



Genetic diversity of cotton (*Gossypium hirsutum* L.) germplasm and development of core set through phenotypic characters

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Introduction

→ 🌱 SE -18 miles	-	Kyaukse Township, Mandalay Region
→ 🌱 NE -19 miles	-	Myittha Twonship
→ 🌱 1.25 miles	-	Hanmyintmo to Ywar Ngan road
→ 🌱 Total area	-	955.42 acre
→ 🌱 Cultivable Land	-	676.33 acre
- Lowland	-	120.00 acre
- Upland	-	556.33 acre (442.33 acre)
→ 🌱 Soil pH	-	8.48-9.19

Introduction

- 🌱 Ten years average rain fall - 31.27 inches
- 🌱 Annual rainfall - 33.91 inches (2017)
- 22.75 inches (2018)
- 🌱 Max. temp. & Min. temp. - 33.0 °C, 13.5 °C
- 🌱 Cultivated crops (acre) - Rice (120), Sesame (50),
Sorghum (50), Green gram (25),
Chick pea (150), Cotton (250),
Research (31.5)
- 🌱 Development of supervisor varieties depends upon the genetic diversity
- 🌱 Need to analyze the genetic variability of cotton germplasm

Objectives

- 🌱 To evaluate the genetic diversity of cotton germplasm
- 🌱 To develop core set varieties using phenotypic characters

Self pollination



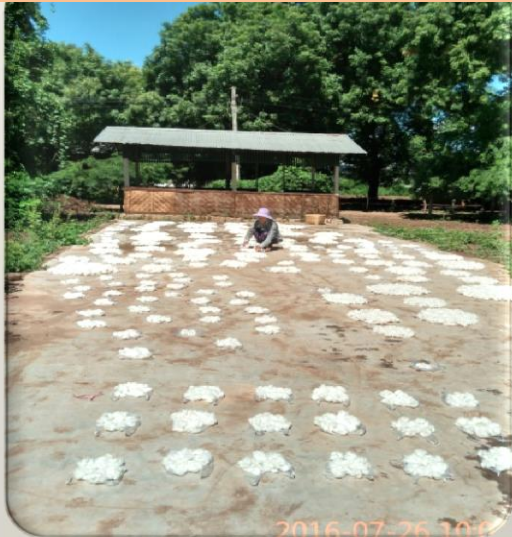
Data collection



Picking



Activities



Drying seed cotton



Ginning



Seed treatment

🌱 Experimental site

🌱 Cotton Research and Technology Development Farm, Lungyaw

🌱 Pre and Post monsoon season (2017)

🌱 Plant material

🌱 223 cotton varieties

🌱 Introduced – 148

🌱 Myanmar – 75

🌱 Single row


🌱 15.24 m length (20 holes)


🌱 Spacing

🌱 76.2 cm x 76.2 cm

 Cultural practices

 Collected data

 Recommended cultural practices
(Cotton and Allied Fiber Crops
Division, DOA)

 51 phenotypic characters
(32 qualitative and 19 quantitative
characters)

(IBPGR 1985, Cotton Gen 2015, and
DUS test in cotton 2001)

Shannon-Weaver diversity index (H')

$$H' = \sum p_i (\log_2 p_i) / \log_2 N$$

p_i = frequency proportion of the descriptor state;

N = number of states

Maximum ($H'=1.00$), High ($H'=0.76-0.99$),

Moderate ($H'=0.46-0.75$) and Low diversity ($H'=0.01-0.45$)

(Shannon and Weaver 1949)

Pearson's correlation coefficient (XLSTAT)

(Clifford and Stephenson 1975)

Weak ($r \leq 0.35$), Moderate ($r = 0.36-0.67$)

High correlations ($r = 0.68-1.00$) (Taylor 1990)

→ Cluster analysis by UPGMA using Numerical Taxonomy System

NTSYS pc Ver. 2.1 software (Rohlf 2000)

→ POWERCORE 1.0 program software (Kim et al. 2007)

$$MD \% = \frac{1}{m} \sum_{j=1}^m \frac{Me - Mc}{Mc} \times 100$$

Me = Mean of entire collection; Mc = Mean of core collection

$$VD \% = \frac{1}{m} \sum_{j=1}^m \frac{Ve - Vc}{Vc} \times 100$$

Ve = Variance of entire collection; Vc = Variance of core collection

$$CR \% = \frac{1}{m} \sum_{j=1}^m \frac{Rc}{Re} \times 100$$

Re = Range of each characters for entire collection; Rc = Range of each characters for core collection

$$VR \% = \frac{1}{m} \sum_{j=1}^m \frac{CVc}{CVe} \times 100$$

CVe = Coefficient variance of each character for entire collection;

CVc = Coefficient variance of each character for core collection

m = the number of characters

$$Coverage \% = \frac{1}{m} \sum_{j=1}^m \frac{Dc}{De} \times 100$$

Dc = number of classes of each characters in core collection;

De = number of classes of each character in entire collection

m = number of variables

Kim et al. 2007

Intercultivation



Weeding



Data collection



Spraying





Results and Discussion

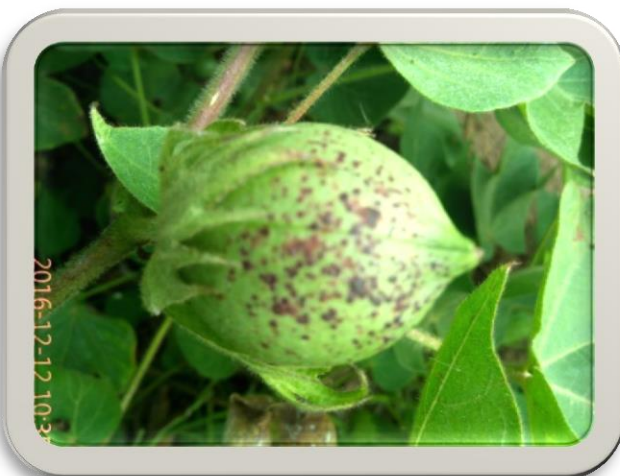


Table 1: Qualitative character in 223 cotton varieties

Characters	Predominant state	Distribution %	State observed	H' index
Invariant				
Leaf nectarines	Present	100	1	0
Stigma	Normal	100	1	0
Bract teeth number	Medium	100	1	0
Bract teeth size	Small	100	1	0
Low diversity				H'=0.01-0.45
Leaf color	Green	99.6	2	0.04
Bract color	Green	99.6	2	0.04
Leaf gland	Medium	99.1	3	0.05
Stem color	Greenish purple (sun red)	99.1	3	0.05
Lint color	White	99.1	3	0.05
Bract type	Normal	99.1	2	0.07
Petal spot	None	99.1	2	0.07
Fruiting type	Normal (Solitary)	98.7	2	0.10
Locules boll-1	Four	97.8	2	0.15
Leaf canopy	Typical	94.6	4	0.18
Leaf lobe	Five	96.9	2	0.20
Leaf shape	Normal	93.3	4	0.22
Boll size	Medium	95.1	2	0.28
Boll glands	Medium	91.9	3	0.30
Stem glands	Medium	89.7	3	0.34
Leaf size	Medium	89.2	3	0.37
Fuzz color	Grey	65.5	5	0.44

Table 1: *Contd.*

Characters	Predominant state	Distribution %	State observed	'H' index
Moderate diversity				H'=0.46-0.75
Petal color	Cream	84.3	3	0.47
Leaf hair	Moderate	74.4	4	0.52
Growth habit	Pyramid	57.8	4	0.61
Seed fuzz	Sparse	57.4	6	0.61
Boll color	Light green	62.3	3	0.63
Stem hair	Moderate	56.1	4	0.63
Boll point	Moderately pointed	74	3	0.69
Boll pitting	Lightly pitted	67.3	3	0.71
High diversity				H'= 0.76-0.99
Boll nectarines	Present	55.2	4	0.82
Pollen color	Cream	70.9	2	0.87
Boll shape	Round	55.2	3	0.91
Average diversity				0.33

Table 2: Quantitative characters in 223 cotton varieties

Characters	Predominant state	Distribution %	State observed	H' index
Low diversity				H'=0.01-0.45
Fiber strength (lb/mg)	Strong (> 8.0 lb/mg)	97.8	2	0.15
Boll weight (g)	Medium (3.1g – 5.0g)	95.1	2	0.28
Fiber maturity	Good (> 80)	87.9	3	0.37
Moderate diversity				H'=0.46-0.75
No. of sympodial branch	21-25	52.9	4	0.59
Fiber finess (micronaire)	Medium (4.0 – 4.9)	70.0	4	0.60
Node of first fruiting branch	>7	57.4	3	0.64
Seed locule ⁻¹	7 seeds	59.2	4	0.65
Fiber length (mm)	Long (29.5 –33.5 mm)	57.8	3	0.66
Plant height	Tall (121-150 cm)	57.8	4	0.66
Boll plant ⁻¹	26 – 50	59.2	5	0.66
Yield plant ⁻¹ (g)	101 – 200 g	54.3	5	0.70
Ginning percent	Low (<31)	60.5	3	0.70
100 Seed weight	Bold (9.1g –11.0g)	72.6	3	0.70
No. of monopodial branch	1-3	79.8	2	0.73
Height node ratio (H/N)	Medium (1-1.3)	79.8	2	0.73
Seed boll ⁻¹	29 -32 seeds	58.7	4	0.73
Days to 50% flowering	Medium (45-60 days)	79.8	2	0.73
High diversity				H'= 0.76-0.99
Days to 50% squaring	Medium (30-45 days)	71.7	2	0.86
Days to 50% boll opening	Medium (105-120 days)	61.9	2	0.96
Average diversity				0.64

Table 3: Pearson's correlation coefficients among phenotypic characters measured in the entire cotton germplasm

	Height node ratio	Number of monopodial l	Days to 50% squaring	Days to 50% flowering	Days to 50% boll opening	Growth habit	Stem color	Stem hair	Leaf canopy	Leaf color	Leaf hair	Fruiting type	Boll size	Locules Boll ⁻¹	Bract color	Ginning percentage	Fiber length	Fiber strength	Fiber finess	Fiber maturity	Boll weight	Seed locule ⁻¹	Seed boll ⁻¹	Boll plant ⁻¹	Yield plant ¹
HNR	1.00																								
NMB	1.00	1.00																							
DS	-0.02	-0.02	1.00																						
DF	0.08	0.08	0.48	1.00																					
DBO	0.04	0.04	0.53	0.90	1.00																				
GH	0.09	0.09	-0.02	0.12	0.11	1.00																			
SC	0.00	0.00	0.11	0.10	0.10	0.09	1.00																		
SH	0.04	0.04	-0.11	-0.03	-0.04	-0.04	0.00	1.00																	
LCN	0.05	0.05	-0.08	-0.02	-0.01	0.42	0.00	0.04	1.00																
LC	-0.03	-0.03	0.11	0.09	0.09	0.04	0.71	0.07	-0.02	1.00															
LH	0.05	0.05	-0.01	0.09	0.08	0.02	0.09	0.63	-0.02	0.11	1.00														
FT	-0.06	-0.06	0.01	-0.01	-0.01	0.39	0.00	-0.01	0.56	-0.01	-0.05	1.00													
BZ	0.14	0.14	-0.10	0.00	-0.01	0.08	0.00	0.11	0.05	-0.02	0.12	-0.03	1.00												
LPB	0.00	0.00	-0.03	0.01	0.01	0.07	0.00	0.12	0.12	-0.01	0.06	-0.02	0.66	1.00											
BRC	-0.03	-0.03	0.11	0.09	0.09	0.04	0.71	0.07	-0.02	1.00	0.11	-0.01	-0.02	-0.01	1.00										
GP	-0.10	-0.10	0.03	-0.05	-0.08	0.06	0.00	-0.07	0.14	-0.05	-0.04	0.12	0.05	0.11	-0.05	1.00									
FL	0.11	0.11	-0.03	0.05	0.06	0.12	-0.09	-0.13	0.05	-0.08	-0.14	0.09	0.02	0.00	-0.08	0.02	1.00								
FS	0.08	0.08	0.03	-0.01	-0.01	0.18	0.00	0.04	0.03	0.01	0.06	0.02	0.03	0.02	0.01	-0.05	0.06	1.00							
FFN	-0.02	-0.02	-0.08	-0.05	-0.08	-0.02	0.00	0.03	0.08	-0.01	0.09	-0.02	0.16	0.20	-0.01	0.17	-0.07	-0.09	1.00						
FBN	0.03	0.03	-0.12	-0.03	-0.04	-0.06	0.00	0.04	0.02	0.02	-0.07	0.04	0.03	-0.03	0.02	0.10	-0.12	-0.05	0.37	1.00					
BW	0.14	0.14	-0.10	0.00	-0.01	0.08	0.00	0.11	0.05	-0.02	0.12	-0.03	1.00	0.66	-0.02	0.05	0.02	0.03	0.16	0.03	1.00				
SPLU	-0.05	-0.05	-0.09	-0.03	-0.05	-0.10	0.00	-0.06	-0.19	-0.03	0.01	-0.06	0.06	0.07	-0.03	0.07	0.01	-0.07	-0.05	-0.12	0.06	1.00			
SPB	-0.07	-0.07	-0.15	-0.08	-0.11	0.02	0.07	-0.06	-0.10	0.00	-0.03	0.00	0.10	0.05	0.00	0.08	-0.06	0.04	-0.05	-0.01	0.10	0.54	1.00		
RPP	0.09	0.09	-0.30	-0.19	-0.24	0.04	0.00	0.17	0.15	-0.04	0.06	0.08	0.02	0.06	-0.04	0.05	0.02	0.02	0.10	0.05	0.02	0.03	0.09	1.00	
YPP	0.12	0.12	-0.39	-0.14	-0.19	0.05	0.00	0.20	0.12	-0.08	0.08	0.00	0.07	0.06	-0.08	0.06	0.02	-0.01	0.02	0.05	0.07	0.06	0.08	0.78	1.00

Weak	Moderate	Strong
95%	3%	2%

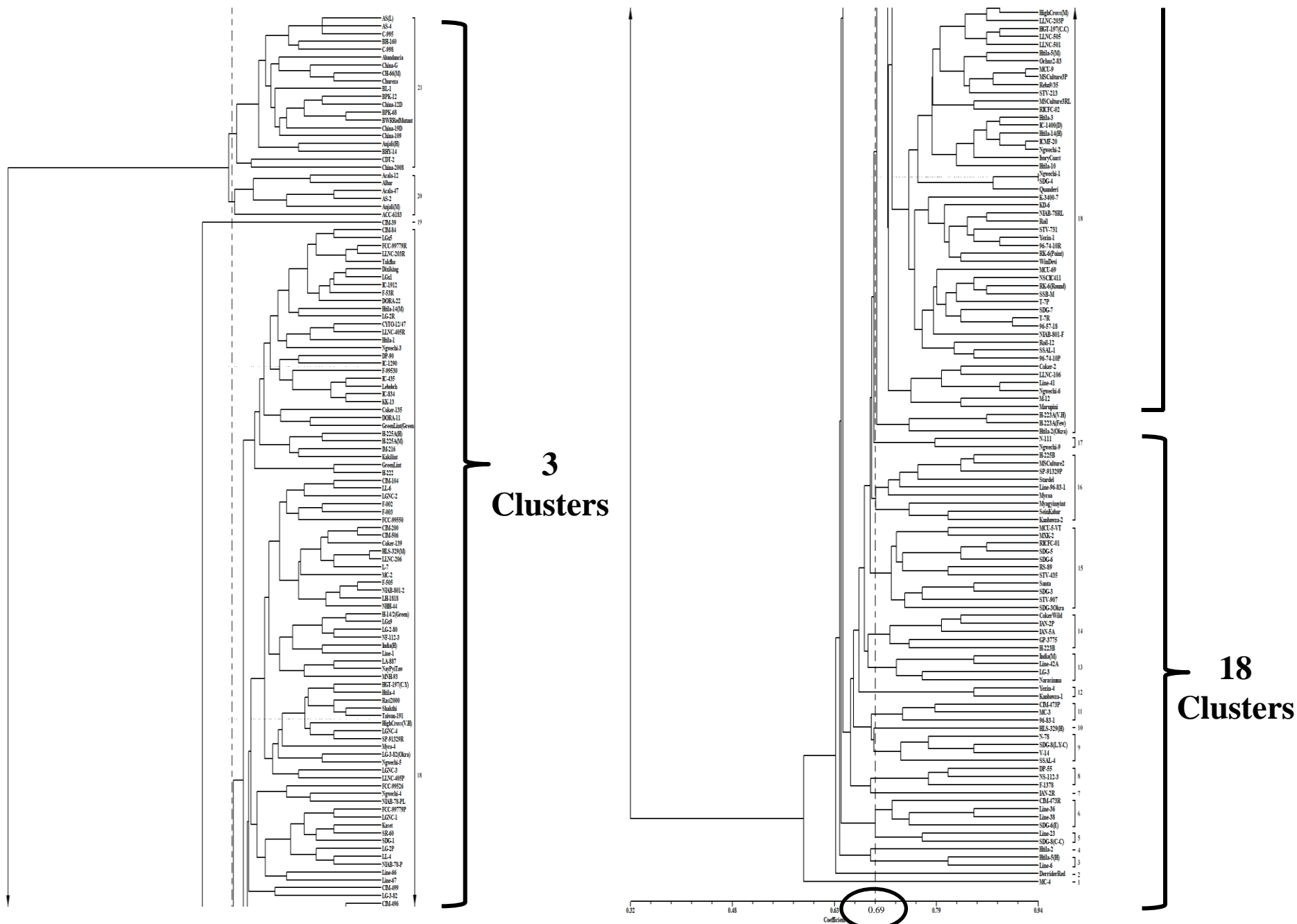


Figure 1: Dendrogram generated by cluster analysis of 51 phenotypic characters using UPGMA

21 Clusters

- 21 (20 varieties)
- 20 (6 varieties)
- 19 (1 variety) CIM-39
- 18 (140 varieties)
- 17 (2 varieties)
- 16 (9 varieties)
- 15 (11 varieties)
- 14 (5 varieties)
- 13 (4 varieties)
- 12 (2 varieties)
- 11 (3 varieties)
- 10 (1 variety) HLS-329
- 9 (4 varieties)
- 8 (3 varieties)
- 7 (1 variety) IAN-2(R)
- 6 (4 varieties)
- 5 (2 varieties)
- 4 (1 variety) Htila-2
- 3 (2 varieties)
- 2 (1 variety) Derrider
- 1 (1 variety) MC-4

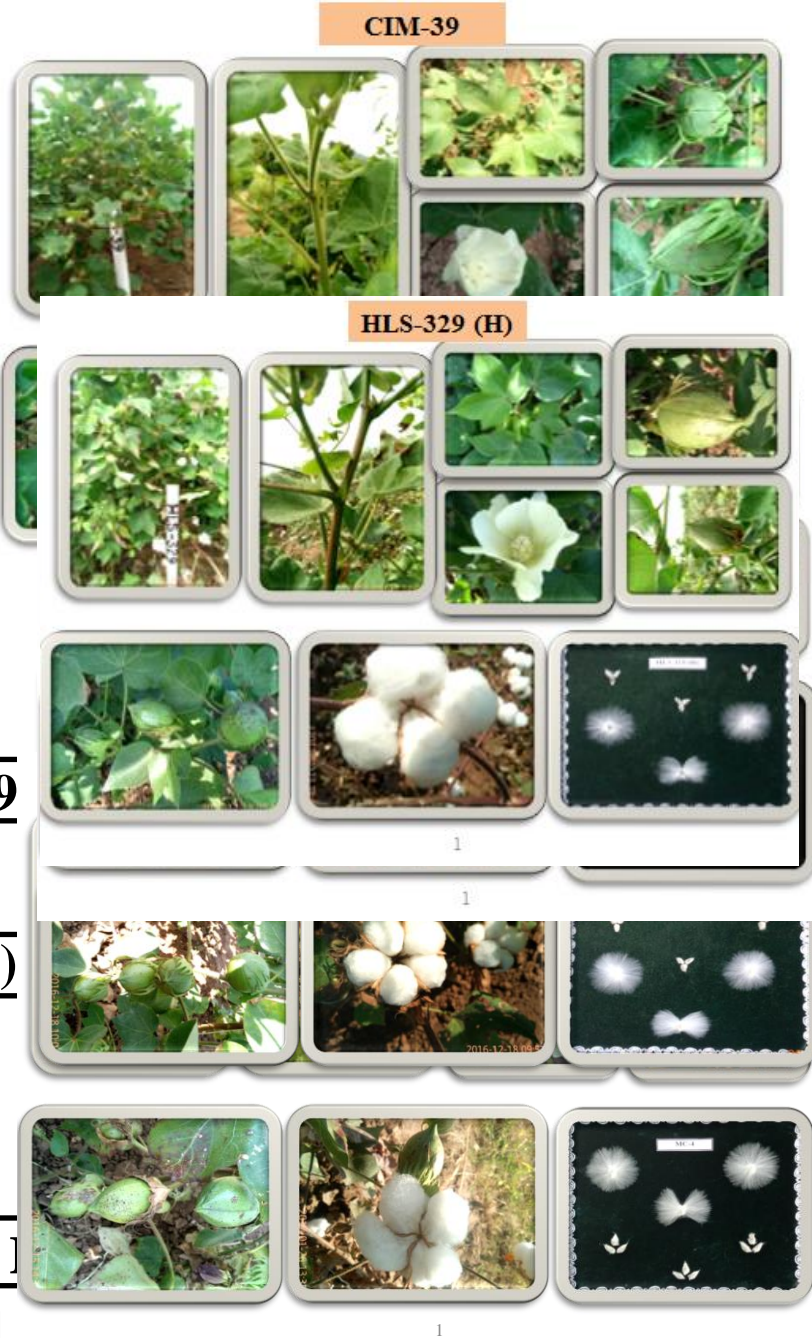


Figure 1: *Contd.*

Table 4: The selected cotton varieties with yield components and fiber quality characters

Variety	NSB	BPP	YPP (g)	BW (g)	FL (mm)	FS (lb/mg)	GP (%)	FFN (micronaire)	FBM	SW (g)
CIM-499	21	38	188	4.3	32	8.3	36.0	4.5	1.0	10.1
Htila-2	17	31	157.5	5.4	28	8.3	36.0	5.2	0.9	10.0
F-002	21	35	167.8	4.4	29	8.1	36.4	4.9	1.0	9.3
Line-36	19	27	136.6	5.7	28	8.4	28.0	4.7	0.8	12.6
LH-1818	26	39	138.6	3.9	29	8.4	30.1	4.8	0.9	9.4
Myagyimyint	26	123	437.6	3.6	28	8.0	28.6	5.1	0.9	9.0
MC-4	20	69	318.7	5.1	34	8.2	31.6	4.3	0.9	11.6
M-12	22	115	700.3	4.8	33	8.4	30.6	3.9	0.9	10.3
K-3400-7	26	70	350.0	4.5	31	8.3	28.6	4.6	0.9	11.8
SDG-6 (E)	16	54	256.8	5.2	29	8.1	36.1	5.9	0.9	11.3
SSB-M	21	65	217.3	4.4	34	8.2	28.5	4.7	1.0	11.0
96-8-31	23	60	337.8	5.3	33	8.3	28.0	5.1	1.0	13.8

NSB= No. of sympodial branch, BPP= Bolls plant⁻¹, YPP= Yield plant⁻¹, BW= Boll weight,
FL= Fiber length, FS= Fiber strength, GP= Ginning percentage, FFN=Fiber finess,
FBM= Fiber maturity SW= 100 seed weight

Table 5: Locations of core set varieties in conserved cotton germplasm

No.	Variety	Location	No.	Variety	Location
1	ACC-6183	USA	14	IAN-2 R	India
2	BHY-14	USA	15	Kakilint	Thailand
3	CDT-2	Zambia	16	LG-3	Myanmar
4	CIM-499	Pakistan	17	LG-3-82 (Okra)	Myanmar
5	Coker-135	USA	18	MC-4	Unknown
6	Derrider Red	USA	19	Myagyimyint	Unknown
7	DORA-22	Thailand	20	N-78	Pakistan
8	F-99530	Unknown	21	N-111	Pakistan
9	Green Lint (Green)	Thailand	22	Ngwechi-3	Myanmar
10	H-223B	Unknown	23	Ngwechi-9	Myanmar
11	H-225A (H)	Unknown	24	NIAB-801-F	Unknown
12	Htila-2	Myanmar	25	SSAL-4	Myanmar
13	Htila-3	Myanmar	26	Kanbawza-1	Myanmar

Table 6: Statistical parameters between entire varieties and core set varieties

No.	Parameters	
1	MD% (Mean difference percentage)	-4.38 %
2	VD% (Variance difference percentage)	82.24 %
3	CR% (Coincidence rate)	93.79 %
4	VR% (Variable rate)	103.23 %
5	Coverage	99.35%

Hu et al. 2000 and Kim et al.2007

Conclusion

- ✿ The diversity of conserved cotton germplasm was low in qualitative and moderate in quantitative characters.
- ✿ The 223 cotton varieties were grouped in 21 different clusters using 51 phenotypic characters.
- ✿ Twenty six varieties could be developed in the core set by PowerCore 1.0 program.
- ✿ Myagyimyint, Htila-2, F-002, M-12, MC-4, CIM-499 which has good yield components and good fiber quality should be used as germplasm sources in cotton breeding program.



Thank you



INTRODUCTION

Cultivable Land	-	676.33 ac
• Lowland	-	120.00 ac
• Upland	-	556.33 ac
Uncultivable Land	-	279.09 ac
• Buildings	-	121.01 ac
• Road	-	29.00 ac
• Irrigation canal	-	30.00 ac
• Problem soil	-	66.00 ac
• Yezin Agricultural University Campus	-	25.08 ac
Total area	-	955.42 ac

- Most of the clusters were generally classified by plant height, boll weight, ginning percentage, fiber length, 100 seed weight, boll plant⁻¹ and yield plant⁻¹
- In the cluster 12, the varieties had the characters of short plant height (88.78 cm), low boll weight (3.3 g), and yield plant⁻¹ (98.75 g).
- The varieties in cluster 17 were distinct in their growth habit (erect) and fruiting type (cluster).

Core set collection

- A core collection is a representative sample of the entire collection with minimum repetitiveness and maximum genetic diversity of a plant species and its relatives

(Frankel 1984; Brown 1989)

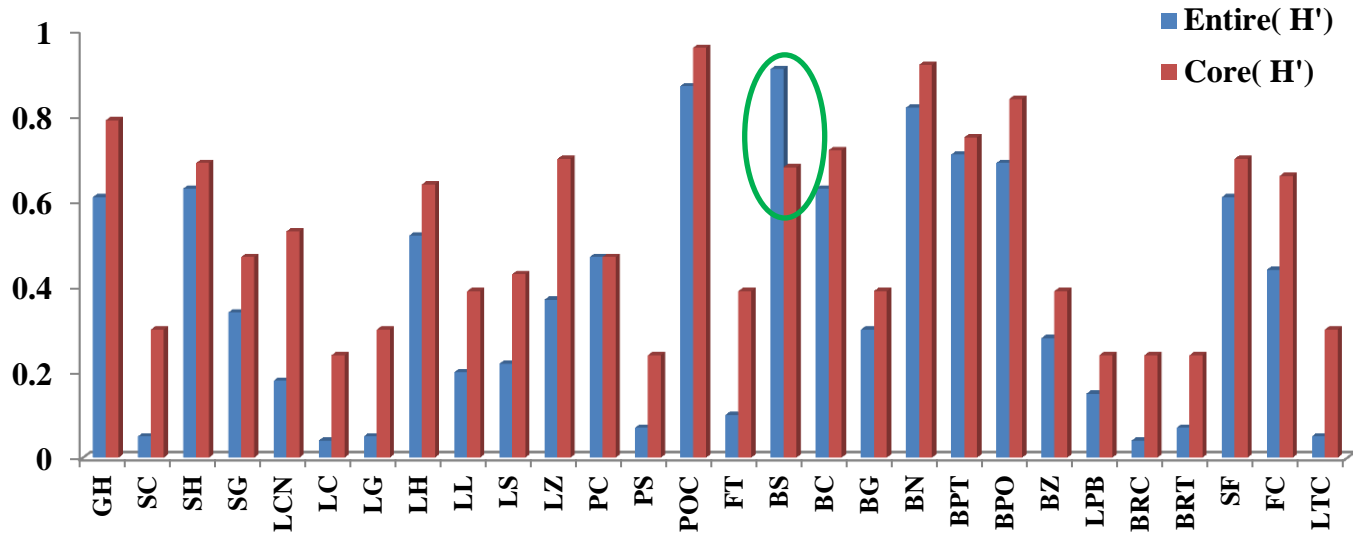
- The concept of core collection was proposed by Frankel (1984) and developed by Brown (1989).

Ngwechi-9	---	Cluster 17
Ngwechi-6	---	Cluster 18
Shwe Daung-8	---	Cluster 5 (C-C)
	---	Cluster 9 (LY-C)

LGNC-1	}	Cluster 18 (140 varieties)
LGNC-2		
LGNC-3		
LGNC-4		

Authors	MD% < 20	VD%	VR%	CR% > 80	Coverage
Hu et al. 2000	-6.25	>		>	
Dutta et al. 2015		>	>		
Xu et al. 2006	>	<	<	>	
Kim et al. 2007					100%
Current	-4.38	82.24	103.23	93.79	99.35

A



B

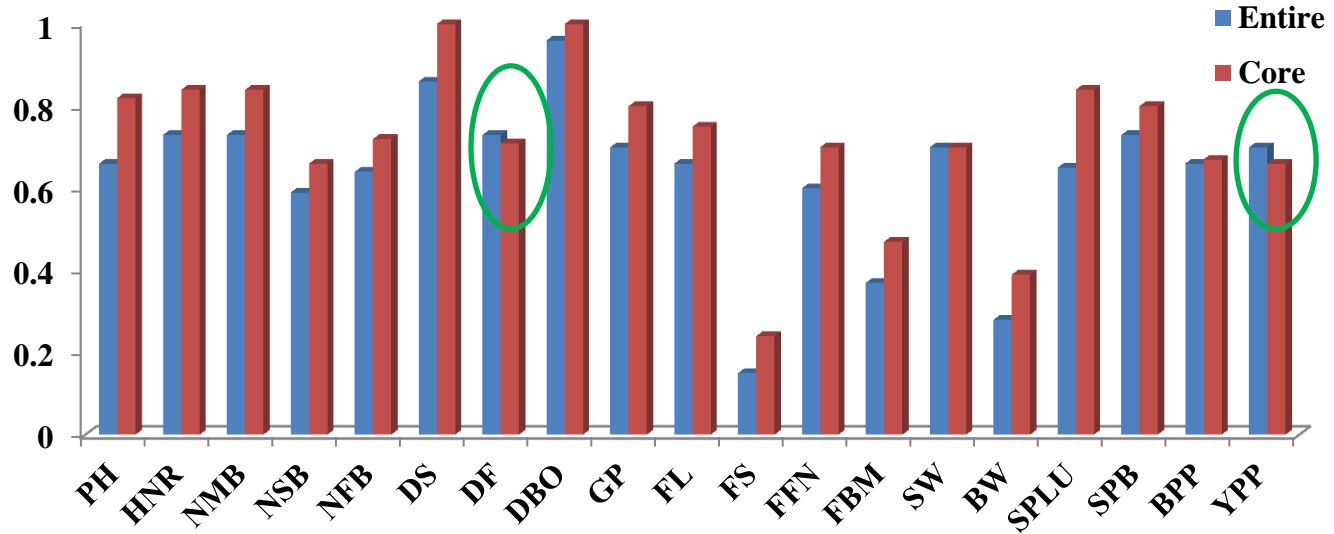


Figure 2: Shannon-Weaver diversity index for (A) qualitative and (B) quantitative characters between core set and entire varieties

Fiber quality characters of commercial cotton varieties

Quality	Ngwe chi-6	Shwe Daung-8	Ngwe Chi-9	Shwe Daung-10	Ngwe Chi-11
Boll weight (g)	4.5	4.5	4.0	4.5	4.5-5
Fiber Length (mm)	29	30	30	28	29-32
Ginning percentage (%)	37	38	39	35	32-35
Fiber Strength (lb/mg)	8.0	8.0	8.0	7.96	7.9-8.4
Fiber finess (micronaire)	4.8	5.1	5.3	5.6	4.5-5.0
Fiber maturity	1.0	1.0	1.0	0.91	0.88-0.95
100 seed weight (g)	9.9	10.7	10.3	9.9	10-11

DOA. 2015.

ဝါသီးနွံအတြကုနုးပုမငုးမားတြာရရှိရေးလိုကွာဆောငုးတြကုရမညုးနညုးစနုး
 နွံး

Gossypium barbadense L. fiber quality

Characters	Giza-70	Giza-86	Giza-88	Giza-92
Yield plant ⁻¹ (g)	158	118	86	62
Boll plant ⁻¹	44	66	47	44
Sympodial branches	27	26	24	21
Boll weight (g)	3.6	1.8	1.9	1.4
Fiber Length (mm)	35	35	36	36
Ginning percentage	32	35	34	31
Fiber strength (lb/mg)	8.5	8.4	8.0	8.4
Fiber finess (micronaire)	3.8	3.8	3.3	3.2
Fiber maturity	0.83	0.87	0.93	0.75
100 seed weight (g)	10.6	9.0	9.2	7.6

Cotton Descriptors (IBPGR, Cotton Gen, DUS testing)

No.	Descriptors	Description code or Rating Scale
1	Growth habit	GH
	• Normal	1
	• Spreading	2
	• Prostrate	3
	• Pyramid	4
	• Compact	5
	• Erect	7
2	Stem color	SC
	• Green	1
	• Greenish purple(sun red)	2
	• Red	3
3	Stem hairs	SH
	• None	1
	• Few	2
	• Moderate	3
	• Hairy	4
	• Very hairy	5
	• Pilose	6
4	Stem glands	SG
	• Glandless	0
	• Medium	1
	• Light	2
	• Heavy	3

No.	Descriptors	Description code or Rating Scale
5	Leaf canopy	LCN
	• Typical	1
	• Open	2
	• Dense	3
	• Compact	4
6	Leaf color	LC
	• Green	1
	• Red	2
	• Dark red	3
7	Leaf glands	LG
	• Glandless	0
	• Medium	1
	• Light	2
	• Heavy	3
8	Leaf hairs	LH
	• None	1
	• Few	2
	• Moderate	3
	• Hairy	4
	• Very hairy	5
	• Pilose	6

Cotton Descriptors (IBPGR, Cotton Gen, DUS testing)

No.	Descriptors	Description code or Rating Scale
9	Leaf nectarines	LN
	• Absent	0
	• Present	1
	• Reduced	2
10	Leaf lobe number	LL
	• One	1
	• Three	2
	• Five	3
	• Seven	4
11	Leaf shape	LS
	• Normal (Palmate)	1
	• Okra (Digitate)	2
	• Sub okra (Semi-digitate)	3
	• Super okra (lanceolate)	4
	• Laciniate	5
	• Ovate	6
	• Cordate (Heart shape)	7
12	Leaf size	LZ
	• Medium	1
	• Small	2
	• Large	3
	• Extra small	4

No.	Descriptors	Description code or Rating Scale
13	Petal color	PC
	• White	1
	• Cream	2
	• Light yellow	3
	• Yellow	4
	• Lavender	5
14	Petal spot	PS
	• None	0
	• Light	1
	• Medium	2
	• Heavy	3
15	Pollen color	POC
	• Cream	1
	• Yellow	2
16	Stigma	ST
	• Normal	1
	• Protruding	2
	• Extreme protruding	3
	• Short buried	4
17	Fruiting type	FT
	• Normal (Solitary)	1
	• Clusters	2

Cotton Descriptors (IBPGR, Cotton Gen, DUS testing)

No.	Descriptors	Description code or Rating Scale
18	Boll shape	BS
	• Oval	1
	• Round	2
	• Conical/Cone	3
	• Cone oval	4
19	Boll color	BC
	• Green	1
	• Dark green	2
	• Light green	3
	• Red	4
	• Sun red (Greenish purple)	5
20	Boll glands	BG
	• Grandless	0
	• Medium	1
	• Light	2
	• Heavy	3
21	Boll nectarines	BN
	• Absent	0
	• Present	1
	• Reduced	2
	• Inactive	3

No.	Descriptors	Description code or Rating Scale
22	Boll pitting	BPT
	• Smooth	1
	• Lightly pitted	2
	• Pitted	3
	• Very pitted	4
23	Boll point	BPO
	• Moderately pointed	1
	• Pointed	2
	• Blunt	3
24	Boll size	BZ
	• Medium	1
	• Large	2
	• Small	3
	• Extra small	4
25	Locules boll ⁻¹	LPB
	• One	1
	• Two	2
	• Three	3
	• Four	4
	• Five	5
	• Greater than five	6

Cotton Descriptors (IBPGR, Cotton Gen, DUS testing)

No.	Descriptors	Description code or Rating Scale
26	Bract color	BRC
	• Green	1
	• Red	2
	• Sun red	3
27	Bract teeth number	BRTN
	• Medium	1
	• Many	2
	• Few	3
28	Bract teeth size	BRTS
	• None	0
	• Medium	1
	• Small	2
	• Large	3
29	Bract type	BRT
	• Normal	1
	• Frego	2
	• Flared	3
	• Recurved	4
30	Seed fuzz	SF
	• Naked	0
	• Medium	1
	• High	2
	• Sparse	3
	• Tufted (bunch of hair)	4

No.	Descriptors	Description code or Rating Scale
	• Fuzzy	7
31	Fuzz color	FC
	• Lintless	0
	• White	1
	• Green	2
	• Grey	3
	• Brown	4
32	Lint color	LTC
	• White	1
	• Cream	2
	• Brown	3
	• Green	4
33	Plant height (cm)	PH
	• Very short (<61cm)	1
	• Short (61cm – 90cm)	3
	• Medium (91cm – 120cm)	5
	• Tall (121cm – 150cm)	7
	• Very tall (>150cm)	9
34	Height node ratio (H/N)	HNR
	• <1 (small)	1
	• 1 – 1.3 (medium)	2
	• 1.4 – 1.6 (high)	3
	• >1.6 (very high)	4

Cotton Descriptors (IBPGR, Cotton Gen, DUS testing)

No.	Descriptors	Description code or Rating Scale
35	Number of monopodial branches	NMB
	• None	0
	• 1 – 3	1
	• >3	2
36	Number of sympodial branches	NSB
	• <10	0
	• 10 - 15	1
	• 16 - 20	2
	• 21 - 25	3
	• >25	4
37	Node of first fruiting branch	NFB
	• <5	0
	• 5 -7	1
	• >7	2
38	Days to 50% squaring	DS
	• Early (< 30 days)	3
	• Medium (30-45days)	5
39	Days to 50% flowering	DF
	• Early (<45 days)	3
	• Medium (45-60 days)	5
	• Late (>60 days)	7

No.	Descriptors	Description code or Rating Scale
40	Days to 50% boll opening	DBO
	• Early (< 105 days)	3
	• Medium (105-120 days)	5
	• Late (> 120 days)	7
41	Ginning percentage (%)	GP
	• Low (<31)	3
	• Medium (31 – 35)	5
	• High (36 – 40)	7
	• Very high (>40)	9
42	Fiber Length (mm)	FL
	• Very short (<20mm)	1
	• Short (20.5mm – 24.5mm)	2
	• Medium (25.0mm – 29.0mm)	5
	• Long (29.5mm –33.5 mm)	7
	• Extra-long (> 33.5mm)	9
43	Fiber strength	FS
	• Weak (< 7.0 lb/mg)	3
	• Medium (7.0-8.0 lb/mg)	5
	• Strong (> 8.0 lb/mg)	7

Cotton Descriptors (IBPGR, Cotton Gen, DUS testing)

No.	Descriptors	Description code or Rating Scale
44	Fiber finess (micronaire)	FFN
	• Very fine (<3.0)	1
	• Fine (3.0 – 3.9)	3
	• Medium (4.0 – 4.9)	5
	• Coarse (5.0 – 5.9)	7
	• Very coarse (> 5.9)	9
45	Fiber maturity	FBM
	• Poor (< 0.70)	3
	• Average (0.70 – 0.80)	5
	• Good (>0.80)	7
46	100 seed weight (Seed index)	SW
	• Very small (< 5.1 g)	1
	• Small (5.1g – 7.0g)	3
	• Medium (7.1g – 9.0g)	5
	• Bold (9.1g –11.0g)	7
	• Very bold (> 11.0g)	9
47	Boll weight	BW
	• Small (< 3.0g)	1
	• Medium (3.1g – 5.0g)	2
	• Large (> 5.0g)	3
48	Seed number locule⁻¹	SPLU
	• 6 seeds	1

No.	Descriptors	Description code or Rating Scale
	• 7 seeds	2
	• 8 seeds	3
	• 9 seeds	4
49	Seed number boll⁻¹	SPB
	• 24 – 28	1
	• 29 -32	2
	• 33 -36	3
	• 37 – 40	4
	• >40	5
50	Number of bolls plant⁻¹	BPP
	• < 25	1
	• 26 – 50	2
	• 51 – 75	3
	• 76 – 100	4
	• >100	5
51	Yield plant⁻¹	YPP
	• <100 g	1
	• 101 – 200 g	2
	• 201 – 300 g	3
	• 301 – 400 g	4
	• >400 g	5