ADOPTION OF IMPROVED TECHNOLOGY PACKAGE BY SESAME GROWERS IN MAGWAY TOWNSHIP

EI EI PHYU

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

Department of Agricultural Economics
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The thesis attached here to entitled **"ADOPTION OF IMPROVED TECHNOLOGY PACKAGE BY SESAME GROWERS IN MAGWAY TOWNSHIP"** was prepared under the direction of the chairman of the candidate supervisory committee and has been approved by all members of that committee and board of examiners as a partial fulfillment of requirements for the degree of **MASTER OF AGRICULTURAL SCIENCE (AGRICULTURAL ECONOMICS).**

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DECLARATION OF ORGINALITY

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 MYINT HTAY AND DAW TIN NYUNT

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ABSTRACT

The study attempted to observe adoption of sesame production technology package recommended by the Department of Agriculture (DoA) in Magway Township. The objectives were to investigate adoption of ten components of improved technology package by the sample households and to investigate the financial profitability of sesame production. Total numbers of 129 sample farmers from 4 villages were chosen by proportionate random sampling method. In data analysis, descriptive statistics and benefit cost ratio were employed. Out of 129 sample farmers, 51.9% were partial adopters who obtained less than 60 adoption points and 48.1% were high adopters who got more than 60 points for adoption of recommended technologies.

The number of family size and family labor were not different between high and partial adopters while farmer's age, and farming experience were slightly different between them. More educated farmers were found in high adopters group. Most popular sesame variety was Samonnet in the high adopters group, whereas, Bapan was mostly used by partial adopters.

According to the results, total material costs and total variables costs were higher in partial adopters because of low level of adoption in spacing recommendation and use of high seed rate. Benefit cost ratio 2.3 indicated that high adopters earned good profit from sesame cultivation compared to benefit cost ratio of partial adopters which was (1.4) in the study area.

Regression results showed that schooling year, training attended and total gross benefits were significant and positively correlated with adoption scores of both types of adopter. Technology constraint was significant and negatively correlated factor among them.

CONTENTS

	Page
ACKNOWLEDGEMENTS	v
ABSTRACT	vi
CONTENTS	vii
LIST OF TABLES	ix
LIST OF FIGURE	xi
LIST OF APPENDIX	xii
LIST OF ABBREVIATIONS	xiii
LIST OF CONVERSION FACTORS	xiii
CHAPTER I. INTRODUCTION	1
1.1 Background of the Study	1
1.2 Importance of Sesame Production in Magway Region	2
1.3 Sesame Production Technology Package Recommended by Department of Agriculture	4
1.4 Rationale of the Study	5
1.5 Objectives of the Study	6
CHAPTER II. LITERATURE REVIEW	7
2.1 Basic Concept of Adoption	7
2.2 Adoption Process	7
2.3 Mode and Sequence of Agricultural Technology Adoption	8
2.4 Selected Empirical and Theoretical Studies of Technology Adoption in Developed Countries	9
2.5 Selected Empirical and Theoretical Studies of Technology Adoption in Myanmar	12
CHAPTER III. RESEARCH METHODOLOGY	14
3.1 Description of the Study Area	14
3.1.1 Location of the study area	14
3.1.2 Climate condition	14
3.2 Area and Population of Magway Township	16
3.3 Data Collection Methods and Selected Villages	16
3.3.1 Data collection	16
3.3.2 Sampling method	17
3.4 Methods of Data Analysis	17

3.5 Adoption Status Analysis 17
3.6 Cost and Return Analysis 19
3.6.1 Weighted average on constraints scoring 20
3.7 Selection of Appropriate Econometric Model 20
CHAPTER IV. RESULTS AND DISCUSSION 22
4.1 Classification of the Sample Farmers Based on Adoption Scores 22
4.2 The Access of Improved Sesame Technology Package of the Sample Farmers 22
4.3 Socio-economic Characteristics of the Sample Farmers 27
4.4 Secondary Occupation and Sources of Incomes of the Sample Farmers 27
4.5 Household Assets by the Sample Farmers 29
4.6 Farming Apparatus by the Sample Farmers 29
4.7 Livestock Assets Ownership of the Sample Farmers 30
4.8 Sesame Sown Area of the Sample Farmers 33
4.9 Cultivated Sesame Varieties in the Study Area 33
4.10 Production of Other Crops in the Study Area 33
4.11 Status of Credit Received by the Sample Farmers 34
4.12 Enterprise Budget for Monsoon Sesame Production of Partial Adopter and High Adopter Farmers in the Study Area 37
4.13 Common Constraints Faced by the Sample Farmers 40
4.14 Access of Information Sources by the Sample Farmers 47
4.15 Production Technology Trainings Attended by the Sample Farmers 47
4.16 Descriptive Statistics of Variables to Analyze the Adoption of Improved Technology Package 49
CHAPTER V. CONCLUSION 52
5.1 Conclusion 52
5.2 Recommendations 54
REFERENCES 56
APPENDICES 61

LIST OF TABLES

Table		Page
1.1	Sesame sown area in Magway Township (2010/2011 - 2017/2018)	3
1.2	Average yield in Magway Township (2010/2011 - 2017/2018)	3
3.1	Number of sample farmers from each village by using proportionate random sampling method	18
4.1	Sesame production technologies package recommended by the Department of Agriculture in Magway Township	24
4.2	Classification of adoption status of the sample farmers on improved sesame production technology package	25
4.3	Adoption status of the sample farmers on each recommended technology	25
4.4	Adoption status of the sample farmers in each sample village	26
4.5	Demographic characteristics of the sample farmers	28
4.6	Secondary occupation of the sample farmers	28
4.7	Sources of secondary income of the sample farmers	28
4.8	Possession of household assets by the sample farmers	31
4.9	Possession of farming apparatus assets by the sample farmers	31
4.10	Possession of livestock assets by the sample farmers	32
4.11	Adopter categories in three types of the sesame farmers	35
4.12	Sesame varieties cultivated by the sample farmers in the study area	35
4.13	Other crops cultivated by the sample farmers in the study area	35
4.14	Number of credit sources received by the sample farmers	36
4.15	Cost and return analysis of sesame production by partial and high adopters	38
4.16	Total material cost of sesame production by partial and high adopters	39
4.17	Input constraints faced by partial adopters in sesame production	42
4.18	Input constraints faced by high adopters in sesame production	43
4.19	Output constraints faced by partial adopters in sesame production	44
4.20	Output constraints faced by high adopters in sesame production	44
4.21	Technology constraints faced by partial adopters in sesame production	45
4.22	Technology constraints faced by high adopters in sesame production	46
4.23	Access of information sources by the sample farmers	48

Table **Page**

4.24 Training received and attended by the sample farmers 48

4.25 Frequency of training received by the sample farmers 48

4.26 Descriptive statistics of the variables to analyze the adoption of improved technology package by sesame growers in the study area 50

4.27 Factors affecting the adoption of improved sesame technology package by the sample farmers 51

LIST OF FIGURE

Figure		Page
3.1	Map of study villages in Magway District	15

LIST OF APPENDIX

Appendix		Page
1.	Enterprise budget of sesame production by partial and high adopter	61
2.	Survey questionnaire (Adoption of Improved Technology Package by Sesame Growers in Magway Township)	63

LIST OF ABBREVIATIONS

DoA	Department of Agriculture
DAR	Department of Agricultural Research
DoP	Department of Population
FAO	Food and Agricultural Organization
FFS	Farmer Field School
HHH	Household Head
MADB	Myanmar Agricultural Development Bank
MMK	Myanmar Kyat
MoAI	Ministry of Agriculture and Irrigation
MoALI	Ministry of Agriculture, Livestock and Irrigation
NGO	Non-Government Organization
CSO	Central Statistical Organization
GDP	Gross Domestic Product
SLRD	Settlement and Land Record Department
USD	US Dollar
ha	Hectare
MT	Metric Ton
kg	Kilogram

LIST OF CONVERSION FACTORS

1basket of sesame	=	24.5 kilograms
1 hectare	=	2.47 acres
1 ton of cow dung	=	2 cartloads of cow dung
1ton	=	1000 kilograms
1USD	=	1505MMK (September 2018)

CHAPTER I
INTRODUCTION

1.1 Background of the Study

In Myanmar, about 62 % of inhabitants relied on agriculture related activities and agriculture is considered as the primary engine of growth of the economy, the main source of income for the majority of people. The agriculture sector contributes 25.6% of GDP and 24.4% of total export earnings in 2017 - 2018 (Ministry of Agriculture, Livestock and Irrigation [MoALI], 2018). For food production with the growing population, agriculture sector will continue to be essential for the country as well as to occupy a large share of the export earnings.

More than 60 different crops are grown based on the prevalence of different agro-ecological zones. The crops are generally classified into eight groups: cereals, pulses, oilseeds, industrial crops, fruits, vegetables, culinary crops and other crops. Other important crops are pulses, sesame, groundnuts and sugarcane. Oilseed crops also play a vital role due to high consumption of cooking oil compared to other neighboring countries (Ministry of Agriculture, Livestock and Irrigation [MoALI], 2017).

The contribution of oilseed crops plays a vital role in Myanmar agricultural sector and agricultural product markets as well as on international markets**.** The 15% of total crop sown area is covered with oilseeds. Major oilseed crops include sesame, groundnut, sunflower, mustard and niger. In many parts of central Myanmar, oilseeds, particularly sesame and groundnut play an important part in ensuring food security and providing cash income for education, health and other social necessities (MoALI, 2017).

Sesame is an essential oilseed crop in Myanmar. In 2017-2018, its sown area (1,590) thousand hectares was 51.4% of total oilseed crop sown area. Magway Region is a major sesame grown area and occupied 60.9% of total sown area of sesame in Myanmar. Sesame is classified according to its colors: black, white, and mixed color sesame, including red, brown, yellow and more. White sesame is roasted and used snacks and salads. Red sesame is cheaper than white and mainly used for oil extraction. Black sesame is mainly exported to Japan, Korea and China from Aunglan and Magway Townships. Myanmar’s export of sesame seeds was increased from 35.5 thousand MT in 2011-2012 to 123.1 thousand MT in 2017-2018 (MoALI, 2018).

About 40% of the sesame production is consumed in the form of edible oil, which is popular for its aroma and unique taste. The by-product of oil production, oil cake is used as feed for livestock and fish farms. The protein content of sesame cake ranges from 35-47%. The oil content of sesame seed is 43.3-49.6% (Jovanovic, 2017).

1.2 Importance of Sesame Production in Magway Region

In Magway Region, sesame cultivated area was 487,739 hectares in premonsoon, 44,009 hectares in post monsoon and 39,162 hectares in summer respectively. In this region, the sown area of rain-fed sesame (pre monsoon and post monsoon) was about 27% of total crop cultivated area. On the other hand, the summer sesame areas occupied 11% of the total crop cultivated area in Magway Region (Department of Agriculture, 2017).

In Magway Township, the cultivated area of pre monsoon sesame in 2017-2018 reached to 75,136 hectares which was comparatively higher than 74,716 hectares in 2010-2011, although it was fluctuated as shown in Table (1.1). Similarly, the sown areas of post monsoon and summer sesame in 2017-2018 were 7,944 hectares and 2,438 hectares respectively which were relatively higher than the acreage in 2010-2011 (Department of Agriculture, 2018).

In 2017-2018, the average yield of pre monsoon sesame in Magway Township reached to 0.7 ton per hectares which was lower than 0.8 in 2010-2011 (Table 1.2). Moreover, the average yield of post monsoon and summer sesame in 2017-2018 were 0.2 ton per hectares and 0.1 ton per hectares respectively which were relatively lower than the yield in 2010-2011 because of unfavorable weather condition (Department of Agriculture, 2018).

Table 1.1 Sesame sown area in Magway Township (2010/2011 - 2017/2018)

Year	**Sesame sown area (ha)**		
	Pre monsoon	Post monsoon	Summer
2010-2011	74,716	7,568	2,346
2011-2012	71,178	8,321	2,336
2012-2013	73,496	6,951	2,113
2013-2014	70,821	6,833	2,028
2014-2015	71,678	7,551	2,087
2015-2016	72,491	7,338	2,159
2016-2017	73,498	7,223	2,221
2017-2018	75,136	7,944	2,438

Source: Department of Agriculture, (2018)

Table 1.2 Average yield in Magway Township (2010/2011 - 2017/2018)

Year	**Average yield (ton/ha)**		
	Pre monsoon	Post monsoon	Summer
2010-2011	0.8	0.3	0.2
2011-2012	0.8	0.2	0.1
2012-2013	0.8	0.3	0.2
2013-2014	0.8	0.3	0.2
2014-2015	0.8	0.3	0.2
2015-2016	0.8	0.3	0.3
2016-2017	0.8	0.3	0.2
2017-2018	0.7	0.2	0.1

Source: Department of Agriculture, (2018)

1.3 Sesame Production Technology Package Recommended by Department of Agriculture

Sesame varieties such as Bapan, Samonnet, Satlatphyu, Majandaw, Sinyadanar-3, Theipannet, Magway7/9, Hnanni 25/160 are mostly cultivated in Magway Township. The choice of sesame variety is determined by the farmer's objectives such as market demand, seed price etc, the length of growing season, and the amount of rainfall at a given locality (Department of Agriculture, 2017).

In order to fulfill the sufficiency of edible oil and expand the sesame export, efforts to increase yield and production of sesame crops such as the use of high yielding varieties, modern cultivation practices and appropriate cropping patterns are being implemented by the Department of Agriculture. The sesame production technology package was introduced in the study area since 2013-2014 by the Department of Agriculture;

(1) Soil type: The recommended soil pH is 5.7-8.

(2) Quality of seed: The recommended seed is mature seed, good quality seed from improved sesame varieties.

(3) Seed rate: The recommended seed rate is 7.5-11.3 kg/ha to be saved seed used and cost of production.

(4) Sowing time: The recommended sowing time is pre monsoon sesame cultivation for May, post monsoon sesame cultivation for 4th week of September and summer sesame cultivation for 4th week of March.

(5) Spacing: Row spacing is important to get sufficient plant populations and good aeration. The recommended row spacing is 15 inches× 4 inches for branching type and 12 inches× 4 inches for single type of sesame.

(6) Fertilizer application: Since phosphorous is rich in soil of the study area, urea and compound fertilizer are mostly used. Fertilizer application is recommended at least 3 times of urea and potassium 62.9 kg/ha and 31.5 kg/ha of potash to support optimum growth and high yield.

(7) Thinning time: The recommended thinning time is 15th & 30th day after sowing (depended on soil type, germination rate and availability of rain).

(8) Weed control: Weeds can seriously affect sesame yield. So, summer fallowing is recommended to destroy weed seed production in last cultivated season and hand weeding is also recommended to do until 30 days after sowing to improve soil aeration and to get more nutrients for roots.

(9) Pest and disease control: Pests and diseases can also seriously affect yield of sesame. Therefore, recommended to control pests and diseases with systemic pesticide to *sesamum phyllody* and contact pesticide to borer and black bug.

(10) Harvesting: Suitable harvesting time is also recommended after 25 % of leaves from the bottom are shed. The bottom capsules lose their color and turn yellow at maturity.

1.4 Rationale of the Study

Magway Township has large potential to produce more sesame by improving sesame yield on existing production areas. In this Township, sesame farmers still rely on owned seed, low rate of access to high quality seed and inadequate supply of improved varieties. Most of sesame farmers were lack of information, poor knowledge and poor adopted improved sesame varieties and technologies (Ashri, 2006). So, sesame production in this Township needs to be increased with limitation of cultivated area.

Most farmers have insufficient investment for purchasing inputs for sesame production. Besides, they also face credit problem. In growing sesame, labor sources and land resources are the strength to increase the productivity. Improvement of land productivity can enhance the yield and profit. Hence, the influencing factors on profitability of sesame production were the farmer's characteristics, input use, labor use, whether the farmers produced for sale or for home consumption as well as the methods of production (Tschering, 2002).

If farmers adopt and apply the improved sesame techniques well, there will be increased sesame productivity. However, it is impossible to promote sesame yield without adoption of improved sesame production technologies. Poor adoption of improved sesame production technologies would lead to high cost of production with corresponding low yield (Oxfam, 2014).

The Department of Agriculture has been providing some training to farmers in group meeting method by extension staff. But the numbers of farmers who access to training and improved agricultural techniques are low. Besides, the technology generation, efforts were also made to promote this technology in potential production areas. This Township is among the area where this improved sesame technologies were introduced to improve the income and food security status of farmers. This has been done through on extension training and seed dissemination through the farmers, rural development and some NGOs. The produced seeds were also popularized to the farming community through farmer-to-farmer seed exchange system (Department of Agriculture, 2017).

Moreover, sesame production need to be increased in order to ensure food and income security through the adoption of improved sesame production technology. The efforts to enhance productivity of sesame are based on the development of improved agricultural technologies such as improved cultivation practices, pest and disease resistant or improved varieties or hybrid varieties, etc (Ashri, 2006). By following the technology package recommended by Department of Agriculture, sesame production has expected to be increased in this Township.

Under this situation, information with regard to adoption of improved sesame technology on locally specific factors influencing adoption, and the financial profitability of improved sesame production technologies being promoted in the township have not been systematically and empirically studied and documented. In addition to this fact, information about farmers' adoption on improved sesame varieties and improved technology attributes and contribution of farmer to farmer knowledge and information sharing in adoption decision are also found to be insufficient and are not well understood (Department of Agriculture, 2017). Hence, this study was aimed at assessing financial profitability and factors that influences the adoption of sesame varieties and farmer's adoption on improved sesame technology attributes.

1.5 Objectives of the Study

The general objective of this study was to observe farmers' adoption status of improved sesame production technology package recommended by Department of Agriculture in Magway Township.

The specific objectives of the study were as follows:

(1) To investigate the adoption of improved sesame production technology package by the sample households in the Magway Township,

(2) To analyze the financial profitability of sesame production as farmers' adoption of improved sesame production technology package in the study area, and

(3) To examine the factors influencing the adoption of recommended improved sesame production technology package in the study area.

CHAPTER II
LITERATURE REVIEW

2.1 Basic Concept of Adoption

Adoption of technologies may be conceptualized at two different levels: aggregate and individual (farm-level) levels of adoption. Aggregate adoption is the adoption of an agricultural technology by a population within a region and farm level new technological adoption is defined as when an individual farmer adopts a new technology. Based on farmers' behavior, farmers are classified into five adopter categories which are (1) innovators, (2) early adopters, (3) early maturity, (4) later majority, and (5) laggards. The farmers who are the first person in a local to try out and adopt an innovation in their environment are innovators. They are willing to take risks and to take failure. If a new idea survive for a period of time and is accepted by more than first few and one can identify a second category of farmers, called early adopters. If the new idea is continue to spread many farmers who ultimately accept the new idea can be classified into early and late maturity depend on time. Laggards are accepted the new ideas very late (Lopes, 2010).

Adoption of innovations by landholders is a dynamic learning process. Adoption depends on a range of personal, social, cultural and economic factors, as well as on characteristics of the innovation itself. Innovations are more adopted if easy to test and learn about before adoption (Pannell, Marshall, Curtis, Vanclay & Wilkinson, 2006). The concept of adopter categories is important to show that all innovations go through a natural, predictable, and sometimes lengthy process before widely adopted within a population (Roger, 1983).

2.2 Adoption Process

Adoption is a decision to make full use of a new idea as the best course of action available and 'adoption process' is the mental process through which an individual passes from first knowledge of an innovation to make a decision to adopt or reject and to later confirmation of this decision (Singh & Mishra, 2007).

The degree of adoption in an individual is related to his social status based on his income, education, and occupation. All individuals in a social system do not adopt an innovation at the same time. They adopt an innovation in an ordered time sequence with the time dimension involved in the adoption process. The process of the adoption of innovations composed of five successive steps: (1) awareness, (2) interest, (3) evaluation, (4) first trial, and (5) either repeated use or rejection.

1. Awareness: The first step towards adoption of an innovation, obviously, is to become aware that it exists.
2. Interest: The second step is to become personally interested.
3. Evaluation: Once a farmer has become interested in an innovation, he begins the process of evaluation it, and of deciding whether or not he wishes to try it.
4. First trial: The fourth step is actual trial on the farm.
5. Either repeated use or rejection: Not until a farmer begins to use an innovation, the second, third, fourth time can be said to have adopted it. Only repeated use indicated that the adoption has taken place (Mosher, 1978).

2.3 Mode and Sequence of Agricultural Technology Adoption

Attentions have also given to explaining the mode (approach and the sequence) of agricultural technology adoption. Two approaches are common in agricultural technology adoption literature. The first approaches the adoption of the whole package while the second one stresses step wise or sequential adoption component of a package. Opponent of the whole package approach strongly argue that farmers do adopt technologies as package, but rather adopt a single component a few suitable technologies. Initially adopt only one component of the package and sequentially adding components over time one at a time. Farmers choose to adopt input sequentially. The major reasons often given for sequential adoption of a package of technologies are profitability, riskiness, uncertainty, limpness of investment and institutional constraints. A farmer selects a technology that exhibit these attributes. Therefore, the process of adoption continues until a whole package is full adopted (Beyrlee & Polanco, 1993).

Technology was the priority requirement for changing agricultural production of rural household. Technology adoption is currently moving in three directions which are innovative econometric and modeling methodologies to understand adoption decisions, examinations of the process of learning and adoption decisions and micro-level studies based on local data collection intended to shed light on adoption decisions. Farmers do not adopt improved technologies with three reasons. The first reason, farmers have misunderstanding about the costs and benefits of the technologies. The second reason is unavailable of the technologies at need times. The third reason is that the technologies are not profitable due to incorrect allocation of their land and labor across agricultural and non-agricultural activities (Doss, 2003).

The adoption of agricultural innovation in developing countries attracts considerable attention because it can provide the basis for increasing production and productivity. It is, therefore, important that the process adoption and diffusion of new technologies in agriculture be clearly understood. Food and Agriculture Organization (FAO), (2009) stated that farmer's adoption was influenced by experience of farming, different income and their household bargaining power were improved by increasing rural wage employment to escape from poverty.

2.4 Selected Empirical and Theoretical Studies of Technology Adoption in Developed Countries

There is a wide body of literature regarding the determinants of adoption of technical innovations in agriculture. A number of adoption studies report that technology adoption is linked to farmer resource endowment in terms of human, physical and financial capital, risk preferences, location factors and characteristics of technology itself. They studied to address empirical evidence from Malawi and focus on can risk-aversion towards fertilizer explained part of the non-adoption puzzle for hybrid maize (Simtowe, 2006).

Featherstone and Goodwin (1993) stated that most of the socio-economic empirical studies on adoption of management practice focused on the following categories of variables that influenced a farmer's decision to adopt, farm /physical factors such as social status, attitudes, beliefs towards land owned and institutional factors like extension services, participation in management practice and extension programmes, economic and financial factors such as farm income, indebtedness, investment costs, availability of labor and technology constraints.

Masavisuthi (2005) mentioned that the socio-economic factors were significantly correlated with adoption of sunflower production technology in Thailand including education, age of farmers and income. Therefore, characteristics of the household head, economic factors and institutional contribution towards the technology are considered as more important factors that influence the adoption process.

Oluoch-Kosura, Phirimarenya & Nzuma (2001) in Kenya also stated that socio-economic factors generally influence farmers' adoption of intensification technologies.

Ayele, (1999) conducted that economic analysis of innovation and adoption of vertisol technology in Ethiopia showed that the family members above the age of 15 years were having the highest impact on the probability of adoption decision. He also showed that the number of livestock owned, credit and fertilizer use were significant determinants of the decision (participation) and use intensity (consumption).

Simtowe, (2006) analyzed that “can risk aversion towards fertilizer explain part of the non adoption puzzle for hybrid maize in Malawi” and he found a negative influence of age on technology adoption in his studies, implying that older farmers had a tendency to stick to his old production technologies and he were usually unwilling to accept change. In addition, Adesina & Baiduforson, (1995) founded that young people were associated with higher risk taking behavior than the elderly in Niger.

However, Damisa & Igono, (2007) argued that older farmers were more likely to try new technologies as they were rich with more resources than younger farmers in Danja. Hoover and Witala, (1980) also found that age was an important factor in their study of Nebraska farmers. The results indicated that the younger and more educated farmers were more likely to perceive improved yield as a problem and perceive benefits from using recommended practices.

Damisa, & Igonoh (2007) stated that farm size, family size and family income were considered as important household characteristics that significantly affected the technology adoption process on the adoption of integrated soil fertility management practices among women farmers in Danja. International Fund for Agricultural Development (2003) found that households with more availability of family labor would find it easier to face the higher demand for labor associated with organic methods of production of the United Nations. Ervin (1982) showed that farm experience was the adoption of environmental practices in Manhattan farmers, while variables relating to the size of farm operation best explained the adoption of commercial practices. Zhou, Herzfeld, Glauben, Zhang & Hu (2008) observed that factor affecting Chinese farmers’ decisions to adopt a water-saving technology in China were farm size had a significant positive effect on technology adoption.

Shultz (1975) found that land tenure contributed to adoption, since landowners tended to adopt more frequently than tenants, an argument that justified numerous efforts to reduce tenure insecurity. Sarwar & Goheer (2007) studied that adoption and impact of zero tillage technology for wheat in rice-wheat system, water and cost saving technology a case study of Pakistan and Zhou, Herzfeld, Glauben, Zhang & Hu (2008) also confirmed that increased landholding farmers had better choices to experiment with new technologies as compared to resource poor farmers and households with large farms were having higher adoption possibilities than small farms.

Carlson, Mcleod, Lssey & Dillman (1977) also found that level of education, farm size, and farmer perception, double cropping, and increasing net farm income were moderately associated with the application of management adoption practices by Australian farmers for improved adoption technologies.

Zhou, Herzfeld, Glauben, Zhang & Hu (2008) found a complex impact of education on technology adoption in their study. Ayele (1999) also showed that high school education was significant determinant of the decision (participation) and use intensity (consumption).

Karki & Bauer (2004) stated that farmers' decision depended on their needs; cost, incurred and benefit accruing to it would be the major motivating factors for the acceptance or rejection of a particular technology in Nepal. In addition, training and extension contacts could be considered as major institutional factors that affect technology adoption.

Bonati & Gelb (2005) also stated that agricultural extension by its nature had an important role in promoting the adoption of new technologies and innovations in Paris. Extension organizations had a key role in brokering between providers of technologies and farmers. Nkamleu (2007) indicated that contacts with extension was found to be positively and significantly related to farmers' adoption in management practice in Caremoon.

According to Palis (2006*),* the role of culture in farmer learning and technology adoption a case study of farmer field schools among rice farmers in central luzon, Philippines, technology adoption in agriculture has often been problematic. He indicated farmers' membership in an extension service, as the most important driving factor for the adoption technology. Wubeneh & Sanders (2006) extension program has to develop technology packages that address farmers' resources constrains rather than wholesale recommendations on variety and other new technology options in Ethiopia.

Oladen, (2005) studied the factors that affect farmers to discontinue the adoption of innovation at Southwestern Nigeria and stated that change in attitude after adoption, extension visit to reinforce the technology, opportunity for expression of reactions to the technology, opportunity to market surplus yields and availability of required input to sustain adoption were important variables which stimulate to the farmers for discontinue adoption.

Bandiera & Rasul (2003) studied technology adoption of northern Mozambique and stated that social networks were important determinants of technology adoption.

2.5 Selected Empirical and Theoretical Studies of Technology Adoption in Myanmar

Nyein Nyein Htwe (2000) studied the adoption behavior of farmers to recommended farm practices in Pyinmana Township in 1999 and found that the major constraints in rice cultivation were difficulty in control of hired transplanters, unavailability of irrigation water in time and difficulty in obtaining farm yard manure. High cost of NPK fertilizer led to partial adoption of recommended fertilizer application. The major problem was scarcity of labor for weeding in peak season and high labor cost.

Tin Cho Cho Myat (2004) studied the adoption of the improved sugarcane production technology in Pyinmana, Yedarshe, Taikkyi and Pyay of Myanmar and the result showed that farmers' education, yield, distance from the field to collection center and amount of government credit received were significant factors influencing the adoption of the technology packages was still weak in the study areas.

Thinn Thinn Aye (2004) studied the extent and factors affecting the adoption of improved cotton production technology packages by pre-monsoon cotton farmers in Meiktila Township in Myanmar. The results showed that level of education, land fragmentation, use of hired labor, annual income and attendance in farmers' meeting were significant factors affecting the adoption of improved cotton production packages. Among the significant factors, land fragmentation had negative impact on the adoption of technology packages. Moreover, increasing the number of farmers' meeting program and intensive use of labor would increase the adoption of improved cotton production technologies.

Moreover, L. Seng Kham (2009) founded that modern maize variety growers were classified as significantly less use of seed, more use of credit, younger age, higher annual income and larger maize cultivated land than traditional maize variety growers in Kyaukme Township in Myanmar. In Kyaukme, the variables of farmers' farming experience, use of chemical fertilizer and maize yield showed the largest negative value coefficients and they were important in placing traditional maize variety growers group. This meant that traditional maize variety growers were categorized by less use of chemical fertilizer, less yield and less farming experiences. Likewise Lashio Township, the average values of technical factors of maize yield, use of chemical fertilizer and total human labor were observed significantly higher in modern maize variety growers.

Finally, Khin San Dar Lin (2017) reported that technology adoption of rice production in Thazi Township, dry zone, Myanmar. The results was serious constraints in rice production were water scarcity, labor scarcity, high price of seed and fertilizer, unavailability of quality seeds for technology adopters groups. Although the same constraints were faced by both types of households in two adopters groups, highly adopted households noticed more constraints in their rice production compared with partially adopted households. High adopters comparatively more participated in agricultural trainings and shared extension advice and technologies to other farmers than partial adopters groups. Female heads were comparatively low participated in trainings in terms of training type and frequency. Age, education, family labor used and total gross benefit were positively correlated with adoption scores of both types of households.

Based on the above literature studies, farmers' attributes commonly included in adoption studies would be varied and mostly were education, age, family labor, family size, farmer adoption, training and extension. Therefore, assessing financial profitability of sesame production and factors that influences the adoption of sesame varieties and farmer's adoption on improved sesame technology attributes would be investigated in this study.

CHAPTER III
RESEARCH METHODOLOGY

3.1 Description of the Study Area

3.1.1 Location of the study area

Magway Region is located in the central part of Myanmar. It is situated between North latitude from 18°50′ and 22°47′ and East longitude between 93°47′ and 95°55′ and has an area of 44,820 square kilometer (km^2). Ya land occupies 0.65 million hectares of total arable land 1.01 million hectares in the Region and the rest lands are paddy land, silt land (Kaing-kyun), hill-side cultivated land (Taungya) and vegetable land. Multiple cropping is practiced in the paddy land and farm land. Magway Region covers 25 townships.

Magway Township is situated on the East bank of the Ayeyarwaddy river. It is bordered by Natmouk Township on the East, Minbu, Sagu and Minhla Townships on the West, Taungdwingyi and Sinpaungwe Townships on the South, and Yenanchaung Township on the North. Magway Township possesses tropical climatic condition and produces a large quantity of sesame and groundnut for edible oil, it is also known as an oil pot of Myanmar (MoALI, 2017).

3.1.2 Climate condition

Average temperatures of the Magway Region are between 37°C and 40°C in summer, especially April which is the hottest month. In cool season, the average temperature is 27°C and the lowest temperature is 18°C. The range of the total rainfall of the Magway Region is from 812.8 mm to 863.6 mm. The average relative humidity is about 72.2 % in Magway Region.

Magway Township is situated 56.66 meter above sea level (maximum sea level is 250 meter and minimum sea level is 50 meter). The average monthly temperature ranges from a minimum of 10°C (in January) to a maximum of 45°C (in May). A maximum precipitation of 174.24 mm is found in June and minimum precipitation is found in January, February and March ((Department of Agriculture, 2017).

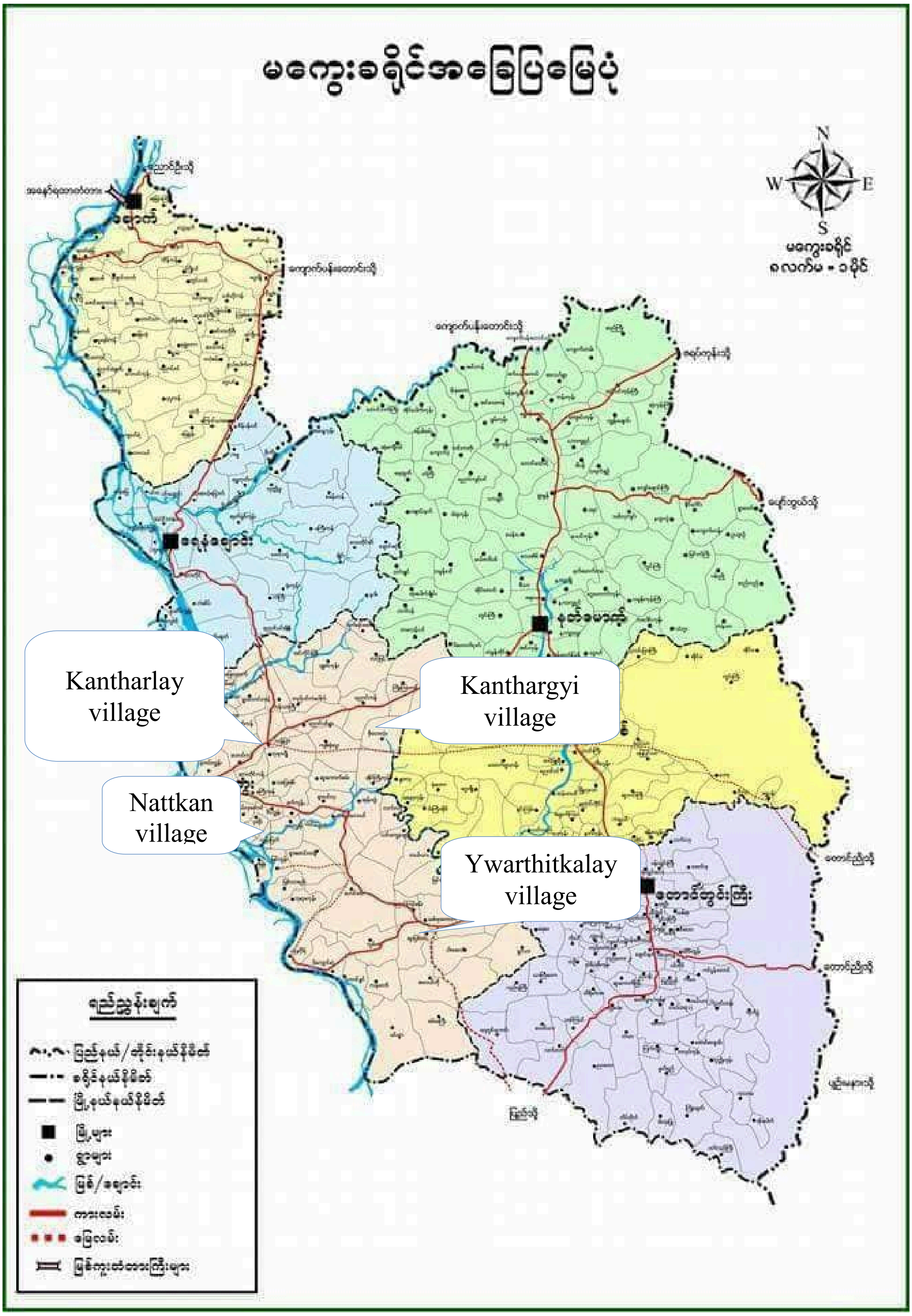

Figure 3.1 Map of study villages in Magway District

3.2 Area and Population of Magway Township

There are 216 villages and 61 village tracts in Magway Township. It has about 334,465 total populations in 2014 (Department of Planning, 2014). In 2017, it was recorded that 12,077 populations were sesame cultivated farmers in the study area ((Department of Agriculture, 2017).

3.3 Data Collection Methods and Selected Villages

3.3.1 Data collection

Both primary and secondary sources of data were used in this study. The primary information was gathered by household interview technique by using a set of structured questionnaires in December 2018. The total 129 respondents were selected with proportionate random sampling technique (one third of their sample group) from four villages, namely, Nattkan, Kanthargyi, Kantharlay and Ywarthitkalay villages in Magway Township (Table 3.1). Detailed socio-economic data such as farmers' age, education level, number of family members, number of farm family labor, farm size, annual income, household assets, farm implements and the extension access, and credit availability etc were inquired. The facts about monsoon sesame cultivation in 2018 including use of labor, access to improves sesame varieties, use of fertilizer, sesame yield, participation in trainings and farming practices such as land preparation, soil type, use of seed rate, chemical fertilizer, spacing, time of sowing, times of thinning and weeding and harvesting were gathered. Besides, the constraints faced by farmers in sesame production, costs and returns information were also collected. Information about in adoption of improved sesame production technology and their availability, technology characteristics, extent of farmers' adoption, institutions and support services, sources of income and other relevant demographic information have been collected.

The secondary data were collected from the local Township and village level government and non-government organizations related to agriculture and administration. Secondary data sources were published and official records of Ministry of Agriculture, Livestock and Irrigation (MoALI), the Department of Planning (DoP), Department of Agricultural Research (DAR), Department of Agriculture (DoA, Magway Township Office), Food and Agriculture Organization (FAO), Central Statistical Organization (CSO) and the other related publications.

3.3.2 Sampling method

Out of total 216 villages in Magway Township, firstly, four villages were selected according to sown area and production amount of sesame. As shown in Table (3.1), the sesame growers were classified into large, medium and small farmers according to their sesame sown areas. In each village, the sample size was proportionately identified according to the types of farmers. Moreover, the sampled farmers were randomly selected from the study villages.

In Kanthargyi village, there were 104 total farmers, 6 large farmers, 16 medium farmers and 12 small farmers were selected and interviewed. Moreover, the village of Kantharlay has 107 total farmers, among them 5 large farmers, 19 medium farmers and 8 small farmers were selected for data collection. Besides, out of 106 farmers in Ywarthitkalay village, 10 large farmers, 6 medium farmers and 16 small farmers were selected for interview. In addition, from 104 total farmers in Nattkan village, 5 large farmers, 18 medium farmers and 8 small farmers were interviewed.

3.4 Methods of Data Analysis

Both qualitative and quantitative data were firstly complied in the Microsoft Excel program. The study was employed with descriptive method and regression models were also applied by the help of statistical software packages, SPSS version 16.0. Descriptive statistics such as mean, percentage and frequencies were computed to describe the socio-economic characteristics (e.g. farmer age, schooling year, farming experience, sesame cultivated area, family labor and family size etc.) of the sample farmers.

3.5 Adoption Status Analysis

The improved sesame varieties and production technology package is composed of 10 main components for increasing yield. The adoption scores were considered on these components which were given by total 100 points. This means that, if the sample farmer adopted one component, this farmer will receive 10 points. If the sesame grower adopted 10 components, he will get 100 points. The more the component adoption, the higher scores the farmer receives. Besides that if farmers obtain above 60 scores, they are classified as high adopters; otherwise are as partial adopters.

1 component	=	10 points
10 components	=	100 points

Table 3.1 Number of sample farmers from each village by using proportionate random sampling method

No.	Village name	Large farmers (≥25ac)		Medium farmers (5-24ac)		Small farmers (>5ac)		Total sample farmers
		Total (No.)	Sample farmers (No.)	Total (No.)	Sample farmers (No.)	Total (No.)	Sample farmers (No.)	
1	Kanthargyi	20	6	54	16	40	12	34
2	Kantharlay	17	5	63	19	27	8	32
3	Ywarthitkalay	33	10	20	6	53	16	32
4	Nattkan	17	5	60	18	27	8	31
	Total	**87**	**26**	**97**	**59**	**147**	**44**	**129**

3.6 Cost and Return Analysis

Enterprise budgeting is the first tool used in the economic analyses. It enables to evaluate the cost and return of production process. The purpose is to show the difference in net benefits under several resources situations in such a way as to help one make management decision. 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).

The cost and return analysis was used to assess the profitability of sesame production in the study area on an average basis. 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. Hired labor costs were valued by market wage rates and man days used in all farming practices. The interest was normally charged on cash expense in the growing season.

In this analysis, the variable cost of the sesame 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 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 (Gross margin) = Total gross benefit – Total variable cost

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

3.6.1 Weighted average on constraints scoring

In this study, three kinds of constraints including input, output and technology faced by sesame growers in sesame cultivation are investigated. Each sesame grower was inquired to indicate the extent of constraints faced by individual measured on a 3-point Likert scale such as high (2) medium (1) and low (0). The weighted average score was determined and used to order the rank according to Iyela & Ikwuakam, 2015.

$$\text{Weighted average} = \frac{\text{Sum of weighted scores}}{\text{Total no.of sample farmers}}$$

3.7 Selection of Appropriate Econometric Model

The regression analysis is one of the most commonly used tools in econometric studies. It is a statistical tool for the investigation of relationships between variables. It is a technique that allows additional factors to enter the analysis separately so that the effect of each can be estimated. It is valuable for quantifying the impact of various simultaneous influences upon a single dependent variable. The general purpose is to learn more about the relationship between several independent or predictor variables and a dependent or criterion variable (Isham, 2002).

In the study, the following model was used to find out the influencing factors on the dependent variables such as adoption of sesame farmer by using some selected socio-economic variables (Isham, 2002).

This model was as follow:

Regression model for sesame farmers

$$Y_i = \beta_o + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_9 X_{9i} + e_i$$

where,

Y_i	=	Adoption score of sesame farmers
X_{1i}	=	Farm experience of HH Head (Yr.)
X_{2i}	=	Schooling year of HH Head (Yr.)
X_{3i}	=	Sesame cultivated area (ha)
X_{4i}	=	Family labor (No.)
X_{5i}	=	Training attendance time (No.)
X_{6i}	=	Total gross benefit of sesame production (MMK/ha)
X_{7i}	=	Output constraints score
X_{8i}	=	Technology constraints score
X_{9i}	=	Total variable cost (MMK/ha)
β_0	=	Constant
e_i	=	Error term

CHAPTER IV
RESULTS AND DISCUSSION

4.1 Classification of the Sample Farmers Based on Adoption Scores

The sesame production technology package had been introduced since 2013-2014 by Department of Agriculture in Magway Township. The improved sesame production technology package as shown in Table (4.1) has 10 main components according to their important in increasing yield. The detailed explanation of the recommended technology is mentioned at section 1.3.

Based on the above 10 main components, the total adoption scores were 100 points. Accordingly, if a sesame grower adopts only one component, he/she will get 10 points. If farmers obtain above 61 points and above, they are classified as high adopters otherwise are as partial adopters as shown in Table (4.2) and Table (4.3).

4.2 The Access of Improved Sesame Technology Package of the Sample Farmers

The distribution of farm households based on adoption of improved sesame production technologies package in the study area is shown in Table (4.3). Approximately 60% of partial adopters and 94 % of high adopters planted monsoon sesame in recommended sowing time. It was also found that 76% of partial adopters and 98% of high adopters used recommended application time and rate of fertilizer in sesame production. In the timely thinning practice, 70% of partial adopters and 95% of high adopters followed this recommendation of Department of Agriculture, Magway Township.

Moreover about 78% of partial adopters and 97% of high adopters practiced weed control system recommended by Department of Agriculture. Although technology recommendation on soil type, seed quality, seed rate and pest and disease control were only adopted by 31%, 36%, 25% and 52% of partial adopters, these cultivation practices were largely accepted by 95%, 94%, 74% and 92% of high adopters. For the recommended harvesting time, the result revealed that only 46% of partial adopters and 71% of high adopters harvested sesame in accordance with the recommendation of Department of Agriculture.

Summing up the adoption on recommendations, recommended technologies on sowing time, fertilizer application, thinning time, weeds control were followed by a larger proportion of partial adopters (ranged from 60-80%). On the other hand, it was obviously found that very large number of 74 - 98% high adopters adopted the recommended technologies on soil type, quality of seed, seed rate, sowing time, fertilizer application, thinning time, weed control, pests and diseases control and harvesting in comparison with to partial adopters, larger proportion of high adopters applied most production technologies. But adoption on recommended spacing and harvesting time were still weak in both adopters.

There were 67 partial adopters in which Nattkan, Kantharlay, Kanthargyi and Ywarthitkalay villages represented 10.4%, 25.4%, 35.8%, 28.4% of partial adopters respectively. In addition, 38.7%, 24.2%, 16.2% and 20.9% of 62 high adopters were found in Nattkan, Kantharlay, Kanthargyi and Ywarthitkalay villages respectively (Table 4.4).

Table 4.1 Sesame production technologies package recommended by the Department of Agriculture in Magway Township

No.	Items	Recommended technologies
1	Soil type	Soil pH 5.7-8
2	Quality of seed	Good quality seed from improved sesame varieties
3	Seed rate	7.5- 11.3 kg/ha
4	Sowing time	Rain fed cultivation (May), winter cultivation (4^{th} week of September) and summer cultivation (4^{th} week of March)
5	Spacing	15 inches ×4 inches (for branching type) and 12 inches ×4 inches (for single type)
6	Fertilizer application	FYM/compost 1.2- 2.5 ton/ha, Urea 62.9 kg/ha, T-super 62.9 kg/ha, Potash 31.5 kg/ha
7	Thinning time	15^{th}& 30^{th} day after sowing
8	Weed control	30^{th} day after sowing
9	Pest and disease control	Control with systemic pesticide to *sesamum phyllody* & contact pesticide to borer and black bug
10	Harvesting	25%of leaves from bottom are shed and bottom capsules lose their color and turn yellow at maturity

Table 4.2 Classification of adoption status of the sample farmers on improved sesame production technology package

No. of technology adopted	Adoption scores	No. of sample farmers	% of sample farmers	Classification of sample farmers
1	10	0	0	Partial adopter
2	20	2	1.6	Partial adopter
3	30	4	3.1	Partial adopter
4	40	22	17.1	Partial adopter
5	50	14	10.9	Partial adopter
6	60	25	19.4	Partial adopter
7	70	17	13.2	High adopter
8	80	14	10.9	High adopter
9	90	10	7.8	High adopter
10	100	21	16.0	High adopter
	Total	**129**	**100.0**	

Table 4.3 Adoption status of the sample farmers on each recommended technology

No.	Recommended technologies	Frequency of sample farmers	
		Partial adopters (n=67)	High adopters (n=62)
1.	Soil type	21 (31)	59 (95)
2.	Quality of seed	24 (36)	58 (94)
3.	Seed rate	17 (25)	46 (74)
4.	Sowing time	40 (60)	58 (94)
5.	Spacing	4 (6)	29 (47)
6.	Fertilizer application	51 (76)	61 (98)
7.	Thinning time	47 (70)	59 (95)
8.	Weed control	52 (78)	60 (97)
9.	Pest and disease control	35 (52)	57 (92)
10.	Harvesting	31 (46)	44 (71)

Note: Numbers in the parentheses represent percentage

Table 4.4 Adoption status of the sample farmers in each sample village

No.	Village name	No. of sample farmers		
		Partial adopters (n=67)	**High adopters (n=62)**	**Total**
1.	Nattkan	7 (10.4)	24 (38.7)	31 (24)
2.	Kantharlay	17 (25.4)	15 (24.2)	32 (24.8)
3.	Kanthargyi	24 (35.8)	10 (16.2)	34 (26.4)
4.	Ywarthitkalay	19 (28.4)	13 (20.9)	32 (24.8)
	Total	**67 (51.9)**	**62 (48.1)**	**129 (100)**

Note: Numbers in the parentheses represent percentage

4.3 Socio-economic Characteristics of the Sample Farmers

As shown in Table (4.5), the average age of partial adopters was 49 and that of high adopters was 47. It was also found that the partial adopter's farm experience in agriculture was an average of 30 years while high adopter was 26 years. Both partial and high adopter groups had the same schooling years of 6 in average. However, higher schooling years of 16 was observed in high adopters. The average family size of partial and high adopters' farm households was nearly the same, about 4.0 members. The average family labor of partial adopters and high adopters were 1.5 and 1.3 respectively.

4.4 Secondary Occupation and Sources of Incomes of the Sample Farmers

In the study area, some farmers were engaged in two occupations: primary and secondary (Table 4.6). Primary occupation, farming cultivation is the major earning of the household head and secondary occupation is the additional income for surplus.

In both types of adopters, 5.9% of partial adopters and 8.1% of high adopters had own business as the main secondary occupation for additional income. In addition, livestock rearing was involved with 2.9% of partial adopters and 6.5% of high adopters. On the other hand, only 3.2% of high adopters worked as non-farm labor. Besides, households with off-farm labor worked only by 1.5% of partial adopters. It is also found that a higher proportion of partial adopters 89.6% had no secondary job while high adopters 82.3% as shown in Table (4.6).

In the sample households, their incomes were a combination of numerous sources, complemented with income from livestock and crop, performed by family members. The partial adopters were 2% whereas 1% of high adopters earned incomes from four main sources. Moreover, 15% of the partial adopters and 18% of high adopters received from three sources of income. Besides, 43% of partial adopters also had two sources of income and the rest 52% of high adopters got from two income sources. Partial adopters 40% and high adopters 29% received of total income from one income source. According to the research finding, nearly half of both adopters depended more on two income sources for the securities of their livelihood (Table 4.7).

Table 4.5 Demographic characteristics of the sample farmers

Items	Units	Partial adopters (n=67)			High adopters (n=62)		
		Mean	SD	Range	Mean	SD	Range
Farmer's age	Yr.	49	8.9	21-68	47	9.6	27-63
Farmer's schooling year	Yr.	6.0	3.0	0-10	6.0	2.6	4-16
Farmer's farming experience	Yr.	30	10.7	5-50	26	11.3	8-46
Family size	No.	4.3	1.2	1-6	4.2	1.3	1-7
Farm family labor	No.	1.5	0.9	1-4	1.3	2.1	1-5

Table 4.6 Secondary occupation of the sample farmers

Occupation	No. of sample farmers	
	Partial adopters (n=67)	High adopters (n=62)
Own business	4 (5.9)	5 (8.1)
Non-farm labours	0 (0.0)	2 (3.2)
Off-farm labours	1 (1.5)	0 (0.0)
Livestock raising	2 (2.9)	4 (6.5)
No secondary job	60 (89.6)	51 (82.3)
Total	**67 (100)**	**62 (100)**

Note: Numbers in the parentheses represent percentage

Table 4.7 Sources of secondary income of the sample farmers

No	No. of secondary income sources	No. of sample farmers	
		Partial adopters (n=67)	High adopters (n=62)
1	One income source	27 (40)	18 (29)
2	Two income sources	29 (43)	32 (52)
3	Three income sources	10 (15)	11 (18)
4	Four income sources	1 (2)	1 (1)

Note: Numbers in the parentheses represent percentage

4.5 Household Assets by the Sample Farmers

Household asset owned by sample farmers were revealed in Table (4.8). Household assets are important for the people to get the information in terms of social, economic, politic and weather condition. Household assets such as hand phone, TV, DVD players, solar panel, skynet receivers, sound box and inverter possession of partial adopters were 92.8%, 77.6%, 77.6%, 59.7%, 40.3%, 38.8% and 26.9% respectively. In high adopters, 96.0%, 87.1%, 79.1%, 59.7%, 56.5%, 53.2% and 50.0% sample farmers owned hand phone, TV, DVD players, solar panel, invertor, sound box and skynet receivers respectively. Therefore the status of household assets owned by high adopters was relatively higher than partial adopters.

Table (4.8) also introduced transportation asset ownership of the respondents. Many of those who own motor cycle were convenient of going around and they also helped their family with relevant works. Bicycle is also useful for the student to go to school. In both adopters, the possession of motorcycles was the same by 80.6% in partial adopters and 87.1% in high adopters respectively. 32.8% of partial adopters and 37.1% of high adopters used bicycles for transportation. Besides, 2.9% of partial adopters and 4.8% of high adopters had car for transportation. Moreover, only 1.6% of high adopters owned refrigerator. Therefore, it can be concluded that the possession of household assets by high adopters were more than that of partial adopters.

4.6 Farming Apparatus by the Sample Farmers

In terms of farm assets, tractor, trailer, water pump, bean splitting machine and fodder cutting machine were owned by partial adopters 8.9%, 2.9%, 1.5%, 91.0% and 14.9% respectively (Table 4.9). On the other hand, 6.5%, 1.6%, 1.6%, 4.8% and 20.9% of high adopters possessed tractor, trailer, water pump, bean splitting machine and fodder cutting machine. In the study area, farming apparatus such as warehouse, sprayer, harrow, plough and bullock cart were owned by 89.5%, 82.1%,79.1%, 79.1% and 79.1% of partial adopters and 93.5%, 87.1%, 90.3%, 90.3% and 87.1% of high adopters. Besides, only high adopters owned harvester 1.9% and seeder 3.2%. In the study area, it was showed that possession of farming assets such as water pump, fodder cutting machine, warehouse, sprayer, harrow, plough and bullock cart, harvester and seeder by high adopters were comparatively higher than that of the partial adopters except bean splitting machine, tractor and trailer.

4.7 Livestock Assets Ownership of the Sample Farmers

Livestock rearing was one of the livelihood activities for rural households in the study area. Draught cattle were raised with the purpose of land preparation. However, pig and chicken were kept for home consumption and additional income. The percentage of partial adopters and high adopters who owned livestock were shown in Table (4.10).

In this study area, 85.1% of partial adopters and 74.1% of high adopters owned draught cattle. Among them, the percentages of households who raised chicken were 50.7% and 50.0% in partial adopters and high adopters respectively. In addition, pigs were also raised by 8.9% of partial adopters and 14.5% of high adopters for their home consumption and extra income. Therefore, it can be said that livestock assets possession of partial adopters, except pig, was higher than that of high adopters.

Table 4.8 Possession of household assets by the sample farmers

Items	Frequency of sample farmers	
	Partial adopters (n=67)	High adopters (n=62)
Hand phone	62 (92.8)	97 (96.0)
Motorcycle	57 (80.6)	54 (87.1)
TV	52 (77.6)	54 (87.1)
DVD players	52 (77.6)	49 (79.1)
Solar panel	40 (59.7)	37 (59.7)
Skynet receivers	27 (40.3)	31 (50.0)
Sound box	26 (38.8)	33 (53.2)
Bicycle	22 (32.8)	23 (37.1)
Inverter	18 (26.9)	35 (56.5)
Car	2 (2.9)	3 (4.8)
Refrigerator	0 (0.0)	1 (1.6)

Note: Numbers in the parentheses represent percentage

Table 4.9 Possession of farming apparatus assets by the sample farmers

Items	Frequency of sample farmers	
	Partial adopters (n=67)	High adopters (n=62)
Bean splitting machine	61 (91.0)	3 (4.8)
Warehouse	60 (89.5)	58 (93.5)
Sprayer	55 (82.1)	54 (87.1)
Harrow	53 (79.1)	56 (90.3)
Plough	53 (79.1)	56 (90.3)
Bullock cart	53 (79.1)	54 (87.1)
Fodder cutting machine	10 (14.9)	13 (20.9)
Tractor	6 (8.9)	4 (6.5)
Trailer	2 (2.9)	1 (1.6)
Water pump	1 (1.5)	1 (1.6)
Harvester	-	2 (1.9)
Seeder	-	2 (3.2)

Note: Numbers in the parentheses represent percentage

Table 4.10 Possession of livestock assets by the sample farmers

Items	Frequency of sample farmers	
	Partial adopters (n=67)	High adopters (n=62)
Draught cattle	57 (85.1)	46 (74.1)
Chicken	34 (50.7)	31 (50.0)
Pig	6 (8.9)	9 (14.5)

Note: Numbers in the parentheses represent percentage

4.8 Sesame Sown Area of the Sample Farmers

The sesame sown area of the sample households in the study area were classified as shown in Table (4.11). As an agrarian society, agricultural land is an important household asset for the crop production.

In the study area, 29.8% of partial adopters and 35.5% of high adopters were small farmers who owned the farm land less than 5 acres of cultivated sesame crop. About 45% of partial adopters and 31% of high adopters were medium farmers, owning 5 to 24 acres of sesame sown area. Large farmers were included in 25.4% of partial adopters and 33.9% of high adopters because they owned over 25 acres of sesame cultivated land. Therefore, this result showed that higher proportion of medium farmers was prominently found in partial adopters.

4.9 Cultivated Sesame Varieties in the Study Area

The common sesame varieties cultivated in the study area were Bapan, Samonnet, Satlatphyu, Majandaw, Sinyadanar-3 and Theitpannet varieties. As shown in Table (4.12), Bapan, Samonnet, Satlatphyu, Majandaw, Sinyadanar-3 and Theitpannet varieties were grown by 61%, 30%, 24%, 39%, 1% and 3% of partial adopters respectively. On the other hand, Bapan, Samonnet, Satlatphyu, Majandaw and Sinyadanar-3 varieties were used by 42%, 63%, 16%, 11% and 2% of high adopters respectively. It was evident that Samonnet, Bapan and Majandaw varieties were the most common cultivated sesame varieties among farmers in the study area.

4.10 Production of Other Crops in the Study Area

Information about other crop production of the sample farmers is shown in Table (4.13). In the study area, other crops cultivated by the sample farmers were winter groundnut, winter sorghum, winter greengram, winter cowpea, monsoon groundnut, monsoon pigeon pea and winter sesame were grown by 87%, 46%, 43%, 30%, 9%, 4% and 3% of partial adopters. On the other hand, Winter groundnut, winter sorghum, winter greengram, winter cowpea, monsoon groundnut, winter sesame and winter lablab bean were sown by 77%, 31%, 44%, 29%, 18%, 18% and 3% of high adopters respectively. Therefore, it can be said that winter groundnut crops were more popular than other crops among both adopters.

4.11 Status of Credit Received by the Sample Farmers

There were 6 credit sources - Myanmar Agricultural Development Bank (MADB), PACT Myanmar, Cooperative, Good brother, Chitthaw Myanmar, Money lender. Among these sources, MADB and Cooperative were the formal credit source, PACT Myanmar was semi-formal credit source and the remaining three sources were informal credit sources. PACT Myanmar was the largest semi-formal financial institution which started operating from 2003 up to now in the study area (Table 4.14).

In the study area, the sample farmers took credit from different sources as shown in Table 4.14. Among them, the sample farmers 34.3% of partial adopters received the credit only from one source. 37.3% of partial adopters had two sources of credit respectively. 14.9% of partial adopters took the credit only from three sources. 1.5% of partial adopters were received from four credits sources. Nevertheless 14.9% of partial adopters did not have any debts so far.

It was found that about 37.1% of high adopters received credit from only one source. The rest of 40.3% of high adopters obtained credit from two sources respectively. Another 16.1% of high adopters had three sources of credit. It was found that, 1.6% of high adopters received credit from four sources. Besides, 14.5% of high adopters did not have any debts. From this finding, it was concluded that about one third of both sample farmers got credit from one source. Thus, the percentage of high adopters which took credit by means of more sources was higher than partial adopters (Table 4.14).

Table 4.11 Adopter categories in three types of the sesame farmers

Items	No. of sample farmers	
	Partial adopters (n=67)	High adopters (n=62)
Small farmers(<5 ac)	20.00 (29.8)	22.00 (35.5)
Medium farmers(5-24 ac)	30.00 (44.7)	19.00 (30.6)
Large farmers(≥25 ac)	17.00 (25.4)	21.00 (33.9)
Total	67 (100)	62 (100)

Note: Numbers in the parentheses represent percentage

Table 4.12 Sesame varieties cultivated by the sample farmers in the study area

No.	Name of varieties	Frequency of sample farmers	
		Partial adopters (n=67)	High adopters (n=62)
1	Bapan	41 (61)	26 (42)
2	Samonnet	20 (30)	39 (63)
3	Satlatphyu	16 (24)	10 (16)
4	Majandaw	26 (39)	7 (11)
5	Sinyadanar-3	1 (1)	1 (2)
6	Theitpannet	2 (3)	0 (0)

Note: Numbers in the parentheses represent percentage

Table 4.13 Other crops cultivated by the sample farmers in the study area

No.	Crops	Frequency of sample farmers	
		Partial adopters (n=67)	High adopters (n=62)
1	Winter groundnut	58 (87.0)	48 (77.0)
2	Winter sorghum	31 (46.0)	19 (31.0)
3	Winter greengram	29 (43.0)	27 (44.0)
4	Winter cowpea	20 (30.0)	18 (29.0)
5	Monsoon groundnut	6 (9.0)	11 (18.0)
6	Monsoon pigeon pea	3 (4.0)	0 (0.0)
7	Winter sesame	2 (3.0)	11 (18.0)
8	Winter lablab bean	0 (0.0)	2 (3.0)

Note: Numbers in the parentheses represent percentage

Table 4.14 Number of credit sources received by the sample farmers

Credit source	Frequency of sample farmers	
	Partial adopters (n=67)	**High adopters (n=62)**
No debt	10 (14.9)	9 (14.5)
One source of credit	23 (34.3)	23 (37.1)
Two source of credit	25 (37.3)	25 (40.3)
Three source of credit	10 (14.9)	10 (16.1)
Four source of credit	1 (1.5)	1 (1.6)
Total	**67 (100)**	**62 (100)**

Note: Numbers in the parentheses represent percentage

4.12 Enterprise Budget for Monsoon Sesame Production of Partial Adopter and High Adopter Farmers in the Study Area

The cost and return analyses of sesame production by partial adopters and high adopters are indicated in Table (4.15). Total variable costs were 590,808 MMK/ha in partial adopters and 548,122 MMK/ha in high adopters. Partial adopter expensed total labor cost of 427,562 MMK/ha while high adopters expensed total labor cost of 404,108 MMK/ha. Seed cost were 25,987MMK/ha in partial adopters whereas high adopters used seed cost were 24,105 MMK/ha. Among total variable costs, total material cost was 153,814 MMK/ha in partial adopters and 134,975 MMK/ha in high adopters. In the detailed material cost mentioned in Table (4.16), the expense on seed, fertilizer, pesticide and herbicide were higher in the partial adopters. As both types of adopters less followed on the recommended spacing, the seed rate usage was almost doubled than the recommended seed rate.

In addition, the average sesame yield in partial adopters 298 Kg/ha was apparently lower than that of high adopters 447 Kg/ha. Therefore, total gross benefit of partial adopters 819,821 MMK/ha was significantly lower than that of high adopters 1,249,268 MMK/ha. Return per unit of cash expensed for partial adopters and high adopters were 2.26 and 3.59 respectively. The benefit and cost ratio of partial adopters and high adopters were 1.40 and 2.32 respectively. It means that the high adopters earned more profit from sesame cultivation and they could get higher profit compared to the partial adopters if they invested a unit capital invested.

Table 4.15 Cost and return analysis of sesame production by partial and high adopters

No.	Items	Units	Partial adopters (n=67)	High adopters (n=62)	t-test
1	Yield	kg/ha	298	447	7.142***
2	Price	MMK/kg	2,776	2,823	0.836^{ns}
3	Gross benefit (1*2)	MMK/ha	819,821	1,249,268	7.391***
4	Total material cost	MMK/ha	153,814	134,975	2.658***
5	Family labor cost	MMK/ha	227,688	200,133	-2.337**
6	Hired labor cost	MMK/ha	199,875	203,975	0.280 ^{ns}
7	Total labor cost (5+6)	MMK/ha	427,562	404,108	1.552 ^{ns}
8	Total interest on cash cost	MMK/ha	9,432	9,039	-1.017 ^{ns}
9	Total variable cash cost (4+6+8)	MMK/ha	363,121	347,989	-1.017 ^{ns}
10	Total variable cost (4+7+8)	MMK/ha	590,808	548,122	13.493***
11	Return above variable cash cost (3 - 9)	MMK/ha	456,701	901,279	5.964***
12	Return above variable cost (3 - 10)	MMK/ha	229,013	701,146	6.566***
13	Return per unit of cash expensed (3/9)	-	2.26	3.59	5.326***
14	Return per unit of capital invested (3/10)	-	1.40	2.32	8.452***

Table 4.16 Total material cost of sesame production by partial and high adopters

No.	Items	Units	Partial adopters (n=67)	High adopters (n=62)
1	Seed	MMK/ha	25,987	24,105
		%	(16.9)	(17.9)
2	FYM	MMK/ha	17,939	20,580
		%	(11.7)	(15.2)
3	Fertilizer	MMK/ha	77,746	64,752
		%	(50.5)	(48.0)
4	Pesticides	MMK/ha	15,447	11,568
		%	(10.0)	(8.5)
5	Fungicide	MMK/ha	5,668	6,028
		%	(3.7)	(4.5)
6	Herbicide	MMK/ha	8,014	5,797
		%	(5.2)	(4.3)
7	Fuel	MMK/ha	3,013	2,145
		%	(2.0)	(1.6)
	Total material cost	**MMK/ha**	**153,814(100)**	**134,975(100)**

4.13 Common Constraints Faced by the Sample Farmers

Most of sample farmers in the study areas faced many constraints in monsoon sesame production in 2018. Among them, input constraints faced by partial and high adopters of sample farmers in sesame production were presented in Table (4.17) and Table (4.18).

Based on the weighted average score of input constraints, the partial adopters' score were fertilizer price 1.9, price of labor 1.9, seed price 1.8, access to labor 1.6, insecticide and pesticide price 1.5, mechanization hired price 1.4, interest rate for credit 1.4, access to credit 1.3, rodenticide and herbicide price 1.1, access to mechanization 0.9, access to water 0.8, access to seed 0.3, access to fertilizer 0.3, access to rodenticide and herbicide 0.3, and access to insecticide and pesticide 0.2. On the other hand, fertilizer price 1.8, price of labor 1.7, seed price 1.6, access to labor 1.3, insecticide and pesticide price 1.6, mechanization hired price 1.0, interest rate for credit 1.0, access to credit 1.1, rodenticide and herbicide price 1.1, access to mechanization 0.6, access to water 0.4, access to seed 0.2, access to fertilizer 0.1, access to rodenticide and herbicide 0.2, access to insecticide and pesticide 0.1 were mentioned by high adopters as shown in Table 4.17 and Table (4.18).

These constraints were ranked as 1st to 15th from serious to mild. For both types of adopters, the 1st constraint was high price of fertilizer and the 2nd was high price of labor and followed by high seed price to buy while the lowest one was access to insecticide and pesticide. So, it can be concluded that fertilizer price, price of labor, seed price were the major constraints for both adopters.

Output constraints faced by partial adopters and high adopters in sesame production is shown in Table (4.19) and Table (4.20). In the partial adopters, the weighted average indicated that sesame price for sale 1.2, the marketing (selling) 0.8 and sesame seed quality 0.8 respectively. Therefore, the 1st constraint was sesame price for sale, and the 2nd constraint was the marketing (selling). The lowest one was sesame seed quality in partial adopter groups. Besides, in the high adopter group, the weighted average indicated that sesame price for sale 1.1 and the marketing (selling) 0.5 sesame seed quality 0.8 brought stronger constraints to high adopters in their efforts. These constraints were ranked as 1st to 3rd from serious to mild. Therefore, it can be said that the 1st constraints was sesame price for sale and the 2nd constraints was sesame seed quality. The lowest one was the marketing in partial adopter group.

Besides, technologies constraints faced partial adopter and high adopter in sesame production was shown in Table (4.21) and Table (4.22). In the partial adopters, the weighted average indicated that clear understanding of improved production technology 1.5, availability to improved production technology 1.5, participation in existing group of the village 1.4, attitude to change 1.3, attitude to risk 1.3, decision making opportunity 1.3 and self-confidence in decision making 1.3. Those facilities posed very strong constraints to partial adopters in their efforts (Table 4.21). These constraints were ranked 1st to 7th from serious to mild. The 1st constraint was clear understanding of improved production technology. The 2nd constraint was availability of improved production technology and then participation in existing group of the village. Moreover, self confidence in decision making was the lowest constraint rank in partial adopter groups.

In the high adopters, the weighted average showed that clear understanding of improved production technology 1.0, availability to improved production technology 1.0, participation in existing group of the village 1.0, attitude to change 0.8, attitude to risk 0.7, decision making opportunity 0.8 and self-confidence in decision making 0.7 facilities posed very strong constraints to high adopters in their efforts (Table 4.22). These constraints were ranked as 1st to 7th from serious to mild. The 1st constraint was clear understanding of improved production technology, the 2nd constraint was availability to improved production technology and then participation in existing group of the village. Moreover, self confidence in decision making had the lowest constraint rank in high adopters. Although the same constraints were faced by both types of adopters, partially adopted farmers noticed more constraints faced in their sesame production compared with highly adopted farmers.

Table 4.17 Input constraints faced by partial adopters in sesame production

No.	Constraints	No. of partial adopters (n=67)			Weighted average	Rank
		Low (0)	Medium (1)	High (2)		
1	Fertilizer price	5	5	57	1.9	1st
2	Price of labor	6	7	54	1.9	2nd
3	Seed price	9	2	56	1.8	3rd
4	Access to labor	13	9	45	1.6	4th
5	Insecticide and pesticide price	18	5	44	1.5	5th
6	Mechanization hired price	18	9	40	1.4	6th
7	Interest rate for credit	16	18	33	1.4	7th
8	Access to credit	20	13	34	1.3	8th
9	Rodenticide and herbicide price	27	10	30	1.1	9th
10	Access to mechanization	36	9	22	0.9	10th
11	Access to water	29	24	14	0.8	11th
12	Access to seed	47	17	3	0.3	12th
13	Access to fertilizer	50	14	3	0.3	13th
14	Access to rodenticide and herbicide	52	12	3	0.3	14th
15	Access to insecticide and pesticide	54	11	2	0.2	15th

Table 4.18 Input constraints faced by high adopters in sesame production

No.	Constraints	No. of high adopters (n=62)			Weighted average	Rank
		Low (0)	Medium (1)	High (2)		
1	Fertilizer price	3	5	54	1.8	1st
2	Price of labor	7	2	53	1.7	2nd
3	Seed price	10	2	50	1.6	3rd
4	Access to labor	20	1	41	1.3	5th
5	Insecticide and pesticide price	12	3	47	1.6	4th
6	Mechanization hired price	25	10	27	1.0	9th
7	Interest rate for credit	24	11	27	1.0	8th
8	Access to credit	22	13	27	1.1	7th
9	Rodenticide and herbicide price	24	7	31	1.1	6th
10	Access to mechanization	40	7	15	0.6	10th
11	Access to water	41	20	1	0.4	11th
12	Access to seed	54	4	4	0.2	13th
13	Access to fertilizer	56	3	3	0.1	14th
14	Access to rodenticide and herbicide	53	6	3	0.2	12th
15	Access to insecticide and pesticide	57	2	3	0.1	15th

Table 4.19 Output constraints faced by partial adopters in sesame production

No.	Constraints	No. of partial adopters (n=67)			Weighted average	Rank
		Low (0)	Medium (1)	High (2)		
1	Sesame price for sale	18	15	34	1.2	1st
2	Marketing (selling)	29	22	16	0.8	2nd
3	Sesame seed quality	33	17	17	0.8	3rd

Table 4.20 Output constraints faced by high adopters in sesame production

No.	Constraints	No. of high adopters (n=62)			Weighted average	Rank
		Low (0)	Medium (1)	High (2)		
1	Sesame price for sale	19	15	28	1.1	1st
2	Marketing (selling)	38	14	10	0.5	3rd
3	Sesame seed quality	30	15	17	0.8	2nd

Table 4.21 Technology constraints faced by partial adopters in sesame production

No.	Constraints	No. of partial adopters (n=67)			Weighted average	Rank
		Low (0)	Medium (1)	High (2)		
1	Clear understanding of the improved production technology	10	14	43	1.5	1st
2	Availability to the improved sesame production technology	9	17	41	1.5	2nd
3	Participation in existing group of the village	13	13	41	1.4	3rd
4	Attitude to change	14	20	33	1.3	4th
5	Attitude to risk	14	20	33	1.3	5th
6	Decision making opportunity	17	15	35	1.3	6th
7	Self-confidence in decision making	17	16	34	1.3	7th

Table 4.22 Technology constraints faced by high adopters in sesame production

No.	Constraints	No. of high adopters (n=62)			Weighted average	Rank
		Low (0)	Medium (1)	High (2)		
1	Clear understanding of the improved production technology	21	17	24	1.0	1st
2	Availability to the improved sesame production technology	21	18	23	1.0	2nd
3	Participation in existing group of the village	22	18	22	1.0	3rd
4	Attitude to change	29	19	14	0.8	5th
5	Attitude to risk	30	18	14	0.7	6th
6	Decision making opportunity	28	20	14	0.8	4th
7	Self-confidence in decision making	30	21	11	0.7	7th

4.14 Access of Information Sources by the Sample Farmers

As shown in Table (4.23), the results for access of information on extension advice and technologies indicated that 34% of partial adopters and 35% of high adopters received information from Department of Agriculture. Among them, 25% of partial adopters accepted information while 26% of high adopters that offered by Non-Government Organization (NGO). Besides, it was also found that 25% of adopters and 23% of high adopters accessed information from input dealer. Moreover, 15% of partial adopters and 16% of high adopters got knowledge from friends and neighbourers. This finding showed that high adopters got the chance to access more information compared to partial adopters.

4.15 Production Technology Trainings Attended by the Sample Farmers

Training in extension programs is one of the most important components in the rural development strategies to increase the livelihoods of the rural people. In the study area, there were many kinds of trainings for different purposes with many development aspects. It is good for the village development in the long run. Table (4.24) demonstrates that the sample farmer's participation in trainings offered by the various organizations. These trainings were offered by Department of Agriculture, private company and Non-Government Organization (NGO).

In the study area, 34% of partial adopters and 65% of high adopters attended technology training programs. Among them, training program relating to agriculture was the seed training program in which 24% of partial adopters and 56% of high adopters were involved. About 39% of partial adopters and 40% of high adopters attended training dealing with systematic fertilizer utilization. Pesticide training program was participated by 39% of trainees from both partial and high adopters. Regarding the specific adopters group, high adopters apparently attended production trainings compared to partial adopter in all levels of training times. In the study area, the partial adopter received 1.7 times of training per crop season on average while high adopter attended 3.8 times of training per crop season (Table 4.25).

Table 4.23 Access of information sources by the sample farmers

No	Source of informatioı	No. of sample farmers	
		Partial adopters (n=67)	High adopters (n=62)
1	DoA	23 (34)	22 (35)
2	NGO	17 (25)	16 (26)
3	Input dealer	17 (25)	14 (23)
4	Friends/ neighbors	10 (15)	10 (16)

Note: Numbers in the parentheses represent percentage

Table 4.24 Training received and attended by the sample farmers

No.	Type of training	No. of sample farmers	
		Partial adopters (n=67)	High adopters (n=62)
1	Technology training	23 (34)	40 (65)
2	Seed training	16 (24)	35 (56)
3	Fertilizer training	26 (39)	25 (40)
4	Pesticide training	26 (39)	24 (39)

Note: Numbers in the parentheses represent percentage

Table 4.25 Frequency of training received by the sample farmers

No.	Training	Frequency of training (average)	
		Partial adopters (n=67)	High adopters (n=62)
1	Training	1.7	3.8

4.16 Descriptive Statistics of Variables to Analyze the Adoption of Improved Technology Package

Table (4.26) mentioned descriptive statistics and expected sign of dependent and independent variables to analyze the adoption of improved technology package by sesame growers in the Magway Township. The dependent variable was adoption score of recommended technology package on sesame production with an average score. The independent variables for adoption rate were farming experience years on average, schooling year, total sesame cultivated area (hectares), the number of family labor (persons), total variable cost (MMK/ha), output constraints scores, technology constraints scores, training attended (times) and total gross benefit (MMK/ha).

According to the regression results, farming experience, schooling year, sesame cultivated area, the number of family labor used, training attended and gross benefit were positively correlated with adoption rate of sample farmers in the study area. According to the results, training attended, schooling year and gross benefit were significant at 1% and 5% level respectively. If training attended increased 1 time, adoption score will be increased 1.009 score. Besides, if schooling year increases 1 year, adoption score will be increased 1.2 score. Moreover, if total gross benefit is increased by 1 MMK/ha, adoption score will be increased 2.269 scores. Total variable cost, output constraints score and technology constraints score in total sesame production were negatively correlated with adoption score. Among them, technology constraints score was significant at 1% level. If technology constraint score increased by 1unit, the adoption rate of improved sesame production technologies will be decreased by 0.919 score. The f -value points out that the model is significant as shown in Table (4.27).

Table 4.26 Descriptive statistics of the variables to analyze the adoption of improved technology package by sesame growers in the study area

Variables	Units	Min.	Max.	Mean	SD
Adoption score	-	20	100	66	22
Farming experience	Yr.	8	50	28	11
Schooling year	Yr.	0	16	6	3
Sesame cultivated area	ha	0.6	36.4	5.1	4.8
Number of family labor	No.	0	4	1	1
Gross benefit	MMK/ha	390,136	2,137,980	1,034,544	385,507
Total variable cost	MMK/ha	452,835	1,046,803	569,465	107,923
Output constraints score	-	1	25	14.8	5.2
Technology constraints score	-	0	14	7.8	5.2
Training attended	-	0	14	3	4

Table 4.27 Factors affecting the adoption of improved sesame technology package by the sample farmers

Independent variables	Unstandardized Coefficients		Standardized Coefficients	t-value	Sig.
	B	Std. Error	β		
(Constant)	46.234***	13.349		3.464	0.001
Farming experience	0.108^ns	0.157	0.053	0.689	0.492
Schooling year	1.200**	0.594	0.160	2.021	0.046
Sesame cultivated area	0.034^ns	0.134	0.018	0.253	0.801
Number of family labor	1.851^ns	1.884	0.074	0.982	0.328
Gross benefit	2.269***	0.000	0.393	5.044	0.000
Total variable cost	-1.403^ns	0.000	-0.068	-0.894	0.373
Output constraints score	-0.827^ns	0.932	-0.068	-0.888	0.376
Technology constraints score	-0.919**	0.352	-0.213	-2.613	0.010
Training attended	1.009**	0.478	0.168	2.112	0.037

Note: Dependent variable = Adoption score

R^2 = 0.443, Adjusted R^2 = 0.401

F-value = 11.92**

*** and ** are significant level at 1% and 5% level and ns is not significant

CHAPTER V
CONCLUSION

5.1 Conclusion

In examining adoption of sesame production technology package recommended by Department of Agriculture (DoA), partial adopters could practice 1 to 6 components while high adopters adopted 7 to 10 components out of total 10 components in the package. Out of 129 sample farmers, high adopters were 51.9% and partial were 48.1%. In the access of production technology, it was obviously found that adoption of recommended technologies on soil type, quality of seed, seed rate, sowing time, spacing, fertilizer application, thinning time, weed control, pests and diseases control and harvesting was higher in high adopters compared to partial adopters. About 84% of sample farmers were not fully utilized the recommended technologies for sesame production. However, adoption of spacing was still weak in both adopters.

Family size and family labor were not different between partial and high adopters. Older age and more farming experience were found in partial adopters. Average schooling year was the same, but more educated farmers were found in high adopters. This factor should be taken into account for improving adoption of young and active farmers by Department of Agriculture (DoA). Larger proportion of medium farmers was found in partial adopters. It is mentioned that the target for technology dissemination should be more emphasized on medium farmers. High adopters had more income sources. The popular sesame varieties used by the high adopters were Samonnet, Bapan and Salatphyu. Bapan, Majandaw and Salatphyu were mostly used by partial adopters.

Cost and benefit analysis, show that high adopters for recommended technologies received higher yield and profit from sesame production. Higher material costs were found in partial adopters. Partial adopters had higher total variable costs of sesame production because of higher expense on input such as seed, fertilizer, pesticide and herbicide and labor cost.

Major input constraints were high fertilizer price, high wages of labor and seed price to buy. Major output constraints were sesame price, marketing and seed quality. Major technology constraints were no clear understanding of improved production technology, not availability of improved production technology, no participation in village, attitude of reluctant to change and attitude for risk bearing ability. In the study area, difficult access of improved seed was one of the most important factors for increasing the yield of monsoon sesame. And then, credit access with low interest rate, water access and high seed price were also serious constraint. Although the same constraints were faced by both types of adopters, highly adopted farmers more noticed about constraints in their sesame production compared with partially adopted farmers. It may lead to large variations in yield and represents a major constraint faced by farmers to adopt recommended input application and systematic management practice of cultivated crop in the study area.

Regarding the participation in training, both adopters were participated in various sesame production trainings. However, high adopters were more participated in sesame production training offered by DoA while in partial adopters were less participated. Number of farmers participated in various sesame production trainings and attended trainings times per crop season were more in high adopters than partial adopters. And then, high adopters more shared extension advices and technologies to others farmers than partial adopters.

As a result of the regression model, there were nine independent variables that affected the adoption of improved sesame technology package recommended by DoA in the study area. Among the three independent variables; total variable cost, output constraints and technology constraints were negatively correlated to the adoption but the other six independent variables were positively correlated with the adoption of improved sesame technology package recommended by DoA. In factor influencing adoption analysis, gross benefit was positively and significantly correlated to adoption rate. Technology constraints score was negatively correlated to adoption rate. Schooling year of farmers, frequency of training attended in sesame production were positively correlated to adoption rate. Based on the regression result, gross benefits, technology constraints and training attended were the most important factors which influenced on the adoption of improved technology package. By getting more gross benefit, the sesame growers would be adopted technology effectively. Moreover, training attended was also important facts because technology constraints could be reduced by organizing farmers to attend more training and receive more information and knowledge about improved production technology. Because of more training attended and got knowledge by high adopters, they received more shared information than partial adopters.

5.2 Recommendations

According to the study, high proportion of medium farmers in partial adopters indicated that they were needed to be encouraged for more technology adoption. To reduce high seed price constraints in quality seed availability, the quality seed production program would be set up by the Department of Agriculture (DoA) in collaboration with farmers, Department of Agricultural Research (DAR) and (Non Government Organization) NGO. To overcome low adoption on recommended plant spacing, research on cost effectiveness of plant spacing trial in sesame production should be carried out by Department of Agricultural Research (DAR) and its valuable information should be disseminated to farmers by holding farmer field days or through the extension activities by the Department of Agriculture (DoA). Seed technology training and education program at farmer level are also needed to be addressed these constraints.

To increase adoption of technology, technology constraints should be reduced such as extension training on improved sesame production technology. Awareness training for risk management and decision makes process. Technology distribution should be clear understanding about production practices, mass media (eg. radio, farmer channel, etc.) for easier availability. In technology transferring training, self-motivation program should be added. To achieve self-confidence in decision making, extension agents should be more emphasized on participation of young and active farmers to increase adoption rate.

Based on this study, seed technology training and education program at farmer level also needed to remove the constraints. The availability of water, the availability of insecticide and fertilizers with reasonable price and availability of credit with low interest rate are required to overcome farmer's constraints. Besides, output constraint is also negatively correlated with the adoption rate. So, to overcome these constraints, market-led approach extension would be implemented for high technological adoption and increased income earning of the farmers.

In the study area, extension institution needs more focus on participation of farmers to increase adoption rate of technologies. Extension agents should emphasize on participation of young and active farmers to increase adoption rate, to aware farmers' low education level in technologies transferring program. Extension contacts and trainings attended were important factors for adoption although these factors significantly influence on adoption of both adopters in the study area.

According to the results, market price of sesame would be a key for decision making of technology adoption. Therefore, policies and programs for private sectors in agricultural development should be timely regulated and oversee by the DoA. Income earning of sesame crop production would be the main incentive for technology adoption and it should be noticed by extension institution for the technology diffusion.

To get better profit of sesame production and to reduce material costs of production, sesame growers should be applied the recommended seed rate, fertilizer, pesticide and herbicide used. Total revenue is incentive for adoption of sesame production, therefore, distribution of sesame technology package should be cost effective. Therefore, sesame growers would be more and more getting profit, more adopted technology they will have.

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APPENDICES

Appendix 1. Enterprise budget of sesame production by partial and high adopter

	Items	Units	Partial Adopters (n=67)	High Adopters (n=62)
1.	**Gross benefit (Yield*Price)**	**MMK/ha**	**819,821**	**1,249,268**
	Yield	kg/ha	298	447
	Price	MMK/kg	2,776	2823
2.	**Total material cost**	**MMK/ha**	**153,814**	**134,975**
	Seed	MMK/ha	25,987	24,105
	FYM	MMK/ha	17,939	20,580
	Fertilizer	MMK/ha	77,746	64,752
	Pesticides	MMK/ha	15,447	11,568
	Fungicide	MMK/ha	5,668	6,028
	Herbicide	MMK/ha	8,014	5,797
	Fuel	MMK/ha	3,013	2,145
3.	**Family labor cost**	**MMK/ha**	**227,688**	**200,133**
	Land preparation	MMK/ha	55,229	70364
	Sowing	MMK/ha	38,926	25745
	Thinning	MMK/ha	30,396	22975
	Weeding	MMK/ha	30,759	30011
	Fertilizer application	MMK/ha	8,501	6397
	Chemical application	MMK/ha	7,118	5918
	Harvesting	MMK/ha	10,917	11677
	Bundling	MMK/ha	15,730	8868
	Threshing and drying	MMK/ha	11,912	7644
	Transportation	MMK/ha	18,201	10531
4.	**Hired labor cost**	**MMK/ha**	**199,875**	**203,975**
	Land preparation	MMK/ha	72,658	55,259
	Sowing	MMK/ha	27,229	33,805
	Thinning	MMK/ha	17,507	17,307

	Weeding	MMK/ha	21,115	31,962
	Fertilizer application	MMK/ha	1,881	8,868
	Chemical application	MMK/ha	2,416	1395
	Harvesting	MMK/ha	24,876	27,954
	Bundling	MMK/ha	11,839	9,784
	Threshing and drying	MMK/ha	7,911	7,929
	Transportation	MMK/ha	12,445	9,711
5.	**Total labor cost (3+4)**	**MMK/ha**	**427,562**	**404,108**
6.	Total interest on cash cost	MMK/ha	9,432	9,039
7.	Total variable cash cost	MMK/ha	363,121	347,989
8.	Total variable cost	MMK/ha	590,808	548,122
9.	Return above variable cash cost	MMK/ha	456,701	901,279
10.	Return above variable cost	MMK/ha	229,013	701,146
11.	Return per unit of cash expenses	-	2.26	3.59
12.	Return per unit of capital invested	-	1.4	2.32

Appendix 2. Survey questionnaire (Adoption of Improved Technology Package by Sesame Growers in Magway Township)

Village Tract-------------------------------Village----------------------------------Enumerator Name-----------------------------Date---------------------------

1. Farmer Information

Name	M/F	Age	Marital status	Education level	Farming experience (yrs)	Phone number

2. Family member's information

No	Name of HH members	M/F	Age	Relation to farmer	Education level	Primary job	Secondary job	Working experience in farming (years)

3. Household's Information and Land Assets

(a) Household's Farming and Other Assets

Livestocks	No	Farming apparatus	No	Farming apparatus	No	Other Household assets	No	Other Household assets	No
Oxen		Power tiller		Harrow		Motorcycle		Car	
Buffalo		Tractor		Seeder		Bicycle		Invertor	
Chicken		Hand Tractor		Cart		Generator/Solar		Skynet	
Pig		Water pump		Thresher		Hand phone		Soundbox	
Fish		Harvester		Sprayer		TV		Refrigerator	
Sheep		Inter-cultivator		Others		EVD		Others	
Goat		Plough				Ttrailer			

(b) Land Asset (acre)

Types of land	Land owned	Total cultivated area	Rent in	Rent out
Upland				
Lowland				
Irrigated area				
Others				

4. Sesame Production

(a) Monsoon Sesame Production

Variety	Cultivated area (ac)	Seed rate (pyi/ac)	Yield (bsk/ ac)	Total yield (bsk)	Seed saved (bsk)	Home consumption (bsk)	Whom to sell	Transport costs (MMK/bsk)	Amount of sold (bsk)	Price (MMK/ bsk)

(b) Other Crops Production

Season	Crop name	Variety	Cultivated area (ac)	Seed rate (pyi/ac)	Yield (bsk/ ac)	Total yield (bsk)	Seed saved (bsk)	Home consumption (bsk)	Whom to sell	Transport Costs (MMK/bsk)	Amount of sold (bsk)	Price (MMK/ bsk)

(c) Monsoon Sesame Costs of Production (Labor and Machinery Costs)

Activities	Family labor		Hired labor		Cash payment (cash/ kind)		Power use(Machinery use)				
	No	Days	No	Days	Type of payment	Amount of cash payment	Type	Own/hire	Hired cost	Fuel cost	Labor cost
Seed											
Line sowing by machine											
Seed broadcasting											
Seeding by hand											
Land preparation											
Ploughing											
Harrowing											
Crop establishment											
Thinning (1st)											
Thinning (2nd)											
Thinning (3rd)											
Cultural practices											
Weeding(1st)											

Weeding(2nd)											
Weeding(3rd)											
Fertilizer application & Chemical application											
Harvesting											
Threshing											
Drying											
Transporting to market place											

(d) Material Costs of Input Per Acre

Activities	Name	Amount		Unit (pyi, bag, cart)	Price	Type of payment (Cash Down/ Credit)	If Credit	
		Owned	Purchased				Duration (Month)	Interest % per month
Seed								
Fertilizer application								
FYM								
Urea								

T-super								
Potash								
Compound								
Others								
Insecticide application								
pesticide application								
Fungicide application								
Herbicide application								
Rodenticide application								
Others								

5. Income Within A Year (ks/yr) and Credit loan

(a) Income Within A Year (ks/yr)

No	Household head/members	Off-farm income	Non-farm income	Activity	No of day per year	No of hours Per day	Wage rate per day (daily wage)	Amount of income (daily wages x no of day per year)

(b)Credit loan

No	Season	Amount of loan	Interest rate	Source of existing loan	When did you borrow? (mm,dd,yr)	When is full payment due?	Remarks

6. Sesame Production Technologies Used by Sesame Growers in Magway Township

No	Sesame production practices	Current using practices				Scores	Reasons for non adopt
1	**Soil type (PH-5.5-7.8)**						
2	**Quality of seed (Improved variety)**						
3	**Seed rate (2-4 pyi/ac)**						
4	**Sowing time**						
5	**Spacing (12”x4”),(15’x4”)**						
6	**Fertilizer Application**	Times	Type	Application Time (DAS)	Amount		
		1^{st}					
		2^{nd}					
		3^{rd}					
7	**Thinning time (15th &30th DAS)**	1^{st}					
		2^{nd}					
		3^{rd}					
8	**Weed control (30th DAS)**						
9	**Pests & Diseases control**						
10	**Harvesting (25% leave are shed and turn yellow)**						

Score explanation: 0-60 (Partial adopter), >70 (High adopter)

7. The Role of Improved Sesame Varieties Production Technologies by Farmer Perception (Adoption)

(a) Source of Production Technology Information Used by the Farmers for Sesame Production

Sources	If yes			
	information distributer		Times of contact per month or crop season	Whom did you share information? (1= HH member, 2= neighbors, 3= friends, 4=others)
	No	Yes		
Extension agent				
Friends/ neighbors				
NGO				
Collectors				
Wholesaler				
Others				

(b)About Sesame Production Technology Which Were Received by Respondent and Family Members

Offered Organization	Type of training	Times of training per crop season	Participated times by respondent per crop season	Number of participated family members

8. About the Constraints Faced in Sesame Production

No.	Constraints	Level (0 or 1 or 2)	Reasons
A	**Input constraints**		
1	Seed access		
2	Seed price to buy		
3	Fertilizer access		
4	Fertilizer price		
5	Insecticide and pesticide access		
6	Insecticide and pesticide price		
7	Labor access		
8	Price of labor		
9	Rodenticide and herbicide access		
10	Rodenticide and herbicide price		
11	Mechanization access		
12	Mechanization hired price		
13	Water access		
14	Credit access		
15	Interest rate for credit		

B	**Output constraints**		
16	Marketing (selling)		
17	Sesame price for sale		
18	Sesame seed quality		
19	Wage different		
C	**Technology constraints**		
20	Decision making opportunity		
21	Self-confidence in decision making		
22	Attitude to risk		
23	Attitude to change		
24	Participation in existing group of the village		
25	Availability to the improved sesame production technology		
26	Clear understanding to the improved production technology		
D	**Weather constraints**		
27	Unfavoured weather conditions for sesame production		

Code for Level: 0 = low, 1 = medium, 2 = high