

# Sorghum genetic resources management & IPR - 2013-14

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## Executive summary

Directorate of Sorghum Research (DSR) is one of the National Active Germplasm Sites (NAGS) with the responsibility to collect, conserve, evaluate, document, and distribute the sorghum germplasm to the bonafied user within the country. The following progress has been made during the reporting period 2013 – 14.

#### **A: Characterization / evaluation**

- **Kharif 2013:** Characterization of 110 accessions collected from Uttarakhand (30 acc.), Kutch regions of Gujarat (40 acc.) and Khammam regions of Andhra Pradesh (40 acc.) were evaluated for 30 agro-morphological traits along with the CSV 15, CSV 23 and DSV 5 as checks.
- Maximum variability was available in the plant height and days to 50% flowering.
- A total of 68 potential accessions were identified for different agro-morphological traits
- **Rabi 2013-14:** A total of 40 accessions collected from Khammam regions of Andhra Pradesh collected during late kharif/maghi were characterized for the following 30 agro-morphological traits. Maximum variability was observed in stem biomass followed by stem dry weight, plant height and grain yield
- Tall plant height, ear head length and leaf length accession IC 0596007 (SE 2) may be used as high biomass sorghum. IC 0596013 (SE 24) may be used as sweet sorghum for its high brix, tall plant height and ear head length. Three accessions viz., IC 0596014 (SE 25), SE 53, IC 0596024 (SE 53) and IC 0596026 (SE 62) may be used in the grain sorghum programme for its good grain yield per plant and 100-seed weight.

#### **B: Pre-breeding**

- **Kharif 2013:** Develop pre-breeding material through crosses among kharif landraces, high biomass germplasm, mini-core collection and wild relatives of sorghum
- A total of 150 high biomass accessions along with 19 wild relatives, 10 B lines, 10 varieties and 115 kharif landraces were used to develop pre-breeding material for the biomass and forage traits.
- 150 hand-crosses were attempted and 109 crosses with seed setting were harvested.
- **Rabi 2013-14:** Out of 109 F1s sown, a total of 67 hand-crosses were germinated and 65 crosses with seed setting were selected and advanced them to F2.

#### **C: Multiplication**

- A total of 26 acc. of indigenous collections from Khammam districts of Andhra Pradesh and 65 F1s are multiplied during rabi (2013 - 14).

#### **D: Distribution**

- A total of 679 acc. distributed to the bonafied user in the country.
- In which, 287 acc. distributed to DSR scientists, 205 acc. to AICSIP scientists, 50 acc. to ICAR scientist, 81 acc. to SAU's and 56 acc. to other universities.

#### **E: Registration**

- **PVP&FRA:** A total of 102 applications were submitted to PPV&FRA. 35 sorghum varieties certificates were received from PPV&FRA so far. A total of 27 sorghum varieties under various stages of DUS testing. A total of 11 sorghum varieties applications closed for various reasons. A total of 29 pending sorghum applications are with the PPV&FRA
- **NBPGR:** Forage mutant line SSG 226 registered for low HCN, high digestibility and high leaf-stem ratio.

#### **F: Licensing and commercialization**

- Three MoU's signed for commercialization of sorghum value added products
- One MoU signed for analytical quality testing
- One MoA signed for sorghum seed production
- One MoA signed for popularization of forage hybrid (CSH 24MF)
- A total of 6.5 lakhs revenue generated through licensing our technologies

## Detailed report

### 1. Sorghum germplasm characterization

#### 1.1: Kharif 2013

##### 1.1.1: Characterization of new kharif germplasm

Characterization of 110 accessions collected from Uttarakhand (30 acc.), Kutch regions of Gujarat (40 acc.) and Khammam regions of Andhra Pradesh (40 acc.) were evaluated for 30 agro-morphological traits along with the CSV 15, CSV 23 and DSV 5 as checks. The descriptive statistics showed that maximum variability was available in the plant height and days to 50% flowering (Table 1). The frequency of qualitative traits is presented in Table 2. The variation for qualitative traits was observed for maximum traits. The variations in grain colour, ear head compactness, glume coverage are presented in Figures 1, 2 and 3. A total of 68 potential accessions were identified for different agro-morphological traits are presented in Table 3.

**Table 1: Descriptive statistics of quantitative characters of germplasm collections from Uttarakhand, Gujarat and Andhra Pradesh**

Characters	Mean	SE	SD	Variance	Range	Min.	Max.
Days to 50% flowering	77.5	1.2	11.7	138.6	66.0	54.0	120.0
Plant natural height (cm)	271.6	5.3	50.5	2553.9	206.0	144.0	350.0
Number of leaves	11.9	0.0	1.7	3.1	9.7	7.3	17
Leaf length of blade (cm)	75.8	1.1	10.1	101.4	41.3	59.7	101
Leaf width of blade (cm)	7.3	0.1	1.3	1.7	5.7	3.8	9.5
Panicle length (cm)	28.7	1.6	15.1	229.5	53.5	7.1	60.6
Panicle width (cm)	4.9	0.1	1.3	1.6	5.9	2.2	8.1
Stem diameter (cm)	1.5	0.1	0.5	0.2	4.3	1.5	5.4
Stem brix (%)	9.0	0.4	3.8	14.7	14.9	2.5	17.4
Biomass fresh weight (kg)	1.3	0.1	0.6	0.3	2.5	0.3	2.8
Biomass dry weight (kg)	0.8	0.0	0.4	0.1	1.8	0.2	2.0
100-Seed weight (g)	1.7	0.0	0.5	0.2	2.6	0.5	3.0
Grain yield (g/plant)	59.8	2.6	24.9	621.0	99.5	6.2	99.5

**Table 2: Frequency distribution of qualitative traits evaluated from new kharif germplasm during kharif 2013**

Character	Status	No. of accessions
Plant vigour	Poor	8
	Good	31
	Very good	69
Leaf colour	Pale green	43
	Light green	63
Leaf sheath pigmentation	Tan	12
	Non-tan	98
Leaf orientation	Erect	38
	Drooping	72
Leaf midrib colour	Yellow	1
	Green	17
	White	92
Ear Head compactness	Loose	5
	Compact	11
	Broom corn	24
	Semi-compact	26
Ear head shape	Cylindrical	3
	Oblong	6
	Ovate	9

Character	Status	No. of accessions
	Elliptical	24
	Broom corn	25
	Durra caudatum (DC)	2
	Guinea caudatum (GC)	2
	Durra guinea (DG)	6
	Durra bicolor (DB)	6
	Bicolor (B)	8
	Guinea bicolor (GB)	18
	Durra (D)	25
Glume colour	Black	1
	Straw & purple	1
	Straw	4
	Light red	10
	Dark red	10
	Reddish brown	11
	Red	12
	purple	15
Glume cover	25%	3
	50%	11
	75%	23
	100%	25
Grain colour	Creamy straw	1
	Light yellow	1
	Light red	3
	Red	3
	Reddish brown	5
	Brown	6
	Chally white	10
	Light brown	13
	White	20
Grain shape	Compactly flat	2
	Sub lenticular round but flat from other side	2
	Elliptical	23
	Round	34
Grain size	Very bold	5
	Medium	10
	Bold	46
Presence of Awn	Absent	18
	Present	41
Grain lusture	Lustrous	8
	Non-lustrous	39
Stay Green	Non-tan	16
	Tan	11

Table 3: Promising entries identified from germplasm collections of Uttarakhand, Gujarat and Andhra Pradesh

Trait	Promising accessions Indigenous Collection No. (Collector No.)	No. of acc.
Days to 50% flowering (<55 days)	IC 597662 (EJN 69)	1
Number of leaves (>17)	IC 0596010 (SE 9), SE 19, (IC 0596012) SE 22, (IC 0596013) SE 24, IC 0596022 (SE 45), IC 0596025 (SE 48), IC 0596026 (SE 62)	7
Leaf length (>100 cm)	IC 0596008 (SE 3), IC 0596010 (SE 9), IC 0596013 (SE 22), IC 0596022 (SE 45)	4
Leaf width (>10 cm)	SE 19, IC 0596024 (SE 54)	2

Trait	Promising accessions Indigenous Collection No. (Collector No.)	No. of acc.
Plant height (>400 cm)	IC 0596015 (SE 24), IC 0596022 (SE 45), IC 0596025 (SE 48)	3
Ear head length (>50 cm)	IC 597603 (ESRK 3), IC 597604 (ESRK 4), IC 597610 (ESRK 10), ESRK 14, IC 597614 (ESRK 15), IC 597615 (ESRK 16), IC 597618 (ESRK 19), IC 597619 (ESRK 20), IC 597620 (ESRK 21), IC 597622 (ESRK 23), IC 597623 (ESRK 24), IC 597626 (ESRK 27), IC 597603 (ESRK 30)	13
Ear head width (>8 cm)	IC 597628 (ESRK 29), IC 597629 (ESRK 30), IC 597635(EJN 42)	3
Stem thickness (>2 cm)	IC 597629 (ESRK 30), IC 0596010 (SE 9), IC 059614 (SE 13), DSV 5, IC 0596019 (SE 32), IC 0596019 (SE 33), IC 0596024 (SE 54), CSV 23, IC 0596028 (SE 58)	7
Brix (>18%)	IC 597640 (EJN 47), IC 597643 (EJN 50), IC 597650 (EJN 57), IC 597655 (EJN 62), IC 597656 (EJN 63), CSV 15	5
Stem fresh weight (>2000g/plant)	IC 597629 (ESRK 30), IC 597630 (EJN 36), IC 597632 (EJN 38), IC 597632 (EJN 40), IC 597633 (EJN 41), IC 597634 (EJN 42), DSV 5, IC 597654 (EJN 61)	7
Stem dry weight (>1500g/plant)	IC 597632 (EJN 38), IC 597635 (EJN 41), IC 597636 (EJN 42) , DSV 5, IC 597654 (EJN 61)	4
Grain yield (>90 g)	IC 597601 (ESRK 1), IC 597609 (ESRK 9), IC 597621 (ESRK 22), IC 597629 (ESRK 30), IC 597630 (EJN 36), IC 597631 (EJN 38), IC 597632 (EJN 39), IC 597636 (EJN 43), IC 597664 (EJN 71), IC 597667 (EJN 74)	10
100-seed weight (>2.5g)	IC 597633 (EJN 40), IC 597634 (EJN 41)	2
	<b>Total</b>	<b>68</b>



Fig. 1: Variation in: Ear head compactness; Fig. 2: grain colour; Fig. 3: glume coverage

### 1.1.2: Develop pre-breeding material through crosses among kharif landraces, high biomass germplasm, mini-core collection and wild relatives of sorghum

A total of 150 high biomass accessions along with 19 wild relatives, 10 B lines, 10 varieties and 115 kharif landraces were used to develop pre-breeding material for the biomass and forage traits. 150 hand-crosses were attempted and 109 crosses with seed setting were harvested. The list of hand-crosses made during kharif 2013 is presented in Table 4.

Table 4: List of hand-crosses made during kharif 2013

S No	Pedigree	S No	Pedigree	S No	Pedigree
1	IS 12748 x IS 14357	4	IS 13238 x IS 14357	7	IS 12743 x IS 14357
2	IS 12748 x IS 12735	5	IS 13566 x IS 14357	8	IS 12748 x IS 14357
3	IS 13238 x E 156	6	IS 13566 x IS 28451	9	IS 12738 x IS 14357

S No	Pedigree
10	IS 29646 x IS 14357
11	IS 29646 x GGUB 36
12	IS 30405 x IS 14241
13	IS 30405 x IS 14357
14	IS 30458 x IS 12735
15	IS 30458 x IS 14357
16	IS 37005 x IS 30383
17	IS 37027 x IS 14357
18	IS 37039 x IS 14357
19	IS 37046 x E 156
20	IS 37046 x IS 14357
21	IS 34246 x IS 31186
22	IS 34246 x IS 14341
23	IS 28313 x GGUB 27
24	IS 28313 x GGUB 25
25	IS 28389 x GGUB 36
26	IS 28389 x GGUB 25
27	IS 28747 x GGUB 51
28	IS 28747 x E JN 71
29	IS 40938 x IS 28389
30	IS 40938 x IS 14357
31	IS 40943 x IS 18850
32	IS 40950 x IS 14357
33	IS 40961 x IS 14357
34	IS 40966 x IS 14357
35	CSV 23 x IS 14357
36	CSV 23 x ESRK 20
37	CSV 17 x IS 14241
38	CSV 17 x IS 18933
39	E 4 x 104B
40	AKMS 14B x IS 2379
41	2077B x IS 40979
42	IMS 9B x ESRK 21
43	IS 12735 x IS 18844

S No	Pedigree
44	IS 12965 x IS 24503
45	IS 12965 x IS 23992
46	IS 20743 x IS 18844
47	IS 23992 x IS 18850
48	IS 29314 x IS 24503
49	IS 41010 x 14357
50	GGUB 21 x E JN 71
51	GGUB 21 x IS 18850
52	EG 11 x IS 18927
53	EG 10 x IS 14241
54	GGUB 55 x IS 14251
55	GGUB 55 x IS 14241
56	IS 18683 x CSV 17
57	IS 40973 x IS 14756
58	IS 18683 x E JN 75
59	IS 12706 x IS 18844
60	IS 41013 x IS 14357
61	IS 41021 x E JN 73
62	IS 41034 x IS 14357
63	2077B x ESRK 27
64	27B x IS 14357
65	AKMS 14B x IS 14301
66	IS 12945 x IS 14357
67	IS 18850 x ESRK 27
68	IS 18850 x IS 23992
69	IS 18933 x CSV 23
70	IS 18927 x 296B
71	IS 18933 x IS 24503
72	IS 14301 x E 159
73	EA 11 x IS 18933
74	IS 19859 x IS 18933
75	IS 14756 x EG 10
76	IS 14756 x IS 24503
77	IS 14351 x CSV 21F

S No	Pedigree
78	IS 40973 x IS 18933
79	IS 14756 x IS 14357
80	IS 14357 x IS 23992
81	IS 14756 x IS 8348
82	IS 14844 x IS 2379
83	IS 10969 x IS 18844
84	IS 41034 x E JN 73
85	IS 40997 x E JN 41
86	IS 40947 x IS 24503
87	IS 41003 x IS 14357
88	IS 40957 x IS 24503
89	IS 41021 x IS 14357
90	IS 41013 x E JN 41
91	IS 41010 x IS 1212
92	IS 40969 x IS 18662
93	IS 40947 x IS 14241
94	IS 40964 x IS 14756
95	IS 40957 x IS 12195
96	IS 14241 x EG 10
97	IS 40973 x IS 14756
98	IS 40961 x IS 28389
99	IS 26484 x IS 18933
100	11859 x IS 18933
101	104B x ESRK 21
102	296B x E JN 73
103	296B x ESRK 27
104	2077B x EG 35
105	IMS 9B x IS 14357
106	CSV 15 x IS 14357
107	104B x E JN 73
108	IS 26484 x IS 26780
109	IS 4515 x IS 14756

## 1.2: Rabi 2013-14

### 1.2.1: Characterization of maghi germplasm collection from Khammam, Andhra Pradesh

A total of 40 accessions collected from Khammam regions of Andhra Pradesh collected during late kharif/maghi were characterized for the following 30 agro-morphological traits. The accessions were evaluated during kharif 2013. Due to heavy rain we could not collect some qualitative and yield traits. Hence, these accessions were re-evaluated. Out of forty accessions evaluated, only 26 accessions could flower and data collected for analysis.

The descriptive statistics showed that maximum variability was observed in stem biomass followed by stem dry weight, plant height and grain yield (Table 5). The frequency of qualitative traits is presented in Table 6. The following distinct traits were identified for utilization in the crop improvement programme, tall plant height, ear head length and leaf length accession IC 0596007 (SE 2) may be used as high biomass sorghum. IC 0596013 (SE 24) may be used as sweet sorghum for its high brix, tall plant height and ear head length. Three accessions viz., IC 0596014 (SE 25), SE 53, IC 0596024 (SE 53) and IC 0596026 (SE 62) may be used in the grain sorghum programme for its good grain yield per plant and 100-seed weight. The potential germplasm accessions identified from Khammam region collection is presented in Table 7.

**Table 5: Descriptive statistics of quantitative characters of maghi germplasm collections from Khammam**

Characters	Mean	SE	SD	Variance	Range	Min.	Max.
Days to 50% flowering (days)	77.58	0.77	3.76	14.17	12.00	71.00	83.00
No. of leaves	6.43	0.21	1.05	1.10	4.00	4.80	8.80
Leaf length (cm)	61.83	1.20	5.89	34.67	27.62	44.92	72.54
Leaf width (cm)	6.65	0.21	1.10	1.04	3.92	4.86	8.78
Ear head length (cm)	20.67	1.75	8.60	73.89	22.22	11.88	34.10
Ear head width (cm)	7.75	0.25	1.22	1.50	4.26	5.04	9.30
Plant height (cm)	181.63	5.47	26.78	714.68	106.00	129.00	235.00
Stem thickness (mm)	1.41	0.03	0.15	0.02	0.66	1.10	1.76
Stem brix (%)	13.38	0.64	3.12	9.73	12.30	7.50	19.80
Stem biomass (g/pl)	263.21	19.21	94.11	8850.70	400.00	150.00	550.00
Stem dry weight (g/pl)	94.88	9.59	46.98	2204.80	180.00	20.00	200.00
Grain yield (g/pl)	62.82	4.26	20.88	436.24	72.80	31.20	104.00
100-Seed weight (g)	2.57	0.10	0.48	0.23	1.74	1.85	3.59

**Table 6: Frequency distribution of qualitative traits characterized from Khammam, Andhra Pradesh**

Character	Status	No. of accessions
Plant vigour	Good	13
	Poor	8
	Very good	5
Leaf colour	Light green	22
	Pale green	3
	Dark green	1
Leaf sheath pigmentation	Non-tan	26
	Tan	0
Leaf orientation	drooping	15
	Erect	11
Leaf midrib colour	White	24
	Green	2
Ear Head compactness	Compact	12
	Loose	10
	Semi compact	2
Ear Head shape	Ovate	10
	Cylindrical	7
	Elliptical	3
	Symmetrical	2

  

Race	Oblong	1
	Durra (D)	12
	Bicolor (B)	3
	Durra bicolor (DB)	3
	Durra caudatum (DC)	1
	Biocolor caudatum (BC)	1
	Caudatum bicolor (CB)	1
	Guinea bicolor (GB)	1
	Guinea caudatum (GC)	1
	Kaffir (K)	1
Glum colour	Light red	6
	Red	5
	Purple	5
	Brown	4
	Black	3
Glum cover	Yellow green	1
	25%	12
	75%	6
	100%	4
Grain colour	50%	2
	Yellow	8

	Red	6
	Light red	4
	White	2
	Yellow green	2
	Orange	1
	Yellow white	1
Grain shape	Round	16
	Elliptical	8
Grain size	Very bold	12

	Bold	12
Presence of Awn	Present	16
	Absent	8
Grain lusture	Lustrous	15
	Non-lustrous	9
Stay Green	Stay-green	19
	Non-tan	0

**Table 7: Promising entries identified from germplasm collections from Khammam regions of Andhra Pradesh**

Trait	Promising accessions Indigenous Collection No. (Collector No.)	No. of acc.
Leaf length (>70 cm)	IC 0596006 (SE 1), IC 0596007 (SE 2)	2
Leaf width (>8 cm)	IC 0596012 (SE 22), IC 0596014 (SE 25), IC 0596015 (SE 26)	3
Plant height (>200 cm)	IC 0596007 (SE 2), IC 0596015 (SE 24), IC 0596014 (SE 25), IC 0596022 (SE 45),	4
Ear head length (>30 cm)	IC 0596007 (SE 2), IC 0596015 (SE 24), IC 0596027 (SE 63), IC 0596028 (SE 64), IC 0596030 (SE 66)	5
Ear head width (>9 cm)	SE 13, IC 0596012 (SE 22), IC 0596022 (SE 45)	3
Brix (>18%)	IC 0596015 (SE 24), SE 56	2
Stem fresh weight (>500g/plant)	IC 0596012 (SE 22)	1
Stem dry weight (>180g/plant)	IC 0596006 (SE 1), IC 0596030 (SE 66)	2
Grain yield (>80 g)	IC 0596014 (SE 25), SE 41, SE 53, IC 0596024 (SE 54), IC 0596026 (SE 62)	5
100-seed weight (>3.0g)	IC 0596014 (SE 25), IC 0596015 (SE 26), SE 53, IC 0596024 (SE 54), IC 0596026 (SE 62)	5
	<b>Total</b>	<b>32</b>

### 1.2.2: Multiplication of F1s

A total of 109 F1s wild relatives, Chinese high biomass and indigenous germplasm crosses. Out of 109 F1s sown, a total of 67 hand-crosses were germinated and 65 crosses with seed setting were selected and advanced them to F2. The list of F1s advanced to F2 is presented in Table 8.

**Table 8: List of hand-crosses made during kharif 2013**

SN	Pedigree	Female		Male	
		Species/Trait	Origin	Species/Trait	Origin
1	IS 12748 x IS 14357	Forage	China	S. bicolor/forage	Malawi
2	IS 13238 x IS 14357	Forage	China	S. bicolor	Malawi
3	IS 13566 x IS 14357	Forage	China	S. bicolor	Malawi
4	IS 13566 x IS 28451	Forage	China		Yemen
5	IS 12743 x IS 14357	Forage	China	S. bicolor	Malawi
6	IS 12748 x IS 14357	Forage	China	S. bicolor	Malawi
7	IS 12738 x IS 14357	Forage	China	S. bicolor	Malawi
8	IS 29646 x IS 14357	Forage	China	S. bicolor	Malawi
9	IS 29646 x GGUB 36	Forage	China	Indigenous collection	India
10	IS 30405 x IS 14241	Forage	China	S. halepense	Angola
11	IS 30405 x IS 14357	Forage	China	S. bicolor	Malawi
12	IS 30458 x IS 12735	Forage	China	Biomass	Yemen
13	IS 30458 x IS 14357	Forage	China	S. bicolor	Malawi



SN	Pedigree	Female		Male	
		Species/Trait	Origin	Species/Trait	Origin
14	IS 37005 x IS 30383	Forage	China	Forage	China
15	IS 37027 x IS 14357	Forage	China	S. bicolor	Malawi
16	IS 37039 x IS 14357	Forage	China	S. bicolor	Malawi
17	IS 37046 x IS 14357	Forage	China	S. bicolor	Malawi
18	IS 34246 x IS 31186	Forage	China	Biomass	Uganda
19	IS 34246 x IS 14241	Forage	China	S. halepense	Angola
20	IS 28313 x GGUB 27	Forage	Yemen	Indigenous collection	India
21	IS 28313 x GGUB 25	Forage	Yemen	Indigenous collection	India
22	IS 28747 x GGUB 51	Forage	Yemen	Indigenous collection	India
23	IS 40938 x IS 28389	Forage	China	Biomass	Yemen
24	IS 40938 x IS 14357	Forage	China	S. bicolor	Malawi
25	IS 40950 x IS 14357	Forage	China	S. bicolor	Malawi
26	IS 40961 x IS 14357	Forage	China	S. bicolor	Malawi
27	IS 40966 x IS 14357	Forage	China	S. bicolor	Malawi
28	CSV 23 x IS 14357	Released variety	India	S. bicolor	Malawi
29	2077B x IS 40979	Parental line	India		
30	IS 12735 x IS 18844	Biomass	Yemen	S. halepense	USA
31	IS 12965 x IS 23992	Biomass	Cuba	Biomass	Yemen
32	IS 23992 x IS 18850	Biomass	Yemen	S. halepense	India
33	IS 29314 x IS 24503	Biomass	Swaziland	Biomass	South Africa
34	IS 41010 x IS 14357	Forage	China	S. bicolor	Malawi
35	GGUB 21 x EJM 71	Indigenous collection	India	Indigenous collection	India
36	GGUB 21 x IS 18850	Indigenous collection	India	S. halepense	India
37	EG 11 x IS 18927	Indigenous collection	India	S. halepense	South Africa
38	GGUB 55 x IS 19251	Indigenous collection	India	Forage	China
39	GGUB 55 x IS 14241	Indigenous collection	India	S. halepense	Angola
40	IS 20845 x IS 14241	Forage	China	S. halepense	Angola
41	IS 12706 x IS 18844	S. bicolor	USA	S. halepense	USA
42	27B x IS 14357	Parental line	India	S. bicolor	Malawi
43	AKMS 14B x IS 14301	Parental line	India	S. bicolor	South Africa
44	IS 12945 x IS 14357	Biomass	Nicaragua	S. bicolor	Malawi
45	IS 18927 x 296B	S. halepense	South Africa	Parental line	India
46	IS 14301 x E 159	S. bicolor	South Africa	Indigenous collection	India
47	EA 11 x IS 18933	Indigenous collection	India	S. propinquum	Philippines
48	IS 19859 x IS 18933	Forage	India	S. propinquum	Philippines
49	IS 14756 x EG 10	Forage		Indigenous collection	India
50	IS 14756 x IS 24503			Biomass	South Africa
51	IS 14357 x CSV 21F	S. bicolor	Malawi	Released variety	India
52	IS 40973 x IS 18933	Forage	China	S. propinquum	Philippines
53	IS 14357 x IS 23992	S. bicolor	Malawi	Biomass	Yemen
54	IS 14756 x IS 8348			Forage	Pakistan
55	IS 41034 x EJM 73	Forage	China	Indigenous collection	India
56	IS 40997 x EJM 41	Forage	China	Indigenous collection	India
57	IS 41003 x IS 14357	Forage	China	S. bicolor	Malawi
58	IS 40957 x IS 24503	Forage	China	Biomass	South Africa
59	IS 40957 x IS 12195	Forage	China		
60	IS 40973 x IS 14756	Forage	China		
61	IS 26484 x IS 18933	Forage	Benin	S. propinquum	Philippines
62	104B x ESRK 21	Parental line	India	Indigenous collection	India
63	CSV 15 x IS 14357	Released variety	India	S. bicolor	Malawi
64	104B x EJM 73	Parental line	India	Indigenous collection	India
65	IS 26484 x IS 26780		Benin		

## 2. Sorghum germplasm multiplication

A total of 26 acc. of indigenous collections from Khammam districts of Andhra Pradesh and 65 F1s are multiplied during rabi (2013 – 14).

## 3. Sorghum genetic stocks distribution

A total of 679 acc. distributed to the bonafied user in the country. In which, 287 acc. distributed to DSR scientists, 205 acc. to AICSIP scientists, 50 acc. to ICAR scientist, 81 acc. to SAU's and 56 acc. to other universities.

## 4. Sorghum genetic resources registration

### 4.1. Sorghum varietal registration with PVPFRA

A total of 102 applications were submitted to PPV&FRA. 35 sorghum varieties certificates were received from PPV&FRA so far. The list of 35 sorghum varieties registered with PPV&FRA is presented in Table 9. The list of 27 sorghum varieties under various stages of DUS testing is presented in Table 10. The list of 11 sorghum varieties applications closed for various reasons is presented in Table 11. The list of 29 pending sorghum applications with the PPV&FRA is presented in Table 12.

**Table 9: Sorghum varieties registered with PPV&FRA (As on 31<sup>st</sup> March 2014)**

SN	Denomination	Category	PPV&FRA Acknowledge No.	Registration No	Date of grant	Period of registration	Status
1	CSV 15	Extant	REG/2008/85 dt 3rd Jan 2008	109 of 2009	July 20, 2010	May 19, 2011	Registered
2	CSV 216R	Extant	REG/2007/302 dt 12th Nov 2007	55 of 2009	April 16, 2009	September 12, 2015	Registered
3	CSV 17	New	REG/2008/17 dt 1st Jan 2008	135 of 2013	September 2, 2013	September 1, 2028	Registered
4	CSV 19SS	Extant	REG/2008/15 dt 1st Jan 2008	144 of 2009	December 21, 2009	August 24, 2020	Registered
5	Haryana Chari 308	Extant	REG/2008/72 dt 3rd Jan 2008	38 of 2010	October 20, 2010	December 31, 2010	Registered
6	Pant Chari 5	Extant	REG/2008/84 dt 3rd Jan 2008	163 of 2009	December 21, 2009	October 25, 2014	Registered
7	CSH 13	Extant	REG/2007/303 dt 12th Nov 2007	32 of 2009	February 12, 2009	September 9, 2012	Registered
8	CSH 15R	Extant	REG/2007/304 dt 12th Nov 2007	102 of 2009	July 20, 2010	December 31, 2010	Registered
9	CSH 16	Extant	REG/2007/305 dt 12th Nov 2007	33 of 2009	February 12, 2009	September 8, 2012	Registered
10	CSH 17	Extant	REG/2007/306 dt 12th Nov 2007	103 of 2009	July 20, 2010	June 7, 2014	Registered
11	CSH 18	Extant	REG/2007/307 dt 12th Nov 2007	34 of 2009	February 12, 2009	October 25, 2014	Registered
12	CSH 20MF	Extant	REG/2008/68 dt 3rd Jan 2008	133 of 2009	December 21, 2009	August 24, 2020	Registered
13	CSH 22SS	Extant	REG/2008/78 dt 3rd Jan 2008	132 of 2009	December 21, 2009	November 4, 2020	Registered
14	CSH 23	New	REG/2007/308 dt 12th Nov 2007	136 of 2013	September 2, 2013	September 1, 2028	Registered
15	CSH 25 (SPH 1567)	Extant	REG/2009/331 dt 7th Aug 2009	268 of 2013	December 16, 2013	May 7, 2023	Registered
16	AKSSV 22	Extant/Notified	REG/2009/50 dt 25th Feb 2009	43 of 2011	June 24, 2011	February 10, 2024	Registered
17	AKSV 13R (PKV Kranti)	Extant/Notified	REG/2009/52 dt 25th Feb 2009	44 of 2011	June 24, 2011	January 9, 2023	Registered
18	Phule Vasudha	Extant/Notified	REG/2009/271 dt 19th May 2009	75 of 2012	July 2, 2012	January 9, 2023	Registered
19	Phule Maulee	Extant/Notified	REG/2009/289 dt 10th Jun 2009	77 of 2012	July 2, 2012	February 5, 2022	Registered
20	Phule Uttara	Extant/Notified	REG/2009/264 dt 05th Nov 2007	74 of 2012	July 2, 2012	February 5, 2022	Registered
21	Pant Chari 4	Extant/Notified	REG/2009/263 dt 19th May 2009	16 of 2012	April 4, 2012	April 30, 2012	Registered
22	Parbhani Moti	Extant/Notified	REG/2009/268 dt 19th May 2009	18 of 2012	April 4, 2012	February 1, 2020	Registered
23	Parbhani Sweta	Extant/Notified	REG/2009/276 dt 19th May 2009	76 of 2012	July 2, 2012	September 2, 2015	Registered
24	Paiyur-2	Extant/Notified	REG/2009/277 dt 19th May 2009	22 of 2012	April 4, 2012	February 1, 2016	Registered
25	APK-1	Extant/Notified	REG/2009/269 dt 19th May 2009	7 of 2012	January 16, 2012	September 16, 2012	Registered
26	BSR-1	Extant/Notified	REG/2009/271 dt 19th May 2009	19 of 2012	April 4, 2012	April 30, 2012	Registered
27	CO (FS) 29	Extant/VCK	REG/2009/273 dt 19th May 2009	108 of 2013	July 2, 2013	November 14, 2016	Registered
28	CO (S)-28	Extant/Notified	REG/2009/274 dt 19th May 2009	20 of 2012	April 4, 2012	November 14, 2016	Registered
29	K-11	Extant/Notified	REG/2009/275 dt 19th May 2009	21 of 2012	April 4, 2012	February 3, 2019	Registered
30	Jawahar Jowar- 1041	Extant/Notified	REG/2009/266 dt 19th May 2009	17 of 2012	April 4, 2012	June 7, 2014	Registered
31	Pratap Jowar- 1430	Extant/Notified	REG/2009/260 dt 19th May 2009	73 of 2012	July 2, 2012	February 3, 2019	Registered
32	NTJ 3	Extant/Notified	REG/2011/296 dt 10th Jun 2011	269 of 2013	December 16, 2013	September 12, 2015	Registered
33	Phule Panchami	Extant		29 of 2014	January 20, 2014	September 9, 2027	Registered
34	Phule Revali	Extant		41 of 2014	January 24, 2014	January 24, 2029	Registered
35	CSV 20	New	REG/2008/20 dt 1st Jan 2008	38 of 2014	January 23, 2014	January 23, 2029	Registered

**Table 10: Sorghum varieties under DUS testing (As on 31<sup>st</sup> March 2014)**

SN	Denomination	Category	PPV&FRA Acknowledge No.	Status
1	CSV 18	New	REG/2008/18 dt 1st Jan 2008	Under DUS Test
2	CSV 21F	New	REG/2008/69 dt 3rd Jan 2008	Under DUS Test
3	CSV 22R	New	REG/2008/86 dt 3rd Jan 2008	Under DUS Test
4	CSV 23	New	REG/2008/82 dt 3rd Jan 2008	Under DUS Test
5	296A	Extant/VCK	REG/2008/59 dt 3rd Jan 2008	Under DUS Test
6	2219A	Extant/VCK	REG/2008/76 dt 3rd Jan 2008	Under DUS Test
7	AKMS 14A	Extant/VCK	REG/2008/65 dt 3rd Jan 2008	Under DUS Test
8	27A	Extant/VCK	REG/2008/62 dt 3rd Jan 2008	Under DUS Test
9	IMS 7A	Extant/VCK	REG/2008/75 dt 3rd Jan 2008	Under DUS Test
10	104A	Extant/VCK	REG/2008/73 dt 3rd Jan 2008	Under DUS Test
11	296B	Extant/VCK	REG/2008/83 dt 3rd Jan 2008	Under DUS Test
12	2219B	Extant/VCK	REG/2008/64 dt 3rd Jan 2008	Under DUS Test
13	AKMS 14B	Extant/VCK	REG/2008/52 dt 3rd Jan 2008	Under DUS Test
14	27B	Extant/VCK	REG/2008/66 dt 3rd Jan 2008	Under DUS Test
15	IMS 7B	Extant/VCK	REG/2008/80 dt 3rd Jan 2008	Under DUS Test
16	IMS 9B	Extant/VCK	REG/2008/67 dt 3rd Jan 2008	Under DUS Test
17	104B	Extant/VCK	REG/2008/74 dt 3rd Jan 2008	Under DUS Test
18	RS 29	Extant/VCK	REG/2008/56 dt 3rd Jan 2008	Under DUS Test
19	RS 585	Extant/VCK	REG/2008/53 dt 3rd Jan 2008	Under DUS Test
20	RS 627	Extant/VCK	REG/2008/57 dt 3rd Jan 2008	Under DUS Test
21	RS 673	Extant/VCK	REG/2008/63 dt 3rd Jan 2008	Under DUS Test
22	AKR 150	Extant/VCK	REG/2008/71 dt 3rd Jan 2008	Under DUS Test
23	AKR 354	Extant/VCK	REG/2008/55 dt 3rd Jan 2008	Under DUS Test
24	C 43	Extant/VCK	REG/2008/70 dt 3rd Jan 2008	Under DUS Test
25	Indore 12	Extant/VCK	REG/2008/54 dt 3rd Jan 2008	Under DUS Test
26	UPMC 503	Extant/VCK	REG/2008/60 dt 3rd Jan 2008	Under DUS Test
27	HJ 513	New	REG/2008/447 dt 11th Sep 2008	Under DUS test

**Table 11: Applications of sorghum varieties closed for various reasons by PPV&FRA (As on 31<sup>st</sup> March 2014)**

SN	Denomination	Category	PPV&FRA Acknowledge No.	Status
1	CSV 14R	Extant	REG/2008/79 dt 3rd Jan 2008	Application closed (the date crossed 15 years from the date of notification)
2	CSH 14	Extant	REG/2008/77 dt 3rd Jan 2008	Application closed (the date crossed 15 years from the date of notification)
3	CSH 19R	Extant	REG/2008/58 dt 3rd Jan 2008	O3 issued
4	PCH 106	Extant	REG/2008/81 dt 3rd Jan 2008	Application closed
5	IMS 9A	Extant/VCK	REG/2008/61 dt 3rd Jan 2008	Pending
6	PMS 28A	New	REG/2009/539 dt 25th Nov 2009	O3 issued
7	IS 84	Extant/VCK	REG/2009/239 dt 01st Sep 2009	Application closed (the date crossed 15 years from the date of notification)
8	PSV-1	Extant/Notified	REG/2009/262 dt 19th May 2009	Application closed (the date crossed 15 years from the date of notification)
9	SSV 84	Extant/Notified	REG/2011/294 dt 03th Jan 2008	Application closed (the date crossed 15 years from the date of notification)
10	Jawahar Jowar- 938	Extant/Notified	REG/2009/267 dt 19th May 2009	Application closed (the date crossed 15 years from the date of notification)
11	SPH-837	Extant/Notified	REG/2009/270 dt 19th May 2009	O3 issued

**Table 12: Pending applications of sorghum varieties with PPV&FRA (As on 31<sup>st</sup> March 2014)**

SN	Denomination	Category	PPV&FRA Acknowledge No.	Remarks
1	CSV 24SS	New	REG/2009/332 dt 9th Oct 2009	
2	CSV 25 (DSV 6)	New	REG/2010/540 dt 15th Jun 2011	
3	CSH 24MF	New	REG/2009/258 dt 9th Sep 2009	
4	463A	New	REG/2010/540 dt 15th Jun 2011	
5	PMS 28B	New	REG/2009/541 dt 25th Nov 2009	
6	463B	New	REG/2011/237 dt 03rd May 2011	

SN	Denomination	Category	PPV&FRA Acknowledge No.	Remarks
7	PKV Ashwini	Extant/VCK	REG/2009/51 dt 25th Feb 2009	
8	Phule Chitra	New	REG/2009/259 dt 19th May 2009	
9	Selection 3	Extant	REG/2009/265 dt 19th May 2009	
10	PVK 809	Extant/VCK	REG/2009/261 dt 19th May 2009	
11	Jawahar Jowar- 1022	Extant/VCK	REG/2009/288 dt 10th Jun 2009	
12	PSH 1	Extant/Notified	REG/2011/294 dt 10th Jun 2011	
13	NTJ 4	Extant/VCK	REG/2011/254 dt 27th May 2011	
14	PSV 2	Extant/VCK	REG/2011/253 dt 27th May 2011	
15	SSV 74	Extant/VCK	REG/2011/252 dt 27th May 2011	
16	DSH 4	Extant/Notified	REG/2011/295 dt 10th May 2011	
17	DSV 4	Extant/Notified	REG/2011/297 dt 10th May 2011	
18	Jowahar Jowar 1022	Extant/VCK	REG/2009/288 dt 10th Jun 2009	
19	NR 486	New	REG/2011/236 dt 03th May 2011	
20	CSH 27	New	REG/2013/668 dt 30th Oct 2013	New application
21	279A	New	REG/2013/669 dt 30th Oct 2013	New application
22	279B	New	REG/2013/670 dt 30th Oct 2013	New application
23	CB 11	New	REG/2013/671 dt 30th Oct 2013	New application
24	CSH 30	New	REG/2013/672 dt 30th Oct 2013	New application
25	415A	New	REG/2013/673 dt 30th Oct 2013	New application
26	415B	New	REG/2013/674 dt 30th Oct 2013	New application
27	CB 33	New	REG/2013/675 dt 30th Oct 2013	New application
28	CSV 28	New	REG/2013/959 dt 25th Nov 2013	New application
29	CSV 29R	New	REG/2013/960 dt 25th Nov 2013	New application

#### 4.2. Genetic stocks registration with NBPGR

Forage mutant line SSG 226 registered for low HCN, high digestibility and high leaf-stem ratio.

### 5. Technical programme (2014 – 15)

#### 5.1: Sorghum germplasm collection

SN	Regions/State	Collaborator	Season/Year	Scientists involved
1	North-eastern Uttarakhand	Pantnagar	Kharif 2014	Elangovan and Shotria
3	Eastern Maharashtra	Akola	Kharif 2014	Elangovan and Ghorade

#### 5.2: Sorghum germplasm evaluation

##### 5.2.1: Kharif 2014

SN	Experiment/materials	Centres	Scientists involved
1	Evaluation of forage segregating material (F2s)	Hyderabad, Pantnagar, Hisar, Udaipur and Deesa	Elangovan, Shotria, Pahuja, Ranwah and SK Jain

##### 5.2.2: Rabi 2014 – 15

SN	Experiment/materials	Centres	Scientists involved
1	Multiplication of new kharif germplasm collections made during Kharif 2014	Hyderabad	Elangovan
2	Evaluation of forage segregating material	Hyderabad	Elangovan

### 6. Acknowledgement

We acknowledge G Vincent Reddy, P Kiran Babu, G Premalatha, Srikanth and N Laxamma for their joint efforts in evaluation / characterization of genetic resources.

## 7. Status of IP Assets at DSR during 2008-2014

Established: 2008-09  
 Chairman: Dr JV Patil, Director  
 Members: Dr Vilas A Tonapi, Technical Experts (Scientist of the Institution)  
 Dr SK Soam, IPR Expert (Scientist form ICAR Institution), NAARM, Hyderabad  
 Dr IK Das, Member Secretary, SRC  
 Dr M Elangovan, ITMU Member Secretary

### Summary of IP management at DSR during 2013-14

- Three MoU's signed for commercialization of sorghum value added products
- One MoU signed for analytical quality testing
- One MoA signed for sorghum seed production
- One MoA signed for popularization of forage hybrid (CSH 24MF)
- A total of 6.5 lakhs revenue generated through licensing our technologies

### 1. Management of IP portfolio

IPR		Before ITMU	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	Total
Patent	In process/ Maintained							1	1
	New Applications				1				1
	Granted								
Trademarks	In process/ Maintained								
	New Applications			3					
	Granted				3				4
Copyright	In process/ Maintained								
	New Applications								
	Granted								
Plant Variety Protection (with PPV&FRA)	In process/ Maintained							28	59
	New Applications	48	4	28		12		10	102
	Granted		3	5	4	3	12	8	35
Genetic Stocks (with NBPGR)	In process/ Maintained								
	New Applications	2	3	25	18			3	51
	Granted	2	3	25	18			3	51

### 2. Commercialization of technologies and agreements

Items	Before ITMU	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	Total
Number of commercialised technologies		4	3		3	3	2	15
Number of Partnerships Developed		4	2		5	4	3	18
Memorandum of Understanding		1	1	1	3	1	4	11
Memorandum of Agreement		3	1		2	3	2	11
GEX / Import Permit through NBPGR	9					1		10
Standard Material Transfer Agreement (with ICRISAT)	24	2	3	2	2	4		37
Material Transfer Agreement (DSR with bonafied users)	182	45	43	52	58	28	15	423
Simple letter agreement							1	

### 3. Capacity building in IP management: Training / workshop / seminar etc., organized on IPR

Items	Before ITMU	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	Total
Number of trainings organized	4		1	3	2	1	2	13
Number of participants trained	161		4	280	260	18	140	863

### 4. Revenue generation from IP assets (in lakhs)

Source	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	Total
Commercialisation of IP Protected Technologies	1.00	1.50			8.50	5.00	16.00
Commercialisation of non-IP Protected Technologies		0.20	0.20	0.40	1.00	1.50	3.30
Training (specific to IP&TM activities)		1.40					1.40
Consultancy							
Contract Research							
Contract Service							
Royalty charges				0.11			0.11
<b>Total</b>	<b>1.00</b>	<b>3.10</b>	<b>0.20</b>	<b>0.51</b>	<b>9.50</b>	<b>6.50</b>	<b>20.81</b>



MoA signed for multi-cut forage sorghum hybrid CSH 24MF with Doctor's Seed, Ludhiana



Short Course on Managing Intellectual Property under PVP and PGR, 15-24<sup>th</sup> May, 2013 Sponsored by HRD Division, ICAR at Directorate of Sorghum Research (DSR), Hyderabad