analysis

Descriptive analysis as a part of the numerical methodology such as mean, minimum, maximum and percentage was used to describe or summarize the demographic and socio-economic characteristics, cropping patterns, yield, inputs used in rice production, general constraints and perception of participant and non-participant households in land consolidation program.

### 3.4.2 Cost and return analysis

Enterprise budgeting is the first tool used in the economic analyses. An enterprise budget is a physical and financial plan for raising and selling a particular crop or livestock commodity. It is a physical plan because it indicates the type and quantity of production inputs and the output or yield, per unit. It is also a financial plan because it assigns costs to all the inputs used in producing the commodity (Carkner 2000).

Enterprise budget enables to evaluate the cost and return of production process. Hired labor costs were valued by market wage rates and man days used in all farming practices. In order to estimate gross return for respective crops, average yield and average price were used. Benefit cost ratio was used as profitability measures for each crop enterprise computing total gross margin or return above variable cost and return above cash costs. Input quantities and values used in production process (costs) and output quantities and values (benefits) are the basic data required for budgets. The purpose of enterprise budgeting was to show the difference in net benefits under several resources situations in such a way as to help one make management decision (Olson 2009).

The cost and return analysis was used to assess the profitability of rice production in the study area on an average basis. In this analysis, the variable cost of the rice production was divided into four categories as follows:

(1) Material input cost,

(2) Hired labor cost,

(3) Family labor cost and

(4) Interest on cash cost.

The interest was normally charged on cash expense for early in the growing season. The counted interest rate was 3% for cropping period of 4 months. The first measurement was the difference between the total gross benefits or total returns and total variable cash costs; excluding on opportunity costs. This value was referred to as "return above variable cash cost". The second measurement was deduction of the opportunity cost and total variable cash cost from gross benefit. This return was referred to as "return above variable cost" or "gross margin". The "return per unit of capital invested" was calculated by gross benefit per total variable cost. The "return per unit of cash cost expensed" was calculated by gross benefit per total cash cost (Olson 2009).

These measurements could be expressed with equations as:

**Measurement (1)**

Return above variable cash cost = Total gross benefit – Total variable cash cost

**Measurement (2)**

Return above variable cost = Total gross benefit – Total variable cost (Gross margin)

**Measurement (3)**

Return per unit of capital invested = Total gross benefit/Total variable cost

**Measurement (4)**

Return per unit cash cost = Total gross benefit/Total cash cost

### 3.4.3 Production function analysis

The production function is a mathematical expression that describes a systematic relationship between inputs and output in an economy and that has been used extensively (Kosianchuk 2013).

In its most standard form for production of a single good with two factors, the function is

$$Y = AL^{\alpha}K^{\beta}$$

Where,

Y = output

L = labor input

K = capital input

A = constant

α and β are the output elasticity of capital and labor, respectively.

The Cobb-Douglas production function was transferred into log-linear form as:

$$LnY = LnA + \alpha LnL + \beta LnK + \mu$$

The goal of a regression analysis is to obtain estimates of the unknown parameters, $\beta_0$ to $\beta_k$ which indicate how a change in one of the independent variable affects the values taken by the dependent variable.

This can be formulated by

$$Y_i = \beta_0 + \beta_i X_{i1} + \ldots + \beta_k X_{ik} + \mu_i$$

Where,

$Y_i$ = dependent variable

$X_{i1} \ldots X_{ik}$ = a set of independent variables

$\beta_0$ to $\beta_k$ = the intercept and asset of parameters related to the independent variables to be estimated

$\mu_i$ = disturbance term or error term

### 3.4.4 Empirical production function of rice production in the study area

To determine influencing factors of rice production of the study area, linear regression function was used. In monsoon rice production, the dependent variable was monsoon rice production by the sample farm households and independent variables were household head's age, household head's education level, household head's farm experience, seed rate, amount of FYM, fertilizer, pesticide, herbicide, fungicide, number of machine day, animal labor, human labor, land consolidation program (participant households = 1, non-participant households = 0), monsoon rice variety (Manawthukha = 1, other = 0).

$$Ln\ Y_i = \beta_0 + \beta_1 LnX_{1i} + \beta_2 LnX_{2i} + \beta_3 LnX_{3i} + \ldots + \beta_{12} LnX_{12i} + D_{1i} + D_{2i} + \mu_i$$

Where,

| | |
|---|---|
| Ln | = Natural logarithm |
| i | = $i^{th}$ farm in the sample |
| Y | = Monsoon rice production (kg) |
| $X_{1i}$ | = Household head's age (Year) |
| $X_{2i}$ | = Household head's education level |
| $X_{3i}$ | = Household head's farm experience (Year) |
| $X_{4i}$ | = Seed rate (kg) |
| $X_{5i}$ | = Amount of FYM (MT) |
| $X_{6i}$ | = Amount of fertilizer (kg) |
| $X_{7i}$ | = Amount of pesticide (L) |
| $X_{8i}$ | = Amount of herbicide (L) |
| $X_{9i}$ | = Amount of fungicide (L) |
| $X_{10i}$ | = Number of machine day (machine day) |
| $X_{11i}$ | = Number of animal labor (animal day) |
| $X_{12i}$ | = Number of human labor (man day) |
| $D_{1i}$ | = Land consolidation program (participant households = 1, non-participant households = 0) |
| $D_{2i}$ | = Monsoon rice variety (Manawthukha = 1, other = 0) |
| $\mu_i$ | = Disturbance term or error term |
| $\beta_o,\ldots,\beta_{12}$ | = Coefficients of respective variables, i = 1,2,3, …, n |

In summer rice production, the dependent variable was summer rice production by the sample farm households and independent variables were household head's age, household head's education level, household head's farm experience, seed rate, amount of FYM, fertilizer, pesticide, herbicide, fungicide, number of machine day, animal labor, human labor, land consolidation program (participant households = 1, non-participant households = 0), summer rice variety (Pearlthwe = 1, other = 0).

$$Ln\ Y_i = \beta_0 + \beta_1 LnX_{1i} + \beta_2 LnX_{2i} + \beta_3 LnX_{3i} + \ldots + \beta_{12} LnX_{12i} + D_{1i} + D_{2i} + \mu_i$$

Where,

Ln = Natural logarithm

i = $i^{th}$ farm in the sample

Y = Summer rice production (kg)

$X_{1i}$ = Household head's age (Year)

$X_{2i}$ = Household head's education level

$X_{3i}$ = Household head's farm experience (Year)

$X_{4i}$ = Amount of seed (kg)

$X_{5i}$ = Amount of FYM (MT)

$X_{6i}$ = Amount of fertilizer (kg)

$X_{7i}$ = Amount of pesticide (L)

$X_{8i}$ = Amount of herbicide (L)

$X_{9i}$ = Amount of fungicide (L)

$X_{10i}$ = Number of machine day (machine day)

$X_{11i}$ = Number of animal labor (animal day)

$X_{12i}$ = Number of human labor (man day)

$D_{1i}$ = Land consolidation program (participant households = 1, non-participant households = 0)

$D_{2i}$ = Summer rice variety (Pearlthwe = 1, other = 0)

$\mu_i$ = Disturbance term or error term

$\beta_o, \ldots, \beta_{12}$ = Coefficients of respective variables, i = 1, 2, 3, …, n

# CHAPTER IV
# RESULTS AND DISCUSSION

In this section, the detailed socio-economic and demographic characteristics of participant and non-participant households in land consolidation program were described. In addition, cost and return analysis of rice production of participant and non-participant households, the determinants of rice production and the major constraints of rice cultivation were explored.

## 4.1 Demographic and Socio-economic Characteristics of the Sample Farm Households

### 4.1.1 Description of participant and non-participant households in land consolidation program

In the sample farm households, there were two types of respondents: participant and non-participant households in land consolidation program. There were 8 participant households from Nutthaye, 6 from Tartikone, 14 from Panpaesu, 15 from Kyanpho, 9 from Mautaw and 8 from Seinsarpin villages interviewed respectively. There were 3 participant households from Nutthaye, 5 from Tartikone, 10 from Panpaesu, 6 from Kyanpho, 20 from Mautaw and 16 from Seinsarpin villages interviewed respectively (Table 4.1).

### 4.1.2 Gender status of participant and non-participant household heads

The gender status of participant and non-participant household heads were presented in Table 4.2. In participant households, 53 (88.33%) of household heads were male and 7 (11.67%) of household heads were female. In non-participant households, 51 (85%) of household heads were male and 9 (15%) of household heads were female. Majority of them were male household heads. The Pearson Chi-square test showed that the gender of household heads was not significantly different between participant and non-participant households.

**Table 4.1 Number of participant and non-participant households in land consolidation program**

| Village names | Participant households (n = 60) | Non-participant households (n = 60) | Total households (n = 120) |
|---|---|---|---|
| Nutthaye | 8 | 3 | 11 |
| Tartikone | 6 | 5 | 11 |
| Panpaesu | 14 | 10 | 24 |
| Kyanpho | 15 | 6 | 21 |
| Mautaw | 9 | 20 | 29 |
| Seinsarpin | 8 | 16 | 24 |
| Total | 60 | 60 | 120 |

**Table 4.2 Gender status of participant and non-participant household heads**

| Gender of household heads | Participant households (n = 60) | Non-participant households (n = 60) | Total households (n = 120) |
|---|---|---|---|
| Male | 53 (88.33) | 51 (85.00) | 104 (86.67) |
| Female | 7 (11.67) | 9 (15.00) | 16 (13.33) |
| *Pearson Chi-square* | $P = 0.591^{ns}$ | | |

Note: Figures in the parentheses represent percentage.

ns = not significant

### 4.1.3 Socio-economic characteristics of participant and non-participant households

In the study area, the average heads' age of participant households were around 50 years and that of non-participant households were around 52 years. There was not significantly different in average head's age between participant and non-participant households. Farmers' farm experience plays a vital role in agricultural farming activities. Participant household heads had 25.13 years farm experience on average while non-participant household heads had farm experience of 25.50 years on average. The average farm experience was not significantly different between these two groups. About 18.33% of participant household heads and about 16.67% of non-participant household heads had secondary job (casual labor, carpenter, driver and so on). There was not significantly different in secondary job of heads between participant and non-participant households.

In this study, education level of the household heads was categorized into five groups: (1) "Monastery education" referred informal schooling although they could read and write, (2) "Primary level" referred formal schooling up to 5 years, (3) "Middle school level" intended formal schooling up to 9 years, (4) "High school level" referred formal schooling up to 11 years and (5) "University education" referred to those who received degree from college or university. The education level of farmers was assumed to do decision making of their farming system.

About 16.67% of participant household heads and about 15% of non-participant household heads had only monastery education level. About 41.67%, 26.67%, 13.33% of participant household heads attended the primary, middle school and high school education levels, respectively. On the other hand, about 53.33%, 15% and 11.67% of non-participant household heads attended at the primary, middle school and high school education level, respectively. About 1.66% of participant household heads and 5% of non-participant household heads had only university education level. In the education statuses, most of participant and non-participant household heads were at the primary education level. The Pearson Chi-square test showed that the average education level was not significantly different between participant and non-participant households (Table 4.3).

**Table 4.3 Socio-economic characteristics of participant and non-participant households**

| Items | Units | Participant households (n = 60) | Non-participant households (n = 60) | Total households (n = 120) |
|---|---|---|---|---|
| Average head's age | Year | 50.48 | 51.88 | 51.18 |
| *t-test* | | *t = -0.618*$^{ns}$ | | |
| Average head's farm experience | Year | 25.13 | 25.50 | 25.32 |
| *t-test* | | *t = -0.155*$^{ns}$ | | |
| Head's secondary job | No. | 11 (18.33) | 10 (16.67) | 21 (17.50) |
| *Pearson Chi-square* | | *P = 0.810*$^{ns}$ | | |
| **Head's education level** | | | | |
| Monastery | No. | 10 (16.67) | 9 (15.00) | 19 (15.83) |
| Primary | No. | 25 (41.67) | 32 (53.33) | 57 (47.50) |
| Middle school | No. | 16 (26.67) | 9 (15.00) | 25 (20.83) |
| High school | No. | 8 (13.33) | 7 (11.67) | 15 (12.50) |
| University | No. | 1 (1.66) | 3 (5.00) | 4 (3.34) |
| *Pearson Chi-square* | | *P = 0.414*$^{ns}$ | | |

Note: Figures in the parentheses represent percentage.

ns = not significant

### 4.1.4 Family size and labor of participant and non-participant households

Family size and labor availability of participant and non-participant households were described in Table 4.4. The average family size was about 5 members for both households. The t-test showed that there was no significant difference in household size between participant and non-participant households.

The family labor is the main input for rice production. The average number of family labor was about 2 members between participant and non-participant households. There was no significant difference in family labor between these groups. The average dependency ratios for participant and non-participant households were 48.05% and 39.80%, respectively. Participant households have more dependent numbers (children) than non-participant households. Therefore, the t-test showed that the dependency ratio between participant and non-participant households was significantly different at 10% level.

### 4.1.5 Farm size and types of land ownership of participant and non-participant households

The average farm size of participant and non-participant households were 2.49 ha and 1.95 ha. The t-test showed that there was no significant difference in land holding size between participant and non-participant households. Among the average farm size, participant households possessed 2.15 ha of lowland including 2 ha of consolidated farmland and 0.15 ha of unconsolidated farmland, 0.34 ha of upland and 0.003 ha of other land. In non-participant households, lowland 1.85 ha and upland 0.11 ha were owned. The t-test showed that there was not significantly different in lowland and other land between participant and non-participant households. However, there was significantly different in upland between these two groups at 5% level (Table 4.5).

In terms of types of land ownership of participant households, average own cultivated area was 2.42 ha, average rent out area was 0.03 ha and rent in area was 0.04 ha. Moreover, average own cultivated area of non-participant households was 1.83 ha, average rent out and rent in area was 0.08 ha and 0.04 ha, respectively. There was significant difference in own cultivated area between these two groups at 10% level (Table 4.6).

Figure 4.1 illustrates percent of types of cultivated land of participant households were 88% in lowland (Le) and 12% in upland (Ya). On the other hand, 96% of non-participant households cultivated lowland and only 4% of non-participant households cultivated upland.

### 4.1.6 Comparison of productive assets of participant and non-participant households

In farm productive assets, more or less 40% of participant households possessed plough, harrow, cattle, bullock cart and power tiller. And also, more or less 30% of non-participant households owned plough, harrow, cattle and bullock cart and 23.33% of non-participant households possessed power tiller. In the possession of seeder and inter-cultivator, participant households were greater than non-participant households. Most of participant and non-participant households possessed sprayer for spraying insecticide. About 71.67% of participant households and 50% of non-participant households owned warehouse for storing rice. Participant households possessed more traditional farm implements such as plough (48.33%), harrow (46.67%) and bullock cart (46.67%) and machineries such as power tiller (41.67%), thresher (26.67%) and pump (31.67%) than those of non-participant households. In the ownership of farming assets, there was significant difference in nearly all items except ownership of cattle, inter-cultivator and sprayer in the sample farm households (Table 4.7).

### 4.1.7 Comparison of participant and non-participant households in the ownership of household and luxury assets

In type of house, majority of participant households and non-participant households owned wooden house. Only 5% of both participant and non-participant households lived in bamboo house.

Most of participant and non-participant households possessed television (TV), digital video disc (DVD), motor bike and hand phone. About 60% of participant households possessed bicycle compared to 76.67% of non-participant households. About 11.67% of participant households and only 3.33% of non-participant households owned freight truck. In household assets, there was no significant difference in all items except ownership of bicycle and freight truck between participant and non-participant households (Table 4.8).

**Table 4.4 Average family size and labor of participant and non-participant households**

| Items | Units | Participant households (n = 60) | Non-participant households (n = 60) | *t-test* | Total households (n = 120) |
|---|---|---|---|---|---|
| Average family size | No. | 5.10 | 5.00 | $t = 0.318^{ns}$ | 5.05 |
| Average family farm labor | No. | 2.13 | 2.07 | $t = 0.284^{ns}$ | 2.10 |
| Average dependency ratio | % | 48.05 | 39.80 | $t = 1.907^{*}$ | 43.93 |

Note: * is significant different at 10% level and ns = not significant.

**Table 4.5 Average farm size of participant and non-participant households**

(ha)

| Items | Participant households (n = 60) | Non-participant households (n = 60) | *t-test* | Total households (n = 120) |
|---|---|---|---|---|
| Average farm size | 2.49 | 1.95 | $t = 1.486^{ns}$ | 2.22 |
| Average lowland | 2.15 | 1.85 | $t = 1.021^{ns}$ | 2.00 |
| (a) Consolidated farmland | 2.00 | - | - | - |
| (b) Unconsolidated farmland | 0.15 | | | |
| Average upland | 0.34 | 0.11 | $t = 2.066^{**}$ | 0.22 |
| Average other land | 0.003 | - | $t = 1.000^{ns}$ | 0.002 |

Note: ** is significant different at 5% level and ns = not significant.

**Table 4.6 Types of land ownership of participant and non-participant households**

(ha)

| Average sown area | Participant households (n = 60) | Non-participant households (n = 60) | *t-test* | Total households (n = 120) |
|---|---|---|---|---|
| Own | 2.42 | 1.83 | $t = 1.697^{*}$ | 2.12 |
| Rent out | 0.03 | 0.08 | $t = -0.826^{ns}$ | 0.06 |
| Rent in | 0.04 | 0.04 | $t = -0.075^{ns}$ | 0.04 |

Note: * is significant different at 10% level and ns = not significant.

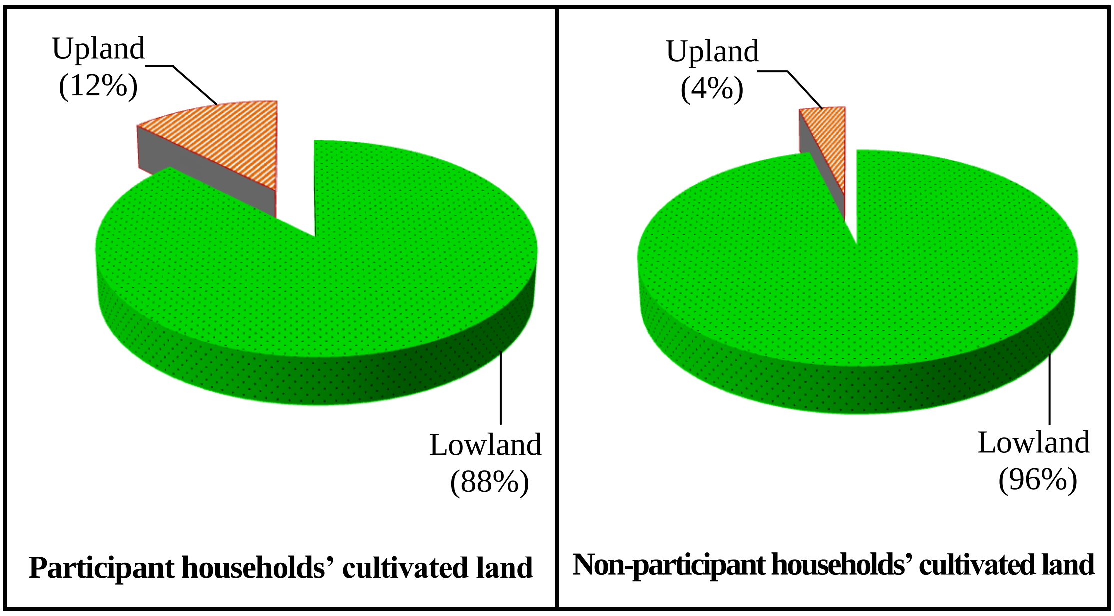


**Figure 4.1 Percent of types of cultivated land of participant and non-participant households**

**Table 4.7 Productive assets of participant and non-participant households**

| Assets | Participant households (n = 60) | Non-participant households (n = 60) | *Pearson Chi-square* | Total households (n = 120) |
|---|---|---|---|---|
| Plough | 29 (48.33) | 17 (28.33) | $P = 0.024^{**}$ | 46 (38.33) |
| Harrow | 28 (46.67) | 18 (30.00) | $P = 0.060^{*}$ | 46 (38.33) |
| Cattle | 24 (40.00) | 16 (26.67) | $P = 0.121^{ns}$ | 40 (33.33) |
| Bullock cart | 28 (46.67) | 18 (30.00) | $P = 0.060^{*}$ | 46 (38.33) |
| Power tiller | 25 (41.67) | 14 (23.33) | $P = 0.032^{**}$ | 39 (32.50) |
| Seeder | 10 (16.67) | 3 (5.00) | $P = 0.040^{**}$ | 13 (10.83) |
| Inter-cultivator | 6 (10.00) | 3 (5.00) | $P = 0.298^{ns}$ | 9 (7.50) |
| Thresher | 16 (26.67) | 8 (13.33) | $P = 0.068^{*}$ | 24 (20.00) |
| Sprayer | 56 (93.33) | 53 (88.33) | $P = 0.343^{ns}$ | 109 (90.83) |
| Pump | 19 (31.67) | 11 (18.33) | $P = 0.092^{*}$ | 30 (25.00) |
| Warehouse | 43 (71.67) | 30 (50.00) | $P = 0.015^{**}$ | 73 (60.83) |

Note: Figures in the parentheses represent percentage.

* and ** are significant different at 10% and 5% level, respectively and ns = not significant.

**Table 4.8 Calculation of household assets by participant and non-participant households**

| Assets | Participant households (n = 60) | Non-participant households (n = 60) | *Pearson Chi-square* | Total households (n = 120) |
|---|---|---|---|---|
| **Type of house** | | | | |
| Wooden house | 43 (71.67) | 45 (75.00) | | 88 (73.33) |
| Brick house | 14 (23.33) | 12 (20.00) | $P = 0.905^{ns}$ | 26 (21.67) |
| Bamboo house | 3 (5.00) | 3 (5.00) | | 6 (5.00) |
| TV | 48 (80.00) | 49 (81.67) | $P = 0.817^{ns}$ | 97 (80.83) |
| DVD | 47 (78.33) | 47 (78.33) | $P = 1.000^{ns}$ | 94 (78.33) |
| Cassette/radio | 25 (41.67) | 29 (48.33) | $P = 0.463^{ns}$ | 54 (45.00) |
| Generator | 13 (21.67) | 10 (16.67) | $P = 0.487^{ns}$ | 23 (19.17) |
| Bicycle | 36 (60.00) | 46 (76.67) | $P = 0.050^{*}$ | 82 (68.33) |
| Motorcycle | 50 (83.33) | 48 (80.00) | $P = 0.637^{ns}$ | 98 (81.67) |
| Freight truck | 7 (11.67) | 2 (3.33) | $P = 0.083^{*}$ | 9 (7.50) |
| Hand phone | 50 (83.33) | 55 (91.67) | $P = 0.168^{ns}$ | 105 (87.50) |
| Chicken | 22 (36.67) | 30 (50.00) | $P = 0.141^{ns}$ | 52 (43.33) |
| Pig | 20 (33.33) | 19 (31.67) | $P = 0.845^{ns}$ | 39 (32.50) |

Note: Figures in the parentheses represent percentage.

* is significant different at 10% level and ns = not significant.

### 4.1.8 Percent share of total household income of participant and non-participant households

In this study, the household income of participant and non-participant households was the sum of the income received from all sources. The household income was divided into three main sources; farm income, non-farm income and off-farm income. Farm income was the sum of earnings by selling various crops from own farm. Non-farm income was income from selling goods, government or company staff, motorcar, three-wheel and freight truck driver, husbandry and handicraft. Off-farm income included casual labor income.

The average income sources of the sample farm households were presented in Table 4.9. The average farm income amount was 4,229,778 MMK per participant household and 3,045,268 MMK per non-participant household. Participant and non-participant households earned from non-farm income about average amount of 703,333 MMK and 1,183,333 MMK, respectively. The average off-farm income of participant households was 30,000 MMK and for non-participant households, average off-farm income was 51,000 MMK. The t-test showed that there was significant different in farm income and non-farm income between participant and non-participant households' income.

As well as, Figure 4.2 shows percent share of the households' income for participant and non-participant households. In participant households, the main source of income was farm income which contributes 85% of the household income. About 14% of the household income was non-farm income and only 1% of the household income was off-farm income. In non-participant households, about 71% of the household income was farm income which was the main source of income. Non-farm income was about 28% of household income and off-farm income was only 1% of household income. In the total households' income, both participant and non-participant households mainly depended on farm income although non-farm income of participant households was lower than that of non-participant households.

### 4.1.9 Percent share of total crop income of participant and non-participant households

In the study area, the crop income mainly included the incomes from monsoon rice, summer rice, black gram and sugarcane. The average crop income amount was presented in Table 4.10. Participant households earned average amount of 1,506,158

MMK from monsoon rice, 2,188,421 MMK from summer rice, 24,700 MMK from black gram and 510,500 MMK from sugarcane.

And also, non-participant households earned average amount of 1,479,932 MMK from monsoon rice, 1,198,836 MMK from summer rice, 268,667 MMK from black gram and 97,833 MMK from sugarcane. There was significantly different among the crop income except monsoon rice income.

In participant households, the main source of crop income was summer rice income 48% of the total crop income followed by monsoon rice income 37%, sugarcane income 11% and black gram income 4% of the total crop income. However, in non-participant households, monsoon rice income was the main source of crop income about 49% of the total crop income and then followed by summer rice income 39%, black gram income 9% and sugarcane income 3% of the total crop income.

From the study, summer rice income of participant households was higher proportion than that of non-participant households because participant households received the irrigation water to grow summer rice. For both participant and non-participant households, rice income was more important than the other crops income for their livelihoods because rice income was higher proportion than the other crops income (Figure 4.3).

**Table 4.9 Household incomes from all sources by participant and non-participant households**

(MMK/year)

| Average income | Participant households (n = 60) | Non-participant households (n = 60) | *t-test* | Total households (n = 120) |
|---|---|---|---|---|
| Farm income | 4,229,778 | 3,045,268 | $t = 1.886^{*}$ | 3,637,523 |
| Non-farm income | 703,333 | 1,183,333 | $t = -2.051^{**}$ | 943,333 |
| Off-farm income | 30,000 | 51,000 | $t = -0.686^{ns}$ | 40,500 |

Note: * and ** are significant different at 10% and 5% level, respectively and ns = not significant.

**Table 4.10 Average crop income from different crops by participant and non-participant households**

(MMK/year)

| Average crop income | Participant households (n = 60) | Non-participant households (n = 60) | *t-test* | Total households (n = 120) |
|---|---|---|---|---|
| Monsoon rice | 1,506,158 | 1,479,932 | $t = 0.112^{ns}$ | 1,493,045 |
| Summer rice | 2,188,421 | 1,198,836 | $t = 2.945^{***}$ | 1,693,628 |
| Black gram | 24,700 | 268,667 | $t = -2.151^{**}$ | 146,683 |
| Sugarcane | 510,500 | 97,833 | $t = 2.250^{**}$ | 304,167 |

Note: ** and *** are significant different at 5% and 1% level, respectively and ns = not significant.

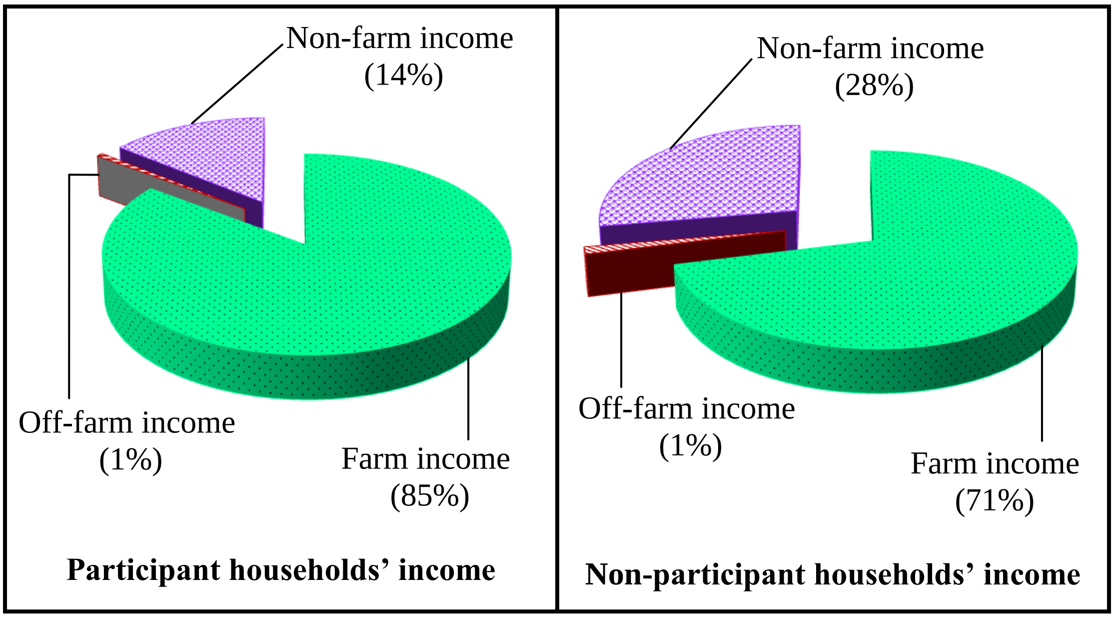


**Figure 4.2 Percent share of income sources of participant and non-participant households**

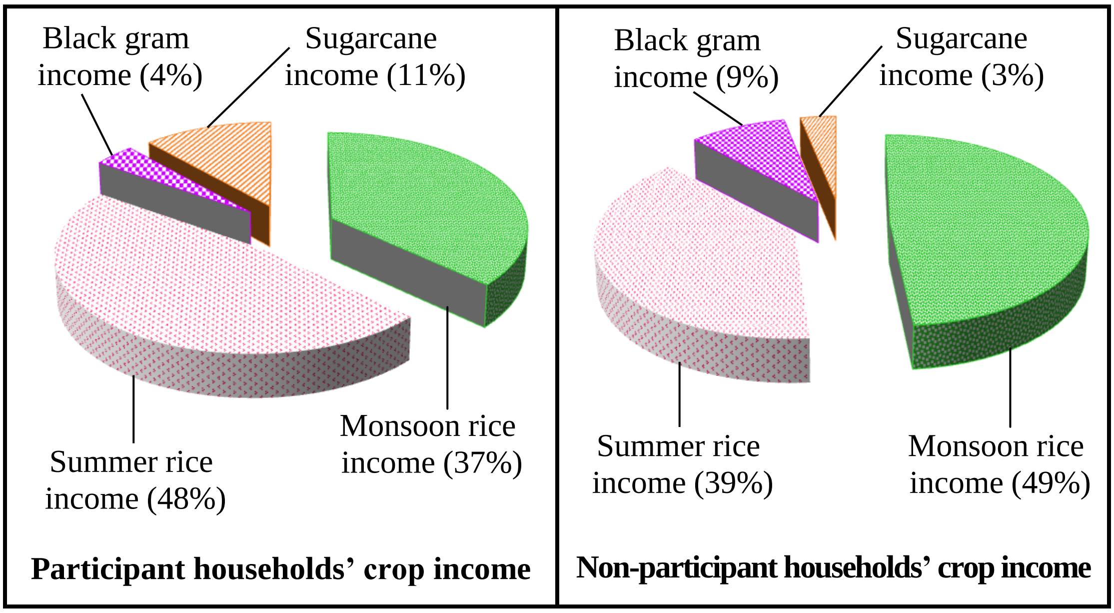


**Figure 4.3 Percent share of crop income of participant and non-participant households**

## 4.2 Cropping Patterns and Inputs Used in the Study Area

### 4.2.1 Growing cropping patterns by participant and non-participant households

In the study area, the main crop was rice that is grown as monsoon rice and summer rice. Monsoon rice was cultivated from mid May to July and harvested from mid October to December. After harvesting monsoon rice, most of the farmers grew summer rice and some of the farmers grew black gram as a winter crop. The planting time for summer rice was started from mid February to March and it was harvested from May to June. Black gram was sown in November and harvested from mid February to mid March (Table 4.11).

The rice-based cropping patterns mostly grown in the study area were indicated in Table 4.12. Three cropping patterns of participant and non-participant households were generally observed in the study area. There were monsoon rice solely, monsoon rice-summer rice and monsoon rice-black gram.

Among the cropping patterns, monsoon rice followed by summer rice was grown by 93.33% of participant households and 66.67% of non-participant households. The Pearson Chi-square showed that there was significant difference in monsoon rice followed by summer rice between these two groups at 1% level. Only 1.67% of participant households and 11.67% of non-participant households cultivated monsoon rice followed by black gram. There was significant difference in monsoon rice followed by black gram between these two groups at 5% level.

### 4.2.2 Average crop sown area and cropping intensity of participant and non-participant households

Table 4.13 presents the sown area of monsoon rice, summer rice, black gram and cropping intensity of participant and non-participant households. The average monsoon rice sown area of participant households was 2.14 ha ranging from 0.40 ha to 7.28 ha and that in non-participant households was 1.81 ha ranging from 0.40 ha to 6.27 ha, respectively. The average summer rice sown area of participant households was 2 ha with the range of 0.40 ha to 7.28 ha and that of non-participant households was 1.69 ha ranging from 0.40 ha to 5.26 ha in the study area. The t-test showed that the average rice sown area was not significantly different between these two groups.

The average sown area of black gram for participant and non-participant households was 2.10 ha and 2.05 ha, respectively. The cropping intensity of participant and non-participant households was 186.93% and 176.82%, respectively.

The t-test showed that there was not significantly different in the cropping intensity between these two groups.

### 4.2.3 Cultivated rice varieties by participant and non-participant households in the study area

According to the survey records, participant and non-participant households used six monsoon rice varieties in monsoon rice production. Among the monsoon rice varieties, Manawthukha variety was mainly grown by 85% of participant households and 91.67% of non-participant households. However, in summer rice cultivation, participant households used five varieties and non-participant households used four varieties. Nearly half of participant households (48.33%) grew Pearlthwe variety while 56.67% of non-participant households grew Manawthukha variety in summer rice cultivation (Table 4.14).

### 4.2.4 Seed rate of monsoon rice and summer rice used by participant and non-participant households

The monsoon rice and summer rice seed rate used by participant and non-participant households were described in Table 4.15. The average seed rate of monsoon rice used by participant households was 122.55 kg/ha and non-participant households were 129.94 kg/ha. The minimum monsoon rice seed rate of participant and non-participant households was 52.15 kg/ha and 78.23 kg/ha, respectively. The maximum monsoon rice seed rate of both participant and non-participant households was 208.60 kg/ha. The t-test indicated that there was no significant difference in the use of monsoon rice seed between participant and non-participant households.

Furthermore, the average seed rate of summer rice used by participant households was 81.23 kg/ha which was lower than 130.01 kg/ha in non-participant households. The minimum summer rice seed rate of participant households was 15 kg/ha and maximum seed rate was 182.53 kg/ha. And then, the minimum summer rice seed rate of non-participant households was 17.50 kg/ha and maximum seed rate was 208.60 kg/ha. In summer rice production, nearly half of participant households grew Pearlthwe variety while 56.67% of non-participant households grew Manawthukha variety. Manawthukha variety expended more seed rate than Pearlthwe variety. Therefore, there was significant difference in the amount of summer rice seed used between these two groups.

### 4.2.5 Yield of monsoon rice and summer rice of participant and non-participant households

Participant and non-participant households were very much enthusiastic to achieve high yield from rice. The average yield of monsoon rice was 4.32 MT/ha (4,319.47 kg/ha) in participant households and that in non-participant households was 4.52 MT/ha (4,524.01 kg/ha). The minimum monsoon rice yield of participant and non-participant households was 2.61 MT/ha (2,607.50 kg/ha) and 3.13 MT/ha (3,129 kg/ha), respectively. The maximum monsoon rice yield of participant and non-participant households was 6.26 MT/ha (6,258 kg/ha). There was no significant difference among the monsoon rice yield in these two groups.

The average summer rice yield of participant households was 6.15 MT/ha (6,146.72 kg/ha) and that of non-participant households was 5.51 MT/ha (5,505.08 kg/ha). The minimum summer rice yield of participant households was 3.65 MT/ha (3,650.50 kg/ha) and non-participant households were 4.17 MT/ha (4,172 kg/ha). The maximum summer rice yield of both households was 9.39 MT/ha (9,387 kg/ha). There was significant difference in summer rice yield between these two groups (Table 4.16).

**Table 4.11 Crop calendar of participant and non-participant households in the study area**

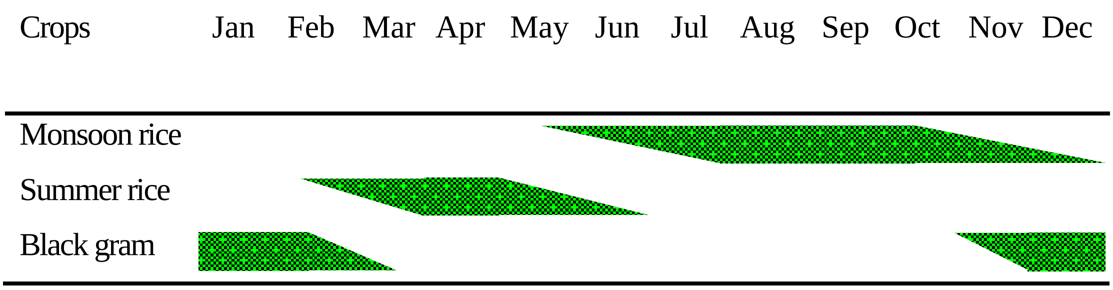


**Table 4.12 Growing cropping patterns by participant and non-participant households in the study area**

| Cropping patterns | Participant households (n = 60) | Non-participant households (n = 60) | *Pearson Chi-square* | Total households (n = 120) |
|---|---|---|---|---|
| Monsoon rice | 60 (100.00) | 60 (100.00) | - | 120 (100.00) |
| Monsoon rice - summer rice | 56 (93.33) | 40 (66.67) | $P = 0.000^{***}$ | 96 (80.00) |
| Monsoon rice - black gram | 1 (1.67) | 7 (11.67) | $P = 0.028^{**}$ | 8 (6.67) |

Note: Figures in the parentheses represent percentage.

** and *** are significant different at 5% and 1% level, respectively.

**Table 4.13 Average sown areas of monsoon rice and summer rice and cropping intensity of participant and non-participant households**

(ha)

| Items | Participant households | Non-participant households | *t-test* | Total households |
|---|---|---|---|---|
| **Monsoon rice sown area** | **n = 60** | **n = 60** | | **n = 120** |
| Mean | 2.14 | 1.81 | $t = 1.147^{ns}$ | 1.98 |
| Range | 0.40 - 7.28 | 0.40 - 6.27 | | 0.40 - 7.28 |
| **Summer rice sown area** | **n = 56** | **n = 40** | | **n = 96** |
| Mean | 2.00 | 1.69 | $t = 1.100^{ns}$ | 1.87 |
| Range | 0.40 - 7.28 | 0.40 - 5.26 | | 0.40 - 7.28 |
| **Black gram sown area** | **n = 7** | **n = 7** | | **n = 14** |
| Mean | 2.10 | 2.05 | $t = 0.058^{ns}$ | 2.08 |
| Range | 0.40 - 4.25 | 0.40 - 6.27 | | 0.40 - 6.27 |
| **Cropping intensity (%)** | **n = 60** | **n = 60** | | **n = 120** |
| Mean | 186.93 | 176.82 | $t = 0.704^{ns}$ | 181.87 |
| Range | 80.00 - 600.00 | 50.00 - 675.00 | | 50.00 - 675.00 |

Note: ns = not significant, Cropping intensity = Sown area (ha)/Total own land (ha)*100

**Table 4.14 Cultivated rice varieties by participant and non-participant households**

| No. | Varieties | Participant households (n = 60) | Non-participant households (n = 60) | *Pearson Chi-square* | Total households (n = 120) |
|---|---|---|---|---|---|
| 1. | **Monsoon rice** | | | | |
| (a) | Manawthukha | 51 (85.00) | 55 (91.67) | $P = 0.255^{ns}$ | 106 (88.33) |
| (b) | Vietnam | 14 (23.33) | 1 (1.67) | $P = 0.000^{***}$ | 15 (12.50) |
| (c) | Pearlthwe | 7 (11.67) | 0 | $P = 0.006^{***}$ | 7 (5.83) |
| (d) | Ayeyarmin | 2 (3.33) | 5 (8.33) | $P = 0.243^{ns}$ | 7 (5.83) |
| (e) | Magyuntaw | 0 | 7 (11.67) | $P = 0.006^{***}$ | 7 (5.83) |
| (f) | Thaikout | 2 (3.33) | 1 (1.67) | $P = 0.559^{ns}$ | 3 (2.50) |
| (g) | Shwethweyin | 1 (1.67) | 0 | $P = 0.315^{ns}$ | 1 (0.83) |
| (h) | Sinthukha | 0 | 1 (1.67) | $P = 0.315^{ns}$ | 1 (0.83) |
| 2. | **Summer rice** | | | | |
| (a) | Manawthukha | 18 (30.00) | 34 (56.67) | $P = 0.003^{***}$ | 52 (43.33) |
| (b) | Pearlthwe | 29 (48.33) | 2 (3.33) | $P = 0.000^{***}$ | 31 (25.83) |
| (c) | Thaikout | 7 (11.67) | 2 (3.33) | $P = 0.083^{*}$ | 9 (7.50) |
| (d) | Shwethweyin | 6 (10.00) | 2 (3.33) | $P = 0.143^{ns}$ | 8 (6.67) |
| (e) | Shwetoe | 1 (1.67) | 0 | $P = 0.315^{ns}$ | 1 (0.83) |

Note: Figures in the parentheses represent percentage.

* and *** are significant different at 10% and 1% level, respectively and ns = not significant.

**Table 4.15 Amount of seed rate for monsoon rice and summer rice used by participant and non-participant households**

(kg/ha)

| Items | Participant households | Non-participant households | *t-test* | Total households |
|---|---|---|---|---|
| **Monsoon rice seed** | **n = 60** | **n = 60** | | **n = 120** |
| Mean | 122.55 | 129.94 | $t = -1.397^{ns}$ | 126.25 |
| Range | 52.15 - 208.60 | 78.23 - 208.60 | | 52.15 - 208.60 |
| **Summer rice seed** | **n = 56** | **n = 40** | | **n = 96** |
| Mean | 81.23 | 130.01 | $t = -4.833^{***}$ | 101.56 |
| Range | 15.00 - 182.53 | 17.50 - 208.60 | | 15.00 - 208.60 |

Note: *** is significant different at 1% level and ns = not significant.

**Table 4.16 Yield of monsoon rice and summer rice of participant and non-participant households**

(MT/ha)

| Items | Participant households | Non-participant households | *t-test* | Total households |
|---|---|---|---|---|
| **Monsoon rice yield** | **n = 60** | **n = 60** | | **n = 120** |
| Mean | 4.32 | 4.52 | $t = -1.577^{ns}$ | 4.42 |
| Range | 2.61 - 6.26 | 3.13 - 6.26 | | 2.61 - 6.26 |
| **Summer rice yield** | **n = 56** | **n = 40** | | **n = 96** |
| Mean | 6.15 | 5.51 | $t = 2.305^{**}$ | 5.88 |
| Range | 3.65 - 9.39 | 4.17 - 9.39 | | 3.65 - 9.39 |

Note: ** is significant different at 5% level and ns = not significant.

### 4.2.6 FYM and different fertilizers application in rice production

Farm yard manure (FYM) and different fertilizers used by participant and non-participant households were summarized in Table 4.17, Table 4.18 and Table 4.19. Among the sample farm households, about one third of participant and non-participant households applied FYM in rice production. All of participant and non-participant households used urea fertilizer as a main fertilizer. About 88.33%, 23.33% and 15% of participant households utilized compound, potash and T-super, respectively. On the other hand, compound, potash and T-super were used by about 90%, 15% and 8.33% of non-participant households, respectively. There was not significantly different in FYM and different fertilizers used between participant and non-participant households (Table 4.17).

In observing FYM and different fertilizers application in monsoon rice production, the average rate of FYM application by participant households was 1.69 MT/ha and 2.60 MT/ha by non-participant households. The maximum rate of FYM was 18.75 MT/ha in participant households and 15 MT/ha in non-participant households. The average rate of urea fertilizer was 177.08 kg/ha in participant households and 164.17 kg/ha in non-participant households. The minimum amount of urea fertilizer was 62.50 kg/ha in participant households. The maximum amount of urea fertilizer was 375 kg/ha and 250 kg/ha in participant and non-participant households, respectively.

In compound fertilizer application, participant households applied average rate of 129.38 kg/ha and non-participant households used 122.08 kg/ha. The maximum rate of compound fertilizer was 375 kg/ha in participant households and 250 kg/ha in non-participant households. The average rate of potash fertilizer used by participant households was 25.52 kg/ha and that by non-participant households was 11.63 kg/ha. The maximum rate of potash fertilizer was 250 kg/ha in participant households and 125 kg/ha in non-participant households. In the use of T-super fertilizer, participant households applied average rate of 11.88 kg/ha and non-participant households applied 9.38 kg/ha. The maximum rate was 187.50 kg/ha and 125 kg/ha in participant and non-participant households, respectively. The t-test indicated that there was no significant difference in the use of FYM and different fertilizers in monsoon rice production between participant and non-participant households (Table 4.18).

In summer rice production, the average use of FYM was 1.32 MT/ha and 2.31 MT/ha in participant and non-participant households, respectively. The maximum

FYM utilization was 18.75 MT/ha and 12.50 MT/ha for participant and non-participant households, respectively. In participant households, the average use of urea was 193.21 kg/ha, ranging from the minimum 7.50 kg/ha to the maximum 375 kg/ha. And also, in non-participant households, average use of urea was 170.31 kg/ha, ranging from the minimum 125 kg/ha to the maximum 250 kg/ha.

The average rate of compound fertilizer was 152.90 kg/ha by participant households and 139.06 kg/ha by non-participant households. The minimum application of compound was 62.50 kg/ha by non-participant households. The maximum compound fertilizer rate was 375 kg/ha and 250 kg/ha in participant and non-participant households, respectively. Average applied amount of potash fertilizer was 19.24 kg/ha within the range between 0 to 250 kg/ha in participant households and then in non-participant households, average used amount of potash fertilizer was 10.43 kg/ha within the range between 0 to 125 kg/ha. In participant households, T-super utilization amount ranged from 0 to 187.50 kg/ha and average rate of T-super utilization was 17.86 kg/ha. In non-participant households, T-super utilization amount ranged from 0 to 125 kg/ha and average rate of T-super utilization was 7.81 kg/ha (Table 4.19).

**Table 4.17 Number and percentage of participant and non-participant households using farm yard manure and different fertilizers**

| Items | Participant households (n = 60) | Non-participant households (n = 60) | *Pearson Chi-square* | Total households (n = 120) |
|---|---|---|---|---|
| FYM | 22 (36.67) | 22 (36.67) | $P = 1.000^{ns}$ | 44 (36.67) |
| Urea | 60 (100.00) | 60 (100.00) | - | 120 (100.00) |
| Compound | 53 (88.33) | 54 (90.00) | $P = 0.769^{ns}$ | 107 (89.16) |
| Potash | 14 (23.33) | 9 (15.00) | $P = 0.246^{ns}$ | 23 (19.16) |
| T-super | 9 (15.00) | 5 (8.33) | $P = 0.255^{ns}$ | 14 (11.67) |

Note: Figures in the parentheses represent percentage.
ns = not significant

**Table 4.18 Amount of FYM and different fertilizers utilization for monsoon rice production by participant and non-participant households**

| Items | Participant households (n = 60) | Non-participant households (n = 60) | *t-test* | Total households (n = 120) |
|---|---|---|---|---|
| **FYM (MT/ha)** | | | | |
| Mean | 1.69 | 2.60 | $t = -1.282^{ns}$ | 2.15 |
| Range | 0 - 18.75 | 0 - 15.00 | | 0 - 18.75 |
| **Urea (kg/ha)** | | | | |
| Mean | 177.08 | 164.17 | $t = 1.147^{ns}$ | 170.63 |
| Range | 62.50 - 375.00 | 0 - 250.00 | | 0 - 375.00 |
| **Compound (kg/ha)** | | | | |
| Mean | 129.38 | 122.08 | $t = 0.541^{ns}$ | 125.73 |
| Range | 0 - 375.00 | 0 - 250.00 | | 0 - 375.00 |
| **Potash (kg/ha)** | | | | |
| Mean | 25.52 | 11.63 | $t = 1.642^{ns}$ | 18.58 |
| Range | 0 - 250.00 | 0 - 125.00 | | 0 - 250.00 |
| **T-super (kg/ha)** | | | | |
| Mean | 11.88 | 9.38 | $t = 0.393^{ns}$ | 10.63 |
| Range | 0 - 187.50 | 0 - 125.00 | | 0 - 187.50 |

Note: ns = not significant

**Table 4.19 Amount of FYM and different fertilizers utilization for summer rice production by participant and non-participant households**

| Items | Participant households (n = 56) | Non-participant households (n = 40) | *t-test* | Total households (n = 96) |
|---|---|---|---|---|
| **FYM (MT/ha)** | | | | |
| Mean | 1.32 | 2.31 | $t = -1.381^{ns}$ | 1.73 |
| Range | 0 - 18.75 | 0 - 12.50 | | 0 - 18.75 |
| **Urea (kg/ha)** | | | | |
| Mean | 193.21 | 170.31 | $t = 1.724^{*}$ | 183.67 |
| Range | 7.50 - 375.00 | 125.00 - 250.00 | | 7.50 - 375.00 |
| **Compound (kg/ha)** | | | | |
| Mean | 152.90 | 139.06 | $t = 0.980^{ns}$ | 147.14 |
| Range | 0 - 375.00 | 62.50 - 250.00 | | 0 - 375.00 |
| **Potash (kg/ha)** | | | | |
| Mean | 19.24 | 10.43 | $t = 1.104^{ns}$ | 15.57 |
| Range | 0 - 250.00 | 0 - 125.00 | | 0 - 250.00 |
| **T-super (kg/ha)** | | | | |
| Mean | 17.86 | 7.81 | $t = 1.316^{ns}$ | 13.67 |
| Range | 0 - 187.50 | 0 - 125.00 | | 0 - 187.50 |

Note: * is significant different at 10% level and ns = not significant.

### 4.2.7 Pesticide, herbicide and fungicide application in rice production

Most of participant and non-participant households used pesticide, herbicide and fungicide to control pest, disease and weed in rice production. The liquid form of pesticide was applied by 93.33% of participant households and 91.67% of non-participant households. Only 6.67% of participant households and 8.33% of non-participant households used pesticide powder. There were 88.33% of participant households and 95% of non-participant households used herbicide liquid. The powder form of herbicide was applied by 15% and 6.67% of participant households and non-participant households, respectively. The fungicide liquid was applied by 55% of participant households and 33.33% of non-participant households. About 15% of participant households and 13.33% of non-participant used fungicide powder. The Pearson Chi-square showed that there was no significant difference in the use of insecticide between participant and non-participant households except in fungicide liquid (Table 4.20).

The pesticide, herbicide and fungicide utilization was presented in Table 4.21 and Table 4.22. In monsoon rice production, the average rate of pesticide liquid used by participant and non-participant households in the survey area were 1.48 L/ha and 1.39 L/ha, respectively. The range between 0 to 3.75 L/ha application of pesticide liquid was used among participant households and the range of 0 to 5 L/ha was applied in non-participant households. The average amount of pesticide powder was 0.05 kg/ha by participant households and 0.08 kg/ha by non-participant households. The maximum rate of pesticide powder was 1.25 kg/ha and 3.75 kg/ha in participant and non-participant households, respectively.

The average quantity of herbicide liquid applied by participant households was 1.47 L/ha while the range of its application from 0 to 2.50 L/ha. And then, non-participant households used 1.53 L/ha of herbicide on average. Quantity ranging from 0 to 3.75 L/ha of herbicide was applied by non-participant households. The average amount of herbicide powder application was 0.04 kg/ha in participant households and 0.01 kg/ha in non-participant households. The maximum herbicide powder utilization was 1.25 kg/ha and 0.88 kg/ha for participant and non-participant households, respectively.

The average fungicide liquid used by participant and non-participant households was found 0.74 L/ha and 0.55 L/ha, respectively. The maximum amount of fungicide liquid was 3 L/ha and 6.25 L/ha by participant and non-participant households, respectively. The powder form of fungicide was used by only non-participant households. In non-participant households, the average amount of fungicide powder used was 0.08 kg/ha and the maximum amount was 3.75 kg/ha.

In summer rice production, the average liquid form of pesticide was 1.63 L/ha and 1.34 L/ha in participant and non-participant households, respectively. For participant and non-participant households, the maximum rate of pesticide liquid was 3.75 L/ha and 5 L/ha, respectively. The average rate of pesticide powder used by participant households was 0.07 kg/ha and that by non-participant households was 0.05 kg/ha. The maximum amount of pesticide powder was 1.50 L/ha in participant households and 0.75 L/ha in non-participant households.

The average amount of herbicide liquid used was 1.35 L/ha and 1.61 L/ha by participant and non-participant households, respectively. The maximum amount of herbicide liquid was 3.13 L/ha in participant households and 3.75 L/ha in non-participant households. The average rate of herbicide powder application in participant households was 0.08 kg/ha and that of non-participant households was 0.04 kg/ha. The maximum rate was 1.25 kg/ha and 1 kg/ha in participant and non-participant households, respectively.

The average rate of fungicide application in participant households was 0.66 L/ha and 0.40 L/ha used by non-participant households. The maximum rate of fungicide liquid was 3.75 L/ha and 2.50 L/ha in participant and non-participant households, respectively. In the use of fungicide powder, participant households applied average rate of 0.16 kg/ha and non-participant households applied 0.18 kg/ha. The maximum rate was 2.50 kg/ha and 3.75 kg/ha in participant and non-participant households, respectively. The t-test showed that there was not significantly different in pesticide, herbicide and fungicide used between participant and non-participant households.

**Table 4.20 Number and percentage of participant and non-participant households using pesticide, herbicide and fungicide**

| Items | Participant households (n = 60) | Non-participant households (n = 60) | *Pearson Chi-square* | Total households (n = 120) |
|---|---|---|---|---|
| Pesticide liquid | 56 (93.33) | 55 (91.67) | $P = 0.729^{ns}$ | 111 (92.50) |
| Pesticide powder | 4 (6.67) | 5 (8.33) | $P = 0.729^{ns}$ | 9 (7.50) |
| Herbicide liquid | 53 (88.33) | 57 (95.00) | $P = 0.186^{ns}$ | 110 (91.67) |
| Herbicide powder | 9 (15.00) | 4 (6.67) | $P = 0.142^{ns}$ | 13 (10.83) |
| Fungicide liquid | 33 (55.00) | 20 (33.33) | $P = 0.017^{**}$ | 53 (44.17) |
| Fungicide powder | 9 (15.00) | 8 (13.33) | $P = 0.793^{ns}$ | 17 (14.17) |

Note: Figures in the parentheses represent percentage.

** is significant different at 5% level and ns = not significant.

**Table 4.21 Amount of pesticide, herbicide and fungicide utilization for monsoon rice production by participant and non-participant households**

| Items | Participant households (n = 60) | Non-participant households (n = 60) | *t-test* | Total households (n = 120) |
|---|---|---|---|---|
| **Pesticide (L/ha)** | | | | |
| Mean | 1.48 | 1.39 | *t = 0.528*$^{ns}$ | 1.43 |
| Range | 0 - 3.75 | 0 - 5.00 | | 0 - 5.00 |
| **Pesticide (kg/ha)** | | | | |
| Mean | 0.05 | 0.08 | *t = -0.455*$^{ns}$ | 0.07 |
| Range | 0 - 1.25 | 0 - 3.75 | | 0 - 3.75 |
| **Herbicide (L/ha)** | | | | |
| Mean | 1.47 | 1.53 | *t = -0.327*$^{ns}$ | 1.50 |
| Range | 0 - 2.50 | 0 - 3.75 | | 0 - 3.75 |
| **Herbicide (kg/ha)** | | | | |
| Mean | 0.04 | 0.01 | *t = 0.932*$^{ns}$ | 0.03 |
| Range | 0 - 1.25 | 0 - 0.88 | | 0 - 1.25 |
| **Fungicide (L/ha)** | | | | |
| Mean | 0.74 | 0.55 | *t = 1.102*$^{ns}$ | 0.65 |
| Range | 0 - 3.00 | 0 - 6.25 | | 0 - 6.25 |
| **Fungicide (kg/ha)** | | | | |
| Mean | 0 | 0.08 | *t = -1.319*$^{ns}$ | 0.04 |
| Range | 0 | 0 - 3.75 | | 0 - 3.75 |

Note: ns = not significant

**Table 4.22 Amount of pesticide, herbicide and fungicide utilization for summer rice production by participant and non-participant households**

| Items | Participant households (n = 60) | Non-participant households (n = 60) | *t-test* | Total households (n = 120) |
|---|---|---|---|---|
| **Pesticide (L/ha)** | | | | |
| Mean | 1.63 | 1.34 | $t = 1.368^{ns}$ | 1.51 |
| Range | 0 - 3.75 | 0 - 5.00 | | 0 - 5.00 |
| **Pesticide (kg/ha)** | | | | |
| Mean | 0.07 | 0.05 | $t = 0.411^{ns}$ | 0.07 |
| Range | 0 - 1.50 | 0 - 0.75 | | 0 - 1.50 |
| **Herbicide (L/ha)** | | | | |
| Mean | 1.35 | 1.61 | $t = -1.333^{ns}$ | 1.46 |
| Range | 0 - 3.13 | 0 - 3.75 | | 0 - 3.75 |
| **Herbicide (kg/ha)** | | | | |
| Mean | 0.08 | 0.04 | $t = 1.004^{ns}$ | 0.06 |
| Range | 0 - 1.25 | 0 - 1.00 | | 0 - 1.25 |
| **Fungicide (L/ha)** | | | | |
| Mean | 0.66 | 0.40 | $t = 1.546^{ns}$ | 0.55 |
| Range | 0 - 3.75 | 0 - 2.50 | | 0 - 3.75 |
| **Fungicide (kg/ha)** | | | | |
| Mean | 0.16 | 0.18 | $t = -0.119^{ns}$ | 0.17 |
| Range | 0 - 2.50 | 0 - 3.75 | | 0 - 3.75 |

Note: ns = not significant

### 4.2.8 Use of machine and animal in rice production

For monsoon rice production, 76.67%, 86.67% and 63.33% of participant households used only machine, only draft cattle and both machine and draft cattle whereas 55%, 88.33% and 43.33% of non-participant households used only machine, only draft cattle and both machine and draft cattle in land preparation. In harvesting, 61.67% of participant households used combine harvester, 56.67% of non-participant households used combine harvester. The Pearson Chi-square showed that there was significant difference in land preparation with only machine and land preparation with both machine and draft cattle between these two groups at 5% level.

In land preparation for summer rice production, 78.57%, 89.29% and 67.86% of participant households used only machine, only draft cattle and both machine and draft cattle, respectively. On the other hand, only machine, only draft cattle and both machine and draft cattle were used by 50%, 85% and 35% of non-participant households, respectively. There was significant difference in land preparation with only machine and land preparation with both machine and draft cattle between these two groups at 1% level. Combine harvester was used by 85.71% of participant households and 70% of non-participant households in summer rice harvesting. There was significant difference in harvesting with combine harvester between these two groups at 10% level (Table 4.23).

### 4.2.9 Access to extension services and credit availability

In the study area, it was found that 35% of participant households and 22% of non-participant households contacted with the extension workers who gave agricultural technology about rice production. The credit from MADB and other sources of money lender were taken for crops production. Participant households borrowed the average amount 425,000 MMK/year and non-participant households borrowed 308,333 MMK/year from MADB for rice production by the interest rate of 0.75%. The t-test showed that there was significant difference at 10% level in the amount of credit taken from MADB between participant and non-participant households (Table 4.24).

Participant and non-participant households borrowed money from the money lenders such as fertilizer shopkeepers and grocers in their villages. The average amount of borrowed money was 85,625 MMK/year and 36,242 MMK/year by an interest rate of 5%, respectively. The t-test showed that there was no significant difference in the amount of credit taken from the money lender between participant and non-participant households. Most of the sample farm households usually borrowed cash to purchase inputs for rice production such as seed, chemical fertilizer and insecticide.

## 4.3 Cost and Return Analysis for Rice Production in the Study Area

### 4.3.1 Cost and return analysis of monsoon rice production

The enterprise budget was used to analyze cost and return of monsoon rice production of participant and non-participant households in the study area. For the usual farming practice, variable costs of production included material input costs, hired labor costs, family labor/opportunity costs and interest on cash costs. Gross returns for rice were determined by using average yield and effective market price. The enterprise budget for monsoon rice production of participant and non-participant households in the study area per hectare basis was presented in Table 4.25.

It was found that participant households expended total variable cost (810,878 MMK/ha) and non-participant households expended total variable cost (782,345 MMK/ha). The average monsoon rice yield of participant households (4,319.47 kg/ha) (Appendix 3) was lower than that of non-participant households (4,524.01 kg/ha) (Appendix 4). Therefore, average gross benefit for non-participant households (945,756 MMK/ha) was higher than that of participant households (894,195 MMK/ha).

Total material cost of participant households (270,593 MMK/ha) was lower than that of non-participant households (269,490 MMK/ha). Total family labor cost was 112,851 MMK/ha in participant households and 103,802 MMK/ha in non-participant households. It was expended for the hired labor cost 407,102 MMK/ha in participant households and 389,289 MMK/ha in non-participant households. In the total interest cost on cash cost, participant households expended 20,331 MMK/ha and non-participant households were 19,763 MMK/ha. Total variable cash cost (TVCC) of participant households was 78.06% of gross benefit and in non-participant households; TVCC was 71.75% of gross benefit.

Return above variable cash cost (RAVCC) were 196,168 MMK/ha in participant households and 267,213 MMK/ha in non-participant households. Return above variable cost (RAVC) for participant and non-participant households were 83,317 MMK/ha and 163,411 MMK/ha, respectively. Otherwise, net benefit (RAVC) of participant households was 9.32% of gross benefit whereas non-participant households were 17.28% of gross benefit. Hence, the benefit-cost ratios were 1.10 and 1.21 for participant and non-participant households, respectively.

### 4.3.2 Cost and return analysis of summer rice production

The enterprise budget for summer rice production per hectare basis of participant and non-participant households was presented in Table 4.26. In summer rice production, although participant households expended total variable cost (983,715 MMK/ha) and yield (6,146.72 kg/ha) (Appendix 5), non-participant households expended less total variable cost (829,595 MMK/ha) and produced average yield of (5,505.08 kg/ha) (Appendix 6). Therefore, gross benefit for participant households was 1,282,320 MMK/ha whereas non-participant households were 1,204,732 MMK/ha.

Total material cost of participant households (386,195 MMK/ha) was higher than that of non-participant households (302,210 MMK/ha). Total family labor cost was 115,835 MMK/ha in participant households and 114,872 MMK/ha in non-participant households. It was expended for the hired labor cost 456,407 MMK/ha in participant households and 391,696 MMK/ha in non-participant households. In the total interest cost on cash cost, participant households expended 25,278 MMK/ha and non-participant households were 20,817 MMK/ha. TVCC of participant households was 67.68% of gross benefit while TVCC of non-participant households was 59.33% of gross benefit in summer rice production.

Return above variable cash cost (RAVCC) were 414,440 MMK/ha in participant households and 490,009 MMK/ha in non-participant households. RAVC for participant and non-participant households were 298,605 MMK/ha and 375,137 MMK/ha, respectively. On the other hand, net benefit (RAVC) of participant households was 23.29% of gross benefit and non-participant households was 31.14% of gross benefit. Hence, the benefit-cost ratios were 1.30 and 1.45 for participant and non-participant households, respectively.

**Table 4.23 Use of machine and animal in rice production of participant and non-participant households**

| Items | Participant households | Non-participant households | *Pearson Chi-square* | Total households |
|---|---|---|---|---|
| **Monsoon rice** | **n = 60** | **n = 60** | | **n = 120** |
| Land preparation with machine | 46 (76.67) | 33 (55.00) | *P = 0.012*** | 79 (65.83) |
| Land preparation with draft cattle | 52 (86.67) | 53 (88.33) | *P = 0.783ns* | 105 (87.50) |
| Land preparation with machine and draft cattle | 38 (63.33) | 26 (43.33) | *P = 0.028*** | 64 (53.33) |
| Harvesting with combine harvester | 37 (61.67) | 34 (56.67) | *P = 0.577ns* | 71 (59.17) |
| Harvesting with manual | 23 (38.33) | 26 (43.33) | *P = 0.577ns* | 49 (40.83) |
| **Summer rice** | **n = 56** | **n = 40** | | **n = 96** |
| Land preparation with machine | 44 (78.57) | 20 (50.00) | *P = 0.003**** | 64 (66.67) |
| Land preparation with draft cattle | 50 (89.29) | 34 (85.00) | *P = 0.531ns* | 84 (87.50) |
| Land preparation with machine and draft cattle | 38 (67.86) | 14 (35.00) | *P = 0.001**** | 52 (54.17) |
| Harvesting with combine harvester | 48 (85.71) | 28 (70.00) | *P = 0.062** | 76 (79.17) |
| Harvesting with manual | 8 (14.29) | 12 (30.00) | *P = 0.062** | 20 (20.83) |

Note: Figures in the parentheses represent percentage.

*, ** and *** are significant different at 10%, 5% and 1% level, respectively and ns = not significant.

**Table 4.24 Amount of credit from different sources by participant and non-participant households**

(MMK/year)

| Sources | Participant households (n = 60) | Non-participant households (n = 60) | *t-test* | Total households (n = 120) |
|---|---|---|---|---|
| MADB | 425,000 | 308,333 | $t = 1.795^{*}$ | 366,667 |
| Money lender | 85,625 | 36,242 | $t = 1.598^{ns}$ | 60,933 |

Note: * is significant different at 10% level and ns = not significant.

**Table 4.25 Enterprise budget for monsoon rice production of participant and non-participant households**

(MMK/ha)

| Items | Participant households (n = 60) | Non-participant households (n = 60) |
|---|---|---|
| Gross benefit (GB) | 894,195 | 945,756 |
| Total material cost | 270,593 | 269,490 |
| Total family labor cost | 112,851 | 103,802 |
| Total hired labor cost | 407,102 | 389,289 |
| Interest on cash cost | 20,331 | 19,763 |
| Total variable cash cost (TVCC) | 698,027 | 678,543 |
| Total variable cost (TVC) | 810,878 | 782,345 |
| Return above variable cash cost (RAVCC) | 196,168 | 267,213 |
| Return above variable cost (RAVC) | 83,317 | 163,411 |
| Return per unit of capital invested (BCR) | 1.10 | 1.21 |
| Break-even price (MMK/kg) | 188 | 173 |
| Break-even yield (kg/ha) | 3,917 | 3,742 |

**Table 4.26 Enterprise budget for summer rice production of participant and non-participant households**

(MMK/ha)

| Items | Participant households (n = 56) | Non-participant households (n = 40) |
|---|---|---|
| Gross benefit (GB) | 1,282,320 | 1,204,732 |
| Total material cost | 386,195 | 302,210 |
| Total family labor cost | 115,835 | 114,872 |
| Total hired labor cost | 456,407 | 391,696 |
| Interest on cash cost | 25,278 | 20,817 |
| Total variable cash cost (TVCC) | 867,880 | 714,723 |
| Total variable cost (TVC) | 983,715 | 829,595 |
| Return above variable cash cost (RAVCC) | 414,440 | 490,009 |
| Return above variable cost (RAVC) | 298,605 | 375,137 |
| Return per unit of capital invested (BCR) | 1.30 | 1.45 |
| Break-even price (MMK/kg) | 160 | 151 |
| Break-even yield (kg/ha) | 4,715 | 3,791 |

## 4.4 Determinants of Rice Production in the Study Area

Table 4.28 and Table 4.30 mention the factors which influenced the monsoon rice and summer rice production in the study area. Unstandardized B regression coefficient indicates the average change in the dependent variable associated with one unit changes in the independent variable, statistically controlling for the other independent variables. Standardized beta coefficient is used to compare the strength of the effect of each independent variable on the dependent variable. The independent variable with the largest standardized beta (independent of the sign) has the strongest effect.

Monsoon rice and summer rice production of participant and non-participant households were estimated by using log form of seed rate, FYM amount, total fertilizer amount, pesticide amount, herbicide amount, fungicide amount, total machine day, total animal labor and total man labor. Other socio-economic variables included in the regression equation were log form of household head’s age, household head’s education level, and household head’s farm experience.

### 4.4.1 Determinants of monsoon rice production of participant and non-participant households

In Table 4.27, the summary statistics of the dependent and independent variables of monsoon rice production were described. In the production function, household head’s characteristics of age, education level, farm experience; inputs used such as seed, FYM, total fertilizer, pesticide, herbicide, fungicide and labor inputs including total machine day, total animal day and total man day were independent variables. Monsoon rice production was assumed as dependent variable. Dummy variable of land consolidation program (participant households = 1, non-participant households = 0) and monsoon rice variety (Manawthukha = 1, other = 0) were also included.

Monsoon rice production in the study area was positively and significantly influenced by seed rate, total fertilizer amount and total man day at 1% level, if other things remain constant. It means that if use of seed rate, total fertilizer amount and man day in rice production is increased in the study area, monsoon rice production will be increased. Unstandardized coefficient B value of seed rate 0.337 indicates that 1% increase in usage of seed rate; monsoon rice production will be increased by 0.337%. In the same way, 0.166, B value of total fertilizer amount means that 1%

increase in total fertilizer amount, 0.166% of monsoon rice production will be increased. Standardized beta coefficient of seed rate (0.330) which is the strength of the effect of seed rate on monsoon rice production explains the highest strength of effect on monsoon rice production.

Monsoon rice production was also positively related to herbicide amount and total machine day at 5% level and pesticide amount at 10% level. The positive relationship in the regression means the more inputs put into rice cultivation the more the monsoon rice production would be. Similarly, the higher the monsoon rice production, the more profits would obtain from monsoon rice cultivation.

Participant households in land consolidation program were negatively and significantly influenced on monsoon rice production at 5% level. So, if one percent of participant households involved in land consolidation program, monsoon rice production will be reduced by 0.113% during the study period. No effect of household head's age, household head's education level, household head's farm experience, FYM amount, fungicide amount, total animal day, Manawthukha variety was observed on monsoon rice production.

Multiple R square statistics in regression analysis measures the combined effects of all independent variables in a regression model. The closer R square is to one, the better the causal explanation provided by a set of independent variable. In this case, R square value was 0.928 means that 92.8% of the variation in monsoon rice production is explained by independent variables used in the production function in the study area (Table 4.28).

**Table 4.27 Summary statistics of the variables for monsoon rice production of participant and non-participant households**

| Variables | Units | Average | Minimum | Maximum | Std. deviation |
|---|---|---|---|---|---|
| Monsoon rice production | kg | 8761.85 | 1055.26 | 37989.19 | 7057.33 |
| Household head's age | Year | 51.18 | 25.00 | 76.00 | 12.37 |
| Household head's education level | | 2.40 | 1.00 | 5.00 | 1.01 |
| Household head's farm experience | Year | 25.32 | 1.00 | 50.00 | 12.91 |
| Seed rate | kg | 241.79 | 21.11 | 844.20 | 183.73 |
| FYM amount | MT | 3.69 | 0 | 48.51 | 8.11 |
| Total fertilizer amount | kg | 653.88 | 50.59 | 3035.25 | 587.95 |
| Pesticide amount | L | 3.08 | 0 | 20.24 | 3.64 |
| Herbicide amount | L | 3.04 | 0 | 18.21 | 3.30 |
| Fungicide amount | L | 1.52 | 0 | 15.18 | 2.81 |
| Total machine day | Mad | 12.10 | 0 | 101.18 | 17.11 |
| Total animal day | Amd | 21.37 | 0 | 121.41 | 24.46 |
| Total man day | Md | 236.93 | 20.24 | 1011.75 | 196.14 |

n = 120

**Table 4.28 Determinants of monsoon rice production of participant and non-participant households**

| Variables | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | 4.255*** | 0.505 | | 8.430 | 0.000 |
| Land consolidation program (participant households = 1, non-participant households = 0) | -0.113** | 0.043 | -0.073 | -2.602 | 0.011 |
| Ln household head's age | 0.082ns | 0.134 | 0.027 | 0.616 | 0.539 |
| Ln household head's education level | 0.023ns | 0.054 | 0.013 | 0.417 | 0.677 |
| Ln household head's farm experience | -0.065ns | 0.048 | -0.060 | -1.348 | 0.181 |
| Ln seed rate | 0.337*** | 0.071 | 0.330 | 4.782 | 0.000 |
| Ln FYM amount | -0.023ns | 0.021 | -0.033 | -1.130 | 0.261 |
| Ln total fertilizer amount | 0.166*** | 0.058 | 0.183 | 2.858 | 0.005 |
| Ln pesticide amount | 0.075* | 0.039 | 0.092 | 1.931 | 0.056 |
| Ln herbicide amount | 0.091** | 0.037 | 0.106 | 2.483 | 0.015 |
| Ln fungicide amount | -0.005ns | 0.038 | -0.004 | -0.124 | 0.902 |
| Ln total machine day | 0.055** | 0.026 | 0.091 | 2.072 | 0.041 |
| Ln total animal day | 0.005ns | 0.021 | 0.008 | 0.227 | 0.821 |
| Ln total man day | 0.277*** | 0.052 | 0.294 | 5.359 | 0.000 |
| Monsoon rice variety (Manawthukha = 1, other = 0) | 0.042ns | 0.069 | 0.018 | 0.613 | 0.541 |
| R square | 0.928 | | | | |
| Adjusted R square | 0.918 | | | | |
| F | 96.422*** | | | | |
| No. of observation | 120 | | | | |

Note: Dependent variable: Ln monsoon rice production

Ln = natural logarithm

*, ** and *** are significant different at 10%, 5% and 1% level, respectively and ns = not significant.

### 4.4.2 Determinants of summer rice production of participant and non-participant households

Table 4.29 shows the summary statistics of the dependent and independent variables of summer rice production. In Table 4.29, dependent variable was summer rice production and independent variables were same as monsoon rice production's variables (Table 4.27) except dummy variable of summer rice variety (Pearlthwe = 1, other = 0).

According to the summer rice production regression estimates, the significant influencing factors of summer rice production were participant households in land consolidation program, household head's age, seed rate, total fertilizer amount, total machine day, total animal labor, total man labor and Pearlthwe variety. Summer rice production was positive relationship with total fertilizer amount, total machine day, total man labor and Pearlthwe variety at 1% level and household head's age, seed rate and total animal labor at 10% level. Other things being equal, if one percent increases in household head's age, seed rate, total fertilizer amount, total machine day, total animal labor, total man labor and Pearlthwe variety, summer rice production will be increased by 0.241%, 0.095%, 0.211%, 0.183%, 0.043%, 0.379% and 0.386%, respectively.

Participant households in land consolidation program were negatively and significantly influenced on summer rice production at 1% level. So, if 1% of participant households involves in land consolidation program, summer rice production will be reduced by 0.233% during the study period. The F value showed that the selected model was statistically significant at 1% level. R square pointed out that the model was significant and it can explain on the variation in summer rice production by 93.9% in Table 4.30.

**Table 4.29 Summary statistics of the variables for summer rice production of participant and non-participant households**

| Variables | Units | Average | Minimum | Maximum | Std. deviation |
|---|---|---|---|---|---|
| Summer rice production | kg | 12485.93 | 1688.41 | 57933.51 | 11757.49 |
| Household head's age | Year | 51.39 | 25.00 | 76.00 | 12.03 |
| Household head's education level | | 2.44 | 1.00 | 5.00 | 1.02 |
| Household head's farm experience | Year | 25.52 | 1.00 | 50.00 | 12.15 |
| Seed rate | kg | 180.88 | 7.08 | 844.20 | 173.03 |
| FYM amount | MT | 3.26 | 0 | 27.32 | 6.35 |
| Total fertilizer amount | kg | 750.92 | 56.66 | 3035.25 | 669.74 |
| Pesticide amount | L | 3.05 | 0 | 18.97 | 3.63 |
| Herbicide amount | L | 2.88 | 0 | 18.21 | 3.33 |
| Fungicide amount | L | 1.22 | 0 | 18.97 | 2.81 |
| Total machine day | Mad | 14.91 | 0 | 109.27 | 20.49 |
| Total animal labor | Amd | 21.42 | 0 | 121.41 | 24.51 |
| Total man labor | Md | 244.93 | 23.27 | 1176.16 | 241.28 |

n = 96

**Table 4.30 Determinants of summer rice production of participant and non-participant households**

| Variables | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. |
|---|---|---|---|---|---|
| (Constant) | 4.088*** | 0.522 | | 7.826 | 0.000 |
| Land consolidation program (participant households = 1, non-participant households = 0) | -0.224*** | 0.057 | -0.132 | -3.942 | 0.000 |
| Ln household head's age | 0.241* | 0.144 | 0.071 | 1.667 | 0.099 |
| Ln household head's education level | 0.051ns | 0.063 | 0.027 | 0.812 | 0.419 |
| Ln household head's farm experience | -0.059ns | 0.057 | -0.046 | -1.051 | 0.297 |
| Ln seed rate | 0.095* | 0.054 | 0.116 | 1.757 | 0.083 |
| Ln FYM amount | 0.041ns | 0.027 | 0.051 | 1.523 | 0.132 |
| Ln total fertilizer amount | 0.211*** | 0.067 | 0.220 | 3.152 | 0.002 |
| Ln pesticide amount | 0.028ns | 0.040 | 0.031 | 0.687 | 0.494 |
| Ln herbicide amount | -0.033ns | 0.037 | -0.034 | -0.909 | 0.366 |
| Ln fungicide amount | -0.002ns | 0.044 | -0.002 | -0.048 | 0.962 |
| Ln total machine day | 0.183*** | 0.037 | 0.269 | 4.902 | 0.000 |
| Ln total animal labor | 0.043* | 0.023 | 0.068 | 1.870 | 0.065 |
| Ln total man labor | 0.379*** | 0.071 | 0.398 | 5.375 | 0.000 |
| Summer rice variety (Pearlthwe = 1, other = 0) | 0.386*** | 0.115 | 0.216 | 3.370 | 0.001 |
| R square | 0.939 | | | | |
| Adjusted R square | 0.929 | | | | |
| F | 89.180*** | | | | |
| No. of observation | 96 | | | | |

Note: Dependent variable: Ln summer rice production

Ln = natural logarithm

* and *** are significant different at 10% and 1% level, respectively and ns = not significant.

### 4.5 General Constraints of Participant and Non-participant Households

As shown in Table 4.31, participant and non-participant households mentioned some general constraints on rice production. The results showed that there were eleven constraints concerning rice production and land consolidation.

Major constraint described by 83.33% of participant households and 91.67% of non-participant households was high labor cost. Almost all of participant and non-participant households faced with this constraint. The Pearson Chi-square test showed that there was no significant difference in constraint of high labor cost between participant and non-participant households.

High production cost was complained by 65% of participant households and 93.33% of non-participant households. The Pearson Chi-square showed that there was significant difference in constraint of high production cost between these two groups at 1% level.

About 65% of participant households and 83.33% of non-participant households responded about high transportation cost. The Pearson Chi-square showed that there was significant difference in constraint of high transportation cost between these two groups at 5% level.

The constraint of labor scarcity was mentioned by 73.33% of participant households and 41.67% of non-participant households. The Pearson Chi-square showed that there was significant difference in problem of labor scarcity between these two groups at 1% level.

Rice is irrigation intensive crop as it needs for its life cycle. Without assured irrigation, the high yield cannot be expected for this crop. In this study, the problem of poor irrigation and drainage system due to urgent preparation was faced by 58.33% of participant households and 26.67% of non-participant households. This has an effect on yield and quality of rice for rice production.

About 45% of participant households and 21.67% of non-participant households faced with low yield. This constraint has an effect on profit and income of households. The constraint of pest and disease infestation, insufficient water, poor soil condition due to removal of top soil and difficulty to hire machine were faced by 41.67%, 18.33%, 13.33% and 8.33% of participant households and 43.33%, 15%, 10% and 38.33% of non-participant households, respectively. Among these constraints, there was significant difference only in difficultly to hire machine between participant and non-participant households at 1% level.

**Table 4.31 General constraints of participant and non-participant households**

| Items | Participant households (n = 60) | Non-participant households (n = 60) | *Pearson Chi-square* | Total households (n = 120) |
|---|---|---|---|---|
| High labor cost | 50 (83.33) | 55 (91.67) | $P = 0.168^{ns}$ | 105 (87.50) |
| High production cost | 39 (65.00) | 56 (93.33) | $P = 0.000^{***}$ | 95 (79.17) |
| High transportation cost | 39 (65.00) | 50 (83.33) | $P = 0.022^{**}$ | 89 (74.17) |
| High fertilizer application | 40 (66.67) | 37 (61.67) | $P = 0.568^{ns}$ | 77 (64.17) |
| Labor scarcity | 44 (73.33) | 25 (41.67) | $P = 0.000^{***}$ | 69 (57.50) |
| Poor irrigation and drainage system | 35 (58.33) | 16 (26.67) | $P = 0.000^{***}$ | 51 (42.50) |
| Pest and disease infestation | 25 (41.67) | 26 (43.33) | $P = 0.853^{ns}$ | 51 (42.50) |
| Low yield | 27 (45.00) | 13 (21.67) | $P = 0.007^{***}$ | 40 (33.33) |
| Difficulty to hire machine | 5 (8.33) | 23 (38.33) | $P = 0.000^{***}$ | 28 (23.33) |
| Insufficient water | 11 (18.33) | 9 (15.00) | $P = 0.624^{ns}$ | 20 (16.67) |
| Poor soil condition due to removal of top soil | 8 (13.33) | 6 (10.00) | $P = 0.570^{ns}$ | 14 (11.67) |

Note: Figures in the parentheses represent percentage.

** and *** are significant different at 5% and 1% level, respectively and ns = not significant.

## 4.6 Perception of Participants and Non-participants on Land Consolidation Program

There were two types of participants; satisfied participants and unsatisfied participants in land consolidation program. Figure 4.4 illustrates percent share of participants' satisfaction or not on land consolidation program. It was found that about 51.67% of participants were satisfied on land consolidation while about 48.33% of participants were not satisfied on land consolidation. In this study, it was found that about half of participants were satisfied on land consolidation program.

Figure 4.5 represents reasons of satisfaction on land consolidation program by satisfied participants. There were various reasons of satisfaction concerning land consolidation program in satisfied participants. The most satisfaction reason described by satisfied participants was easy to transport (50%). Furthermore, another reasons were good irrigation and drainage (30%), convenience for production (5%), easy to hire machine (5%), low production cost (5%), high yield (5%).

And also unsatisfied participants have different dissatisfaction reasons on land consolidation program (Figure 4.6). About 40.82% of unsatisfied participants mentioned the reason of uneven land condition. Moreover, the reasons of poor irrigation and drainage system, low yield, poor soil condition due to removal of top soil and land asset problems were answered by 26.53%, 16.33%, 10.20% and 6.12% of unsatisfied participants, respectively.

Non-participants were asked whether they had willingness to cooperate in land consolidation program. In non-participants, there were willing non-participants and unwilling non-participants in land consolidation program. About 53.34% of non-participants were unwillingness to cooperate in land consolidation program whereas 38.33% of non-participants were willingness to cooperate in land consolidation program with government budget and only 8.33% of non-participants had willingness to cooperate in land consolidation program with their budget (Figure 4.7).

According to Figure 4.8, non-participants had different reasons of willingness to cooperate in land consolidation program. The reasons given by about 52.63% and 18.42% of non-participants were to follow majority decision and to get higher production. In addition, other reasons of willingness to cooperate in land consolidation program were to facilitate irrigation and drainage system (13.16%), easy to hire combine harvester (7.89%), to reduce transportation constraint (5.27%) and to reduce land fragmentation (2.63%).

There were several reasons of unwillingness to cooperate in land consolidation program by non-participants (Figure 4.9). Their main reasons were uneven land condition (36.95%) and followed by loss of some land area (28.26%), poor soil condition due to removal of top soil (21.74%), mis-allocated land (8.70%) and high cost (4.35%).

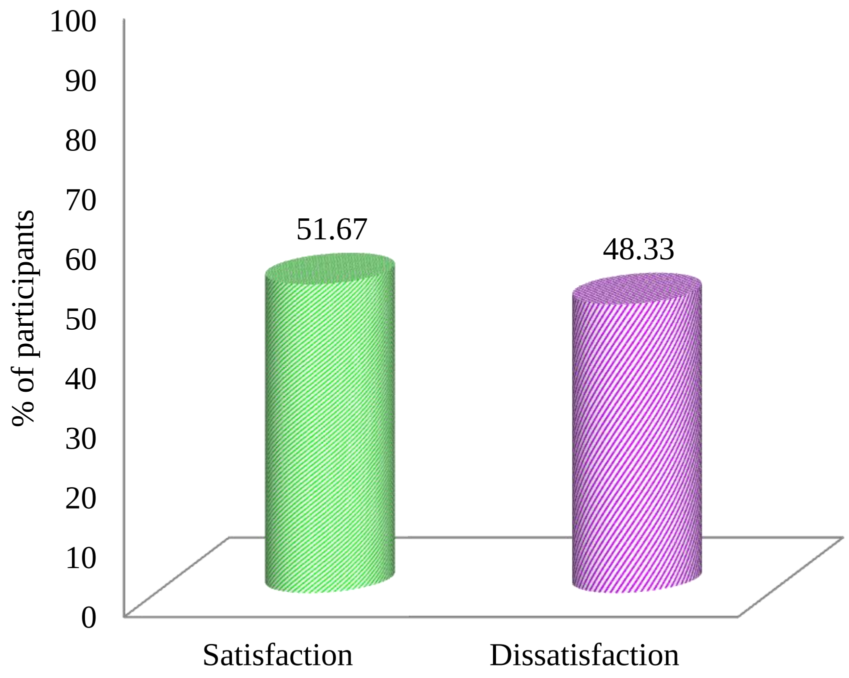


**Figure 4.4 Percent share of participants' satisfaction or not on land consolidation program (n = 60)**

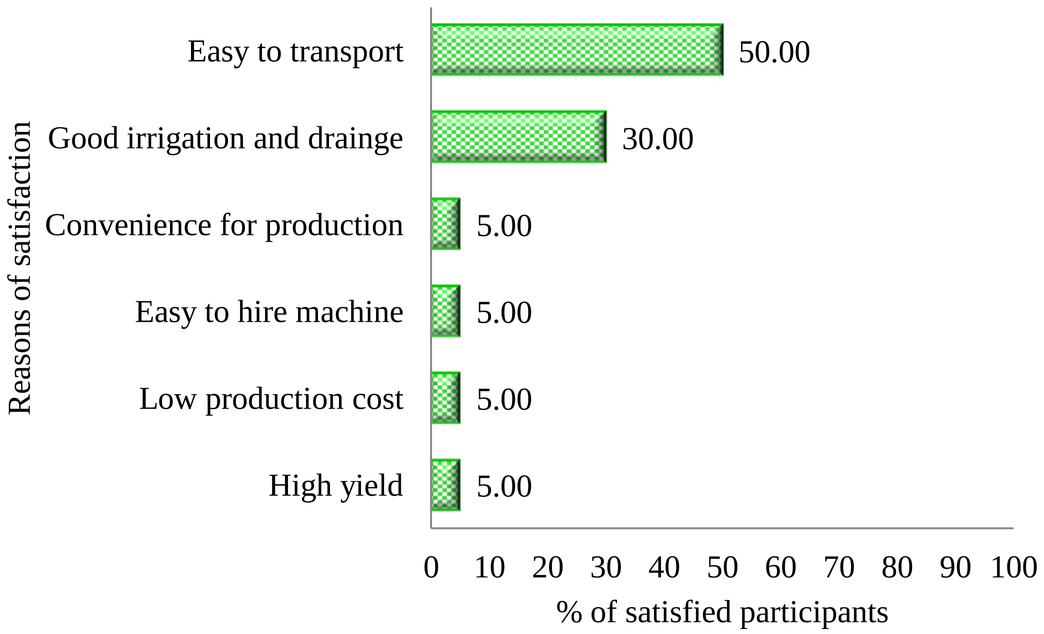


**Figure 4.5 Reasons of satisfaction on land consolidation program by satisfied participants (n = 31)**

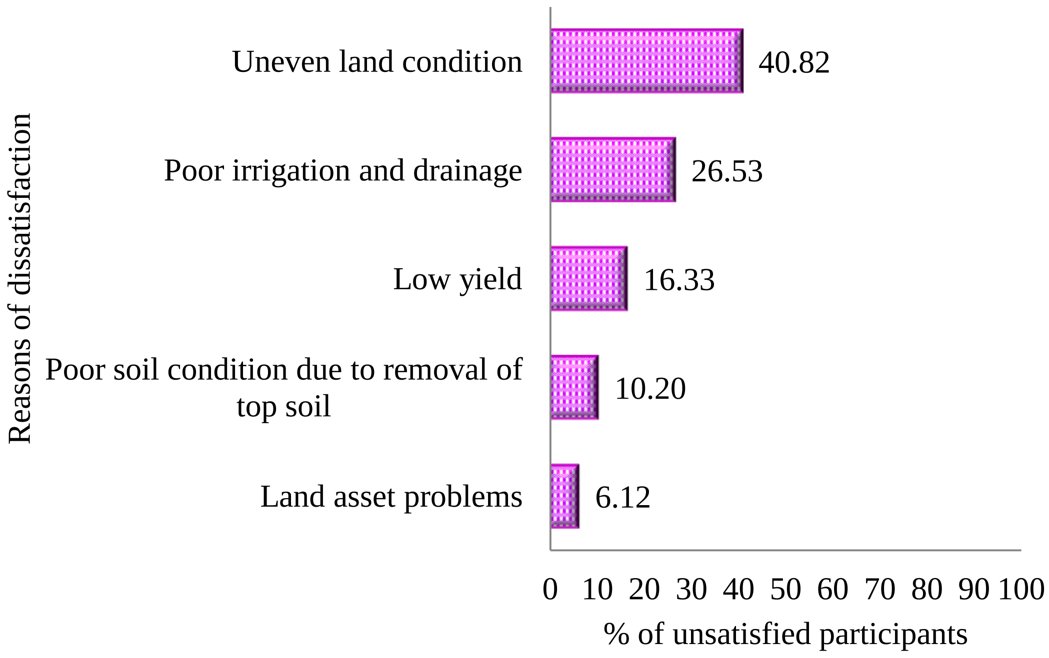


**Figure 4.6 Reasons of dissatisfaction on land consolidation program by unsatisfied participants (n = 29)**

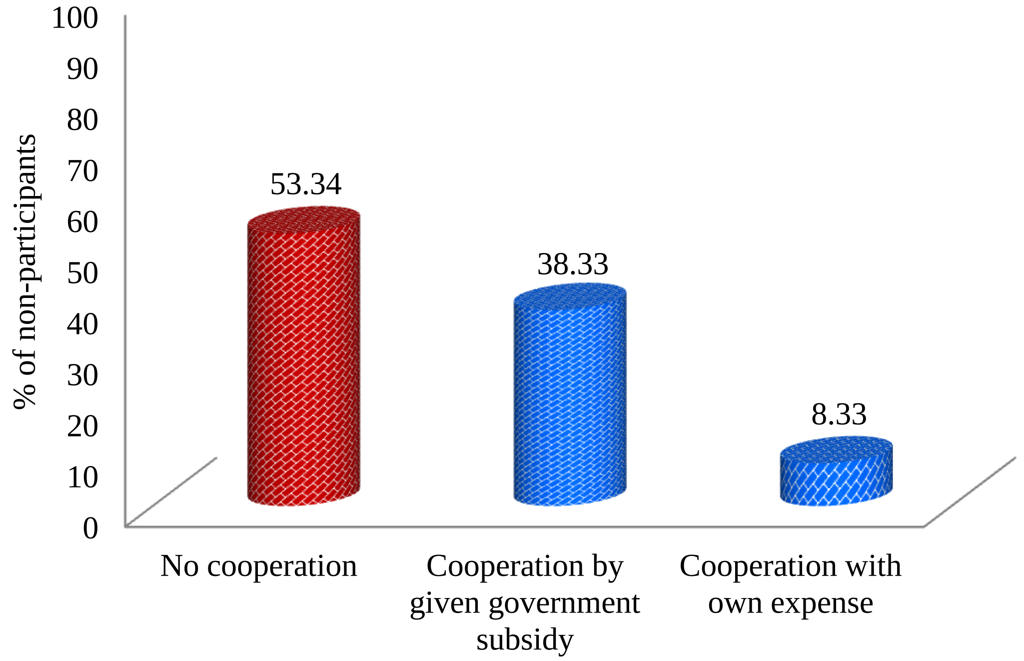


**Figure 4.7 Willingness to cooperate in land consolidation program by non-participants (n = 60)**

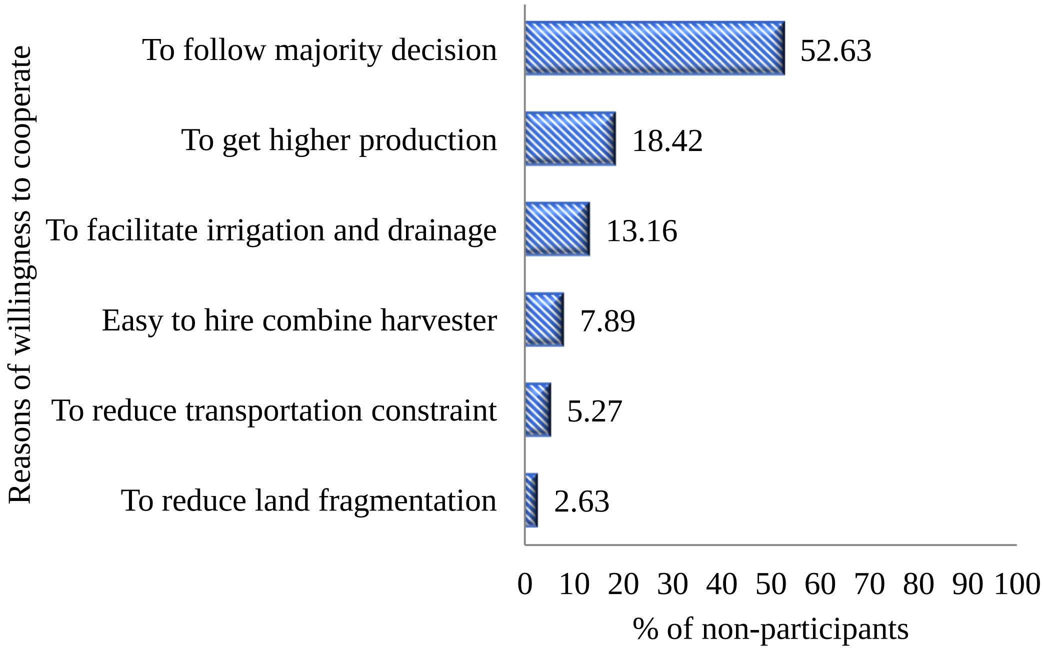


**Figure 4.8 Reasons of willingness to cooperate in land consolidation program by non-participants (n = 28)**

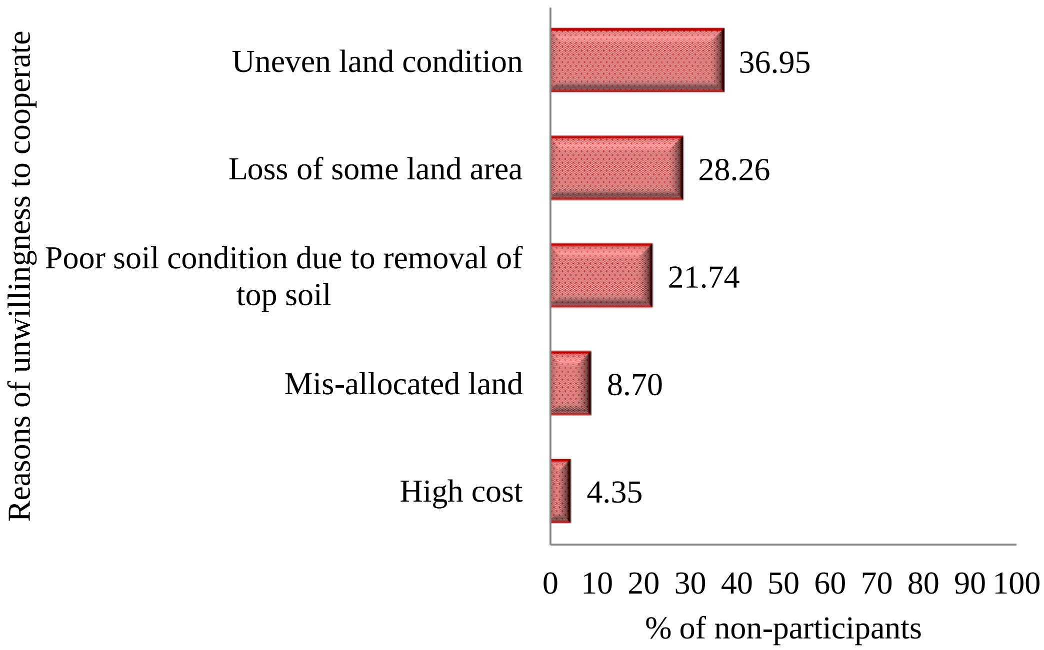


**Figure 4.9 Reasons of unwillingness to cooperate in land consolidation program by non-participants (n = 32)**

# CHAPTER V
# CONCLUSION AND POLICY IMPLICATION

## 5.1 Conclusion

This study was an attempt to describe participant and non-participant households' current circumstances, to study demographic and socio-economic status and constraints faced by participant and non-participant households in Pyinmana and Zeyarthiri Townships, Nay Pyi Taw. In addition, this study analyzed the profitability of rice production and investigated the determinants of rice production of the sample farm households. The study was conducted 120 sample farm households in Pyinmana and Zeyarthiri Townships, Nay Pyi Taw during the period of November to December, 2014.

The descriptive analysis showed that the majority of both participant and non-participant household heads was male household heads. There were not many differences between average heads' ages of the sample farm households in study area. Farmers' farm experience plays a vital role in agricultural farming activities. However, the average farm experience in the study area was not significantly different between participant and non-participant households. Participant household heads had 25.13 years farm experience on average while average 25.50 years of farm experience was found in non-participant household heads. Nearly half of participant and non-participant household heads were at the primary education level. The percentages of participant and non-participant household head's secondary job were 18.33% and 16.67%, respectively. There was no significant difference in household head's gender, age, farm experience, education and secondary job between these two groups.

The average family members of both participant and non-participant households were about five members and about two of them worked in their own farms. The family labor was the main input for rice production. The average dependency ratio of participant households was higher than that of non-participant households.

The average farm size of participant households was 2.49 ha and the average land holding size of non-participant households was 1.95 ha. Among them, lowland area of participant households and non-participant households were 2.15 ha and 1.85 ha, respectively. In terms of types of land ownership, average own cultivated area of participant households was 2.42 ha and that of non-participant households was 1.83

ha. The majority of cultivated land types of both participant and non-participant households were lowland.

When comparing productive assets, participant households possessed more plough, harrow, cattle, bullock cart and power tiller than those of non-participant households. Both participant and non-participant households did not possess any tractor. In household assets, the majority of participant and non-participant households owned wooden houses. Most of the household assets of both participant and non-participant households were TV, DVD, motorcycle and hand phone.

In participant and non-participant households, the main source of households' income was farm income. Among the farm income, the main source of crop income of participant households was summer rice income and that of non-participant households was monsoon rice income.

The most common cropping pattern of participant and non-participant households was rice-rice cropping pattern. Among the sample farm households, the most cultivated crop was monsoon rice and the second one was summer rice. Participant and non-participant households used six monsoon rice varieties. Five summer rice varieties were used by participant households and four summer rice varieties were used by non-participant households. In monsoon rice varieties, almost all of participant and non-participant households grew Manawthukha variety. In summer rice varieties, nearly half of participant households grew Pearlthwe variety while 56.67% of non-participant households grew Manawthukha variety.

The average seed rate of monsoon rice used by participant households was 122.55 kg/ha and non-participant households were 129.94 kg/ha in the study area. Furthermore, the average amount of summer rice seed used by participant households was 81.23 kg/ha which was lower than 130.01 kg/ha in non-participant households because most of participant households used hybrid rice variety.

The average monsoon rice yield obtained by participant households was lower than that of non-participant households but the average summer rice yield obtained by participant households was higher than that of non-participant households. All of participant and non-participant households applied urea fertilizer in rice cultivation. Moreover, the majority of participant and non-participant households used compound fertilizer. About one third of participant and non-participant households applied FYM.

Both participant and non-participant households received credit mainly from MADB with low interest rate. Some of participant and non-participant households borrowed money from local money lenders. The requirements of the sample farm households were needs of credit and technology for agricultural development.

In the evaluation of the profitability of monsoon rice production, participant households received lower gross benefit than non-participant households. The benefit-cost ratio of monsoon rice production in participant and non-participant households were 1.10 and 1.21, respectively. From the study, the benefit of rice in the study area just covered the total variable costs. It means that the surveyed rice farmers just received money back for their family effort in the rice production and the interest on the capital. When the farmers invest one MMK in the rice production, they will receive 1.10 MMK for participant households and 1.21 MMK for non-participant households after harvest.

Similarly, according to comparison of participant and non-participant households for summer rice production, participant households received higher gross benefit than non-participant households. Non-participant households received better yield with less variable costs even though there was less of a difference in received price for rice. Therefore, profit from summer rice production in non-participant households was higher than that of participant households.

In the analysis of the monsoon rice production determinant, the monsoon rice production in the study area was positively and significantly influenced by seed rate, total fertilizer amount, pesticide amount, herbicide amount, total machine day and total man day. The more inputs put into rice cultivation the more the monsoon rice production would be. Similarly, the higher the monsoon rice production, the more profits would obtain. Participant households in land consolidation program were negatively and significantly influenced on monsoon rice production. So, if 1% of participant households one percent involved in land consolidation program, monsoon rice production will be reduced. No significant effect of household head's age, household head's education level, household head's farm experience, FYM amount, fungicide amount, total animal labor, Manawthukha variety was observed on monsoon rice production.

According to regression estimates of the summer rice production, the significant influencing factors of summer rice production were participant households in land consolidation program, household head's age, seed rate, total fertilizer amount, total machine day, total animal day, total man day and Pearlthwe variety. Summer rice production was positively related to household head's age, seed rate, total fertilizer amount, total machine day, total animal day, total man day and Pearlthwe variety. Other things being equal, if one percent increases in household head's age, seed rate, total fertilizer amount, total machine day, total animal labor, total man labor and Pearlthwe variety, summer rice production will be increased. Participant households in land consolidation program were negatively and significantly influenced on summer rice production. So, if 1% of participant households involved in land consolidation program, summer rice production will be reduced.

There were several constraints concerning with rice production and land consolidation in the study area. Almost all of participant and non-participant households frequently mentioned high labor cost. And also, most of participant and non-participant households faced with high transportation cost and high production cost. According to the survey, the input cost and transportation cost of rice production remained high for rice farmers. About 66.67% of participant households and 61.67% of non-participant households used high fertilizer application for their crops production and consequently, leading to soil nutrient deficiencies later. However, the output prices they received remained low.

Not only participant households but also non-participant households faced with poor irrigation and drainage system and unavailable water as needed for crop production. About 45% of participant households and 21.67% of non-participant households faced with low yield. According to this result, the rice yield of participant households was lower than that of non-participant households in land consolidation program. Moreover, 8.33% of participant households and 38.33% of non-participant households faced with difficult to hire machine especially combine harvester. These factors lead to decline in the quantity of yield and consequently affected the profitability of the rice farmers. High variability in agricultural production was caused by high inputs and transportation cost and unavailable water as needed for crop production.

## 5.2 Policy Implication

The main focus of this study is to analyze the sample farm households whether profitability or not in rice production by land consolidation program. Some valuable findings emerged from this study can be useful for future policy implications. A number of policy options can be suggested for improving land consolidation program and for promoting livelihoods of rural farm households.

Myanmar agricultural sector is still affected by land fragmentation. Not only the majority of farms are very small, but also they are frequently divided into many farmland plots, which are often badly shaped for the agricultural purposes. Because of the extensive nature of fragmentation and the growing importance of rural space for non-agricultural purposes, land consolidation has remained an important instrument in strategies.

In the study area, nearly half of household heads were at the primary education level. Meanwhile, education is very important for everyone to be able to adopt new technologies. So, projects are in urgent need to upgrade the level of education of rural households. Moreover, extension agents should be trained and empowered to educate farmers on how to process rice to different products.

In the total households' income, both participant and non-participant households mainly depend on rice crop income. Second largest income for participant and non-participant households was non-farm income. Therefore, programs on capital based intensive agriculture more accompanied with small and medium enterprise development in the study area are needed to encourage and achieve high production with less labor per unit area and increase non-farm income job opportunities.

In addition, the credit from MADB was insufficient amount for crop production in the study area. Therefore, government should work with existing social organization and involve them in distribution of necessary inputs and credit for rice production and timely provision of necessary farm inputs and sufficient credit to enhance rice production.

At current situation, total variable cost of rice production by participant households was a little higher than that of non-participant households. So, the benefit was lesser in participant households than non-participant households. What is more, in regression analysis of this study, monsoon rice and summer rice production were negatively and significantly related to participant households in land consolidation program. However, the study was just a short term study. So, proper planning is needed for land consolidation program in the long run. Further studies on impact of land consolidation program are needed to get better understanding and complete picture for proper planning extensively. In doing so, we may see benefits from nationwide land consolidation program along with sustainable natural resources.

Therefore, the policy for benefits from land consolidation program should emphasize to increase gross income of farmers. As well as, the policy for land consolidation program should be to improve rural livelihoods rather than to improve only the primary production of agricultural products.

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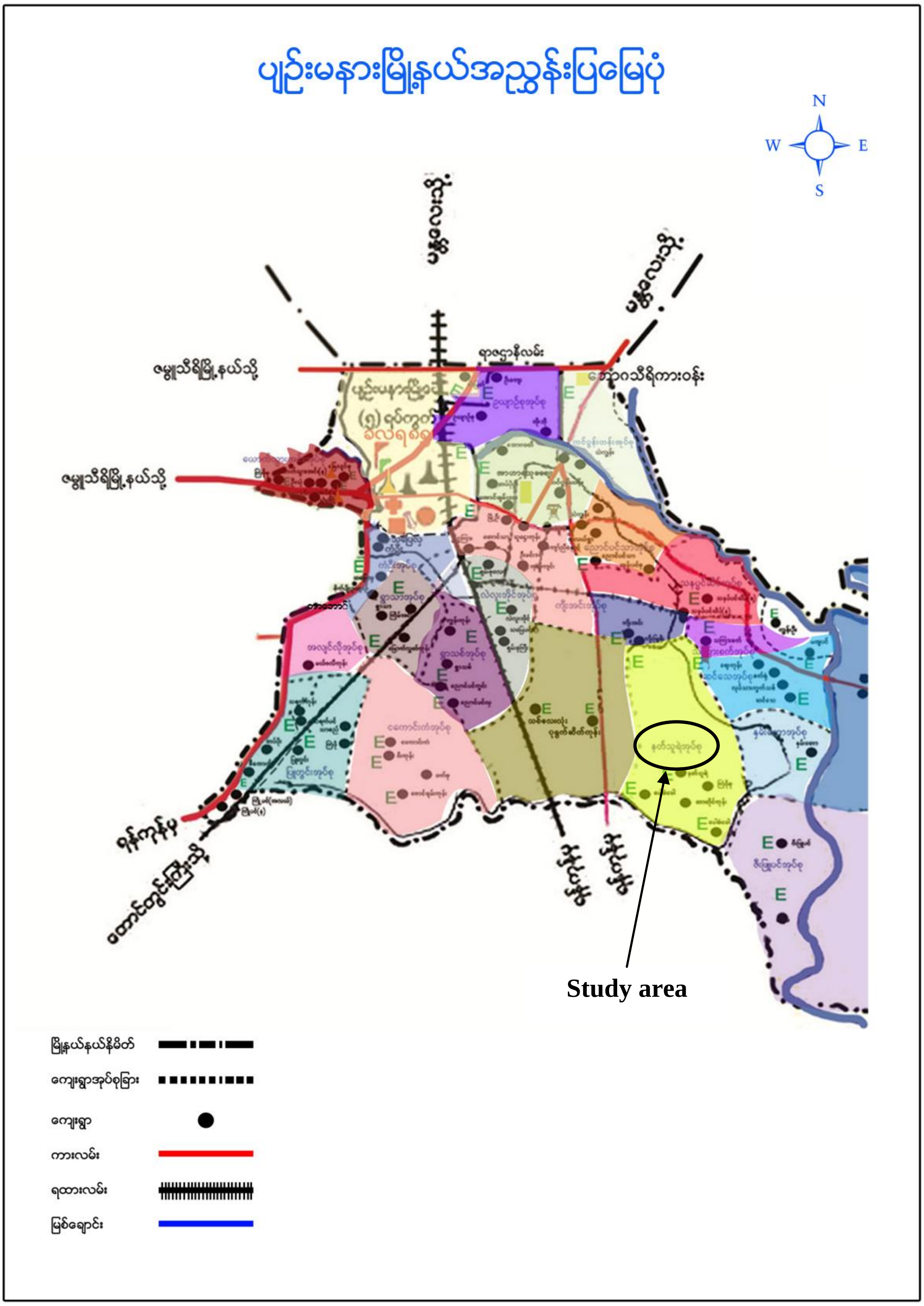
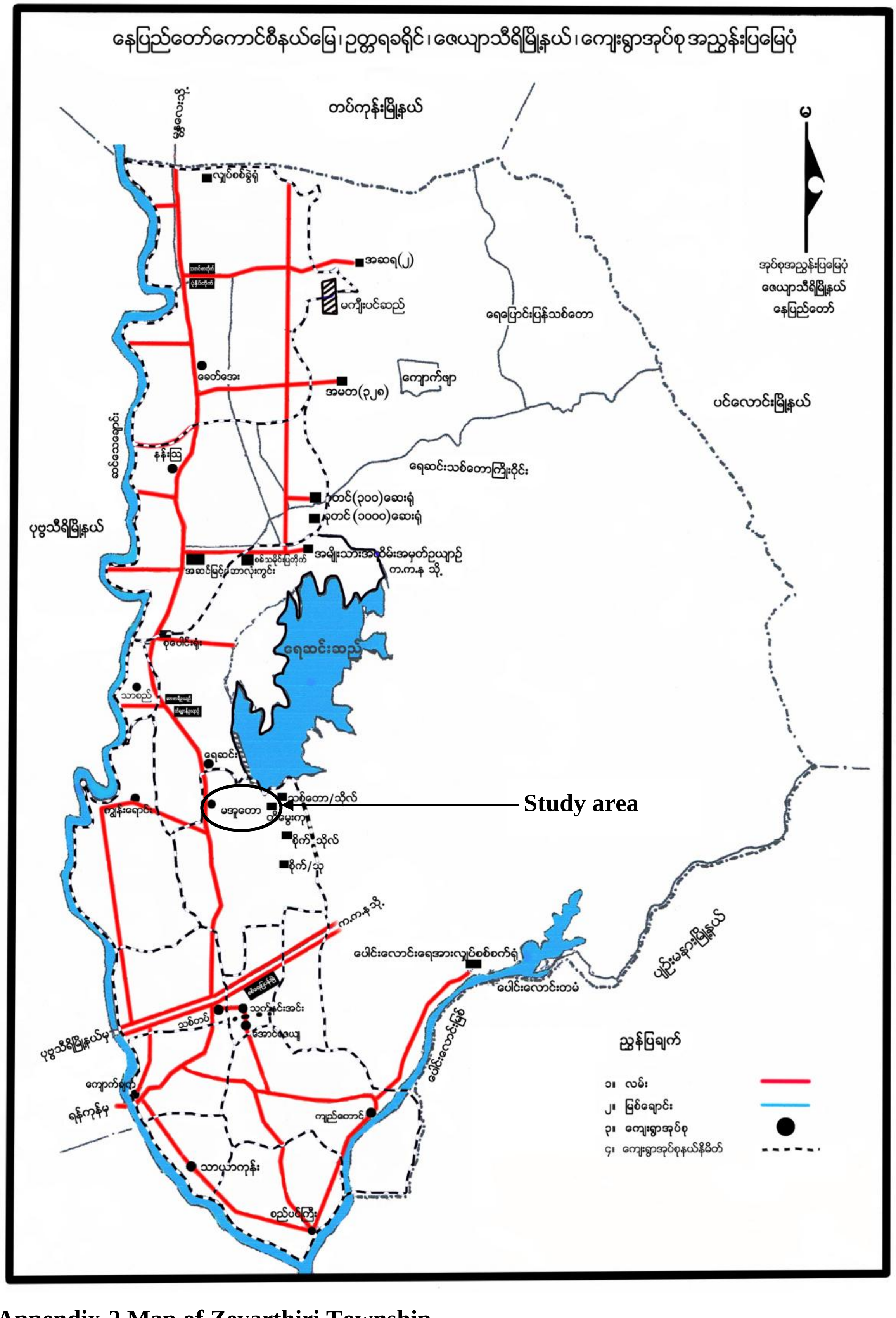
# APPENDICES




**Appendix 1 Map of Pyinmana Township**

Source: DoA, Pyinmana Township (2014)




**Appendix 2 Map of Zeyarthiri Township**

Source: DoA, Zeyarthiri Township (2014)

**Appendix 3 Enterprise budget for monsoon rice production of participant households (n = 60)**

| Items | Unit | Level | Effective price | Total value (MMK/ha) |
|---|---|---|---|---|
| **1.Gross benefit (GB)** | | | | |
| Yield of rice | kg/ha | 4,319.47 | 207 | 894,195 |
| **Total gross benefit** | | | | |
| **2. Variable cost** | | | | |
| **(a) Material cost** | | | | |
| Seed | kg/ha | 122.55 | 328 | 40,244 |
| FYM | MT/ha | 1.69 | 5,824 | 9,827 |
| Urea fertilizer | kg/ha | 177.08 | 422 | 74,788 |
| Compound fertilizer | kg/ha | 129.38 | 482 | 62,399 |
| Potash fertilizer | kg/ha | 25.52 | 481 | 12,270 |
| T-super fertilizer | kg/ha | 11.88 | 454 | 5,395 |
| Pesticide liquid | L/ha | 1.48 | 17,613 | 26,015 |
| Pesticide powder | kg/ha | 0.05 | 26,500 | 1,380 |
| Herbicide liquid | L/ha | 1.47 | 17,760 | 26,123 |
| Herbicide powder | kg/ha | 0.04 | 26,667 | 1,111 |
| Fungicide liquid | L/ha | 0.74 | 14,868 | 11,042 |
| Fungicide powder | kg/ha | 0 | 0 | 0 |
| **Total material cost (a)** | MMK/ha | | | 270,593 |
| **(b) Family labor cost** | | | | |
| Land preparation with machine | Mad/ha | 1.58 | 14,531 | 23,008 |
| Land preparation with draft cattle | Amd/ha | 2.96 | 4,888 | 14,459 |
| FYM application | Md/ha | 0.71 | 3,250 | 2,302 |
| Picking | Md/ha | 0.63 | 2,000 | 1,250 |
| Seeding | Md/ha | 2.04 | 2,453 | 5,008 |
| Fertilizer application | Md/ha | 4.00 | 2,176 | 8,706 |
| Pesticide application | Md/ha | 2.25 | 2,077 | 4,673 |
| Irrigation and drainage | Md/ha | 24.29 | 1,711 | 41,552 |
| Manual weeding | Md/ha | 0.17 | 2,000 | 333 |
| Threshing with machine | kg/ha | 334.63 | 7 | 2,406 |

| | | | | |
|---|---|---|---|---|
| Threshing | Md/ha | 0.38 | 3,000 | 1,125 |
| Transportation | Md/ha | 1.58 | 2,150 | 3,404 |
| Sun drying | Md/ha | 1.63 | 2,846 | 4,625 |
| **Total family labor cost (b)** | MMK/ha | | | 112,851 |
| **(c) Hired labor cost** | | | | |
| Land preparation with machine | Mad/ha | 3.25 | 17,688 | 57,486 |
| Land preparation with draft cattle | Amd/ha | 8.15 | 4,653 | 37,905 |
| FYM application | Md/ha | 0.50 | 3,063 | 1,531 |
| Picking | Md/ha | 3.96 | 1,882 | 7,451 |
| Seeding | Md/ha | 18.00 | 2,755 | 49,588 |
| Fertilizer application | Md/ha | 3.50 | 1,933 | 6,767 |
| Pesticide application | Md/ha | 3.63 | 2,114 | 7,664 |
| Irrigation and drainage | Md/ha | 1.25 | 1,667 | 2,083 |
| Manual weeding | Md/ha | 23.75 | 1,789 | 42,494 |
| Harvesting with machine | Mad/ha | 1.54 | 46,622 | 71,875 |
| Harvesting with manual | Md/ha | 10.75 | 3,020 | 32,465 |
| Threshing with machine | kg/ha | 1,244.65 | 8 | 9,613 |
| Threshing | Md/ha | 2.92 | 2,528 | 7,373 |
| Transportation | Md/ha | 10.96 | 3,380 | 37,041 |
| Sun drying | Md/ha | 12.54 | 2,852 | 35,767 |
| **Total hired labor cost (c)** | MMK/ha | | | 407,102 |
| **(d) Interest on cash cost** | | | | |
| Material cost | MMK/ha | | | 8,118 |
| Hired labor cost | MMK/ha | | | 12,213 |
| **Interest on cash cost (d)** | MMK/ha | | | 20,331 |
| Total variable cash cost (TVCC) (a + c + d) | | | | 698,027 |
| Total variable cost (TVC) (a + b + c + d) | | | | 810,878 |
| Return above variable cash cost (GB - TVCC) | | | | 196,168 |
| Return above variable cost (GB - TVC) | | | | 83,317 |
| Return per unit of cash expensed (GB/TVCC) | | | | 1.28 |
| Return per unit of capital invested (GB/TVC) | | | | 1.10 |
| Break-even price (TVC/effective yield) (MMK/kg) | | | | 188 |
| Break-even yield (TVC/effective price) (kg/ha) | | | | 3,917.00 |

**Appendix 4 Enterprise budget for monsoon rice production of non-participant households (n = 60)**

| Items | Unit | Level | Effective price | Total value (MMK/ha) |
|---|---|---|---|---|
| **1.Gross benefit (GB)** | | | | |
| Yield of rice | kg/ha | 4,524.01 | 209 | 945,756 |
| **Total gross benefit** | | | | |
| **2. Variable cost** | | | | |
| **(a) Material cost** | | | | |
| Seed | kg/ha | 129.94 | 325 | 42,223 |
| FYM | MT/ha | 2.60 | 6,048 | 15,749 |
| Urea fertilizer | kg/ha | 164.17 | 424 | 69,534 |
| Compound fertilizer | kg/ha | 122.08 | 486 | 59,369 |
| Potash fertilizer | kg/ha | 11.63 | 624 | 7,264 |
| T-super fertilizer | kg/ha | 9.38 | 380 | 3,563 |
| Pesticide liquid | L/ha | 1.39 | 17,578 | 24,463 |
| Pesticide powder | kg/ha | 0.08 | 36,467 | 3,039 |
| Herbicide liquid | L/ha | 1.53 | 22,263 | 33,975 |
| Herbicide powder | kg/ha | 0.01 | 18,000 | 263 |
| Fungicide liquid | L/ha | 0.55 | 18,342 | 10,050 |
| Fungicide powder | kg/ha | 0.08 | 36,467 | 3,039 |
| **Total material cost (a)** | MMK/ha | | | 269,490 |
| **(b) Family labor cost** | | | | |
| Land preparation with machine | Mad/ha | 0.83 | 14,778 | 12,315 |
| Land preparation with draft cattle | Amd/ha | 3.00 | 4,444 | 13,333 |
| FYM application | Md/ha | 0.42 | 3,250 | 1,354 |
| Picking | Md/ha | 0.42 | 2,429 | 1,012 |
| Seeding | Md/ha | 2.33 | 2,489 | 5,809 |
| Fertilizer application | Md/ha | 4.75 | 2,622 | 12,454 |
| Pesticide application | Md/ha | 3.08 | 2,559 | 7,890 |
| Irrigation and drainage | Md/ha | 20.63 | 1,554 | 32,042 |
| Manual weeding | Md/ha | 0.83 | 1,958 | 1,632 |
| Threshing with machine | kg/ha | 308.55 | 8 | 2,404 |

| | | | | |
|---|---|---|---|---|
| Threshing | Md/ha | 0.08 | 2,000 | 167 |
| Transportation | Md/ha | 0.75 | 2,975 | 2,231 |
| Sun drying | Md/ha | 3.67 | 3,043 | 11,159 |
| **Total family labor cost (b)** | MMK/ha | | | 103,802 |
| **(c) Hired labor cost** | | | | |
| Land preparation with machine | Mad/ha | 1.83 | 17,760 | 32,560 |
| Land preparation with draft cattle | Amd/ha | 10.27 | 4,692 | 48,191 |
| FYM application | Md/ha | 0.58 | 3,409 | 1,989 |
| Picking | Md/ha | 1.46 | 2,727 | 3,977 |
| Seeding | Md/ha | 10.19 | 2,781 | 28,328 |
| Fertilizer application | Md/ha | 2.79 | 2,600 | 7,258 |
| Pesticide application | Md/ha | 2.92 | 2,567 | 7,486 |
| Irrigation and drainage | Md/ha | 0.88 | 3,333 | 2,917 |
| Manual weeding | Md/ha | 25.96 | 2,296 | 59,598 |
| Harvesting with machine | Mad/ha | 1.42 | 49,853 | 70,625 |
| Harvesting with manual | Md/ha | 10.79 | 3,488 | 37,636 |
| Threshing with machine | kg/ha | 1,434.13 | 8 | 11,516 |
| Threshing | Md/ha | 2.58 | 2,675 | 6,910 |
| Transportation | Md/ha | 11.17 | 3,440 | 38,412 |
| Sun drying | Md/ha | 9.96 | 3,202 | 31,886 |
| **Total hired labor cost (c)** | MMK/ha | | | 389,289 |
| **(d) Interest on cash cost** | | | | |
| Material cost | MMK/ha | | | 8,085 |
| Hired labor cost | MMK/ha | | | 11,679 |
| **Interest on cash cost (d)** | MMK/ha | | | 19,763 |
| Total variable cash cost (TVCC) (a + c + d) | | | | 678,543 |
| Total variable cost (TVC) (a + b + c + d) | | | | 782,345 |
| Return above variable cash cost (GB - TVCC) | | | | 267,213 |
| Return above variable cost (GB - TVC) | | | | 163,411 |
| Return per unit of cash expensed (GB/TVCC) | | | | 1.39 |
| Return per unit of capital invested (GB/TVC) | | | | 1.21 |
| Break-even price (TVC/effective yield) (MMK/kg) | | | | 173 |
| Break-even yield (TVC/effective price) (kg/ha) | | | | 3,742.34 |

**Appendix 5 Enterprise budget for summer rice production of participant households (n = 56)**

| Items | Unit | Level | Effective price | Total value (MMK/ha) |
|---|---|---|---|---|
| **1.Gross benefit (GB)** | | | | |
| Yield of rice | kg/ha | 6,146.72 | 209 | 1,282,320 |
| **Total gross benefit** | | | | |
| **2. Variable cost** | | | | |
| **(a) Material cost** | | | | |
| Seed | kg/ha | 81.23 | 1,607 | 130,514 |
| FYM | MT/ha | 1.32 | 6,118 | 8,057 |
| Urea fertilizer | kg/ha | 193.21 | 468 | 90,328 |
| Compound fertilizer | kg/ha | 152.90 | 473 | 72,332 |
| Potash fertilizer | kg/ha | 19.24 | 410 | 7,889 |
| T-super fertilizer | kg/ha | 17.86 | 425 | 7,589 |
| Pesticide liquid | L/ha | 1.63 | 18,072 | 29,407 |
| Pesticide powder | kg/ha | 0.07 | 22,500 | 1,657 |
| Herbicide liquid | L/ha | 1.35 | 18,168 | 24,576 |
| Herbicide powder | kg/ha | 0.08 | 44,708 | 3,553 |
| Fungicide liquid | L/ha | 0.66 | 15,554 | 10,294 |
| Fungicide powder | kg/ha | 0.16 | 20,667 | 3,368 |
| **Total material cost (a)** | MMK/ha | | | 386,195 |
| **(b) Family labor cost** | | | | |
| Land preparation with machine | Mad/ha | 1.70 | 14,833 | 25,164 |
| Land preparation with draft cattle | Amd/ha | 2.01 | 4,888 | 9,819 |
| FYM application | Md/ha | 0.85 | 2,813 | 2,386 |
| Picking | Md/ha | 0.04 | 2,000 | 89 |
| Seeding | Md/ha | 1.96 | 2,516 | 4,942 |
| Fertilizer application | Md/ha | 4.11 | 2,182 | 8,961 |
| Pesticide application | Md/ha | 2.19 | 2,125 | 4,648 |
| Irrigation and drainage | Md/ha | 29.24 | 1,660 | 48,551 |
| Manual weeding | Md/ha | 0.04 | 3,000 | 134 |
| Threshing with machine | kg/ha | 167.63 | 7 | 1,205 |

| | | | | |
|---|---|---|---|---|
| Threshing | Md/ha | 0.13 | 3,000 | 402 |
| Transportation | Md/ha | 0.58 | 3,000 | 1,741 |
| Sun drying | Md/ha | 2.68 | 2,909 | 7,792 |
| **Total family labor cost (b)** | MMK/ha | | | 115,835 |
| **(c) Hired labor cost** | | | | |
| Land preparation with machine | Mad/ha | 3.44 | 16,943 | 58,242 |
| Land preparation with draft cattle | Amd/ha | 8.15 | 4,716 | 38,422 |
| FYM application | Md/ha | 0.63 | 2,688 | 1,680 |
| Picking | Md/ha | 4.02 | 1,859 | 7,471 |
| Seeding | Md/ha | 20.76 | 3,519 | 73,050 |
| Fertilizer application | Md/ha | 3.44 | 2,000 | 6,875 |
| Pesticide application | Md/ha | 3.66 | 2,250 | 8,237 |
| Irrigation and drainage | Md/ha | 1.65 | 2,167 | 3,579 |
| Manual weeding | Md/ha | 22.63 | 1,750 | 39,609 |
| Harvesting with machine | Mad/ha | 2.14 | 46,417 | 99,464 |
| Harvesting with manual | Md/ha | 4.87 | 2,591 | 12,608 |
| Threshing with machine | kg/ha | 507.53 | 7 | 3,650 |
| Threshing | Md/ha | 1.79 | 2,667 | 4,762 |
| Transportation | Md/ha | 8.30 | 3,767 | 31,281 |
| Sun drying | Md/ha | 23.39 | 2,885 | 67,479 |
| **Total hired labor cost (c)** | MMK/ha | | | 456,407 |
| **(d) Interest on cash cost** | | | | |
| Material cost | MMK/ha | | | 11,586 |
| Hired labor cost | MMK/ha | | | 13,692 |
| **Interest on cash cost (d)** | MMK/ha | | | 25,278 |
| Total variable cash cost (TVCC) (a + c + d) | | | | 867,880 |
| Total variable cost (TVC) (a + b + c + d) | | | | 983,715 |
| Return above variable cash cost (GB - TVCC) | | | | 414,440 |
| Return above variable cost (GB - TVC) | | | | 298,605 |
| Return per unit of cash expensed (GB/TVCC) | | | | 1.48 |
| Return per unit of capital invested (GB/TVC) | | | | 1.30 |
| Break-even price (TVC/effective yield) (MMK/kg) | | | | 160 |
| Break-even yield (TVC/effective price) (kg/ha) | | | | 4,715.37 |

**Appendix 6 Enterprise budget for summer rice production of non-participant households (n = 40)**

| Items | Unit | Level | Effective price | Total value (MMK/ha) |
|---|---|---|---|---|
| **1.Gross benefit (GB)** | | | | |
| Yield of rice | kg/ha | 5,505.08 | 219 | 1,204,732 |
| **Total gross benefit** | | | | |
| **2. Variable cost** | | | | |
| **(a) Material cost** | | | | |
| Seed | kg/ha | 130.01 | 472 | 61,414 |
| FYM | MT/ha | 2.31 | 5,786 | 13,379 |
| Urea fertilizer | kg/ha | 170.31 | 431 | 73,447 |
| Compound fertilizer | kg/ha | 139.06 | 492 | 68,384 |
| Potash fertilizer | kg/ha | 10.43 | 653 | 6,816 |
| T-super fertilizer | kg/ha | 7.81 | 380 | 2,969 |
| Pesticide liquid | L/ha | 1.34 | 18,391 | 24,713 |
| Pesticide powder | kg/ha | 0.05 | 25,423 | 1,382 |
| Herbicide liquid | L/ha | 1.61 | 24,718 | 39,780 |
| Herbicide powder | kg/ha | 0.04 | 33,889 | 1,324 |
| Fungicide liquid | L/ha | 0.40 | 21,500 | 8,600 |
| Fungicide powder | kg/ha | 0.18 | 16,600 | 2,957 |
| **Total material cost (a)** | MMK/ha | | | 302,210 |
| **(b) Family labor cost** | | | | |
| Land preparation with machine | Mad/ha | 1.06 | 14,750 | 15,672 |
| Land preparation with draft cattle | Amd/ha | 3.31 | 4,208 | 13,940 |
| FYM application | Md/ha | 0.56 | 3,286 | 1,848 |
| Picking | Md/ha | 0.69 | 2,500 | 1,719 |
| Seeding | Md/ha | 2.50 | 3,056 | 7,639 |
| Fertilizer application | Md/ha | 4.94 | 2,926 | 14,447 |
| Pesticide application | Md/ha | 2.69 | 2,895 | 7,780 |
| Irrigation and drainage | Md/ha | 21.19 | 1,566 | 33,175 |
| Manual weeding | Md/ha | 0.44 | 2,833 | 1,240 |
| Threshing with machine | kg/ha | 247.71 | 8 | 2,078 |

| | | | | |
|---|---|---|---|---|
| Threshing | Md/ha | 0.00 | 0 | 0 |
| Transportation | Md/ha | 0.19 | 3,000 | 563 |
| Sun drying | Md/ha | 5.00 | 2,955 | 14,773 |
| **Total family labor cost (b)** | MMK/ha | | | 114,872 |
| **(c) Hired labor cost** | | | | |
| Land preparation with machine | Mad/ha | 1.38 | 20,077 | 27,606 |
| Land preparation with draft cattle | Amd/ha | 11.03 | 4,563 | 50,338 |
| FYM application | Md/ha | 0.50 | 3,500 | 1,750 |
| Picking | Md/ha | 0.94 | 3,071 | 2,879 |
| Seeding | Md/ha | 3.53 | 2,571 | 9,080 |
| Fertilizer application | Md/ha | 2.88 | 2,853 | 8,202 |
| Pesticide application | Md/ha | 3.25 | 2,727 | 8,864 |
| Irrigation and drainage | Md/ha | 0.69 | 1,500 | 1,031 |
| Manual weeding | Md/ha | 20.69 | 2,700 | 55,856 |
| Harvesting with machine | Mad/ha | 1.75 | 49,138 | 85,991 |
| Harvesting with manual | Md/ha | 7.63 | 4,125 | 31,453 |
| Threshing with machine | kg/ha | 1,303.75 | 8 | 10,313 |
| Threshing | Md/ha | 3.00 | 2,792 | 8,375 |
| Transportation | Md/ha | 11.16 | 3,362 | 37,509 |
| Sun drying | Md/ha | 16.56 | 3,167 | 52,448 |
| **Total hired labor cost (c)** | MMK/ha | | | 391,696 |
| **(d) Interest on cash cost** | | | | |
| Material cost | MMK/ha | | | 9,066 |
| Hired labor cost | MMK/ha | | | 11,751 |
| **Interest on cash cost (d)** | MMK/ha | | | 20,817 |
| Total variable cash cost (TVCC) (a + c + d) | | | | 714,723 |
| Total variable cost (TVC) (a + b + c + d) | | | | 829,595 |
| Return above variable cash cost (GB - TVCC) | | | | 490,009 |
| Return above variable cost (GB - TVC) | | | | 375,137 |
| Return per unit of cash expensed (GB/TVCC) | | | | 1.69 |
| Return per unit of capital invested (GB/TVC) | | | | 1.45 |
| Break-even price (TVC/effective yield) (MMK/kg) | | | | 151 |
| Break-even yield (TVC/effective price) (kg/ha) | | | | 3,790.88 |