

Study on Production Characters of Cultivated Cotton Varieties in Selected Cotton Growing Areas of Myanmar

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Abstract

A base line survey was conducted to observe farmers' cultivated varieties in the cotton growing areas and to investigate the farmers' preferred characters which are demanded for future use in cotton breeding program. A total of 100 respondent farmers from 5 townships were interviewed using a structured questionnaires. Focus group discussion was also done among farmers in each township. The respondent farmers were asked to evaluate the cultivated cotton varieties using preference scale. According to the survey data, the five varieties, Ngwechi-6, Shwe Daung-8, Ngwechi-9, RAKA-F₁ and RAKA-F₂ were farmers' cultivated varieties in the survey sites. On the basis of benefit cost ratio (BCR), Ngwechi-6 was found to have more commercial benefit than the other cultivated cotton varieties. In the comparison of the varieties on the basis of farmers' preferred ten characters, farmers' preference were significantly different in all characters across varieties except growth in drought condition and boll size. The highest preference score in the yield character was found in RAKA-F₁ and the lowest score in Ngwechi-9. There was clear evidence of a preference in RAKA-F₁ hybrid cotton for all characters. No significant difference and the least preference were found between two varieties, Shwe Daung-8 and RAKA-F₂. The farmers had different preferred characters for different cultivated cotton varieties and the most important varietal characters were high yield, pest resistance and adaptability. Hence, the breeding efforts should be done to supply a range of new cotton varieties that can fulfill the farmers' requirement.

Keywords: cotton, preference score, characters, BCR.

Introduction

Cotton is one of the most important fiber crop with significant role for textile industry and also commercial crop in Myanmar. It can be used to produce various products rather than fiber. Its role has not diminished but widened and diversified with time due to the technological advances. The cotton became economically important industrial crop with the introduction of upland cotton (*G. hirsutum* L.) in early 1960 (MCSE 2006). However, cotton is subjected to attack by a wide range of pests which damage throughout the plant growth stages and it leads to heavy yield losses. Yield losses from bollworm are rather significant ranging from 30-70 percent. Therefore, the bollworm tolerant variety Ngwechi-6 with adaptable to wide range of seasons, early mature, good yield and fiber quality were released by Myanma Cotton and Sericulture Enterprise (MCSE) under the Ministry of Agriculture and Irrigation in

2006-2007. Due to the release of Ngwechi-6 variety, not only total sown acres but also yield per unit area increased.

In 2010-2011, almost all of long staple cotton growing areas were occupied by Ngwechi-6 (DICD 2015). The improved cotton varieties like Shwe Daung-8 which was developed by hybridization followed by selection and Ngwechi-9 which was selected from germplasm collection and evaluation program were also released in 2014-2015. Cotton breeders are trying to do research for varietal development with pest and disease tolerant, good yield and fiber quality and suitable for adverse agro climatic conditions in different localities. The total cotton cultivation area of Myanmar was 291,000 ha with average yield of 1.79 MT/ha and the total production was about 521,000 MT in 2015-2016 (MOALI 2016). Depending on water availability, cropping system, pest and disease incidences, and marketability, cotton farmers select the cotton varie-

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ties from different seed sources for their income. The department rapidly and cost-effectively supplies the seed of farmer-preferred varieties such as Ngwechi-6, Shwe Daung-8 and Ngwechi-9. The older varieties lose yield potential after continuously growing several years, therefore it is needed to provide new varieties which have farmers' preferred characters from time to time. New improved varieties are often developed by Research Farms under the Cotton and Allied Fiber Crop Division with regional involvement at the final stages of testing.

Therefore, a base line survey study was conducted with the following objectives:

- to observe farmers' cultivated varieties in the cotton growing areas
- to investigate the farmers' preferred varietal characters which are essential for future use in cotton breeding program

Materials and Methods

The study was conducted at five townships in five cotton growing regions of Myanmar. Pilot survey was done on December 2015 and main survey was carried out from December 2015 to February 2016 after harvesting of post monsoon cotton at Tatkon Township in Nay Pyi Taw, Yamethin Township in Mandalay Region, Aunglan Township in Magway Region, Pyay Township in Bago Region, and Myinmu Township in Sagaing Region. Two villages were selected in each township and 10 farmers from each village were selected using purposive random sampling method with the assistance of the respective local extension officers. A total of 100 household heads were interviewed in the survey sites. The survey included collection of demographic data, cultural practices, currently grown cotton varieties, area under cotton, farmers' preference for variety characteristics, cotton seed sources, cost and benefit of cotton per hectare. The relevant data for 2015-2016 post-monsoon cropping season were collected by using a structured questionnaire. Focus group discussion was also done to observe farmers' preference characters. Ten members were included in each group and two groups were discussed in each Township. Respondent farmers' evaluation of the cotton varieties by using preferences scale was also included. Simple descriptive statistics and data analysis were generated using SPSS version 23 and Statistix 8.0. Cost and benefit ratio (BCR) of cotton production was calculated using the following equation:

$$\text{Benefit cost ratio of cotton production (BCR)} = \text{Total Revenue} / \text{Total Cost}$$

Results and Discussion

Demographic data of cotton farm households in the survey sites

The individual interview found that 91 % of a total of 100 farmers from 10 villages were male (Figure 1a). Among the respondent farmers, the majority of farmers (73%) were between 41 to 60 years old (Figure 1b). The farming experience of less than 20 years was found in 21% of the respondent farmers, whereas 21 to 30 years and 31 to 40 years of farming were experienced by 31% and 40% of farmers respectively (Figure 1c). Their educations varied from primary education to graduate level. Among them, most of farmers (62 %) finished primary school and a few farmers (4%) were graduates (Figure 1d). In addition, the land holding size ranged from less than 5 hectares to more than 20 hectares. The large numbers of respondent farmers (73%) possessed less than 5 hectares, whereas small number (2%) owned more than 20 hectares (Figure 1e). The land size under cotton crop ranged from less than 1 hectare to more than 4 hectares and majority of farmers (86%) cultivated cotton less than 1 hectare to 2 hectares. Only 2% of the respondents could grow cotton on more than 4 hectares of their land (Figure 1f). The average land holding size owned by individual farmer was 5.13 hectares and the average area under cotton crop was 1.3 hectares in the survey sites. The farmers in Tatkon Township cultivated cotton in the largest area proportion (53%) of their land holding while the smallest area proportion (13%) was cultivated in Myinmu Township. The average proportion of cotton cultivated area was 25% of their land holding in post-monsoon season of 2015-2016 (Table 1).

Cotton varieties grown in the survey sites (post-monsoon season, 2015-2016)

It was found that 48 % of the respondent farmers used cotton seed from Government Farm whereas some farmers (28%) used seed from company. The other seed sources were neighbor (15%), seed dealers (8%) and own seed (1%) (Table 2). Farmers sold their seed cotton to the dealers within their locations and the dealers collected any varieties of cotton for sale to the private ginning factories. The cotton seed from the ginning factories would not be purified because of mixing the cotton varieties. Therefore, most of the farmers used pure quality seed from Government Farm. Among the varieties, RAKA-F₂ was a variety which was grown by 30% of farmers followed by RAKA-F₁ (24%), Ngwechi-

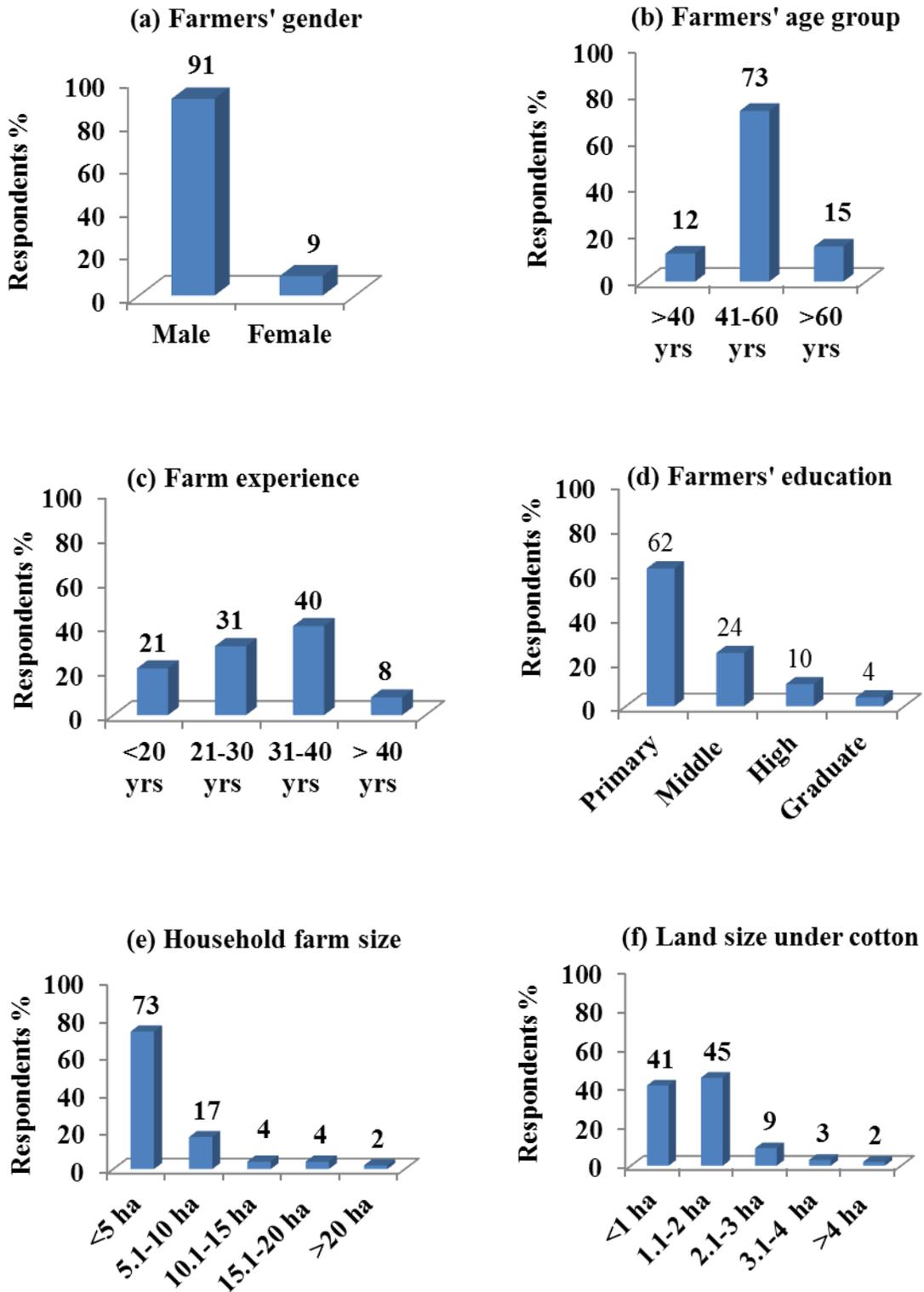


Figure 1. Frequency distribution of farmers' household characteristics in the survey sites

Table 1. Average land holding size and cotton cultivation area in the survey sites

| Survey sites | Land holding size (ha) | Land under cotton (ha) | Cotton cultivation (%) |
|--------------|------------------------|------------------------|------------------------|
| Myinmu | 144.57 | 19.27 | 13 |
| Yamethin | 59.92 | 27.43 | 46 |
| Tatkon | 66.19 | 35.02 | 53 |
| Aunglan | 139.47 | 25.71 | 18 |
| Pyay | 102.83 | 18.52 | 18 |
| Average | 5.13 | 1.30 | 25 |

n=100

Table 2. Seed sources of cotton grown by the respondent farmers in the survey sites (post-monsoon season, 2015-2016)

| Seed sources | Percentage of respondent farmers |
|-----------------|----------------------------------|
| Government Farm | 47 |
| Company | 29 |
| Merchant | 8 |
| Neighbor | 15 |
| Own seed | 1 |

n=100

6 (23%), Shwe Daung-8 (15%), Ngwechi-9 (7%) and Winall (1%) (Table 3). The variety, RAKA-F₁ was popular in Tatkon whereas RAKA-F₂ was popular among farmers in Aunglan Township because the highest percent (65%) of total respondent farmers were observed as the growers of these two varieties in Tatkon and Aunglan Township respectively. Ngwechi-6 was still common variety and evenly grown in all the survey sites but the variety Shwe Daung-8 (65%) was mainly grown in Myinmu Township. The farmers of Alakapa in Myinmu Township said that Shwe Daung-8 would become a popular variety in the cotton growing areas due to its high yield.

In the group discussion with farmers of Yamethin Township, some farmers wanted to grow Ngwechi-6 variety in pre-monsoon season due to its relatively shorter growth duration compared with other varieties so that they can grow monsoon rice after cotton in irrigated area. The farmers who have to cultivate succeeding crops preferred early maturing cotton variety as Ngwechi-6. The Ngwechi-6, bollworm tolerant variety was grown for many

years since its release in 2006. Farmers wanted to grow Ngwechi-6 if they can get purified quality seed because of its high yield potential. However, farmers from Thapyay Pin Inn in Pyay Township demanded the variety Lungyaw-3 which was popular in 1983. It gave income the whole year from postmonsoon season (July-August) to until green gram grown in monsoon season (May-June). As for Ngwechi-9 which was released at the same time with the Shwe Daung-8 in 2014-2015, it had limitation due to difficulty in picking cotton. The plant type of Ngwechi-9 variety is erect and the fruiting type is cluster or closed together each other. This character caused the hand injured in picking the cotton. However, this variety could give high yield by increasing plant population with narrow spacing. The farmers were not interested to grow Winall variety for its low yield and poor adaptability in Yamethin Townships. This variety has never been grown by the farmers in other survey sites and it was grown as new variety by the recommendation of Seed Company in 2015-2016 post-monsoon season of Yamethin Township.

Table 3. Cotton varieties grown in the survey sites (Post-monsoon season, 2015-2016)

| Variety | Farmers (%) | | | | | Total |
|---------------------|-------------|----------|----------|----------|---------|-------|
| | Myinmu | Yamethin | Tatkon | Aunglan | Pyay | |
| Ngwe Chi-6 | 5 (25%) | 5 (25%) | 3 (15%) | 3 (15%) | 7 (35%) | 23 |
| Shwe Daung-8 | 13 (65%) | 2 (10%) | 0 | 0 | 0 | 15 |
| Ngwe Chi-9 | 0 | 1 (5%) | 1 (5%) | 2 (10%) | 3 (15%) | 7 |
| RAKA-F ₁ | 0 | 4 (20%) | 13 (65%) | 2 (10%) | 5 (25%) | 24 |
| RAKA-F ₂ | 2 (10%) | 7 (35%) | 3 (15%) | 13 (65%) | 5 (25%) | 30 |
| Winall | 0 | 1 (5%) | 0 | 0 | 0 | 1 |
| Total | 20 | 20 | 20 | 20 | 20 | 100 |

n=100

Yield, cost and benefit of cotton production in the survey sites (post-monsoon season, 2015-2016)

The cotton yield was estimated on the basis of the area cultivated and the quantity of seed cotton that was sold to the dealers by the farmer. The cotton yield ranged from ≤ 1000 kg ha⁻¹ to >4000 kg ha⁻¹ and a total of 49% of farmers attained cotton yield between 1001-2000 kg ha⁻¹ from the cultivated varieties (Table 4). About 25% of farmers got 2001-3000 kg ha⁻¹ of cotton yield. The hybrid variety, RAKA-F₂ was grown by the farmers in all survey sites due to the lower seed price than the RAKA-F₁ hybrid cotton. RAKA-F₂ gave high yield in some areas. Moreover, the yield level of 2001 to 3000 kg ha⁻¹ and 3001-4000 kg ha⁻¹ were mostly obtained (by 10% and 4% of farmers respectively) in Ngwechi-6 and (8% and 3% respectively) in RAKA-F₁. The highest yield (>4000 kg ha⁻¹) was obtained by 1% of farmers in the variety, Shwe Daung-8. The average yield of the varieties, Ngwechi-6, RAKA-F₁, Shwe Daung-8, Ngwechi-9, RAKA-F₂ and Winnall were 2028 kg ha⁻¹, 1908 kg ha⁻¹, 1736 kg ha⁻¹, 1613 kg ha⁻¹, 1293 kg ha⁻¹, 1210 kg ha⁻¹ respectively. The minimum cost and maximum benefit per unit area were noticed for the variety, Ngwechi-6 in the survey sites. Therefore, maximum benefit cost ratio (BCR) was observed in the Ngwechi-6 variety (3.0) followed by RAKA-F₁ (2.7), Ngwechi-9 (2.1), RAKA-F₂ (1.9) and Shwe Daung-8 (1.7) (Table 5). On the basis of BCR, Ngwechi-6 was found to have more commercial benefit than the other cultivated cotton varieties of post-monsoon season 2015-2016 in the survey sites.

Farmers' preference score on varietal characters of cotton in the survey sites (Post-monsoon season, 2015-2016)

Farmers' preference on varietal characters of cotton was examined was based on the focus group discussion among farmers in each township. The analysis involved a comparison of the varieties on the basis of ten characters, namely, yield, sucking pest occurrence, bollworm occurrence, disease incidence, adaptability, growth in the drought condition, easy to pick, boll size, crop duration, and marketability (Table 6). It was based on a score of one to five with one representing 'very bad' and five representing 'very good'. Scorings were significantly different in all characters across varieties except growth in the drought condition and boll size. Mean preference on yield was significantly different among the five varieties. High yield was one of the most preferred characters of farmers. The highest preference score in yield character was found in RAKA-F₁ and the lowest score in Ngwechi-9. For each of the remaining characters, there was clear evidence of a preference in RAKA-F₁ hybrid cotton. The preferred characters of the farmers, Ngwechi-6 were adaptability, easy to pick, crop duration and marketability. The least preference score of Ngwechi-6 was found in the characters of sucking pest occurrence and disease incidence. Although the stunting disease was a problem due to sucking pest incidence in Ngwechi-6, the farmers could overcome this problem by application of insecticides.

It was noticed that there was no significant difference in the least preference between the two vari-

Table 4. Distribution of the respondent farmers who got the different cotton yield level of different cotton varieties in the survey sites (post-monsoon season, 2015-2016)

| Yield (kg ha ⁻¹) | Cotton varieties | | | | | | Total (%) |
|---|------------------|-------|------|---------------------|---------------------|--------|--------------|
| | NC-6 | SDG-8 | NC-9 | RAKA F ₁ | RAKA F ₂ | Winall | |
| ≤1000 | 3 | 4 | 0 | 0 | 8 | 0 | 15 |
| 1001-2000 | 6 | 6 | 5 | 13 | 18 | 1 | 49 |
| 2001-3000 | 10 | 3 | 2 | 8 | 3 | 0 | 26 |
| 3001-4000 | 4 | 1 | 0 | 3 | 1 | 0 | 9 |
| >4000 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| | 23 | 15 | 7 | 24 | 30 | 1 | 100 |
| Average yield (kg ha ⁻¹) | 2028 | 1736 | 1613 | 1908 | 1293 | 1210 | |

n=100, NC-6= Ngwechi-6, SDG-8= Shwe Daung-8, NC-9= Ngwechi-9

Table 5. The average total cost and benefit per unit area of the cultivated cotton varieties in the survey sites (post-monsoon season, 2015-2016)

| No. | Variety | Total revenue (MMK)/ha | Total cost (MMK)/ha | Benefit cost ratio (BCR) |
|-----|---------------------|---------------------------|------------------------|-----------------------------|
| 1 | Ngwechi-6 | 1476791.5 | 510635.0 | 3.0 |
| 2 | Shwe Daung-8 | 1267959.2 | 730718.6 | 1.7 |
| 3 | Ngwechi-9 | 1187364.3 | 564571.4 | 2.1 |
| 4 | RAKA-F ₁ | 1327419.2 | 559197.6 | 2.7 |
| 5 | RAKA-F ₂ | 923767.7 | 565753.5 | 1.9 |
| | Average | 1236660.4 | 586175.2 | 2.3 |

Table 6. Mean scores* of the preference characters for cotton varieties given by farmers in the survey sites

| Variety | Yield | Sucking pest oc- currence | Boll- worm oc- currence | Disease incidence | Adapta- bility | Growth in the drought condition | Easy to Pick | Boll Size | Crop Dura- tion | Marketa- bility |
|---------------------|---------|---------------------------------|-------------------------------|----------------------|-------------------|--|-----------------|-----------|-----------------------|--------------------|
| Ngwe Chi-63.91 a | Shwe | 2.61 c | 3.82 a | 2.32 c | 3.40 a | 2.94 ab | 4.17 a | 3.67 ab | 3.81 a | 4.05 a |
| Daung-8 | 3.19 b | 3.39 ab | 3.52 ab | 2.86 ab | 3.08 ab | 2.78 ab | 2.93 b | 3.46 ab | 2.97 b | 3.03 b |
| Ngwe Chi-92.67 c | | 3.10 b | 2.28 b | 2.76 b | 2.82 b | 2.72 b | 2.15 c | 3.36 b | 2.99 b | 3.05 b |
| RAKA-F ₁ | 4.21 a | 3.57 a | 3.72 a | 3.16 a | 3.12 ab | 3.23 b | 3.23 b | 3.81 a | 3.05 b | 3.38 b |
| RAKA-F ₂ | 3.38 b | 3.21 b | 3.23 b | 2.96 ab | 2.89 b | 3.18 b | 3.18 b | 3.43 b | 3.01 b | 3.19 b |
| LSD _{0.05} | 0.39 | 0.32 | 0.35 | 0.37 | 0.36 | 0.34 | 0.31 | 0.35 | 0.34 | 0.36 |
| Pr > F | <0.0001 | <0.0001 | 0.0018 | 0.0003 | 0.0143 | 0.1231 | <0.0001 | 0.0721 | <0.0001 | <0.0001 |
| CV % | 40.89 | 36.18 | 35.53 | 47.83 | 41.79 | 43.34 | 36.13 | 35.94 | 38.49 | 38.75 |

*Very bad = 1, Bad = 2, Fair = 3, Good = 4, Very good = 5

In each column, means having a common letter are not significantly different at 5% LSD.

eties, Shwe Daung-8 and RAKA-F₂ hybrid cotton. The variety, Ngwechi-9, could also be differentiated as less preference by the preference scores except on two characters, yield and easy to pick. Varietal comparisons in term of farmer preference on varietal attributes are useful to make recommendations not only for release of a new variety but also for currently grown cotton varieties. From the group discussion among farmers in five townships, it was found that high yield, adaptability and pest resistance were important characters for farmers' choice of cotton varieties. According to focus group discussion among the farmers in five townships, the household resource endowments (particularly land holdings and investment), years of farming experience, and contact with extension services or dealers are the related factors causing variation of cotton varieties selection. The breeders should consider and select those preferable characters, and the breeding program should develop a range of varieties in order to meet the multiple demands of the farmers as a single variety may not be able to fulfill for their variety requirement.

Conclusion

The farmers in the study sites cultivated five cotton varieties and Ngwechi-6 was cultivated for several years since it was released in 2006. The average cotton cultivated area was 25% of their land holding in the survey sites. The yield level of 2001 - 4000 kg ha⁻¹ was found in Ngwechi-6 and RAKA-F₁ and the highest yield (>4000 kg ha⁻¹) was observed in Shwe Daung-8. The maximum benefit cost ratio (BCR) was noticed in Ngwechi-6 and it had more commercial benefit than the other cotton varieties in the survey sites. Mean preference on yield was significantly different among the five varieties. The highest preference score in yield characters was found in RAKA-F₁ and the lowest score in Ngwechi-9. Although high yield was one of the most preferred characters of farmers, the farmers selected five cotton varieties depending on their locations, land type and availability of variety and the mean preference score of all characters for these varieties were between fair and good. The farmers had different preference characters on their cultivated cotton varieties and the most important varietal characters were high yield, pest resistance and adaptability. The farmers' preference on varietal characters should be selected to improve promising new cotton varieties (RAKA-F₁ and Ngwechi-6)

and to promote farmers' preferable varieties (RAKA-F₂ and Shwe Daung-8) with those preferable characters. Hence, the breeding efforts should be done to supply a range of new cotton varieties that can fulfill the farmers' requirement.

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