# CHAPTER IV

# CHARACTERISTICS OF UPLAND COTTON-BASED FARMING SYSTEMS IN THE STUDY AREA

This chapter discusses about farmers' utilization of various production practices in post-monsoon cotton cultivation in Mandalay Division. Techniques and frequency of production practices are slightly different in each township. Farmers' perception of production constraints related with seed cotton yield is also deviated among townships. As the study is mainly emphasized on livelihood strategies of cotton farmers and these strategies are totally dependent on the accessibility of livelihood assets. Therefore, five capital assets are crucial to make detail analysis of post-monsoon cotton production. Through this analysis, the considerable effects of livelihood assets on seed cotton yield are taken into account for cotton-based farming system.

## 4.1 Description of the study areas

In Myanmar, major cotton growing areas are situated in Central Myanmar. Cotton is commercially grown in Mandalay, Sagaing and Magway Divisions. Mandalay Division is the largest cotton growing area, its annual temperature varies from a minimum of about 21°C to a maximum of around 33°C and the annual rainfall is about 882 mm. Its total cultivable area under three cotton growing seasons (pre-monsoon, monsoon and post-monsoon) was about 141,964 ha that was 39.48% of total cotton planted area of the country (CSD, 2010). Kyaukse, Myittha and Wundwin

townships under Mandalay Division were selected as the study areas. There were the cotton cultivation of about 23%, 20% and 8% of the total net sown area in Kyaukse, Myittha and Wundwin, respectively. Land utilization of the selected areas was presented in Table 4.1.

Table 4.1 Land utilization (thousand ha) in the selected study areas (2009-2010)

| **Type of land** | **Kyaukse** | **Myittha** | **Wundwin** |
|---|---|---|---|
| Total planted area | 44.29 | 49.99 | 79.55 |
| - Lowland | 26.01 | 28.54 | 41.12 |
| - Upland | 17.79 | 21.24 | 37.63 |
| - Orchard | 0.50 | 0.21 | 0.80 |
| Fallow land | 0.64 | 4.12 | 7.51 |
| Reserved forest | 99.13 | 13.05 | 17.11 |
| Other forest | 2.88 | 0.57 | 2.74 |
| Other | - | 1.72 | 1.63 |
| Uncultivable land | 40.98 | 19.35 | 32.30 |
| **Total** | **187.93** | **88.78** | **140.85** |

Source: Settlement and Land Records Department (SLRD) (Township office of Kyaukse, Myittha and Wundwin) (2010)

Kyaukse township is 1,879 sq km wide and the net planted area under lowland, upland and orchard area is about 44.29 thousand ha (98.57% of arable land) and fallow land area is 0.64 thousand ha of 44.93 thousand ha arable land. There are about 17.79 thousand ha of upland area that occupies about 40.15% of net agricultural

land. The average annual rainfall of the township was 62.99 mm and the total number of rainy days was 44 days per year in 2008-2009 cropping season (Figure 4.1). The planted areas of pre-monsoon, monsoon and post-monsoon cotton seasons were 276 ha, 2133 ha and 7,733 ha and the average yield were 1497, 1430 and 1123 kg $ha^{-1}$, respectively. Post-monsoon cotton cultivation was about 76% of total cotton planted area in this area.

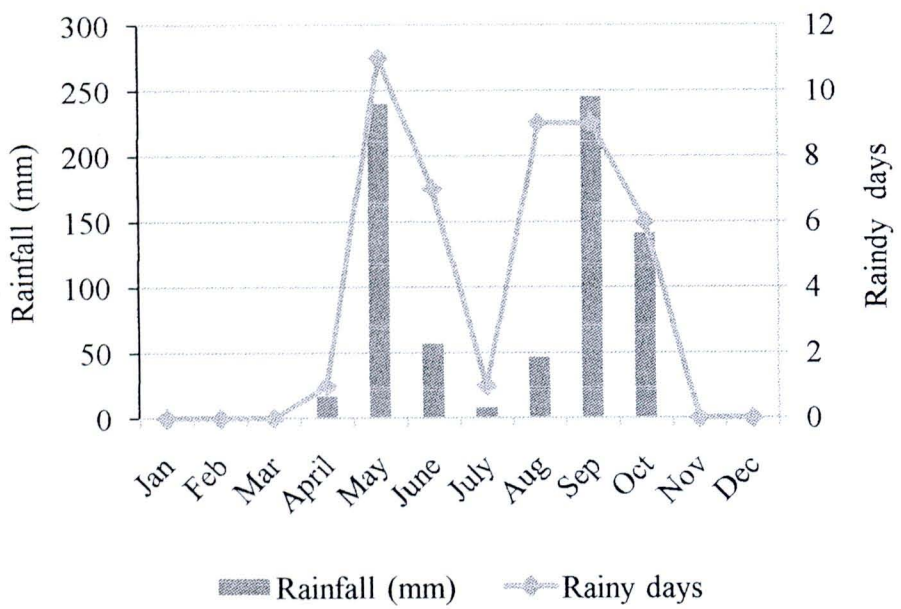


Figure 4.1 Distribution of rainfall (mm) and rainy days in Kyaukse township

Source: Cotton and Sericulture Department (CSD), Kyaukse township (2010)

The total area of Myittha township is 888 sq km and the agricultural land area is about 54.11 ha (60.94% of total area). The net planted area and the fallow land area are 49.99 thousand ha and 4.12 thousand ha, respectively. The mean annual rainfall and the number of rainy days for the area during 2008-2009 cropping season were 71.67 mm and 33 days per year (Figure 4.2). Cotton planted area under three growing

seasons was 10,137 ha (41% of total cotton planted land) and the average yield of area wide was about 1229 kg $ha^{-1}$.

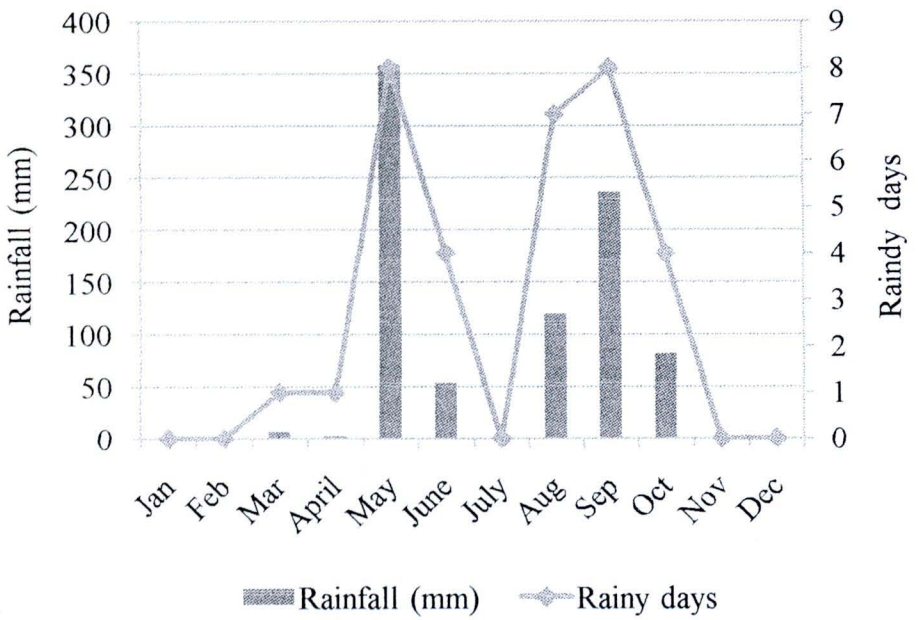


Figure 4.2 Distribution of rainfall (mm) and rainy days in Myittha township

Source: Cotton and Sericulture Department (CSD), Myittha township (2010)

Wundwin township covers 1,408 sq km and the arable land area is about 87.06 thousand ha that occupies the largest share of total area (61.83%). The net planted area under lowland, upland and orchard area is about 79.55 thousand ha and the fallow land area is about 7.51 thousand ha, respectively. Total cotton growing area was 6,365 ha that was about 71% of total cotton grown area and the average yield of three growing seasons was 1238 kg $ha^{-1}$. The study area received an annual rainfall of 783.35 mm during the 34 rainy days per year (Figure 4.3). Table 4.2 illustrates the area planted and per hectare yield of long-staple cotton in Kyaukse, Myittha and Wundwin townships.

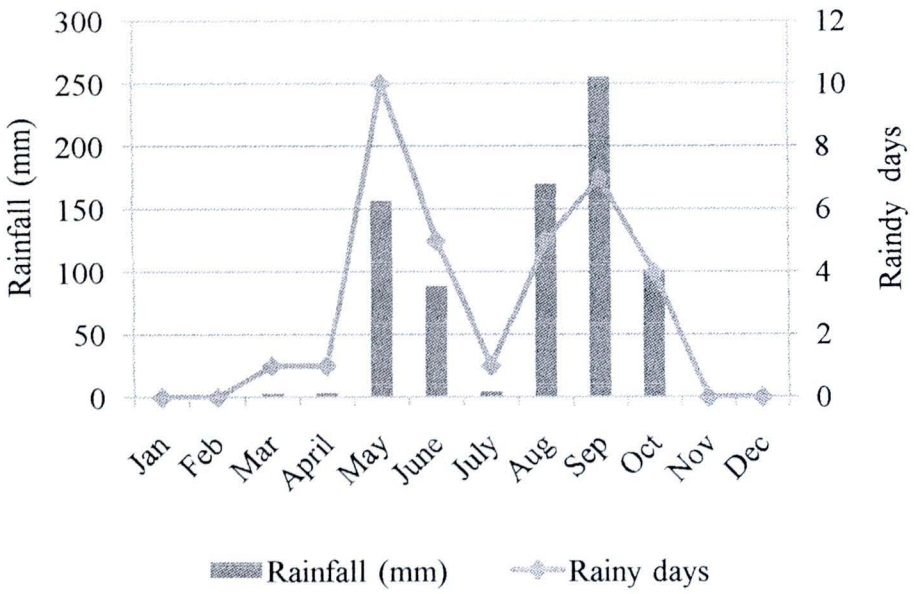


Figure 4.3 Distribution of rainfall (mm) and rainy days in Wundwin township

Source: Cotton and Sericulture Department (CSD), Wundwin township (2010)

Table 4.2 Area planted and per hectare yield of long-staple cotton in Kyaukse, Myittha and Wundwin townships (2009-2010)

| Crop season | Kyaukse | | Myittha | | Wundwin | |
|---|---|---|---|---|---|---|
| | Planted area (ha) | Yield (kg $ha^{-1}$) | Planted area (ha) | Yield (kg $ha^{-1}$) | Planted area (ha) | Yield (kg $ha^{-1}$) |
| Pre-monsoon | 276 | 1497 | 5480 | 1333 | 1055 | 1515 |
| Monsoon | 2133 | 1430 | 486 | 1422 | 812 | 1029 |
| Post-monsoon | 7733 | 1123 | 4171 | 1070 | 4498 | 1211 |
| **Total** | **10142** | **1198** | **10137** | **1229** | **6365** | **1238** |

Source: Cotton and Sericulture Department (CSD), 2010

## 4.2 General characteristics of post-monsoon cotton farmer respondents

### 4.2.1 Current production practices of post-monsoon cotton

According to the rainfed mode of cotton production and relatively longer duration of cotton than other crops, majority of the respondents planted cotton as a sole crop. Some cultural practices performed by the sample post-monsoon cotton farmers were mentioned in Table 4.3.

#### (a) Use of improved varieties

In all the cotton production areas studied, a single cotton variety, Ngwe Chi 6 is being sown for post-monsoon cotton production. This cultivar is relatively resistant to bollworm and mainly distributed by Cotton and Sericulture Department (CSD) by the multiplication of seeds in the research farms under CSD. In Kyaukse study area, 88% of farmers received cotton seed from CSD, only 2% of farmers used their own cultivar and 10% bought cotton seed from the private cotton dealers and private seed crushing mill. In Myittha, 72% of farmers got cotton seed for cultivation from CSD, 24% of respondents used own variety and only 4% bought cotton seeds from the cotton dealers. In Wundwin study area, 90% of the respondents obtained cotton seed from CSD and only 10% used their own variety in cotton production.

#### (b) Land preparation methods

Unlike the other study areas, basal land preparation was carried out more commonly with tractor plows by 80% of farmers in Kyaukse and all of the farmers applied draught power for second step land preparation (harrowing) and intercultivation. Hired animal power was used by only 26% of farmer respondents.

All of the selected farmers in Myittha and Wundwin areas applied land preparation and intercultivation with their owned draught power. Only about 10% of farmers in Kyaukse, 14% in Wundwin and 16% in Myittha planted post-monsoon cotton with unsatisfactory tillage because of the competition with other crops for animal power depending on the receiving of rainfall.

**(c) Sowing time**

According to the rainfed mode of production, sowing time relies on rainfall precipitation and all of the post-monsoon cotton growing farmers used wet sowing method. Post-monsoon cotton is mainly grown in the middle of rainy season and the recommended growing time is from July to August (Tin, 2006). The majority of the respondents in all selected areas planted cotton on August because sufficient moisture for germination was received on August.

**(d) Recommended spacing and population**

All of the respondents in Kyaukse area used the recommended spacing and the recommended plant population denoted by CSD (2 plants per hole and 90 cm x 30 cm or 75 cm x 30 cm). However, 74% of the respondents in Myittha and 64% in Wundwin used the recommended spacing and population because of their less experience in cotton cultivation compared to Kyaukse.

**(e) Timely thinning**

Most of the cotton farmers followed timely thinning of within 21 days after planting. According to the result of survey, most of the farmers in Kyaukse used man

power in thinning practice. However, some farmers in Myittha and Wundwin used both man and animal power in thinning practice.

**(f) Fertility management**

The recommended rate of chemical fertilizer for long staple cotton containing major nutrients of N, P and K respectively are urea, triple superphosphate and muriate of potash at recommended rates ranging from 63-63-63 kg $ha^{-1}$ to 126-63-63 kg $ha^{-1}$ depending on soil type, availability of water and target yield (Tin, 2006). The recommended amount of fertilizer was rarely used in cotton production in the study areas according to the uncertainty of rain shower and insufficient amount of capital for inputs. Types of chemical fertilizer mostly used by farmers were urea, triple superphosphate (T-super) and compound. Urea fertilizer was normally applied split applications, one-half side dress at the pin head square stage and one-half side dress at near peak blooming. Compound and T-super fertilizer were commonly used as basal application at the time of sowing. However, farmers used compound fertilizer as basal and also used as side dress by mixing with urea fertilizer in this study. Farm yard manure (FYM) and chemical fertilizer application was mainly restricted in Kyaukse according to their possession of fertile soil and these farmers did not want to invest for fertilizer according to their experience because of the uncertainty of rain shower. Only 22% and 8% of the respondents used farm yard manure and chemical fertilizer in cotton production in this study area with the average amount of 846 kg $ha^{-1}$ and 7.82 kg $ha^{-1}$. In order to increase the application of fertilizers, the advantages of using additional fertilizers in consecutive growing of cotton field will be instructed by the technical staff.

Table 4.3 Current production practices used by sample farmers in selected townships

| Items | Kyaukse | | Myittha | | Wundwin | |
|---|---|---|---|---|---|---|
| | Frequency | % | Frequency | % | Frequency | % |
| **Use of cultivar** | | | | | | |
| - Ngwe Chi 6 | 50 | 100 | 50 | 100 | 50 | 100 |
| **Source of improved seeds** | | | | | | |
| - CSD | 44 | 88 | 36 | 72 | 45 | 90 |
| - Own | 1 | 2 | 12 | 24 | 5 | 10 |
| - Market | 5 | 10 | 2 | 4 | - | - |
| **Proper land preparation** | | | | | | |
| - Both machinery and draught power | 40 | 80 | 0 | 0 | 0 | 0 |
| - Only draught power | 10 | 20 | 50 | 100 | 50 | 100 |
| - Good tillage | 45 | 90 | 42 | 84 | 43 | 86 |
| - Poor tillage | 5 | 10 | 8 | 16 | 7 | 14 |
| **Recommended spacing** | | | | | | |
| - 2 plants/hole (90 x 30) cm or (75 x 30) cm | 50 | 100 | 37 | 74 | 35 | 70 |
| - Otherwise | 0 | 0 | 13 | 26 | 15 | 30 |
| **Fertility management** | | | | | | |
| - Applied farm yard manure | 11 | 22 | 30 | 60 | 16 | 32 |
| - No applied farm yard manure | 39 | 78 | 20 | 40 | 34 | 68 |
| - Applied chemical fertilizer | 4 | 8 | 19 | 38 | 39 | 78 |
| - No applied chemical fertilizer | 46 | 92 | 31 | 62 | 11 | 22 |
| **Pest management** | | | | | | |
| - Applied seed treatment | 14 | 28 | 27 | 54 | 34 | 68 |
| - No applied seed treatment | 36 | 72 | 23 | 46 | 16 | 32 |
| - Number of spraying | | | | | | |
| - 2-5 times | 33 | 66 | 45 | 90 | 25 | 50 |
| - > 5 times | 17 | 34 | 5 | 10 | 25 | 50 |
| **Interculture** | | | | | | |
| - 2-5 times | 35 | 70 | 43 | 86 | 46 | 92 |
| - > 5 times | 15 | 30 | 7 | 14 | 4 | 8 |
| **Weeding** | | | | | | |
| - Zero | 1 | 2 | 0 | 0 | 0 | 0 |
| - 1-2 times | 19 | 38 | 32 | 64 | 16 | 32 |
| - > 2 times | 30 | 60 | 18 | 36 | 34 | 68 |

Source: Survey, 2010

In Myittha area, the highest amount of farm yard manure was used as the basal application at the time of land preparation with the average amount of 2192 kg $ha^{-1}$ because they mainly depend on cotton cultivation for income and they cannot spend their capital for chemical fertilizer according to their relatively low income. The highest amount of chemical fertilizer application was found in Wundwin with the average amount of 91.62 kg $ha^{-1}$ according to their significantly high income. However, these farmers spent the smaller amount of farm yard manure as basal compared to Myittha because they applied their manure in other important crops particularly rice and chili.

**(g) Intercultivation and weeding**

The average number of intercultivation and weeding was generally different among all areas according to weed infestation, rainfall precipitation and labor and draught power availability. The average number of intercultivation was about 5 times per season with the mean minimum of about 2 times and the mean maximum of about 15 times for good ventilation and reduction of weed infestation in Kyaukse. In Myittha and Wundwin, 4 intercultivations were done throughout the cropping season. According to survey results, most of the respondents used hoe weeding method with the average number of between 1 to 2 times by 38%, 64% and 32% of farmers and more than 2 times of weeding was done by 60%, 36% and 68% of farmers in Kyaukse, Myittha and Wundwin, respectively throughout the cotton growing season. Only 2% of the respondents in Kyaukse did not use hoe weeding because they applied the intercultivation of 15 times instead of weeding.

**(h) Management of pest infestation**

In pest management practice, there was different among the study areas of all townships because pest occurrence is depended on weather factors i.e., temperature, relative humidity and precipitation. To prevent the early season sucking pests, 28% of farmers in Kyaukse, 54% of farmers in Myittha and 68% of farmers in Wundwin treated cotton seeds with chemical powder as the trade names of Gaucho, Dozer and Formire under the chemical group of Chloro-nicotinyl and the active ingredient is Imidacloprid. In Kyaukse, the lowest percentage of the respondents was observed in using seed treatment method compared to the other two townships because these respondents would like to prevent sucking pests when pest infestation was occurred. They would like to prevent sucking pests by the spraying method instead of seed treatment. Also according to their large plantation of cotton than the other two townships, they firstly emphasized on the sowing time under available moisture condition to get good germination and hence they did not perform seed treatment method simultaneously for all planted areas and the other thing they did not apply seed treatment was due to their constraint for financial capital to spend for pesticide at sowing time. Most of the farmer respondents (90%) in Myittha, 66% in Kyaukse and 50% in Wundwin sprayed 2 to 5 times per season to prevent bollworm infestation and late season sucking pests according to pest incidence. The most commonly used of pesticides by farmers were Formire, Dozer, Infano and Incharge (Trade names) under the chemical group of Chloro-nicotinyl and the active ingredient is Imidacloprid, Hurricane (Trade name) under the chemical group of Organophosphate (OPI) plus Pyrethroid and the active ingredient is the combination of Alpha cyper and Chlorpyrifos, Concept (Trade name) under the chemical group of Organophosphate

(OPI) and the active ingredient is Chlorpyrifos, Shaolin (Trade name) under the chemical group of Pyrethroid and the active ingredient is Lambda-cyhalothrin and Azephate (Trade name) under the chemical group of Organophosphate (OPI) and the active ingredient is Acephate.

**(i) Harvesting**

Manual picking was practiced and frequency of picking depended on a variety of factors such as weather, crop requirement and labor availability. Majority of the respondents picked cotton until the end of the growing season because there was any risk for the next crop cultivation because cotton was cultivated under single cropping system. The duration of the cotton crop has a strong positive influence on cotton yield.

Based on the production practices of respondents, it can be concluded that all of the respondents used resistant variety. Although all of the farmers in Myittha and Wundwin applied only draught power in cotton production, 80% of respondents in Kyaukse used both animal power and machinery power. In Kyaukse, all of the respondents used recommended spacing and plant population. Fertilizer management was restricted in Kyaukse, however, 60% of respondents in Myittha applied FYM and 78% of respondents used chemical fertilizer to improve soil fertility. In pest management practices, although 54% of farmers in Myittha and 68% of farmers in Wundwin used seed treatment method for sucking pests, only 28% of farmers in Kyaukse used this method. About 90% of farmers in Myittha prevented pest infestation by the spraying frequency of within 2 to 5 times per season. There was

observed that frequency of spraying was relatively low because of the characteristic of the relatively resistant to bollworm of Ngwe Chi 6 variety.

### 4.2.2 Competitiveness of cotton with the other crops

According to the rainfed mode of production system, majority of the crop growing activities are depended on rainfall distribution in all the study areas. During the rainy season, from May to October, most of the crops were planted after receiving enough moisture for germination. Majority of the farmers grew post-monsoon cotton as sole crop on August and after harvesting of cotton around February, the land was then fallowed. Main agricultural crops and their cultivated areas as a percentage of total land size in the cotton production areas of selected townships were described in Table 4.4.

In the study area of Kyaukse, cotton is the principal crop, covering about 58.68% of the cropped area followed by sorghum (21.99%), pulses (11.67%) such as butter bean, pigeon pea and mung bean and oilseed crops (11.46%) particularly sesame, sunflower and groundnut. Majority of the farmers in this area cultivated cotton along their agriculture life according to their suitable soil types for cotton and therefore these farmers have more experience in cotton cultivation. Normally oilseed crops and pulses were sown in their small amount of alluvial soil as double cropping. Therefore, competition with cotton and the other crops was relatively rare.

Cotton and pulses especially chickpea were the main crops in the study area of Myittha followed by sorghum, rice and oilseed crops (sesame and groundnut). Cotton was normally competed with sorghum and sesame but there was no competition with chickpea because of the totally different of the sowing time. Although the respondents

in this area interested in cotton cultivation and their planted area was about 29.59% of the total land for cotton, this is relatively low compared to their own land and also Kyaukse study area. The reason of this small area was according to their lower fertile soil area compared to the total land. Chickpea is the second most important crop covering about 21.98% of the total area followed by sorghum (16.52%), rice (15.40%), sesame (11.07%) and groundnut (5.48%) of the total farm size.

Table 4.4 Diversity of agricultural crops and their cultivated areas as a percentage of total land size (ha) in the cotton production areas of the selected townships

| Cultivated crops | Kyaukse | | Myittha | | Wundwin | |
|---|---|---|---|---|---|---|
| | Position of crop | % of total area (ha) | Position of crop | % of total area (ha) | Position of crop | % of total area (ha) |
| Cotton | 1st | 58.68 | 1st | 29.59 | 2nd | 18.17 |
| Sorghum | 2nd | 21.99 | 3rd | 16.52 | 8th | 3.76 |
| Rice | - | - | 4th | 15.40 | 1st | 30.17 |
| Chickpea | - | - | 2nd | 21.98 | 3rd | 15.94 |
| Chili | 9th | 0.97 | - | - | 5th | 12.79 |
| Sesame | 4th | 6.56 | 5th | 11.07 | 4th | 15.56 |
| Groundnut | 8th | 1.98 | 6th | 5.48 | 6th | 7.91 |
| Sunflower | 5th | 2.92 | - | - | - | - |
| Butter bean | 3rd | 6.77 | - | - | - | - |
| Mung bean | 7th | 2.40 | - | - | 7th | 3.97 |
| Pigeon pea | 6th | 2.50 | - | - | 9th | 1.70 |

Source: Survey, 2010

Note: Total % was not 100% because of the double cropping of some crops.

In the study area of Wundwin, rice was the leading crop occupying about 30.17% of the total land area. However, rice and cotton did not normally compete against each other except in certain area according to their widely different soil type and agroclimatic conditions. Cotton is totally competed with chili and oilseed crops in terms of both cultivated area and labor although the sowing time was a little different. Farmers' cotton production was substantially lower than that of the other two townships because of the difference of major crops and also the farmers' less interested in cotton cultivation in this area compared with the other two townships according to the lower net benefit of the cotton compared to that of the other crops. Cotton accounted for 18.17% of the total land area followed by chickpea (15.94), sesame (15.56%) and chili (12.79%). Although chili growing area was lower than cotton, the total revenue from that crop was higher than cotton. Sorghum was planted in this area as fodder crop for cattle.

### 4.3 Contract farming system in cotton production

Contract farming in cotton production was initiated in post-monsoon cropping season of 2007-2008. The main objective is the production of purity cotton seed of Ngwe Chi 6 variety to sufficiently distribute for all commercial cotton growing areas. The reason of the introducing of this system was that purity cotton seed cannot be produced for all areas from the cotton farms under CSD because of the limitation of cotton cultivated area. In contract farming system, besides the provision of technical expertise relevant to the cotton production, supporting the advanced payment to purchase purity cotton seed and the basic inputs for cotton production from the CSD's procurement finance was involved. The amount of payment under contract farming is

about 12,350 to 14,820 kyats $ha^{-1}$. As well as, contract farmers' responsibility are to follow and apply the improved technologies disseminated by extension staff, to produce required commodity and to sell the equivalent amount of quality seed cotton with the advanced payment at the CSD's procurement price. In Kyukse study area, contract farming system was not adopted. However, 12% of respondents in Myittha adopted the contract farming. In the study area of Wundwin, it was found that 54% of respondents performed contract farming with CSD in cotton production.

**4.4 Production constraints of post-monsoon cotton production**

Cotton is one of the major crops grown in the selected study areas under rainfed upland of Central Myanmar. Rainfed cotton farming is a risky enterprise and it has always been a challenge to sustain cotton productivity under this conditions. Post-monsoon cotton is planted as sole crop and the other cultivated crops are sorghum, rice, chili, chickpea, groundnut, sesame, sunflower, mung bean, butter bean and pigeon pea.

The average seed cotton yield obtained by the three selected areas was 947 kg $ha^{-1}$ in Kyaukse, 770 kg $ha^{-1}$ in Myittha and 891 kg $ha^{-1}$ in Wundwin, respectively. The gap between yields was according to their widely different soil type and agro-climatic conditions. Farmers' accepting of actual yields was substantially lower than the potential yield of 1613 kg $ha^{-1}$. Only 8% of farmers in Kyaukse, 4% of farmers in Myittha and 12% of farmers in Wundwin accepted seed cotton yield more than the national target yield. According to the survey results, cotton production fluctuation perceived by farmers was due to the cumulative effects of production problems such as poor land preparation, no optimum sowing time, poor seed quality, no seed

treatment, lack of chemical and organic fertilizers, pest infestation, non-appropriate rainfall, shortage of farm labor, lack of capital to invest in production inputs, insufficient local extension system, deficient knowledge in management practices and low product price and quality (Table 4.5).

Pest problem is one of the most important constraints in cotton production and 15% of cotton yield loss was caused by insect infestation. In developing countries, it was estimated that approximately 50% of all pesticides were applied in cotton cultivation (Kooistra and Termorshuizen, 2006). Majority of the farmers in all the study areas faced with the pest problem and normally they used seed treatment method and spraying pesticide to prevent this. According to the survey results, lack of seed treatment (72% of respondents) to prevent sucking pests was the most serious constraints in Kyaukse. The respondents would like to prevent sucking pests when pest infestation was occurred, in that case, preventive method is the most effective for sucking pests. Therefore, seed treatment is the essential way of pest protection. The spraying times of 5 and more than 5 times per season was observed in 64% of respondents in Kyaukse, 24% of respondents in Myittha and 82% of farmers in Wundwin to prevent pest infestation. The rest of the respondents in all areas used less than 5 spraying times for pest problem.

The application of inorganic and organic fertilizer is an important input to increase cotton yield. Lack of application of fertilizers or insufficient use of fertilizers is one of the constraint factors in cotton yield reduction. Although farmers possessed relatively fertile soil condition in Kyaukse, there was necessary to use fertilizer for additional nutrient according to the continuously growing of cotton. Most farmers in the study area of Kyaukse township did not use fertilizers. This was one of the

problems in cotton yield reduction; about 92% and 78% of respondents faced with problems by lack of application of inorganic and organic fertilizers. Although most of the respondents in this area already known the advantages of additional application of fertilizers in the field, they presumed that there was not necessary to put additional fertilizers in their soil according to good soil type and hence they sold FYM to the other areas for income. The other things they did not want to put additional fertilizers in cotton field were due to the uncertainty of rainfall and weed infestation. According to their experience, they did not want to put chemical fertilizer under the uncertainty of rainfall and they did not want to put FYM to avoid weed establishment. Most of weed seeds were involved in FYM. According to lack of application of both types of fertilizers, farmers did not receive cotton yield as they expected. Lack of application of chemical fertilizer was the second most important constraint facing by 62% of farmers in Myittha and the majority of farmers (60%) used FYM and about 30% of respondents did not apply any fertilizer. In contrast, most of the farmers in Wundwin applied inorganic fertilizer in cotton production and only 16% did not use any fertilizer. About 68% of the respondents faced with the serious problem as lack of application of FYM. According to their intensive cropping system, there was necessary to apply additional nutrient to improve soil fertility. In order to sustainable use of soil for production, organic fertilizer is essential. Therefore, constraint faced by lack of application of fertilizers was relatively low in Myittha and Wundwin compared to Kyaukse.

Post-monsoon cotton is normally grown in the middle of rainy season and therefore rainfall can support crop requirement of moisture up to the initial flowering stage (50-60 days after planting). Accordingly, cotton farmers received moisture

stress from peak flowering onwards (Tin, 2006). Accessibility of non appropriate rainfall was the major serious problem in Myittha (74%) because the lowest rainfall precipitation was received on October, at the time of peak flowering. Therefore, they faced with the shortage of moisture on October compared to the other townships. In Kyaukse township, 42% of respondents faced with the constraint by non appropriate rainfall followed by 10% of farmers in Wundwin.

According to the high labor requirement of cotton crop, labor unavailability at the right time not only affects the reduction of cotton yield variability, but also the quality of seed cotton by contaminating of foreign particles and hence lowers the grade in the market and also get lower price. Fifty six percent of farmers in Kyaukse and 40% of farmers in Myittha encountered with the labor shortage because cotton is labor demanded crop and a lot of cotton was grown in these areas. In Wundwin, 36% of respondents faced with labor shortage at the time of picking because of the competitiveness of cotton and other crops such as rice and chili for labor.

Although the recommended growing practices particularly the recommended spacing and timely and systematically thinning were used in all of the respondents in Kyaukse township, 26% in Myittha and 30% in Wundwin did not follow those practices according to the less experience in cotton cultivation. These respondents used narrower spacing between rows than the recommended spacing. According to doing this, the plants did not received good ventilation because of the crowded of plants. That was one of the problems to reduce the cotton yield faced by the farmers.

There was observed about 28% of respondents in Kyaukse and 24% in Myittha encountered with limited financial for production. This problem was higher than that of Wundwin (12% of respondents) because of their relatively lower income

and lower amount of credit accessibility from formal and informal money lenders in Kyaukse and Myittha compared to Wundwin.

Table 4.5 Common constraints perceived by the farmer respondents on post-monsoon cotton

| Constraints | Kyaukse | | Myittha | | Wundwin | |
|---|---|---|---|---|---|---|
| | Frequency | % | Frequency | % | Frequency | % |
| Poor land preparation | 5 | 10 | 8 | 16 | 7 | 14 |
| No optimum sowing time | 9 | 18 | 12 | 24 | 1 | 2 |
| No recommended spacing | 0 | 0 | 13 | 26 | 15 | 30 |
| Poor seed quality | 7 | 14 | 1 | 2 | 7 | 14 |
| No seed treatment | 36 | 72 | 23 | 46 | 16 | 32 |
| Lack of application of FYM | 39 | 78 | 20 | 40 | 34 | 68 |
| Lack of application of chemical fertilizer | 46 | 92 | 31 | 62 | 11 | 22 |
| Pest problem | 42 | 84 | 24 | 48 | 47 | 94 |
| Unfavorable rainfall | 21 | 42 | 37 | 74 | 5 | 10 |
| Labor shortage | 28 | 56 | 20 | 40 | 18 | 36 |
| Limited financial | 14 | 28 | 12 | 24 | 6 | 12 |
| Low product price and quality | 24 | 48 | 19 | 38 | 4 | 8 |
| Insufficient extension contact | 15 | 30 | 18 | 36 | 17 | 34 |

Source: Survey, 2010

Also, product price and quality of cotton was one of the constraint factors in production. There was observed 48% and 38% of respondents in Kyaukse and Myittha accepted lower farm gate price according to their lower quality of seed cotton compared to Wundwin because of the relatively higher cotton cultivation of these areas and therefore the farmers did not emphasize quality for large production. According to the poor quality, the product price was also low.

Majority of the farmers would like to receive the improved technologies from the technical staff. Although the professional skill of the extension workers from Cotton and Sericulture Department and the staff from the private sectors disseminated these technologies, there was not adequate field visits under the insufficient ratio of extension agents to cotton area and also inadequate logistic support including of transport facilities. On the site of farmers, they occasionally absent to attend this extension agents' dissemination of technologies according to their full of activity with field work and sometimes according to their lack of enthusiasm to attend this. Therefore, they faced with the constraint factor.

About 16% of respondents in Myittha grew cotton under unsatisfactory land preparation followed by 14% of farmers in Wundwin and only 10% of farmers in Kyaukse. This poor land preparation was observed according to their draught power availability in each area. No optimum sowing time was faced by respondents of 18% in Kyaukse, and 24% in Myittha that was relatively higher than Wundwin (2% of respondents) because cotton cultivated land of these two areas was higher than that of Wundwin and hence they shared their labor and animal power for large production when enough moisture for germination of cotton was received. Poor seed quality was another problem faced by the respondents on all areas. About 14% of farmers in

Kyaukse and Wundwin and only 2% of farmers in Myittha used poor quality seed and hence there was a problem in cotton production.

## 4.5 Farmers' access to livelihood assets in post-monsoon cotton production

An analysis of the capital assets of the household is the heart of the framework, which are divided into natural, social, human, physical and financial. These five capital assets were presented in Table 4.6.

### 4.5.1 Human Capital

Human capital included age of household head, household size, household head education, experience in farming and cotton cultivation, number of farm labor available per season and farming management knowledge. According to the results, Myittha township has the youngest age of household head, the smallest household size, the lowest educational attainment and the experience in farming and cotton cultivation of household head. Education of household head was not significantly difference under three selected townships. Experience in cotton cultivation in Kyaukse was significantly higher than that of Myittha and Wundwin townships.

The average age of household head in Kyaukse was 52 years with minimum of 23 years and maximum of 84 years. The age of household heads in Myittha ranged from 23 to 82 years, with mean of 50, while the average age was 56 years; with minimum and maximum age were 30 and 78 years in Wundwin township. Household size of the study area of Wundwin was generally larger than Kyaukse and Myittha and there was significantly difference. The mean value of the family members was 5.70, 4.92 and 4.82 in Wundwin, Kyaukse and Myittha, respectively.

Education was classified according to the number of schooling years in this case. All respondents in the study area, household heads attained only the primary education (schooling years 1-5). This indicated that there was no significant difference in formal education attainment of household head observed in Kyaukse, Myittha and Wundwin. According to the surveyed results, 76% of farmers in Kyaukse, 68% in Myittha and 66% in Wundwin received well farming management knowledge. Knowledge was evaluated on the basis of seven categories in this study, such as farmers' knowledge on the advantages of crop rotation, disadvantages of consecutive growing of one crop in the same plot, safety application practices of pesticides, harmful effects of pesticides, integrated pest management (IPM) practices, problematic condition of extremely used of chemical fertilizers and integrated nutrient management (INM) practices.

The majority of farmers in Kyaukse area had good experience in years of farming and years of cotton cultivation with the average years of 27 and 21 years. This pointed out those households in this study area planted cotton almost along their farming life. To compare the experience in Kyaukse, although farming experience of respondents in Myittha and Wundwin was 27 years and 32 years, experience in cotton production was 10 and 11 years, respectively. Thus, it can be generally observed that farmers in these study areas less interested in cotton cultivation in comparison of the other crops according to their soil condition and also compared to Kyaukse. However, household heads in Wundwin interested in the other crops production than cotton while Myittha respondents more interested in cotton cultivation.

Cotton unlike the other crops, most of the operations involved is labor intensive, especially weeding and harvesting. According to labor intensive crop, the

number of labor used per season of three townships was 121 man days per growing season and the smallest number of labor was found in Myittha that was significantly difference with Kyaukse and Wundwin townships. The reason for this lowest labor usage was due to the lower number of weeding times compared to the other two townships. The higher number of labor was used in Wundwin although seed cotton yield was lower than in Kyaukse because of their lack of skillfulness in cotton cultivation especially at the picking time according to less experience.

### 4.5.2 Natural Capital

Natural capital is the most important asset for rural households because their livelihoods mainly depend on resource-based activities. Farmers' accepted soil type in the selected areas is loamy clay in Kyaukse, sandy loam and clay soil in Myittha and Wundwin, respectively. The agricultural land holding is one of the major natural capitals of farmers. The average size of farm size per household in the surveyed area of Kyaukse was 3.57 ha that was significantly less than the land size of Myittha (5.38 ha) and Wundwin (4.93 ha). Although the lowest average land holding was observed in Kyaukse, there was the highest mean maximum land holding with the size of about 14.17 ha. The lowest farm size was owned in Kyaukse, however cotton cultivation was performed 59% of the total land holding with the average size of 2.07 ha because the majority of farmers' cropping was depended on cotton.

Although the highest amount of cultivated land was owned by the respondents in Myittha, the mean operational cotton land size by individual farmer was lower than that of Kyaukse. The average amount of cotton cultivated land was 1.55 ha that was only 30% of the total land holding because their appropriate soil condition for cotton

cultivation was comparatively lower than that of Kyaukse. In Wundwin, it was found that only 18% of the total farm size was cultivated under cotton. The reason for this lower cotton farm size was according to their difference of major crop compared with the other two townships. The major crop in this region was rice because of the availability of the irrigation facility, fewer intensive cares compared with cotton and better price of the crop. There was significantly difference in cotton cultivated land among the three townships.

Farmers' access to irrigated land holding was the highest in Myittha with the percentage of about 48% that was significantly higher than that of Kyaukse (4%). In this area, the most of the soil types possessed by the respondents were sandy loam and clay soil. There was nearly 50% of the irrigated area in this area; however the irrigation facility was relativity poor that only depended on rainfall for irrigation. They stored rain water in the pond in the rainy season and then applied the supplementary irrigation for only rice and that amount was not sufficient for all irrigated areas.

In Kyaukse, there was about only 4% of the total farm size under irrigation. Normally the farmers used the irrigated water for oilseeds and pulses in the alluvial soil. The source of irrigated water was from the canal by water pump. Although there was the lower irrigated area (30% of the total land holding) in Wundwin compared to Myittha, the irrigation facility was completed by the left hand canal of Kinda dam. The farmers normally applied the water by irrigating in the pond and then used for supplementary irrigation for rice. Contrast to Myittha, their water source was both from rainfall and canal. Therefore, they can use irrigation system when they necessary for rice crop.

Table 4.6 Comparison of main five capital assets of post-monsoon cotton production under the three selected townships

| Capitals | Kyaukse (N=50) | Myittha (N=50) | Wundwin (N=50) | Average (N=150) |
|---|---|---|---|---|
| **Human capital** | | | | |
| Age of household head (years) | 52.02 | 49.54 | 56.14 | 52.57 |
| Household size (no.) | 4.92 | 4.82 | 5.70 | 5.15 |
| Education (years) | 5.10 | 4.40 | 4.70 | 4.73 |
| Farming experience (years) | 27.06 | 26.32 | 32.32 | 28.57 |
| Experience in cotton cultivation (years) | 20.52 | 10.28 | 10.58 | 13.79 |
| Farming knowledge (%) | 76 | 68 | 66 | 70 |
| Total labor (man days) | 127.85 | 103.94 | 130.55 | 120.78 |
| **Natural capital** | | | | |
| Total land holding (ha) | 3.57 | 5.38 | 4.93 | 4.62 |
| Fertile land (ha) | 3.57 | 4.20 | 4.14 | 3.97 |
| Cotton cultivated land (ha) | 2.07 | 1.55 | 0.83 | 1.48 |
| Irrigated land (ha) | 0.15 | 2.57 | 1.47 | 1.40 |
| **Physical capital** | | | | |
| Transportation system (%) | 60 | 36 | 60 | 52 |
| Information access (%) | 70 | 60 | 66 | 65 |
| Seed rate (kg) | 20.29 | 18.26 | 15.41 | 17.99 |
| Chemical fertilizer (kg) | 7.82 | 22.09 | 91.62 | 40.51 |
| Farm yard manure (kg) | 846 | 2192 | 1367 | 1468 |
| Pesticide cost (kyats) | 38,329 | 35,943 | 42,321 | 38,864 |

Table 4.6 Comparison of main five capital assets of post-monsoon cotton production under the three selected townships (Continued)

| Capitals | Kyaukse (N=50) | Myittha (N=50) | Wundwin (N=50) | Average (N=150) |
|---|---|---|---|---|
| **Physical capital** | | | | |
| Land preparation cost (kyats) | 88,316 | 80,275 | 91,958 | 86,850 |
| Draught power (no.) | 24.58 | 32.11 | 30.65 | 29.11 |
| Farm equipment value (kyats) | 419,100 | 518,020 | 644,360 | 527,160 |
| Cattle amount (no.) | 4.54 | 4.64 | 5.60 | 4.93 |
| **Social capital** | | | | |
| Labor network (%) | 34 | 42 | 52 | 43 |
| Extension contacts (no) | 2.98 | 2.66 | 3.24 | 2.96 |
| **Financial capital** | | | | |
| Total income (kyats) | 1,931,960 | 1,770,645 | 3,052,851 | 2,254,485 |
| Saving amount (kyats) | 308,000 | 391,300 | 719,000 | 472,767 |
| Credit amount (kyats) | 78,880 | 137,000 | 218,640 | 144,840 |

Source: Survey, 2010

Note: 1 US$ = 1000 kyats

### 4.5.3 Physical Capital

Level of physical capitals endowments are the fundamental indicator of households' income and their livelihoods. Sixty percent of the household respondents in Kyaukse and Wundwin accepted good transportation system and 36 % in Myittha. Transportation system in this case was determined according to the possession of owned vehicle, particularly motorbike because they can go everywhere easily if they

have owned vehicle. In a general manner, road and transport services were appropriate in Kyaukse and Wundwin, whilst extremely weak in Myittha.

The households in the study areas used average cotton seed rate of about 20.29 kg $ha^{-1}$ in Kyaukse followed by 18.26 in Myittha and 15.41 in Wundwin and that was significantly difference among three townships. In study area of Kyaukse, large amount of seed rate was used by the respondents to avoid the risk of poor germination under the uncertainty of rain shower according to their experience.

The proportion of farmers that apply chemical and organic fertilizers to cotton fields varied among the three areas and there was significantly difference among townships. In the study area of Kyaukse, there was relatively small percent of interviewed farmers applied chemical fertilizer and organic manure (8% and 22% of respondents) to cotton plots with the average quantity of 7.82 kg $ha^{-1}$ and 845.98 kg $ha^{-1}$, respectively. This was because of their possession of relatively good soil type of loamy clay that was suitable for cotton cultivation. In the study area of Wundwin, cotton was not the major crop for income and therefore farmers used their manure for other important crops like rice and chili and they applied large amount of chemical fertilizer for cotton. This was because of their intensive cropping system and hence soil condition was necessary to put chemical fertilizer for crop requirement and according to their significantly high income, they can spend chemical fertilizer for production.However, the study area of Myittha, farmers used the highest amount of farm yard manure because they mainly depended on cotton cultivation for income and they cannot spend their capital for chemical fertilizer according to their relatively low income.

Cotton as a crop is susceptible to attack by various insects and diseases throughout the life cycle and the efficient control of these is inevitable if reasonable yield is expected. Therefore, all cotton farmer respondents in these study areas applied chemical pesticides for increased yield and there was only significantly difference of pesticide cost at 10% level among townships. The highest cost of pesticide was expensed by the study area of Wundwin with the average value of 42,321 kyats $ha^{-1}$ (US$ 42) and the lowest cost was 35,943 kyats $ha^{-1}$ (US$ 36) in the study area of Myittha. Frequency of pesticide spraying varied from 2 to 12 times per season in Kyaukse, 2 to 7 times in Myittha and 2 to 10 times in Wundwin, respectively.

According to the survey results, land preparation cost (including intercultivation cost) was significantly difference among townships. Also, there was significantly difference of draught power used among townships according to their use of draught power availability and crop requirement. The average number of draught power used by Kyaukse was 24.58 animal days $ha^{-1}$ and there was significantly lower than the other two townships because most of the farmers used machinery power at basal land preparation. There was about 32.11 animal days $ha^{-1}$ in Myittha and 30.65 animal days $ha^{-1}$ in Wundwin.

Majority of the farmers in all study areas possessed essential farm tools such as plow, harrow, hoe, and bullock cart and also knapsack sprayer. In Kyaukse, 28% of farmers possessed water pump, 22% of respondents in Myittha and 48% in Wundwin. The value of total farm equipments was the highest in Wundwin followed by Myittha and Kyaukse with the average amount under the three townships was 527,160 kyats $household^{-1}$ (US$ 527). The average amount of cattle owned by the individual household in Kyaukse was 4.54, 4.64 in Myittha and 5.60 in Wundwin and there was

not significantly difference among the three townships. Cattle were mainly used for crop production as animal power.

### 4.5.4 Social Capital

The social capital of any community is very important as mutual trusts and connectedness supports to cope with shocks in any vulnerability especially for the poor farmers such as provide subsidies, give the technologies of production practices by extension services and shared labor at the time of sowing, weeding and harvesting seasons. In Wundwin, the highest access to a labor network from their neighbors, relatives and villagers in their farm work (52%) was observed and followed by Myittha (42%) and Kyaukse (34%) and there was significantly difference among the three townships.

Extension contact was evaluated with the frequency of visits per cotton growing season by supporting technical knowledge of production. The average maximum visits (3.24) were observed in Wundwin and the other two townships received 2.98 and 2.66 times per season. This was because farmers in the study area of Wundwin relatively less interested in cotton compared to other crops and other townships and hence the extension officers more emphasized on this area for area expansion and increased cotton productivity.

### 4.5.5 Financial Capital

With regard to financial asset, farmers' yearly total income, saving amount and amount of credit received were considered in post-monsoon cotton production system. The farmers' total income was mainly come from agriculture and they also

used off-farm and non-farm activities for capital. The average yearly income per household was 3,052,851 kyats (US$ 3052) in Wundwin that was significantly higher than that of Kyaukse and Myittha with the average income of 1,931,960 kyats (US$ 1932) and 1,770,645 kyats $year^{-1}$ (US$ 1771), respectively. The highest amount of total income was obtained in Wundwin because their cropping system was mainly based on rice and chili and these crops gave the higher revenue than the other crops.

The average amount of money saved by farmers in Wundwin was also nearly doubled and significantly higher compared to that of Myittha and Kyaukse because of their higher income and the higher they get the total income, the more they can save the money. The access to credit includes any type of access whether from formal or informal methods. Also, accessibility of credit amount was the highest in Wundwin followed by Myittha and Kyaukse with the average amount of 218,640 (US$ 219), 137,000 (US$ 137) and 78,880 kyats $year^{-1}$ (US$ 79), respectively. The reason for this highest amount of credit received was performing of more contract farming system by the Cotton and Sericulture Department according to less interested in cotton cultivation of Wundwin compared to other townships and hence CSD supported capital for inputs in order to increase planted area and more productivity.

### 4.6 Effects of livelihood assets on cotton yield

In this study, some important factors under the five assets were taken into account as the independent variables to determine their effect on cotton productivity. To determine the effect of the important variables on cotton yield, correlation matrix analysis was firstly used and multiple regression analysis was applied as the second step analysis.

### 4.6.1 Correlation matrix analysis

Correlation matrix analysis was used to investigate the multicollinearity of all independent variables. The independent variables used in the correlation matrix analysis in all the study areas were household size, household head's education, experience in cotton cultivation, total labor used, farm size, cotton cultivated area, seed rate, amount of chemical fertilizer, amount of FYM, pesticide cost, land preparation cost, farm equipment value, labor network, frequency of extension officers' field visit, total income and credit amount.

In Kyaukse, according to the results of correlation analysis of independent variables, total labor used in the whole season for cotton was highly correlated with cost of pesticide spent by the respondents in cotton and frequency of extension officers' field visit per season with the correlation coefficient values of 0.61 and 0.72, respectively. Total farm size was highly correlated with cotton cultivated land and total income with the correlation coefficient values of 0.88 and 0.82, respectively. Also, cotton cultivated land was highly correlated with total income with the correlation coefficient value of 0.73. The results of the correlation matrix for listed independent variables are presented in Table 4.7.

In Myittha, the results of correlation analysis indicated that total farm size was highly correlated with cotton cultivated land, farm equipment value and total income with the correlation coefficient values of 0.70, 0.66 and 0.52, respectively. Total labor used was also highly correlated with cost of pesticide (0.53) and frequency of extension contact per season (0.59). Cotton cultivated land was highly correlated with the total income by the correlation coefficient value of 0.61. Farm equipment value and total income was highly correlated with the correlation coefficient value of 0.52.

Table 4.7 Correlation matrix for listed variables of Kyaukse township

| Variables | V1 | V2 | V3 | V4 | V5 | V6 | V7 | V8 | V9 | V10 | V11 | V12 | V13 | V14 | V15 | V16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V1 | 1.00 | | | | | | | | | | | | | | | |
| V2 | - 0.07 | 1.00 | | | | | | | | | | | | | | |
| V3 | 0.02 | - 0.43 | 1.00 | | | | | | | | | | | | | |
| V4 | 0.14 | 0.00 | - 0.00 | 1.00 | | | | | | | | | | | | |
| V5 | 0.17 | 0.16 | 0.40 | - 0.22 | 1.00 | | | | | | | | | | | |
| V6 | 0.16 | - 0.04 | 0.44 | - 0.23 | **0.88** | 1.00 | | | | | | | | | | |
| V7 | - 0.13 | - 0.07 | 0.11 | - 0.00 | - 0.17 | - 0.20 | 1.00 | | | | | | | | | |
| V8 | 0.25 | 0.02 | 0.08 | 0.41 | 0.17 | 0.14 | - 0.30 | 1.00 | | | | | | | | |
| V9 | 0.02 | 0.14 | - 0.13 | 0.13 | - 0.16 | - 0.09 | 0.28 | - 0.13 | 1.00 | | | | | | | |
| V10 | 0.22 | 0.12 | - 0.12 | **0.61** | 0.04 | 0.00 | - 0.17 | 0.48 | 0.06 | 1.00 | | | | | | |
| V11 | 0.11 | 0.12 | - 0.08 | 0.05 | 0.04 | - 0.07 | - 0.03 | 0.09 | - 0.04 | 0.36 | 1.00 | | | | | |
| V12 | 0.17 | 0.05 | 0.16 | 0.01 | 0.38 | 0.37 | - 0.40 | 0.33 | 0.07 | 0.01 | 0.14 | 1.00 | | | | |
| V13 | 0.49 | - 0.17 | 0.10 | - 0.02 | - 0.20 | - 0.21 | - 0.11 | 0.11 | - 0.04 | - 0.15 | 0.09 | 0.06 | 1.00 | | | |
| V14 | 0.07 | - 0.18 | 0.27 | **0.72** | - 0.09 | - 0.10 | 0.16 | 0.30 | 0.08 | 0.42 | 0.08 | 0.21 | 0.08 | 1.00 | | |
| V15 | 0.26 | 0.18 | 0.30 | 0.04 | **0.82** | **0.73** | - 0.16 | 0.31 | - 0.07 | 0.21 | 0.06 | 0.35 | - 0.15 | 0.14 | 1.00 | |
| V16 | 0.13 | - 0.17 | 0.05 | - 0.11 | - 0.10 | - 0.06 | 0.03 | 0.10 | - 0.18 | 0.00 | - 0.04 | 0.06 | 0.26 | 0.03 | - 0.11 | 1.00 |

Note: V1 = Household size, V2 = Education, V3 = Experience in cotton cultivation, V4 = Total labor, V5 = Farm size, V6 = Cotton land, V7 = Seed, V8 = Chemical fertilizer, V9 = FYM, V10 = Pesticide cost, V11 = Land preparation cost, V12 = Equipment value, V13 = Labor network, V14 = Extension contacts, V15 = Income, V16 = Credit

Table 4.8 Correlation matrix for listed variables of Myittha township

| Variables | V1 | V2 | V3 | V4 | V5 | V6 | V7 | V8 | V9 | V10 | V11 | V12 | V13 | V14 | V15 | V16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V1 | 1.00 | | | | | | | | | | | | | | | |
| V2 | 0.07 | 1.00 | | | | | | | | | | | | | | |
| V3 | 0.25 | - 0.02 | 1.00 | | | | | | | | | | | | | |
| V4 | 0.31 | - 0.05 | 0.14 | 1.00 | | | | | | | | | | | | |
| V5 | 0.27 | 0.02 | 0.06 | 0.09 | 1.00 | | | | | | | | | | | |
| V6 | 0.29 | 0.06 | - 0.04 | 0.02 | **0.70** | 1.00 | | | | | | | | | | |
| V7 | - 0.10 | 0.19 | 0.05 | 0.07 | - 0.25 | - 0.34 | 1.00 | | | | | | | | | |
| V8 | - 0.09 | - 0.04 | - 0.01 | 0.31 | 0.01 | 0.06 | - 0.21 | 1.00 | | | | | | | | |
| V9 | - 0.27 | - 0.02 | 0.05 | 0.09 | - 0.05 | - 0.10 | 0.18 | 0.25 | 1.00 | | | | | | | |
| V10 | 0.23 | - 0.02 | 0.05 | **0.53** | - 0.04 | 0.06 | 0.03 | 0.44 | 0.18 | 1.00 | | | | | | |
| V11 | - 0.13 | 0.29 | - 0.13 | 0.32 | - 0.21 | - 0.23 | 0.03 | 0.26 | 0.15 | 0.30 | 1.00 | | | | | |
| V12 | 0.35 | - 0.14 | 0.15 | 0.05 | **0.66** | 0.46 | - 0.18 | - 0.10 | - 0.10 | - 0.03 | - 0.39 | 1.00 | | | | |
| V13 | 0.47 | 0.07 | 0.14 | 0.41 | 0.23 | 0.03 | - 0.03 | - 0.05 | - 0.05 | 0.15 | 0.11 | 0.09 | 1.00 | | | |
| V14 | 0.23 | - 0.14 | 0.31 | **0.59** | 0.38 | 0.26 | 0.06 | 0.26 | 0.19 | 0.35 | 0.05 | 0.29 | 0.16 | 1.00 | | |
| V15 | 0.40 | 0.15 | 0.14 | 0.38 | **0.52** | **0.61** | 0.07 | 0.00 | - 0.11 | 0.22 | - 0.09 | **0.52** | 0.04 | 0.44 | 1.00 | |
| V16 | 0.08 | - 0.08 | 0.11 | 0.25 | 0.17 | 0.02 | 0.22 | 0.08 | 0.04 | 0.24 | - 0.04 | 0.16 | 0.15 | 0.04 | 0.15 | 1.00 |

Note: V1 = Household size, V2 = Education, V3 = Experience in cotton cultivation, V4 = Total labor, V5 = Farm size, V6 = Cotton land, V7 = Seed, V8 = Chemical fertilizer, V9 = FYM, V10 = Pesticide cost, V11 = Land preparation cost, V12 = Equipment value, V13 = Labor network, V14 = Extension contacts, V15 = Income, V16 = Credit

Table 4.9 Correlation matrix for listed variables of Wundwin township

| Variables | V1 | V2 | V3 | V4 | V5 | V6 | V7 | V8 | V9 | V10 | V11 | V12 | V13 | V14 | V15 | V16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V1 | 1.00 | | | | | | | | | | | | | | | |
| V2 | - 0.30 | 1.00 | | | | | | | | | | | | | | |
| V3 | 0.03 | - 0.16 | 1.00 | | | | | | | | | | | | | |
| V4 | 0.16 | 0.05 | 0.20 | 1.00 | | | | | | | | | | | | |
| V5 | - 0.03 | - 0.26 | 0.21 | - 0.16 | 1.00 | | | | | | | | | | | |
| V6 | - 0.07 | - 0.17 | 0.18 | - 0.03 | **0.57** | 1.00 | | | | | | | | | | |
| V7 | - 0.03 | 0.02 | 0.19 | 0.29 | 0.06 | 0.16 | 1.00 | | | | | | | | | |
| V8 | 0.01 | - 0.15 | 0.16 | 0.28 | - 0.05 | - 0.02 | 0.26 | 1.00 | | | | | | | | |
| V9 | - 0.04 | 0.16 | - 0.42 | 0.01 | - 0.29 | - 0.12 | - 0.27 | 0.14 | 1.00 | | | | | | | |
| V10 | 0.04 | 0.10 | - 0.07 | **0.52** | - 0.11 | 0.17 | 0.09 | 0.09 | 0.31 | 1.00 | | | | | | |
| V11 | - 0.04 | 0.28 | - 0.27 | 0.06 | - 0.39 | - 0.25 | - 0.09 | - 0.01 | 0.44 | 0.26 | 1.00 | | | | | |
| V12 | - 0.13 | - 0.07 | 0.07 | 0.20 | **0.51** | **0.51** | 0.15 | 0.02 | - 0.22 | 0.24 | - 0.26 | 1.00 | | | | |
| V13 | **0.52** | - 0.18 | 0.03 | 0.02 | 0.02 | - 0.11 | - 0.04 | 0.00 | - 0.13 | - 0.13 | - 0.10 | - 0.02 | 1.00 | | | |
| V14 | 0.03 | 0.14 | 0.17 | **0.55** | - 0.01 | 0.20 | 0.27 | 0.19 | - 0.06 | 0.44 | 0.18 | 0.32 | 0.14 | 1.00 | | |
| V15 | 0.12 | - 0.04 | 0.07 | 0.30 | **0.56** | 0.44 | 0.01 | 0.07 | - 0.14 | 0.29 | - 0.27 | **0.79** | 0.08 | 0.29 | 1.00 | |
| V16 | 0.17 | - 0.23 | 0.13 | - 0.17 | 0.15 | 0.13 | - 0.11 | - 0.25 | - 0.23 | - 0.01 | - 0.00 | 0.02 | 0.26 | - 0.03 | - 0.02 | 1.00 |

Note: V1 = Household size, V2 = Education, V3 = Experience in cotton cultivation, V4 = Total labor, V5 = Farm size, V6 = Cotton land, V7 = Seed, V8 = Chemical fertilizer, V9 = FYM, V10 = Pesticide cost, V11 = Land preparation cost, V12 = Equipment value, V13 = Labor network, V14 = Extension contacts, V15 = Income, V16 = Credit

The results of the correlation matrix for listed independent variables are presented in Table 4.8.

In Wundwin, household size and labor network (0.52), total labor used and cost of pesticide (0.52) and total labor used and frequency of extension officers' field visit per season (0.55) were highly correlated. Farm size was highly correlated with cotton cultivated land, farm equipment value and total income with the correlation coefficient values of 0.57, 0.51 and 0.56, respectively. Cotton cultivated area was also highly correlated with farm equipment value (0.51). The results of the correlation matrix for listed independent variables are presented in Table 4.9.

### 4.6.2 Multiple regression analysis

Based on the results of the correlation matrix analysis, farm size, total labor used and total income were excluded in the regression model in all areas and labor network was omitted in Wundwin. Farm size was omitted in the model because the effect of cotton cultivated land on cotton yield was more important than that of total land. There was no effect on cotton yield when additional inputs were put in the other crops area. Total labor was also excluded in the model because extension officers' dissemination of improved technologies was more important in cotton according to the difficulties of production by various insect attacks. The relationship between household size and cotton yield was more important in cotton production because if the larger the size the more they have the network for labor in their field work. The results of multiple regression to analyze the effect of the vital independent variables on cotton yield of sample farmers are presented in Table 4.10.

Table 4.10 Multiple regression analysis of livelihood assets on cotton yield of farmers in the selected townships

| Variables | Kyaukse | | Myittha | | Wundwin | |
|---|---|---|---|---|---|---|
| | Coefficient | t–ratio | Coefficient | t–ratio | Coefficient | t–ratio |
| Constant | 430.75 | 1.46 | -191.99 | -0.61 | 166.11 | 0.48 |
| Household size | -13.60 | -0.55 | 16.80 | 0.69 | 18.40 | 0.88 |
| Education | -19.52 | -1.03 | 13.64 | 0.34 | -28.45 | -1.18 |
| Experience in cotton | 5.48 | 1.12 | 4.03 | 0.64 | 2.41 | 0.34 |
| Cotton land | -64.03 | -1.97* | 19.92 | 0.40 | -45.53 | -0.33 |
| Seed rate | -6.17 | -1.02 | 1.97 | 0.35 | 2.80 | 0.35 |
| Chemical fertilizer amount | 0.65 | 0.38 | 1.22 | 1.07 | -0.24 | -0.38 |
| FYM | -0.003 | -0.13 | -0.01 | -0.46 | 0.02 | 0.75 |
| Pesticide cost | 12.45 | 3.94*** | 5.80 | 1.62 | 13.18 | 3.85*** |
| Land preparation cost | -0.80 | -0.29 | 2.64 | 0.84 | -3.16 | -1.25 |
| Equipment value | -0.20 | -1.14 | 0.07 | 0.32 | -0.08 | -0.46 |
| Labor network | 83.64 | 0.78 | -3.10 | -0.04 | - | - |
| Extension visit | 173.13 | 4.67*** | 75.35 | 2.20** | 185.94 | 5.02*** |
| Credit access | -0.52 | -1.59 | 0.34 | 1.19 | -0.44 | -1.93* |
| $R^2$ | 0.80 | | 0.51 | | 0.71 | |
| F value | 10.84*** | | 2.87*** | | 7.66*** | |
| Durbin-Watson | 1.67 | | 1.84 | | 2.33 | |

Source: Survey, 2010

Note: *, **, *** indicate the level of significance at 10%, 5% and 1% respectively.

The adjusted coefficient of multiple determination ($R^2$) is an $R^2$ statistic adjusted for the number of parameters in the equation and the number of data observations. Detailed analysis of multiple regression indicated that the coefficient of determination ($R^2$) value of 0.80 in Kyaukse, 0.51 in Myittha and 0.71 in Wundwin can be regarded as quite a good fit in view of the cross-sectional data included in this study and it indicated that about 80%, 51% and 71% of the total variation in cotton yield in each area was together explained by the independent variables and the remaining 20%, 49% and 29% may be due to error and other factors omitted in the model such as climatic factors. The F value and probability (F) statistics test the overall significance of the regression model. According to the F test, the independent variables in the estimated regression equation were highly significant with the dependent variable (cotton yield) at 1% probability level in all areas. Durbin-Watson statistic is used to detect the significant autocorrelation among the independent variables. Regarding the results of Durbin-Watson statistic, the autocorrelation is not statistically significant in all areas since they are all inconclusive.

In cotton production, frequency of extension officers' field visit is one of the most important factors that effects on cotton yield. This variable is highly significant on cotton yield at 1% significance level in Kyaukse and Wundwin and 5% level of significance in Myittha. Cotton is considered to be quite a difficult crop to grow and hence dissemination of improved technologies by the extension staff from both public and private sectors is necessary. Pest problem is the vital yield reduction factor in cotton production in all cotton growing areas. Cotton is attacked by a wide range of pests especially by the infestation of bollworms and sucking pests along the growing season. Protection of pest infestation by effective way is essential and therefore right

time application, correct insecticide and correct dosage of pesticide is important. In the regression result of Kyaukse and Wundwin, cost of pesticide spending in production is highly significant on cotton yield at 1% significance level. Area of cotton cultivated land is also important in production because cotton is needed to emphasize along the growing season more than the other crops. If cotton planted area is too large, farmers cannot emphasize simultaneously for all areas. Therefore, size of cotton planted land is negatively significant on cotton yield in Kyaukse because of the largest cotton cultivated size of this area. Credit accessibility is also crucial factor in production for necessary inputs. However, systematic allocation of this credit amount according to inputs requirement for crop is necessary to increase crop yield.

Regarding Kyaukse area, there were consists of thirteen explanatory variables and it was observed that the statistically insignificant variables but positively related on cotton yield were experience in cotton cultivation, quantity of chemical fertilizer and labor network and negatively related variables were household size, education of household head, seed rate, FYM amount, land preparation cost, farm tools value and credit access. The statistically significant variables on seed cotton yield were cotton planted area, pesticide cost and frequency of extension contact.

In Mtittha township, it was found that although only one independent variable, time of extension officers' field visit was significantly effect on seed cotton yield, the rest of the explanatory variables except amount of FYM added to the cotton field and labor network were positively correlated on cotton yield.

Pesticide cost and time of field visit were statistically significant on cotton yield with positive correlation and credit access was negatively significant among twelve explanatory variables in Wundwin. It was found that household size,

experience in cotton cultivation, seed rate and amount of FYM were positively related with seed cotton yield.

With regard to the explanations of significant variables on cotton yield, size of cotton cultivated land was significant with the negative algebraic sign of the estimated coefficient (-64.03) in Kyaukse. It indicates that if cotton land increase by 1 ha, cotton yield will decrease by 64.03 kg $ha^{-1}$. The possible reason of this negative relationship is that if the cotton land is too large for the farmers, they cannot emphasize with the whole area for production. Also, they cannot invest the sufficient inputs for the crop requirements such as labor, animal power, fertilizers, pesticides, etc. This result is in consonance with that of Adesoji and Farinde (2006) in Osun State, Nigeria.

The coefficients of the cost of pesticide (12.45) and (13.18) were positively related with the yield of cotton and significant at 1% level in Kyaukse and Wundwin. This result showed that an increase in the cost of pesticide by 1000 kyats would lead to increase the yield of cotton by 12.45 kg $ha^{-1}$ in Kyaukse and 13.18 kg $ha^{-1}$ in Wundwin respectively. The majority of the constraint of cotton production is due to the incidence of pests and disease in all cotton growing areas of the world and the spraying and seed treatment of pesticide is the important plant protection methods among cotton farmers. This result is agreement with that of Bakhsh *et al.* (2005) in Sargodha, Pakistan and they mentioned that additional cost of plant protection measures increased cotton yield significantly.

The variable of extension contact was positively significant in all selected areas. This implies that the frequency of extension agents' visits could increase by 1 time, the yield of seed cotton would increase by about 173.13 kg $ha^{-1}$ in Kyaukse, 75.35 kg $ha^{-1}$ in Myittha and 185.94 kg $ha^{-1}$ in Wundwin, respectively. This indicates

that the extension officers' dissemination of improved technologies is the vital role to play in the adoption of these technologies among farmers in cotton production. The more the households' head has contact with the extension workers, the more they get these technologies, they follow the officers' instruction and they obtain the acceptable yield. Adesoji and Farinde (2006) approved that the importance of training and demonstrations by extension agents in arable crop production.

In this study, access to agricultural credit is significant with a negative coefficient (-0.44) in Wundwin. It shows that if the amount of credit could be increased by 1000 kyats (US$ 1), cotton yield would decrease by 0.44 kg $ha^{-1}$ in Wundwin. The reason for this negative relationship was due to the lack of systematic allocation of financial according to crop requirement. Credit was not fully invested in cotton production and sometimes they used their credit to solve food insecurity instead of using for crop production. If they expensed on these inputs effectively according to crop requirements, they would get the higher amount of cotton yield.

Out of these statistically significant independent variables on seed cotton yield, relationships between some important variables and yield but not statistically significant variables were explained. The negative regression coefficient of household size in Kyaukse indicated that although there was large number of family member in the household, there had the smaller number of efficient agricultural working member due to the high dependency ratio of elder family members and younger children. In the case of the negative sign of educational attainment in Kyaukse and Wundwin, generally, the higher the household heads education level, the more they get the higher yield because of the higher knowledge. However, in this case, the majority of the household heads education was only in the primary level. According to this lack

of formal education, the farmers cannot understand well the modernized agricultural technologies and also they cannot easily relinquish their traditional technologies.

In Kyaukse, the reason of the negative relationship of the seed rate and cotton yield was due to the lack of germination test of cotton seed before sowing. According to this, farmers used large amount of seed rate in production to avoid the risk of poor germination.

Amount of farm yard manure used also showed negative sign of coefficient value in Kyaukse and Myittha. This means that the yield of seed cotton would decrease although farmers applied farm yard manure in cotton field because of the farmers' used manure amount was relatively lower than the recommended rate and also faced with soil problem. That soil problem was due to the consecutive growing of cotton in the same area for many years. Therefore, these soils couldn't easily recover by using small amount of farm yard manure and needed other trace elements for sustainability of soil.

The negative coefficient of the cost of land preparation and intercultivation in Kyaukse and Wundwin was that the majority of the farmers used hired tractor power in Kyaukse and animal power for basal land preparation in both Kyaukse and Wundwin. They cannot manage effectively these hired machine and animal power for all cultivated area. Therefore, although they spent higher cost of land preparation, they didn't receive acceptable cotton yield as they expected.

Cotton yield was increased by the application of chemical fertilizer in Kyaukse and Myittha. However, this increased yield was not statistically significant because of the relatively lower than the recommended rate. Regarding the result of Wundwin township, there was observed that negative relation with inorganic fertilizer

and cotton yield. Although substantially higher amount of chemical fertilizer was applied to cotton field, relationship between those was negative because of the lack of emphasize on the balance dose of fertilizers (N:P:K). If farmers used the recommended rate and the balance dose of fertilizers, they would receive significant amount of yield in all areas.

Another variable that impact positively on cotton yield was capacity to work together in the field in Kyaukse. If household labors work together in their fields, they will easily manage labor requirement in time and they applied their working hours effectively by allocation of labors one field to another. Therefore, they can get positive return.

Regarding the results across three townships, there were observed different relationships between the explanatory variables and seed cotton yield according to their livelihood assets' deviation and different usage of management practices. Frequency of extension staff' field visit was highly significant on cotton yield in all the study areas. Cost of pesticide was highly significant on cotton yield with a positive coefficient and credit access was also significant on cotton yield with a negative coefficient in Wundwin. Size of cotton cultivated land was negatively significant on cotton yield in Kyaukse.