

Report on evaluation of forage sorghum genotypes

C.Aruna Co-ordinating with scientists at several SAUs

Contents

Executive summary	1
<i>Trial 1. Advanced varietal trial on Single-cut forage sorghum.....</i>	<i>4</i>
1.1 <i>Advanced Varietal Trial for single-cut forage sorghum (AVT-SC)</i>	<i>5</i>
<i>Trial 2. Initial varietal and hybrid trial on Single-cut forage sorghum</i>	<i>8</i>
2.1 <i>Initial Varietal and Hybrid Trial for single-cut forage sorghum (IVT-SC).....</i>	<i>8</i>
<i>Trial 3. Multi-cut forage sorghum: Initial and Advanced varietal and hybrid trial on Multi-cut forage sorghum.....</i>	<i>11</i>
3.1 <i>Initial, Advanced Varietal and Hybrid Trial for multi-cut forage sorghum (IAVHT-MC)</i>	<i>12</i>
<i>Trial 4. Advanced seed yield trial</i>	<i>16</i>
<i>Trial 5. Evaluation of Sudangrass germplasm lines.....</i>	<i>17</i>
<i>Trial 6. Evaluation of brown midrib lines</i>	<i>18</i>
<i>Trial 7. Evaluation of advanced generation progenies of the crosses made across locations</i>	<i>20</i>
<i>Overall conclusions</i>	<i>21</i>
<i>Shortfalls.....</i>	<i>21</i>
<i>Follow-up for Kharif 2014.....</i>	<i>21</i>
<i>Publications during 2013-14.....</i>	<i>21</i>



Executive summary

Introduction: During 2013-14 four multilocation trials, two on single-cut forages, one on multi-cut forages and one advanced seed yield trial were carried out across 15 locations, comprising of two zones (zone I- 9 locations in North India; zone II- 6 locations in rest of India). Three more basic experiments were conducted under co-ordinated forage sorghum research. The most important findings of forage breeding trials for the year are mentioned below.

A. Multi-location trials

Trial 1: Advanced varietal trial (Single-cut)

- Nine genotypes along with 2 checks (HC 308 and CSV 21F) were evaluated at 15 locations during kharif 2013.
- Among the entries in first year of advanced testing, SPV 2191 was most promising with more than 10% improvement in green (461 q/ha) and dry (158 q/ha) fodder yields over the checks, HC 308 and CSV 21F.

- SPV 2191 was also promising for per day productivity and forage quality in terms of protein yield (12 q/ha) and digestible dry matter yield (78 q/ha). It had better level of resistance to shoot pests compared to the checks.
- Other entries, SPV 2186 and SPV 2185 were promising for fodder yield and per day productivity.

Trial 2: Initial varietal and hybrid trial (Single-cut)

- Twelve genotypes along with 2 checks (HC 308 and CSV 21F) were evaluated at 14 locations during kharif 2013.
- Among the hybrids, SPH 1752 was most promising for green (553 q/ha) and dry (181 q/ha) fodder yields and per day productivity over the checks.
- The variety, SPV 2262 recorded superiority for green (515 q/ha) and dry (165 q/ha) fodder yields and per day productivity over the checks.
- SPV 2265 had better level of tolerance to shoot fly (45% shoot fly deadhearts) compared to HC 308 (59%) and CSV 21F (62%)

Trial 3: Initial and Advanced varietal and hybrid trial (Multi-cut)

- Sixteen entries including 12 test hybrids, one test variety, 2 hybrid checks (CSH 20MF and CSH 24MF) and one variety check (SSG 59-3) were evaluated over 13 locations.
- The hybrid SPH 1697 (1037 q/ha GFY; 289 q/ha DFY) was the most promising hybrid with significant improvement in green fodder yield and about 10% improvement in dry fodder yield over the checks, CSH 20MF and CSH 24MF.
- Per day productivity of green and dry fodder yields of SPH 1697 was also high.
- SPH 1697 had performed consistently well over three years in the AICSIP multi-location testing for fodder yield and quality traits.
- The multi-cut variety, SPV 2242 recorded significant superiority for green (969 q/ha) and dry (295 q/ha) fodder yields compared to the check, SSG 59-3. Its per day productivity of green and dry fodder was also significantly superior to SSG 59-3.
- For the quality traits such as protein yield and digestible dry matter also, SPV 2242 is standing in first position.

Trial 4: Advanced seed yield trial

- Eight genotypes including six single cut test varieties and two single cut national checks (HC 308 and CSV 21F) were evaluated for grain yield potential at five locations.
- The single-cut variety, SPV 2128 (24 q/ha) was found to yield more grain compared to the checks at all India level.

B. Co-ordinated forage sorghum research

Trial 5: Evaluation of Sudangrass germplasm lines

- Seventeen sudangrass germplasm lines along with the check, SSG 59-3 were evaluated in RCBD with 2 replications in 3 locations.
- The genotypes, CO(FS)29 and IS 30209 were found more promising for green and dry fodder yields with more than 10% increase for green and dry fodder yields over the check, SSG 59-3.
- More number of tillers were observed in CO(FS) 29, IS 20624, IS 869 and SGL 60.
- High protein yield was observed in CO(FS) 29, SGL 98-M and IS 14278 and high IVDMD in IS 30209 (58%), SGL 87 and IS 607.

Trial 6: Evaluation of brown midrib lines

- Fifteen brown midrib lines along with three checks were evaluated in RCBD with two replications in two locations for fodder yield and quality traits.
- The bmr lines, EC 582504 and EC 582508 recorded high IVDMD values (61 to 63%) compared to the checks.
- The improved lines, PBMR 1, PBMR 3 and PBMR 4 were found promising for fodder yield and quality.

Trial 7: Evaluation of advanced generation progenies of the crosses made across locations

- Ten advanced generation derivatives of the crosses made towards improvement of forage sorghum were evaluated across two locations in RCBD with two replications in order to identify promising derivatives for fodder yield and quality.
- The line, FABN 13-1 was the best genotype for green (719 q/ha) and dry (241 q/ha) fodder yields with 16% and 37% improvement over the check, CSV 21F.
- Among other lines, FABN 13-4 was promising for fodder yield (648 q/ha GFY and 181 q/ha DFY).
- FABN 13-4, FABN 13-3 and FABN 13-1 were promising for leaf traits such as more number of long and broad leaves
- FABN 13-4 and FABN 13-1 had high percent of protein (8.6 and 8.9%) with high protein yield.
- IVDMD was high in FABN 13-2 (55.5%) and FABN 13-4 (54.4%) with high DDM in FABN 13-1 (124 q/ha) and FABN 13-4 (105 q/ha).

Overall conclusions

- In AVT (SC), the varieties SPV 2191, SPV 2186 and SPV 2185 were promising for fodder yield and per day productivity.
- SPV 2191 was promising for fodder quality in terms of protein yield and digestible dry matter yield. It had good level of resistance to shoot fly, stem borer and leaf diseases.
- In IVHT (SC), the entry SPH 1752 among the hybrids and SPV 2262 among the varieties were the promising genotypes for fodder yield, per day productivity and quality. SPV 2265 had better level of resistance to shoot fly.
- In IAVHT (MC), the hybrid SPH 1697 recorded more than 10% improvement for both green and dry fodder yields over the checks, CSH 20MF and CSH 24MF. Their per day productivity of green and dry fodder yields was also high compared to the checks.
- Over three years also, the hybrid, SPH 1697 showed superiority for fodder yield, per day productivity and quality in comparison to both the checks. For pest and disease resistance, it was on par with the checks.
- The multicut variety, SPV 2242 recorded significant superiority for both green and dry fodder yields over the check, SSG 59-3. It had more tiller number and high regeneration potential compared to all entries.
- In the advanced seed yield trial, the single-cut variety, SPV 2128 was found to yield more grain compared to the checks, HC 308 and CSV 21F at all India level.
- In the trial on evaluation of sudangrass germplasm lines, the genotypes CO(FS) 29 and IS 30209 were found promising for various fodder yield traits.
- More number of tillers were observed in CO(FS) 29, IS 20624, IS 869 and SGL 60.
- In the trial on evaluation of bmr lines, EC 582504 and EC 582508 recorded high IVDMD values. The improved lines, PBMR 1, PBMR 3 and PBMR 4 were promising for fodder yield and quality.
- Evaluation of advanced generation progenies of the crosses made across locations showed that the lines FABN 13-1 and FABN 13-4 to be more promising for fodder yield and quality.
- FABN 13-2 had high IVDMD values, while high DDM was observed in FABN 13-1 and FABN 13-4.

Shortfalls

- Regenerability score is very important in multi-cut genotypes and needs to be recorded by all the centres.
- Plant population per plot was not given by some centres.

Follow-up for Kharif 2014

- Promising genotypes from initial trials of both single-cut and multi-cut types will be evaluated in the advanced trials during kharif 2014
- The promising sudangrass germplasm lines and bmr lines identified in the trials will be utilized in the forage sorghum improvement program

Detailed report

During 2013-14 emphasis continued to be given on identification of genotypes with improved fodder yield and quality both for single-cut and multi-cut forages. Seven experiments were conducted, 4 under multilocation trials and 3 under Co-ordinated forage sorghum research. The improved genotypes were contributed by various SAUs, ICAR institutes and private organizations for their evaluation at all India level under different eco-geographical regions of the country. One trial on brown midrib genotypes and one on sudangrass germplasm lines were taken up in 3 locations during this year. A program on trait based improvement of forage genotypes has been initiated during 2008 involving different centers working on forage sorghum. The advanced generation progenies of those crosses were evaluated over two locations during this year. The performance of test genotypes was evaluated at all India level as well as in two zones.

Zone I : UP, Uttaranchal, Gujarat, Rajasthan, Haryana and Punjab

Zone II: Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu

Zone I is characterized by the areas where sorghum is utilized as fodder whereas Zone II involves the states where grain and dual purpose sorghums are mainly grown. The co-ordinated trials which were conducted as per technical programme of kharif 2013 over 16 locations are listed below:

A. Multi-location trials

Trial 1: Advanced Varietal Trial on Single-cut forage Sorghum

Trial 2: Initial Varietal and Hybrid Trial on Single-cut forage Sorghum

Trial 3: Initial and Advanced Varietal and Hybrid Trial on Multi-cut forage Sorghum

Trial 4: Seed yield trial

B. Co-ordinated forage sorghum research

Trial 5: Evaluation of Sudangrass germplasm lines

Trial 6: Evaluation of brown midrib genotypes

Trial 7: Evaluation of advanced generation progenies of the crosses made across locations

The results of the above experiments are discussed below.

Trial 1. Advanced varietal trial on Single-cut forage sorghum

A trial comprising of 9 single-cut forage genotypes (one in second year of advanced trial and 5 entries in first year of advanced trial, two nationally released single cut forage sorghum checks, CSV 21F and HC 308, and one local check) was conducted under advanced single-cut forage sorghum experiment. This trial was conducted in 15 locations and the data from these 15 locations was used for presenting the results. The genotypes were tested for their green fodder yield, dry fodder yield, per day productivity and quality parameters. The summary of performance of checks and test entries is given in the table below (Table 1).

Table 1. Summary results of Single-cut Advanced varietal trial

S. No	Traits	GFY (q/ha)	DFY (q/ha)	GFY/day (q/ha)	DFY/day (q/ha)	Protein %	PY (q/ha)	IVDMD (%)	DDM (q/ha)
1	HC 308	416	140	4.91	2.05	8.31	11.0	54.0	74.0
2	CSV 21F	417	139	4.93	1.97	8.48	11.0	54.0	73.0
3	Mean	416	143	4.94	2.08	8.25	11.0	54.0	70.0
4	Min.	377	125	4.30	1.82	7.59	8.0	52.0	64.0
5	Max.	461	158	5.42	2.32	8.48	12.0	56.0	78.0
6	CD (0.05)	58.0	20.0	0.67	0.3	0.99	5.0	3.2	30.0
7	CV (%)	16.7	16.1	15.6	13.8	8.93	20.5	8.0	22.6
8	Lines sig. > check	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
9	Lines > best check	SPV 2191, SPV 2186, SPV 2185	SPV 2191, SPV 2185, SPV 2186, SPV 2185	SPV 2191, SPV 2186, SPV 2185	SPV 2185, SPV 2191, SPV 2186, SPV 2128, SPV 2190	Nil	SPV 2191	SPV 2211, SPV 2186, SPV 2191, SPV 2185	SPV 2191
10	Data from locations (no)	15	15	14	14	7	7	7	7
11	Loc. for national av. (no)	13	11	12	10	7	7	7	7

1.1 Advanced Varietal Trial for single-cut forage sorghum (AVT-SC)

The advanced varietal trial for single cut forages was carried out with 9 genotypes including two national checks, HC 308 and CSV 21F and one local check. Out of the test entries, one was in second year of advanced testing (SPV 2128), and five were in first year of testing (SPV 2211, SPV 2185, SPV 2186, SPV 2190 and SPV 2191). The zone wise and all India results of the trial are presented below (Tables 1.1 to 1.16 and 1A to 1 F). The single-cut genotypes tested in the trial are given in the table 2.

Zone-I:

Yield parameters

Green fodder yield: The check CSV 21F (475 q/ha) yielded better than all test entries. Among the test entries, SPV 2191 (470 q/ha) was the highest yielder in this zone, followed by the other check, HC 308 (457 q/ha).

Dry fodder yield: The checks, CSV 21F (151 q/ha) and HC 308 (148 q/ha) recorded highest dry fodder yields in this zone. Among the entries, SPV 2191 (141 q/ha) and SPV 2190 (132 q/ha) were in the first two positions in Zone I.

Green fodder yield per day: Per day green fodder productivity was reported to be more in the check, CSV 21F (5.44 q/ha) followed by SPV 2191 (5.37 q/ha) and HC 308 (5.24 q/ha).

Dry fodder yield per day: The check, HC 308 (2.43 q/ha) recorded high dry fodder productivity per day, followed by SPV 2185 (2.38 q/ha) and CSV 21F (2.35 q/ha).

Phenology and morphological parameters

Days to 50% flowering ranged from 73 to 81 days. Among the test entries, SPV 2186 and SPV 2128 were early (76 days) genotypes in this zone followed by SPV 2185 (77 days) and CSV 21F (79 days). The check, HC 308 flowered in 80 days.

Early vigour varied from 3.04 to 3.50. Among the test entries SPV 2190 recorded high vigor with a score of 3.40 in zone I.

Plant height of the entries ranged from 237 to 260 cm in this zone. The check CSV 21F was the tallest (260 cm) in this trial followed by HC 308 (254 cm) and SPV 2186 (251 cm).

Leaf parameters There was no much difference in number of leaves among the entries which ranged from 12-13. Long leaves were observed in SPV 2211 (76.3 cm). Long and broad leaves were observed in SPV 2190 (74.6 cm; 7.81 cm) and SPV 2185 (73.0 cm; 7.26 cm).

Stem girth ranged from 2.54 cm to 3.27 cm. Thin stems were observed in CSV 21F (2.54 cm), HC 308 (2.71 cm) and SPV 2185 (2.75 cm).

High leaf-stem ratio was observed in HC 308 (0.36) followed by SPV 2190 (0.35) and SPV 2211 (0.34). The check, CSV 21F showed leaf-stem ratio of 0.33.

Zone-II:

Yield parameters

Green fodder yield: In Zone II, three varieties (SPV 2186, SPV 2191 and SPV 2185) recorded significant improvement over the best check, HC 308 (368 q/ha). SPV 2186 ranked first for green fodder yield (455 q/ha) followed by SPV 2191 (451 q/ha) and SPV 2185 (443 q/ha). The checks HC 308 and CSV 21F yielded 368 q/ha and 349 q/ha of green fodder respectively in this zone.

Dry fodder yield: For this trait, SPV 2191 (173 q/ha) ranked first followed by SPV 2185 (172 q/ha) and SPV 2128 (161 q/ha). All these entries yielded significantly higher than the checks. The checks, HC 308 and CSV 21F yielded 133 q/ha and 128 q/ha of dry fodder yield in this zone.

Green fodder yield per day ranged from 4.22 to 5.48 q/ha in this zone. For this trait, SPV 2191 (5.48 q/ha), SPV 2186 (5.34 q/ha) and SPV 2185 (5.26 q/ha) showed significant improvement over both the checks. Other varieties with high per day green fodder productivity were SPV 2128 (4.93 q/ha), SPV 2190 (4.88 q/ha) and SPV 2211 (4.72 q/ha). Checks, HC 308 & CSV 21F recorded 4.44 & 4.22 q/ha of green fodder yield per day.

For *Dry fodder yield per day* SPV 2191 (2.29 q/ha), SPV 2185 (2.28 q/ha) and SPV 2186 (2.10 q/ha) stood in the first three positions in this zone. The checks, HC 308 and CSV 21F recorded 1.82 q/ha and 1.74 q/ha of dry fodder per day.

Phenology and morphological parameters

Days to 50% flowering: All the genotypes flowered earlier compared to zone I. It ranged from 67 to 73 days, the early genotypes in this zone being CSV 21F (67 days) followed by HC 308 (69 days) and SPV 2211 and SPV 2190 (both flowered in 70 days).

Early vigour was observed to be more in SPV 2128 (3.33) and CSV 21F (3.33) in this zone followed by HC 308 (3.00) and SPV 2190 (2.83).

Plant height in this zone varied from 222 to 255 cm. SPV 2191 was the tallest, followed by SPV 2185 (252 cm) and SPV 2211 (250 cm). HC 308 and CSV 21F recorded 226 cm and 224 cm of plant height respectively in this zone.

Leaf parameters: There was not much difference between the entries for number of leaves which ranged from 9-11 per plant. Long and broad leaves were observed in SPV 2190 (83.2 cm; 8.13 cm) compared to checks, HC 308 (74.9 cm long and 6.22 cm wide leaves) and CSV 21F (73.9 cm long and 5.83 cm wide leaves).

Stem girth ranged from 2.83 to 3.85 cm with thinner stems in CSV 21F followed by HC 308 (3.21 cm). Among the test entries, SPV 2191 was having thin stems (3.34 cm).

Leaf-stem ratio ranged from 0.34 to 0.45, and was higher in the varieties SPV 2211 (0.45 cm), SPV 2190 (0.41 cm) and SPV 2191 (0.38 cm).

National level:

Yield parameters

Green fodder yield: Among the advanced entries SPV 2191 ranked at the top (461 q/ha) at all India level with 10% improvement for green fodder yield over both the checks, HC 308 (416 q/ha) and CSV 21F (417 q/ha). The other two advanced varieties, SPV 2186 (433 q/ha) and SPV 2185 (420 q/ha) were in second and third positions.

Dry fodder yield: SPV 2191 (158 q/ha) was the best among all the entries for dry fodder yield with 13-14% increase in dry fodder yield over the checks, HC 308 (140 q/ha) and CSV 21F (139 q/ha). Among the other varieties, SPV 2185 (152 q/ha) and SPV 2128 (148 q/ha) were promising with more than 5% improvement over the check for dry fodder yield.

Green fodder yield per day: Per day green fodder productivity ranged from 4.3 to 5.42 q/ha. Highest per day productivity was observed in SPV 2191 (5.42 q/ha) followed by SPV 2186 (5.26 q/ha) and SPV 2185 (5.04 q/ha). The checks CSV 21F and HC 308 yielded 4.93 q/ha and 4.91 q/ha of green fodder per day.

Dry fodder yield per day: Dry fodder yield per day ranged from 1.82 to 2.32 q/ha at all India level. The advanced entry SPV 2185 (2.32 q/ha) was the best for per day dry fodder productivity, followed by SPV 2191 (2.22 q/ha) and SPV 2186 (2.16 q/ha). The checks, CSV 21F and HC 308 yielded 1.97 and 2.05 q/ha of dry fodder per day.

Phenology and morphological parameters

Days to 50% flowering ranged from 70 - 76 days. Among the test entries, SPV 2186 was the earliest to flower (73 days), followed by SPV 2128 which flowered in 74 days. The checks HC 308 and CSV 21F flowered in 74 and 73 days respectively.

Early vigour ranged from 2.83 to 3.47. High vigour was observed in CSV 21F (3.47) followed by SPV 2128 (3.37 score) and HC 308 (3.30).

Plant height ranged from 232 to 250 cm. SPV 2186 was the tallest followed by SPV 2191 and SPV 2185 (248 cm). HC 308 and CSV 21F recorded 242 cm and 244 cm of height at all India level.

Leaf parameters: Not much variation was observed among the varieties for number of leaves which ranged from 11-12 per plant. Long and broad leaves were observed in SPV 2190 (78.4 cm; 7.95 cm), SPV 2211 (79.1 cm; 6.51 cm) and SPV 2185 (76.4 cm; 7.19 cm).

Stem girth ranged from 2.66 to 3.47 cm. Thin stems were observed in CSV 21F (2.66 cm), followed by HC 308 (2.92 cm) and SPV 2211 (3.04 cm).

Leaf-stem ratio ranged from 0.32 to 0.39. SPV 2211 was the best genotype (ratio of 0.39) followed by SPV 2190 (0.38).

Reaction to major pest and diseases

Shoot fly resistance: In the entomology trials, SPV 2191 was found to be the best among all the varieties in this trial with deadheart percentage (DH%) of 51%. It was followed by SPV 2186 (58% DH). The checks, CSV 21F and HC 308 reported 51% and 59% of shoot fly deadhearts.

Stem borer resistance: For stem borer resistance also SPV 2191 was the best genotype with 17% of stem borer deadhearts in the entomology trials, followed by SPV 2211 (18%) and SPV 2128 (19%). CSV 21F and HC 308 recorded 19% stem borer deadhearts.

For *leaf diseases:* In the pathology trials, SPV 2191, SPV 2185, SPV 2211, SPV 2190 and SPV 2128 showed multiple leaf disease resistance, and were on par with the checks.

Quality parameters: Six test genotypes along with two single-cut forage checks, HC 308 and CSV 21F, and one local check were analyzed for quality for the samples of 7 locations and the results are presented below.

Total soluble sugars ranged from 9.17% (SPV 2211) to 10.64% (SPV 2190). The checks, HC 308 and CSV 21F had TSS of 9.83 and 9.80% respectively. The entries, SPV 2186 (10.6%) and SPV 2128 (10.28%) were also promising with TSS more than both the checks.

HCN content ranged from 67.4 ppm (SPV 2191) to 95.6 ppm (SPV 2190) which is within the safe limit of <200ppm. All the entries had HCN with in the safe limits.

Protein percent varied from 7.59 (SPV 2211) to 8.48 percent (CSV 21F). The checks have recorded protein percent of 8.31 (HC 308) and 8.48% (CSV 21F). Among the trial entries, SPV 2191 (8.46%) and SPV 2185 (8.38%) were promising.

Protein yield (q/ha) varied from 8.0 q/ha (SPV 2211) to 12.0 q/ha (SPV 2191). Both the checks, CSV 21F and HC 308 recorded protein yield of 11q/ha. The entry, SPV 2186 also recorded protein yield of 11q/ha.

IVDMD values ranged from 54.0 (SPV 2190 and SPV 2128) to 56% (SPV 2211) among the test entries. Both the checks recorded IVDMD value of 54%. SPV 2211 was the best entry with 56% IVDMD followed by SPV 2185, SPV 2186 and SPV 2191 (all with 55% IVDMD).

Digestible dry matter (DDM) yield ranged from 64.0 q/ha (SPV 2211) to 78.0 q/ha (SPV 2191) among the test entries. The best variety for DDM was SPV 2191, which was followed by HC 308 (74.0 q/ha), CSV 21F (73.0 q/ha) and SPV 2186 (71.0 q/ha).

Table 2: Performance of promising single-cut forage sorghum genotypes in advanced trial during 2013-14
(Entries- 6; Checks- 2; Locations: 15)

Entry	GFY (q/ha)				DFY (q/ha)				GFY/day (q/ha)		DFY/day (q/ha)		Protein %	
		R	% +/- over CSV 21F	% +/- over HC 308		R	% +/- over CSV 21F	% +/- over HC 308		R		R		R
SPV 2128	400	7	-4.08	-3.85	148	3	6.47	5.71	4.84	7	2.13	4	8.17	7
SPV 2211	377	9	-9.59	-9.38	125	9	-10	-10.7	4.30	9	1.82	9	7.59	9
SPV 2185	420	3	0.72	0.96	152	2	9.35	8.57	5.04	3	2.32	1	8.38	3
SPV 2186	433	2	3.84	4.09	143	4	2.88	2.14	5.26	2	2.16	3	8.24	6
SPV 2190	410	6	-1.68	-1.44	142	5	2.16	1.43	4.77	8	2.06	5	8.31	5
SPV 2191	461	1	10.55	10.8	158	1	13.7	12.9	5.42	1	2.22	2	8.46	2
Checks														
HC 308	416	5			140	6			4.91	6	2.05	6	8.31	4
CSV 21F	417	4			139	7			4.93	4	1.97	8	8.48	1
CD (5%)	58.0				20				0.67		0.3		0.99	
CD (1%)	77.0				27				0.88		0.4		1.34	
C.V. (%)	16.7				16.1				15.6		13.8		9.0	

Entry	IVDMD (%)		DDM (q/ha)		SF	SB	ZLS	ALS	LB
		R		R					
SPV 2128	54.0	7	66.0	8	60.9	18.5	2.9	3.6	2.0
SPV 2211	56.0	1	64.0	9	59.0	18.2	4.0	4.4	1.8
SPV 2185	55.0	4	66.0	7	64.8	19.4	3.3	4.2	1.9
SPV 2186	55.0	2	71.0	4	58.0	20.3	3.1	3.7	1.8
SPV 2190	54.0	8	69.0	6	60.3	22.0	4.4	4.4	1.8
SPV 2191	55.0	3	78.0	1	51.2	16.8	3.4	3.2	1.8
HC 308	54.0	5	74.0	2	58.7	19.0	4.0	3.9	1.8
CSV 21F	54.0	6	73.0	3	51.0	19.0	3.0	3.5	1.7
CD (5%)	3.0		30.0		18.4	8.02	1.5	0.8	0.3
CD (1%)	4.0		40.0		24.6	10.8	2.1	1.1	0.4
C.V. (%)	8.0		22.6		22.1	26.2	23.9	12.8	8.9

GFY- Green fodder yield, DFY- Dry fodder yield, DDM- Digestible dry matter, SF- Shoot fly (% deadhearts), SB- Stem borer (% deadhearts), ZLS- Zonate leaf spot, ALS- Anthracnose leaf spot, LB- Leaf Blight (1-9 scale)

The advanced entry, SPV 2191 was the most promising variety for fodder yield, per day productivity and quality. SPV 2186 and SPV 2185 were promising for fodder yield and per day productivity. SPV 2191 had good level of resistance to shoot fly, stem borer and leaf diseases. The performance of promising genotypes tested in All India Co-ordinated trials during last 3 years is presented in the following table:

Table 3: Performance of single cut forage sorghum genotypes tested in AICSIP over last 3 years

Entry	Year	Yield				Quality				Insect pests DH (%)		Diseases (score)						
		GFY (q/ha)	DFY (q/ha)	GFY/day (q/ha)	DFY/day (q/ha)	PY (q/ha)	DDM (q/ha)	SF	SB	ZLS	ALS	LB						
SPV 2128	2011	412	6	136	2	5.54	4	1.95	4	7.9	8	51.4	8	62.1	22.2	3.3	3.5	4.1
	2012	451	1	140	4	5.99	1	1.83	3	5.7	6	54.5	4	56.8	20.0	4.33	2.67	4.81
	2013	400	7	148	3	4.84	7	2.13	4	10.0	7	66.0	8	60.9	18.5	2.9	3.6	2.0
	Av	421		141		5.46		1.97		7.87		57.3		59.9	20.2	3.51	3.26	3.64
HC 308	2011	386	11	124	12	5.09	11	1.74	12	8.6	3	54.1	6	60.5	23.1	3.5	3.4	3.6
	2012	431	5	133	7	5.61	6	1.76	8	5.8	5	52.0	8	49.4	21.8	3.8	2.7	4.1
	2013	416	5	140	6	4.91	6	2.05	6	11.0	3	74.0	2	58.7	19.0	4.0	3.9	1.8
	Av	411		132		5.20		1.85		8.47		60.0		56.2	21.3	3.77	3.33	3.17
CSV 21F	2011	388	10	127	10	5.22	10	1.80	9	9.0	2	57.5	3	60.2	27.9	3.5	3.7	3.3
	2012	430	6	132	8	5.65	4	1.77	6	5.6	7	53.4	5	50.8	18.5	5.3	3.1	4.9
	2013	417	4	139	7	4.93	4	1.97	8	11.0	2	73.0	3	51.0	19.0	3.0	3.5	1.7
	Av	412		133		5.27		1.85		8.53		61.3		54.0	21.8	3.93	3.43	3.3

GFY- Green fodder yield, DFY- Dry fodder yield, PY- Protein yield; DDM- Digestible dry matter, SF- Shoot fly (% deadhearts), SB- Stem borer (% deadhearts), ZLS- Zonate leaf spot, ALS- Anthracnose leaf spot, LB- Leaf Blight (1-9 scale)

Conclusions: Over three years the variety SPV 2128 was marginally superior to the checks, HC 308 and CSV 21F for fodder yield and per day productivity.

Trial 2. Initial varietal and hybrid trial on Single-cut forage sorghum

A trial comprising of 16 single-cut forage genotypes (10 test varieties, two test hybrids, two nationally released single cut forage sorghum variety checks, CSV 21F and HC 308, one dual purpose hybrid check, CSH 27 and one local check) was conducted under initial single-cut forage sorghum experiment. Since single cut forage hybrid seed was not available, the dual purpose hybrid, CSH 27 was used as a check in this trial. This trial was conducted in 14 locations and the data from these 14 locations was used for presenting the results. The genotypes were tested for their green fodder yield, dry fodder yield, per day productivity, quality and resistance to important pests and diseases. The summary of performance of checks and test entries is given in Table 4.

Table 4. Summary results of Single-cut Initial varietal and hybrid trial (Trial 2)

S. No	Traits	GFY (q/ha)	DFY (q/ha)	GFY/day (q/ha)	DFY/day (q/ha)	Protein %	PY (q/ha)	IVDMD (%)	DDM (q/ha)
1	HC 308	507	163	6.41	2.08	8.03	12.32	52.0	84.0
2	CSV 21F	499	160	6.44	2.10	8.24	11.58	52.0	78.0
3	Mean	472	150	6.18	1.99	8.09	10.43	53.0	72.0
4	Min.	412	127	5.70	1.76	7.53	8.60	51	54.0
5	Max.	553	181	7.04	2.31	8.39	12.68	56	89.0
6	CD (0.05)	63	22	0.83	0.29	1.22	5.49	4.0	20.6
7	CV (%)	16	18	15.0	15.9	11.6	14.6	6.65	13.4
8	Advanced lines sig. > check	Nil	Nil	Nil	Nil	Nil	Nil	SPV 2261, SPV 2263	Nil
9	Adv. Lines > best check	SPH 1752, SPV 2262	SPH 1752, SPV 2262	SPH 1752, SPV 2262	SPH 1752, SPV 2262	SPV 2259, 2260, 2262, 2265, SPH 1753, SPV 2264	SPH 1752	SPV 2264, 2259, SPH 1752, SPV 2266	SPH 1752
10	Data from locations (no)	14	14	13	13	7	7	7	7
11	Loc. for national av. (no)	12	12	11	11	7	6	7	6

2.1 Initial Varietal and Hybrid Trial for single-cut forage sorghum (IVT-SC)

The initial varietal trial for single cut forages was carried out with 16 genotypes including two national checks, HC 308 and CSV 21F and one local check. The zone wise and all India results of the trial are presented below (Tables 2.1 to 2.16 and 2A to 2F). The promising single-cut genotypes tested in the trial are given in the table 5.

Zone-I:

Yield parameters

Green fodder yield: The entry, SPH 1752 (656 q/ha) was the best genotype for green fodder yield in Zone I, followed by the check, CSV 21F (610 q/ha) and SPV 2262 (609 q/ha). The other check variety, HC 308 yielded 601 q/ha of green fodder yield in this zone.

Dry fodder yield: Among the test entries, SPH 1752 (205 q/ha) among the hybrids, and SPV 2262 (182 q/ha) among varieties were in the first place in this zone. The checks, HC 308 and CSV 21F yielded 178 q/ha and 187 q/ha of dry fodder in this zone.

Green fodder yield per day: Per day green fodder productivity was reported to be more in the hybrid, SPH 1752 (7.95 q/ha) followed by the checks, HC 308 (7.43 q/ha) and CSV 21F (7.43 q/ha). Among the test varieties, SPV 2262 (7.23 q/ha) produced high green fodder per day.

Dry fodder yield per day: Again the entry SPH 1752 (2.44 q/ha) was the best for per day dry fodder productivity, followed by CSV 21F (2.25 q/ha) and HC 308 (2.16 q/ha). Among the test varieties, SPV 2262 (2.15 q/ha) produced high dry fodder per day.

Phenology and morphological parameters

Days to 50% flowering ranged from 73 to 87 days. SPV 2258 was the earliest (75 days) genotype among the test entries in this zone followed by SPV 2259 (78 days) and SPV 2261 (79 days). The hybrids flowered late in 82 days (SPH 1753) and 84 days (SPH 1752) compared to the varieties. The checks, HC 308 and CSV 21F flowered in 82-83 days.

Early vigour varied from 3.07 to 3.55. Among the test entries SPV 2262 recorded high vigor with a score of 3.55 in zone I, followed by SPH 1752 (3.50).

Plant height of the entries ranged from 214 to 269 cm in this zone. The entry SPH 1752 was the tallest (269 cm) in this trial followed by SPV 2262 (265 cm) and SPV 2263 (265 cm).

Leaf parameters There was no much difference in number of leaves among the entries which ranged from 12-14. Long and broad leaves were observed in SPV 2260 (77 cm; 7.8 cm), SPH 1752 (75 cm; 7.54 cm) and SPV 2265 (73 cm; 7.85 cm).

Stem girth ranged from 2.77 cm to 3.35 cm. Thin stems were observed in CSV 21F (2.77 cm), SPV 2257 (2.8 cm) and SPV 2258 (2.9 cm).

High leaf-stem ratio was observed in SPH 1753 (0.36) and SPV 2257 (0.36) followed by SPV 2265 (0.35) and SPV 2260 (0.35). The checks showed leaf-stem ratio of 0.33 (HC 308) and 0.32 (CSV 21F).

Zone-II:

Yield parameters

Green fodder yield: In Zone II, the variety, SPV 2265 (453 q/h) was in the first position for green fodder yield, followed by SPV 2260 (420 q/ha) and SPV 2266 (414 q/ha). The hybrids SPH 1752 and SPH 1753 yielded 409 q/ha and 397 q/ha of green fodder and stood in fourth and fifth positions. The checks, HC 308 and CSV 21F yielded 376 q/ha and 343 q/ha of green fodder in this zone.

Dry fodder yield: For this trait also SPV 2265 (154 q/ha) ranked first followed by SPH 1752 (149 q/ha) and SPV 2266 (146 q/ha) and SPV 2260 (144 q/ha). The checks, HC 308 and CSV 21F recorded 142 q/ha and 123 q/ha of dry fodder yield in this zone.

Green fodder yield per day ranged from 4.40 to 6.38 q/ha in this zone. For this trait, SPV 2265 (6.38 q/ha), SPV 2266 (5.91 q/ha), SPV 2260 (5.72 q/ha) and SPH 1753 (5.65 q/ha) showed significant improvement over the checks. The checks, HC 308 and CSV 21F recorded 4.63 and 4.7 q/ha of green fodder yield per day.

Dry fodder yield per day: The entries, SPV 2265 (2.29 q/ha), SPV 2266 (2.27 q/ha) and SPV 2262 (2.18 q/ha) stood in the first three positions for per day dry fodder yield. The checks, HC 308 and CSV 21F recorded per day dry fodder yields of 1.93 q/ha and 1.83 q/ha in this zone.

Phenology and morphological parameters

Days to 50% flowering: All the genotypes flowered earlier compared to zone I. It ranged from 67 to 72 days, the earliest genotype in this zone being SPV 2258 followed by CSV 21F (68 days) and CSH 27 (68 days).

Early vigour: The hybrid, SPH 1752 and SPV 2262 showed high early vigour of 3.00 score, followed by SPV nos. 2257, 2258, 2261, 2266 all with vigour score of 2.67.

Plant height in this zone varied from 171 to 259 cm. SPH 1752 was the tallest, followed by SPV 2263 (250 cm), SPV 2266 (246 cm) and SPV 2262 (243 cm). HC 308 recorded 237 cm of plant height in this zone.

Leaf parameters: There was no much difference between the entries for number of leaves which ranged from 9-11 per plant. Long and broad leaves were observed in SPV 2260 (84 cm; 8.26 cm), SPV 2265 (83 cm; 8.15 cm) and SPH 1752 (83 cm; 7.76 cm) compared to the checks, HC 308 (76 cm long and 6.87 cm wide leaves) and CSV 21F (78 cm long and 5.97 cm wide leaves).

Stem girth ranged from 2.83 to 3.86 cm with thinner stems in CSV 21F followed by HC 308 (3.17 cm) and SPV 2261 (3.2 cm).

Leaf-stem ratio ranged from 0.27 to 0.32, and was higher in the entries SPH 1752 (0.32), SPV 2265 and SPV 2260, SPV 2257, SPV 2259, SPV 2263 and SPH 1753 all with leaf stem ratio of 0.31.

National level:

Yield parameters

Green fodder yield: Among the test entries, SPH 1752 ranked at the top (553 q/ha) followed by SPV 2262 (515 q/ha). The checks, HC 308 and CSV 21F recorded 507 q/ha and 499 q/ha of green fodder respectively at all India level.

Dry fodder yield: For dry fodder yield also, SPH 1752 (181 q/ha) was the best among all the entries followed by SPV 2262 (165 q/ha). The checks, HC 308 and CSV 21F recorded 163 q/ha and 160 q/ha of dry fodder respectively.

Green fodder yield per day: Per day green fodder productivity ranged from 5.70 to 7.04 q/ha. Highest per day productivity was observed in SPH 1752 (7.04 q/ha) followed by SPV 2262 (6.63 q/ha) and CSV 21F (6.44 q/ha). The check HC 308 yielded 6.41 q/ha of green fodder per day.

Dry fodder yield per day: Dry fodder yield per day ranged from 1.76 to 2.31 q/ha at all India level. The entry SPH 1752 (2.31 q/ha) was the best for per day dry fodder productivity, followed by SPV 2262 (2.16 q/ha), and CSV 21F (2.1 q/ha). The other check, HC 308 yielded 2.08 q/ha of dry fodder per day.

Phenology and morphological parameters

Days to 50% flowering ranged from 71 - 81 days. Among the test entries, SPV 2258 (72 days) was the earliest to flower, followed by SPV 2261, SPV 2259 and SPV 2266, all of which flowered in 75 days. The checks HC 308 and CSV 21F flowered in 77- 78 days.

Early vigor ranged from 2.94 to 3.48. High vigour was observed in SPV 2262 (3.48) followed by SPH 1752 (3.44 score) and CSV 21F (3.35).

Plant height ranged from 200 to 266 cm. SPH 1752 was the tallest followed by SPV 2263 (260 cm). The checks, CSV 21F and HC 308 recorded plant height of 250-251 cm.

Leaf parameters: Not much variation was observed among the varieties for number of leaves which ranged from 11-13 per plant. Long and broad leaves were observed in SPV 2260 (79 cm; 7.95 cm), SPH 1752 (78 cm; 7.63 cm) and SPV 2265 (77 cm; 7.96 cm).

Stem girth ranged from 2.79 to 3.53 cm. Thin stems were observed in CSV 21F (2.79 cm), followed by SPV 2257 (3.01 cm) and HC 308 (3.02 cm).

Leaf-stem ratio ranged from 0.30 to 0.34. SPH 1753 and SPV 2257 were having high leaf stem ratio (ratio of 0.34).

Reaction to major pest and diseases

Shoot fly resistance: In the entomology trials, SPV 2265 was found to be the best among all the varieties with deadheart percentage (DH%) of 45.1%. SPV 2266 (49.2% DH), SPV 2258 (50.8% DH), SPV 2263 (51.5%), SPV 2260 (52.5%) and SPH 1752 (52.5%) were promising compared to the checks CSV 21F and HC 308 which reported 59% and 62% of shoot fly deadhearts respectively.

Stem borer resistance: For stem borer resistance SPV 2258 was the best genotype with 18.1% of stem borer deadhearts in the entomology trials followed by SPV 2260 (18.2%). The checks CSV 21F and HC 308 recorded 18.6% and 19.8% of stem borer deadhearts respectively.

For *leaf diseases:* In the pathology trials, SPV 2263 and SPV 2264 showed multiple leaf disease resistance, and were better than the checks.

Quality parameters: The test genotypes along with two single-cut forage checks, HC 308 and CSV 21F, and one local check were analyzed for quality for the samples of 7 locations and the results are presented below.

Total soluble sugars ranged from 9.5% (SPV 2263) to 11.0% (SPV 2258). The checks, HC 308 and CSV 21F had TSS of 10.4 and 10.8% respectively.

HCN content ranged from 30 ppm (SPV 2264) to 79 ppm (SPV 2260) which is within the safe limit of <200ppm. All the entries had HCN within the safe limits.

Protein percent varied from 7.53 (SPV 2266) to 8.39 percent (SPV 2259). The checks have recorded protein percent of 8.03 (HC 308) and 8.24% (CSV 21F). Besides SPV 2259 (8.39%), the entries SPV 2260 (8.35%), SPV 2262 (8.35%), SPV 2265 (8.28%) and SPH 1753 (8.26%) were also promising with high protein percentage.

Protein yield (q/ha) varied from 8.6 q/ha (CSH 27) to 12.68 q/ha (SPH 1752). The checks CSV 21F and HC 308 recorded protein yield of 11.6 and 12.3 q/ha respectively.

IVDMD values ranged from 51 (SPV 2258) to 56% (SPV 2261 and SPV 2263) among the test entries and the checks. The entries, SPV 2261 (56%), SPV 2263 (56%), SPV 2259 (54%) and SPV 2264 (54%) were in the first four positions for digestibility. Both the checks recorded digestibility of 52% (HC 308, CSV 21F).

Digestible dry matter (DDM) yield ranged from 54 q/ha (CSH 27) to 89 q/ha (SPH 1752). The best variety for DDM was SPH 1752, which was followed by HC 308 (84 q/ha) and SPV 2262 (78 q/ha).

Table 5: Performance of promising single-cut forage sorghum genotypes in initial trial during 2013-14
(Entries- 12; Checks- 3; Locations: 14)

Entry	GFY (q/ha)				DFY (q/ha)				GFY/day (q/ha)		DFY/day (q/ha)		Protein %	
	R	% +/- over CSV 21F	% +/- over HC 308		R	% +/- over CSV 21F	% +/- over HC 308		R	R	R	R	R	R
SPH 1752	553	1	10.8	9.07	181	1	13.1	11.0	7.04	1	2.31	1	8.23	8
SPV 2262	515	2	3.21	1.58	165	2	3.13	1.23	6.63	2	2.16	2	8.35	3
SPV 2265	503	4	0.80	-0.79	157	5	-1.9	-3.68	6.31	7	2.01	7	8.28	4
Checks														
HC 308	507	3			163	3			6.41	5	2.08	5	8.03	11
CSV 21F	499	5			160	4			6.44	3	2.10	3	8.24	7
CD (5%)	63				22				0.83		0.29		1.22	
CD (1%)	83				29				1.10		0.38		1.63	
C.V. (%)	16				18				15.0		15.9		11.6	

Entry	IVDMD (%)	R	DDM (q/ha)	SF	SB	ZLS	ALS	LB	
SPH 1752	53	5	89	1	52.5	22.1	2.6	3.2	3.8
SPV 2262	53	9	78	3	58.5	18.9	3.0	3.1	3.5
SPV 2265	52	11	74	8	45.1	19.1	3.3	3.0	3.8
Checks									
HC 308	52	10	84	2	58.8	19.8	2.5	3.0	3.7
CSV 21F	52	12	78	4	62.4	18.6	2.8	3.5	3.3
CD (5%)	4.0		20.6		16.3	8.29	1.3	1.3	0.9
CD (1%)	5.0		27.3		21.7	11.1	1.7	1.7	1.2
C.V. (%)	6.65		13.4		19.7	24.6	31.0	20.2	15.1

GFY- Green fodder yield, DFY- Dry fodder yield, PY- Protein yield; DDM- Digestible dry matter, SF- Shoot fly (% deadhearts), SB- Stem borer (% deadhearts), ZLS- Zonate leaf spot, ALS- Anthracnose leaf spot, LB- Leaf Blight (1-9 scale)

The entry, SPH 1752 was the most promising variety for fodder yield, per day productivity and quality, followed by SPV 2262.

Trial 3. Multi-cut forage sorghum: Initial and Advanced varietal and hybrid trial on Multi-cut forage sorghum

A multi-cut forage trial comprising of 17 entries (12 test hybrids, one test variety, 2 hybrid checks, one variety check and one local check) was conducted across 13 locations. Out of 13 test entries, two were in second AHT (SPH 1697 and SPH 1698), 4 hybrids (SPH 1695, SPH 1700, SPH 1715 and SPH 1717) were in first year of AHT, 6 hybrids (SPH 1748, SPH 1749, SPH 1750, SPH 1751, SPH 1752, SPH 1753) and one variety (SPV 2242) were in initial testing. The genotypes were tested for their green fodder yield, dry fodder yield, per day productivity at different cuts, other forage yield parameters and forage quality parameters.

Table 6: Summary results of multi-cut trial

S. No	Traits	GFY (q/ha)	DFY (q/ha)	GFY/day (q/ha)	DFY/day (q/ha)	Protein %	PY (q/ha)	IVDMD (%)	DDM (q/ha)
1	SSG 59-3	787.7	240.0	5.61	1.68	8.97	19.93	50.0	108.9
2	CSH 20MF	913.4	266.1	6.47	1.86	8.20	19.93	48.3	115.4
3	CSH 24MF	886.3	251.9	6.28	1.81	8.59	19.31	48.1	104.5
4	Mean	866.4	250.7	6.18	1.78	8.37	19.94	49.1	113.2
5	Min.	776.4	231.3	5.52	1.62	7.51	16.10	46.6	95.2
6	Max.	1037.2	294.8	7.42	2.11	8.59	26.26	50.5	143.9
7	CD (0.05)	101.5	32.9	0.74	0.24	1.25	5.71	4.1	29.1
8	CV (%)	13.67	15.4	14.02	15.47	10.83	21.9	5.49	21.9

S. No	Traits	GFY (q/ha)	DFY (q/ha)	GFY/day (q/ha)	DFY/day (q/ha)	Protein %	PY (q/ha)	IVDMD (%)	DDM (q/ha)
9	Lines signi.> check	SPH1697 SPV 2242	SPV 2242	SPH1697 SPV 2242	SPV 2242	Nil	SPV 2242	Nil	SPV 2242
10	Lines > check	SPH 1700	SPH 1697	SPH 1700	SPH 1697	SPH 1748, SPH 1717, SPH 1698	SPH 1697, SPH 1748, SPH 1750, SPH 1700, SPH 1752	SPH 1748, SPH 1751, SPH 1717, SPH 1697, SPH 1752, SPH 1750, SPH 1749, SPH 1715, SPH 1753, SPH 1700	SPH 1697, SPH 1748, SPH 1750, SPH 1700, SPH 1753
11	Data from loc. (no)	13	13	13	12	7	7	7	7
12	Loc. for national av. (no)	12	11	12	11	7	7	7	7

3.1 Initial, Advanced Varietal and Hybrid Trial for multi-cut forage sorghum (IAVHT-MC)

The initial and advanced varietal and hybrid trial for multi cut forages was carried out with 17 genotypes including 12 test hybrids (six in initial level of testing, 4 in first year of advanced testing and two in second year of advanced testing), one test variety in initial level of testing, three multicut checks (CSH 20MF, CSH 24MF, SSG 59-3) and one local check. The results of the trial are presented below (Tables 3.1 to 3.35 and 3.A and 3.K).

Zone-I:

Yield parameters

Green fodder yield: The multicut variety, SPV 2242 (1008 q/ha) ranked first for total green fodder yield with significant improvement over the check, SSG 59-3 (808 q/ha) in this zone. Among the hybrids, SPH 1697 (1003 q/ha) ranked first for total green fodder yield followed by CSH 20MF (907 q/ha) and SPH 1700 (902 q/ha). The latest hybrid check, CSH 24MF yielded 872 q/ha of total green fodder yield from three cuts in zone I. Considering the green fodder yield in individual cuts, SPH 1697 showed consistently good yield in all the 3 cuttings in this zone. SPV 2242 recorded excellent performance in second and third cuts indicating high regeneration ability of this variety.

Dry fodder yield: For total dry fodder yield also, SPV 2242 (285 q/ha) ranked first with significant improvement over SSG 59-3 (241 q/ha). Among the hybrids, SPH 1697 (272 q/ha) was in first position followed by the hybrid check, CSH 20MF (253 q/ha) and SPH 1700 (250 q/ha) and SPH 1695 (247 q/ha) in this zone. The check, CSH 24MF recorded 243 q/ha of total dry fodder yield in this zone. SPH 1697 performed consistently well in all three cuts. SPV 2242, eventhough has not shown superior performance in first cut, it performed very well in second and third cuts.

Green fodder yield per day: Average per day productivity of green fodder over 3 cuts was reported to be high in SPV 2242 (7.07 q/ha) which is significantly higher than that of SSG 59-3 (5.59 q/ha). This was followed by SPH 1697 (7.42 q/ha). The checks, CSH 20MF and CSH 24MF yielded 6.25 q/ha 5.96 q/ha of green fodder yield per ha per day. The per day productivity of SPH 1697 was consistently good in all the 3 cuts.

Dry fodder yield per day: Per day productivity of dry fodder over all the cuts was also high the variety, SPV 2242 followed by the hybrid, SPH 1697 (1.96 q/ha) and CSH 20MF (1.81 q/ha). The other check, CSH 24MF recorded 1.75 q/ha of dry fodder per day in this zone. SPH 1697 showed relatively good per day productivity in all the three cuts.

Phenology and morphological parameters

Days to 50% flowering ranged from 63 to 78 days among the hybrids. SPH 1715 was the earliest hybrid in this zone, followed by SPH 1752 and SPH 1753 (65 days). The checks, CSH 20MF and CSH 24MF flowered in 68 and 72 days respectively.

Early vigour was found to be high in CSH 20MF (3.81) followed by SPH 1695 (3.80). The other check CSH 24MF recorded early vigour score of 3.54.

Plant height: SPH 1695 was the tallest (229 cm) among the test entries, followed by SPH 1751 (228 cm) and SPH 1750 (227 cm). The check hybrid, CSH 20MF was 208 cm tall, while CSH 24MF had 204 cm of height.

Leaf parameters: The number of leaves varied from 11 to 12 in different genotypes, with more leaves in SSG 59-3 (12.3). Long and broad leaves were observed in SPH 1748 (84 cm; 6.6 cm) and SPH 1697 (84 cm; 6.7 cm) in this zone. The checks, CSH 20MF and CSH 24MF recorded 82 and 82.9 cm of leaf length and 6.1 and 6.7 cm of leaf breadth respectively.

Stem girth varied from 2.33 cm to 3.0 cm. Thin stems (2.33 cm) were observed in SSG 59-3 followed by SPV 2242 (2.47 cm) in this zone.

Number of tillers ranged from 3-6 in all the genotypes tested, the highest being in SPV 2242 (6.25) followed by SSG 59-3 (4.36).

High leaf-stem ratio was observed in SPH 1715 and CSH 24MF (0.44) followed by SPH 1752 (0.43) and SPH 1748 (0.42). The check, CSH 20MF recorded leaf-stem ratio of 0.43.

Zone-II:

Yield parameters

Green fodder yield: In the zone II, SPH 1697 produced highest green fodder yield across all the cuts (1106 q/ha), followed by SPH 1717 (984 q/ha) and SPH 1700 (983 q/ha) where CSH 20MF and CSH 24MF had given 927 q/ha and 916 q/ha of total green fodder in this zone. SPH 1697 showed consistently superior performance in each of the individual cuts in this zone. The variety SPV 2242 (892 q/ha) recorded high green fodder yield compared to the check, SSG 59-3 (748 q/ha) in this zone also.

Dry fodder yield: For total dry fodder yield also, SPH 1697 (337 q/ha) ranked first in zone II, followed by SPV 2242 (322 q/ha). The checks, CSH 20MF, CSH 24MF and SSG 59-3 yielded 300 q/ha, 276 q/ha and 237 q/ha of total dry fodder yield in this zone. SPH 1697 consistently well in all the three cuts.

Green fodder yield per day: The average green fodder yield per day over all the 3 cuts ranged from 5.63 to 8.41 q/ha, the highest being in SPH 1697 (8.41 q/ha) followed by SPH 1700 (7.40 q/ha) and SPH 1717 (7.40 q/ha) in this zone. The hybrid checks, CSH 20MF and CSH 24MF yielded 6.92 and 6.93 q/ha of green fodder per day respectively in this zone.

Dry fodder yield per day: Per day productivity of dry fodder in this zone ranged from 1.53 q/ha to 2.28 q/ha, the highest being in SPH 1697 (2.28 q/ha), followed by SPV 2242 (2.13 q/ha) and SPH 1717 (2.04 q/ha). The checks, CSH 20MF, CSH 24MF and SSG 59-3 recorded 1.96, 1.91 and 1.53 q/ha of dry fodder yield per day in this zone.

Phenology and morphological parameters

Days to 50% flowering: All the genotypes flowered earlier compared to zone I. It ranged from 59 to 67 days. SPH 1715 and SPH 1751 were the early genotypes to flower (59 days).

Early vigour was observed to be high in SPH 1697, SPH 1698, SPH 1700, SPH 1715, SPH 1717, SPH 1748, SPH 1751, SPH 1752, all with vigour score of 4.0 in this zone.

Plant height ranged from 213 to 257 cm in this zone. SPH 1752 was the tallest, followed by SPH 1697 (254 cm) among the hybrids.

Leaf parameters: Number of leaves ranged from 15 to 24 in different genotypes. SPV 2242 ranked first for leaf number (24) followed by SPH 1715 (20). Long and broad leaves were observed in SPH 1697 (83 cm long and 7.3 cm broad) and SPH 1717 (82 cm long and 6.9 cm broad). SPV 2242 had long (85 cm) and narrow leaves (5.0 cm broad).

Stem girth varied from 3.01 cm to 4.03 cm. Thin stems (3.01 cm) were observed in SSG 59-3 followed by SPH 1715 (3.12 cm) in this zone.

Number of tillers ranged from 1-5 in all the genotypes tested, the highest being in SPV 2242 (5.33) followed by SSG 59-3 (2.67).

Leaf-stem ratio ranged from 0.41 to 0.47 and was higher in SPV 2242 (0.47), followed by SPH 1749 (0.47).

National level:

Yield parameters

Green fodder yield: The hybrid SPH 1697 (1037 q/ha) ranked first for green fodder yield at National level with 14% and 17% increase over the checks, CSH 20MF (913 q/ha) and CSH 24MF (886 q/ha) respectively. It is significantly superior to both the checks. Another hybrid, SPH 1700 (929 q/ha) showed 5% improvement over CSH 24MF. SPH 1697 performed well in all the three cuts. The variety, SPV 2242 (969 q/ha) recorded significant improvement over SSG 59-3 (788 q/ha).

Dry fodder yield: It ranged from 231 to 295 q/ha at all India level. SPV 2242 ranked first for total dry fodder yield (295 q/ha) which recorded significant improvement over the check, SSG 59-3 (240 q/ha). The hybrid, SPH 1697 (289 q/ha) recorded 9% and 15% improvement over the checks, CSH 20MF (266 q/ha) and CSH 24MF (252 q/ha). Another hybrid, SPH 1700 (262 q/ha) recorded 4% improvement over CSH 24MF. The hybrid SPH 1697 performed well in all the three cuts for dry fodder yield also.

Green fodder yield per day: For per day productivity of green fodder also SPH 1697 (7.42 q/ha) ranked first, while SPV 2242 (6.99 q/ha) occupied the second place. The checks, CSH 20MF and CSH 24MF recorded 6.47 q/ha and 6.28 q/ha of green fodder per day respectively.

Dry fodder yield per day: Per day dry fodder productivity was high in SPV 2242 (2.11 q/ha) followed by SPH 1697 (2.07 q/ha) and CSH 20MF (1.86 q/ha). CSH 24MF recorded 1.81 q/ha of dry fodder yield per day.

Phenology and morphological parameters

Days to 50% flowering ranged from 61 - 69 days. SPH 1715 was the earliest to flower (61 days) among all the genotypes, where the checks, CSH 20MF and CSH 24MF flowered in 65 and 68 days respectively.

Early vigour ranged from 3.41 to 3.83. CSH 20MF showed highest vigour (3.83), followed by SPH 1695 and SPH 1751 (3.78). The other checks recorded early vigour score of 3.61 (SSG 59-3) and 3.6 (CSH 24MF).

Plant height ranged from 204 to 235 cm. SPH 1695 was the tallest among all (235 cm), followed by SPH 1753 (233 cm) and SPH 1752 (232 cm).

Leaf parameters: Among all the entries, more number of leaves were observed in SPV 2242 (15), followed by SPH 1715 (14). SPH 1697 was found to be good with desirable leaf parameters such as long (83 cm) and wide (6.9 cm) leaves. SPH 1717 was also found to have longer (82 cm) and wider (6.65 cm) leaves, besides the check, CSH 24MF (82 cm; 6.8 cm).

Stem girth ranged from 2.52 to 3.16 cm. SSG 59-3 was found to have thin stems (2.52 cm) followed by SPV 2242 (2.66 cm).

Number of tillers varied from 3-6 in all the genotypes, the highest being in SPV 2242 (6.25), followed by SSG 59-3 (4.36). Among the hybrids, high tiller number was observed in SPH 1695 (4.23), while it was 3.67 in CSH 20MF and 3.59 in CSH 24MF.

For *leaf-stem ratio*, CSH 24MF was the best genotype (ratio of 0.45) followed by SPH 1715 (0.44) and SPH 1748 (0.43). The hybrid checks showed leaf-stem ratio of 0.43 (CSH 20MF) and 0.45 (CSH 24MF).

Regenerability score: Since regeneration is a very important trait for multi-cut forages, it was scored on a 1-5 scale, where 1 is poor regeneration and 5 is high regeneration. In this trial, it ranged from 2.76 to 4.10. SPV 2242 (4.1) had the best regeneration capacity followed by SPH 1752 and SPH 1695 (3.67).

Reaction to major pests and diseases

Shoot fly incidence was found to be in the range of 53.2 to 65.8% deadhearts in the multi-cut entomology trial at all India level. The hybrid, SPH 1695 recorded 53% of deadhearts followed by CSH 24MF (54%), SSG 59-3 (56%) and SPH 1717 with 56.9% shoot fly deadhearts. Another hybrid check, CSH 20MF recorded 64% of deadhearts.

Stem borer incidence in the multi-cut entomology trial ranged from 14.2% to 20.1% of stem borer deadhearts. Again SPH 1695 showed less of stem borer deadhearts (14.2%) followed by SPH 1698 (14.7%) and SPV 2242 (15.2%). The hybrid checks, CSH 20MF and CSH 24MF recorded 16.1% and 18.3% of stem borer deadhearts respectively.

For *leaf diseases* all the genotypes were observed to be on par with the checks. The hybrids SPH 1753 and SPV 2242 were found to have multiple resistance to leaf diseases.

Quality parameters

Total soluble sugars ranged from 6.4 to 7.91% at all India level. Among the test hybrids, TSS was found to be high in SPH 1715 (7.91%) followed by SPH 1695 (7.75%) and SPH 1750 (7.61%). The checks CSH 20MF and CSH 24MF recorded 6.69% and 6.74% of TSS respectively.

HCN of all the test entries was within the safe limit ranging from 48 to 66.5 ppm during the first cut, the lowest value being in SPH 1715.

Protein percent ranged from 7.51 to 8.97%, the highest being in SSG 59-3, followed by SPH 1748 (8.92%) and SPH 1717 (8.66%). The checks CSH 20MF and CSH 24MF recorded 8.2% and 8.59% of protein respectively.

Average protein yield over two cuts was high in SPV 2242 (26.3 q/ha), followed by SPH 1697 (22.9 q/ha) and SPH 1748 (22.3 q/ha). The checks yielded 19.9 q/ha (CSH 20MF), 19.3 q/ha (CSH 24MF) and 19.9 q/ha (SSG 59-3) of protein.

IVDMD values ranged from 46.6 to 50.5%. The hybrid SPH 1748 had high IVDMD value (50.5%) followed by SPH 1751 (50.1%) and SPH 1717 (50%) compared to the checks, CSH 20MF (48.3%) and CSH 24MF (48.1%).

Total digestible dry matter (DDM) over two cuts ranged from 101.3 to 143.9 q/ha in this trial. It was highest in the variety SPV 2242 (143.9 q/ha) followed by SPH 1697 (135 q/ha), SPH 1748 (119 q/ha) and SPH 1750 (119 q/ha). The hybrid checks, CSH 20MF and CSH 24MF recorded 115 and 105 q/ha of digestible dry matter.

The performance of promising multi-cut genotypes tested during kharif 2013 are given in table 7.

Table 7. Performance of promising multi-cut sorghum genotypes in initial and advanced trial
(Entries- 13; Checks- 3; Locations: 13)

Entry	GFY (q/ha)				DFY (q/ha)				GFY/day (q/ha)		DFY/day (q/ha)	
	R	% +/- over CSH 20MF	% +/- over CSH 24MF		R	% +/- over CSH 20MF	% +/- over CSH 24MF		R		R	
Hybrids												
SPH 1697	1037*	1	13.6	17.0	289	2	8.7	14.8	7.42*	1	2.07	2
SPH 1700	929	3	1.69	4.8	262	4	-1.62	3.93	6.59	3	1.85	4
SPH 1748	872	7	-4.5	-1.6	251	7	-5.64	-0.32	6.17	9	1.75	9
Checks												
CSH 20MF	913	4			266	3			6.47	4	1.86	3
CSH 24MF	886	5			252	6			6.28	5	1.81	5
Varieties												
SPV 2242	969*	2	23.1	-	295*	1	22.8	-	6.99*	2	2.11*	1
SSG 59-3	788	16			240	12			5.61	16	1.68	14
CD (5%)	101.5				32.9				0.74		0.24	
CD (1%)	134.1				43.5				0.97		0.32	
C.V. (%)	13.7				15.4				14.0		15.5	

Entry	PY (q/ha)		DDM (q/ha)		SF	SB	ALS	ZLS	LB
	R		R						
Hybrids									
SPH 1697	22.9	2	134.8	2	61.3	15.7	4.4	4.0	2.7
SPH 1700	20.7	5	118.6	5	58.5	16.6	3.7	3.1	3.7
SPH 1748	22.3	3	119.4	3	62.4	15.9	3.8	3.0	2.8
Checks									
CSH 20MF	19.9	7	115.4	7	64.2	16.1	3.6	3.2	2.8
CSH 24MF	19.3	10	104.5	13	54.0	18.3	3.3	2.9	3.0
Varieties									
SPV 2242	26.3	1	143.9	1	62.5	15.2	3.3	2.6	2.7
SSG 59-3	19.9	8	108.9	10	56.0	15.4	4.4	3.5	3.3
CD (5%)	5.71		29.1		13.5	7.6	1.2	1.6	1.3
CD (1%)	7.62		38.8		18.0	10.2	1.7	2.1	1.8
C.V. (%)	21.9		21.9		15.7	27.9	19.0	25.2	20.9

GFY- Green fodder yield, DFY- Dry fodder yield, PY- Protein yield; DDM- Digestible dry matter, DH- deadhearts, SF- Shoot fly, SB- Stem borer, ALS- Anthracnose leaf spot, ZLS- Zonate leaf spot, GLS- Grey leaf spot, LB-Leaf Blight

Conclusions: The hybrid, SPH 1697 and the variety, SPV 2242 recorded more than 10% improvement for both green and dry fodder yields over the respective hybrid and varietal checks. Their per day productivity of green and dry fodder yields was also high compared to the checks. The hybrid in the advanced testing, SPH 1700 recorded 4- 5% improvement for green and dry fodder yields over CSH 24MF. Performance of the hybrids over three years in AICSIP multilocation trials is given in the Table 8.

Table 8: Performance of Multicut cut forage sorghum genotypes tested in AICSIP over last 3 years

Entry	Year	Yield						Quality				Insect pests DH (%)		Diseases (score)				
		GFY (q/ha)		DFY (q/ha)		GFY/day (q/ha)	DFY/day (q/ha)	PY (q/ha)		DDM (q/ha)		SF	SB	ZLS	ALS	LB		
		R		R		R	R	R	R	R								
SPH 1697	2011	1017	2	242	1	7.40	2	2.04	4	18.3	2	112	1	63.1	20.2	3.11	1.92	2.67
	2012	860	4	256	4	6.36	4	1.95	4	18.8	4	103.0	8	72.6	15.3	4.67	2.25	3.78
	2013	1037*	1	289	2	7.42*	1	2.07	2	22.9	2	134.8	2	61.3	15.7	4.0	4.4	2.7
	Av	971.3		262.3		7.06		2.02		20.0		116.6		65.7	17.1	3.93	2.86	3.05
SPH 1698	2011	975	3	238	3	7.24	4	2.18	1	18.1	3	103	3	62.6	16.7	3.00	1.83	2.33

Entry	Year	Yield								Quality				Insect pests DH (%)		Diseases (score)		
		GFY (q/ha)	DFY (q/ha)	GFY/day (q/ha)	DFY/day (q/ha)	PY (q/ha)	DDM (q/ha)	SF	SB	ZLS	ALS	LB						
	2012	858	5	253	5	6.31	5	1.91	5	16.9	8	107.9	6	70.9	15.8	4.78	2.25	3.44
	2013	823	12	243	10	5.84	13	1.71	10	19.7	9	106.8	12	65.8	14.7	3.3	4.2	3.2
	Av	885.3		244.7		6.46		1.93		18.2		105.9		66.4	15.7	3.69	2.76	2.99
CSH 20MF	2011	934	6	218	7	6.88	5	1.90	8	16.9	6	99.3	5	61.2	13.9	3.11	1.83	2.00
	2012	888	3	262	2	6.53	3	1.99	2	17.8	6	111.0	4	73.0	16.7	6.33	3.00	4.56
	2013	913	4	266	3	6.47	4	1.86	3	19.9	7	115.4	7	64.2	16.1	3.2	3.6	2.8
	Av	911.7		248.7		6.63		1.92		18.2		108.6		66.1	15.6	4.21	2.81	3.12
CSH 24MF	2011	936	5	221	6	6.74	6	1.91	6	16.9	5	95.2	7	64.9	18.7	2.67	1.92	3.00
	2012	807	8	229	10	5.99	8	1.75	9	15.1	9	89.2	9	65.4	19.5	5.33	2.58	3.78
	2013	886	5	252	6	6.28	5	1.81	5	19.3	10	104.5	13	54.0	18.3	2.9	3.3	3.0
	Av	876.3		234.0		6.34		1.82		17.1		96.3		61.4	18.8	3.63	2.60	3.26

GFY- Green fodder yield, DFY- Dry fodder yield, PY- Protein yield; DDM- Digestible dry matter, SF- Shoot fly (% deadhearts), SB- Stem borer (% deadhearts), ZLS- Zonate leaf spot, ALS- Anthracnose leaf spot, LB- Leaf Blight (1-9 scale)

Over three years, the hybrid, SPH 1697 showed superiority for fodder yield, per day productivity and quality in comparison to both the checks. For pest and disease resistance, it is on par with the checks.

Trial 4. Advanced seed yield trial

The seed yield trial was taken up at 5 locations to understand the seed production ability of the varieties in advanced trials of single-cut sorghum. There were 6 test entries and two checks, CSV 21F and HC 308. Data was recorded on grain yield, dry fodder yield, days to 50% flowering, days to maturity and plant height (Tables 4.1 to 4.3). The results are discussed below.

Grain yield ranged from 21 to 24 q/ha. The best genotype with high grain yield was SPV 2128 (24 q/ha) followed by SPV 2211, SPV 2185 and SPV 2186, all with grain yield of 22 q/ha. All the entries were on par with the single cut checks, HC 308 and CSV 21F which yielded 21-22 q/ha of grain.

Dry fodder yield at all India level varied from 154 q/ha to 199 q/ha, the highest being in SPV 2191 (199 q/ha), followed by CSV 21F (192 q/ha) and SPV 2128 (189 q/ha). HC 308 yielded 183 q/ha of dry fodder at all India level in this trial.

Days to flower ranged from 70 to 79 days at all India level. SPV 2128 was the earliest to flower in 70 days. Days to maturity ranged from 106-118 days, with SPV 2128 being early to mature in 106 days followed by SPV 2186 (107 days)

Table 8. Seed yield potential of single-cut forage sorghum genotypes in AVT (SC)

(Entries- 6; Checks- 2; Locations: 5)

S. No.	Entry	Grain yield (q/ha)	R	Days to 50% flowering	Days to maturity	Plant height (cm)	Early vigour
1	SPV 2128	24.0	1	70	106	240	4.00
2	SPV 2211	22.0	3	79	118	282	3.83
3	SPV 2185	22.0	2	71	108	270	3.94
4	SPV 2186	22.0	4	71	107	265	3.83
5	CSV 21F	21.0	9	75	113	262	4.06
6	SPV 2190	21.0	6	76	114	252	4.28
7	SPV 2191	21.0	8	76	115	265	3.78
8	HC 308	21.0	7	75	111	257	3.78
9	CSV 21F	22.0	5	75	112	266	4.00
	C.D. (5%)	3.0		6.51	6	28.00	0.51
	C.D. (1%)	4.0		8.75	9	37.00	0.71
	C.V. (%)	8.7		6.79	3	8.16	7.52

Conclusions: The single-cut variety, SPV 2128 was found to yield more grain compared to the checks at all India level.

Trial 5. Evaluation of Sudangrass germplasm lines

An effort was made to evaluate the sudangrass germplasm lines as a part of Co-ordinated forage sorghum research involving different forage centres with an aim to diversify multi-cut genetic base. 17 germplasm lines were collected from different centres and they were evaluated against the check, SSG 59-3. A total of 18 genotypes were tested at 3 centres, *i.e.* at Pantnagar, Hisar and DSR Hyderabad in RCBD with two replications. These lines were evaluated for their fodder yield components and quality. The performance of these hybrids is given in Tables 9-11. For green fodder yield, CO(FS) 29 was in first rank with 1273 q/ha of green fodder. It was followed by IS 30209 (738 q/ha) and Pant Chari 8 (713 q/ha). Both these lines recorded superior fodder yield compared to SSG 59-3 (693 q/ha). For dry fodder yield also, CO(FS) 29 (279 q/ha) had taken the first position. Next comes, IS 14278 (167 q/ha), SGL 98-M (159 q/ha), IS 30209 (152 q/ha) and SSG 231 (152 q/ha).

Table 9. Performance of sudangrass germplasm lines for green and dry fodder yields

S. No.	Genotype	Green fodder yield (q/ha)					Dry fodder yield (q/ha)				
		PANT	HIS	HYD	Av	R	PANT	HIS	HYD	Av	R
1	IS 14278	1283.2	341.7	441.6	688.8	5	295.1	90.9	116.0	167.3	2
2	IS 607	1249.9	310.5	256.2	605.5	11	250.0	65.3	72.7	129.3	13
3	SSG 231	1099.9	368.8	570.8	679.8	6	220.0	87.5	149.1	152.2	5
4	IS 20624	1366.5	267.7	350.0	661.4	8	273.3	76.7	93.2	147.7	8
5	IS 30209	1333.2	345.8	535.3	738.1	2	253.3	71.3	132.4	152.3	4
6	PANT CHARI 8	1216.6	390.7	531.2	712.8	3	243.3	72.1	128.1	147.8	7
7	PANT CHARI 9	1199.9	470.8	318.7	663.1	7	228.0	96.5	87.1	137.2	10
8	SGL 87	916.6	384.4	399.9	567.0	13	201.6	73.1	108.3	127.7	14
9	SGL 60	966.6	524.0	350.0	613.5	10	212.6	80.5	102.3	131.8	12
10	SGL 70	900.0	401.1	366.6	555.9	14	207.0	93.8	105.9	135.5	11
11	SGL 98-1	916.6	437.5	297.9	550.6	15	229.2	102.1	88.0	139.7	9
12	SGL 98-5	916.6	388.6	314.6	539.9	16	192.5	81.5	77.9	117.3	17
13	SGL 98-M	1066.6	464.6	439.5	656.9	9	266.7	83.8	126.7	159.0	3
14	IS 3266	1016.6	177.1	322.9	505.5	17	233.8	42.3	83.1	119.7	15
15	IS 3191	1033.2	143.8	220.8	465.9	18	206.6	36.7	52.4	98.6	18
16	IS 869	1166.6	380.3	222.9	589.9	12	245.0	56.5	52.2	117.9	16
17	SSG 59-3	1099.9	408.4	570.8	693.0	4	220.0	85.7	139.3	148.3	6
18	CO (FS)29	2066.5	805.2	945.7	1272.5	1	434.0	162.3	239.5	278.6	1
	Mean	1156.4	389.5	414.2	653.3		245.1	81.0	108.5	144.9	
	C. V.	7.7	23.2	13.5	14.8		7.8	20.2	14.1	14.0	
	F Prob.	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	
	CD 95%	187.4	190.5	118.2	165.4		40.2	34.5	32.2	35.7	
	CD 99%	257.5	261.7	162.4	227.2		55.2	47.4	44.3	49.0	

Table 10: Performance of sudangrass germplasm lines for morphological traits

S No.	Genotype	Plant ht (cm)	Leaves/plant	LS ratio	Leaf Length (cm)	Leaf Breadth (cm)	Stem Girth (cm)	Tillers
1	IS 14278	203.0	16.78	0.35	68.5	5.67	2.38	4.39
2	IS 607	193.2	12.67	0.35	65.7	5.87	2.29	2.39
3	SSG 231	203.4	18.17	0.36	78.4	4.40	1.81	5.61
4	IS 20624	178.5	33.33	0.44	73.6	3.51	1.55	7.78
5	IS 30209	200.5	12.39	0.34	80.8	6.91	2.33	3.33
6	PANT CHARI 8	216.1	13.56	0.31	76.4	5.21	2.17	2.67
7	PANT CHARI 9	218.3	12.33	0.32	72.5	6.44	2.11	2.67
8	SGL 87	187.0	14.89	0.41	67.6	4.20	1.87	5.28
9	SGL 60	214.9	25.67	0.35	56.6	3.32	1.52	6.83
10	SGL 70	206.2	26.00	0.32	52.1	3.25	1.80	5.44
11	SGL 98-1	211.4	18.39	0.33	56.3	3.67	1.62	5.33
12	SGL 98-5	172.4	26.56	0.48	66.4	4.98	1.61	5.17
13	SGL 98-M	200.7	28.34	0.33	63.2	4.36	1.68	6.56
14	IS 3266	184.6	23.61	0.37	62.1	4.18	1.73	4.95
15	IS 3191	151.7	27.39	0.38	65.6	4.71	1.82	6.11
16	IS 869	159.2	29.39	0.47	70.9	4.56	1.95	7.22
17	SSG 59-3	202.2	31.67	0.38	80.8	4.28	1.48	5.67
18	CO (FS)29	225.1	55.83	0.36	91.2	4.41	2.09	9.67
	Mean	196.0	23.72	0.37	69.4	4.66	1.88	5.39
	C. V.	9.8	14.91	14.43	10.8	13.64	13.07	22.13
	F Prob.	0.0	0.01	0.01	0.0	0.00	0.00	0.11
	CD 95%	36.4	9.83	0.12	14.8	1.26	0.58	2.52
	CD 99%	50.0	13.50	0.16	20.3	1.73	0.80	3.46

CO(FS) 29 was the tallest among all the genotypes, followed by Pant Chari 9 (Table 10). More leaf number was observed in IS 20624, IS 869 and SGL 98-M, besides CO(FS) 29. Long leaves were observed in CO(FS) 29, IS 30209, SSG 59-3 and SSG 231. Broad leaves were observed in IS 30209 and Pantchari 9. More number of tillers were observed in CO(FS) 29 (10), IS 20624 (7.78), IS 869 (7.22) and SGL 60 (6.83). High protein was observed in IS 3191 (11.1%). IS 869, SGL 70, SGL 87, Pantchari 9, SGL 98-M and IS 30209 had protein more than 10% while it was 9.8% in SSG 59-3. Protein yield was high in CO(FS) 29, SGL 98-M and IS 14278 (Table 11). High IVDMD was observed in IS 30209 (58%) followed by SGL 87 and IS 607. High DDM was recorded in CO(FS) 29 and IS 30209.

Table 11. Performance of sudangrass germplasm lines for fodder quality traits

S No.	Genotype	Pedigree	Centre	Protein %	Protein Yield (q/ha)	IVDMD %	DDM (q/ha)
1	SGT 1	IS 14278	Pantnagar	9.91	14.84	51.29	93.85
2	SGT 2	IS 607	Pantnagar	9.41	10.79	56.91	82.40
3	SGT 3	SSG 231	Pantnagar	9.78	14.13	54.61	89.10
4	SGT 4	IS 20624	Pantnagar	9.87	13.00	52.78	89.30
5	SGT 5	IS 30209	Pantnagar	10.07	13.99	58.17	97.62
6	SGT 6	PANT CHARI 8	Pantnagar	9.79	13.84	53.84	83.91
7	SGT 7	PANT CHARI 9	Pantnagar	10.37	12.89	54.21	79.27
8	SGT 8	SGL 87	Ludhiana	10.54	12.33	57.99	76.62
9	SGT 9	SGL 60	Ludhiana	10.08	12.08	50.89	72.15
10	SGT 10	SGL 70	Ludhiana	10.66	13.30	49.22	70.81
11	SGT 11	SGL 98-1	Ludhiana	9.99	12.69	51.83	76.63
12	SGT 12	SGL 98-5	Ludhiana	9.75	10.23	51.87	64.48
13	SGT 13	SGL 98-M	Ludhiana	10.54	14.97	55.06	90.88
14	SGT 14	IS 3266	DSR	9.85	10.33	50.61	65.06
15	SGT 15	IS 3191	DSR	11.13	9.08	52.87	59.17
16	SGT 16	IS 869	DSR	10.80	10.03	53.47	72.26
17	SGT 17	SSG 59-3		9.79	13.63	53.21	83.66
18	SGT 18	CO (FS)29		9.97	25.36	48.79	144.25
	Mean			10.13	13.19	53.20	82.86
	C. V.			4.29	14.29	2.91	14.60
	F Prob.			0.00	0.00	0.00	0.00
	C.D. (5%)			1.00	3.67	3.57	21.87
	C.D. (1%)			1.37	5.05	4.90	30.04

Conclusions: The genotypes CO(FS) 29 and IS 30209 were found promising for various fodder yield and quality traits.

Trial 6. Evaluation of brown midrib lines

Brown midrib lines were observed to be associated with low lignin content in the leaves and stems and hence were expected to have high digestibility. Hence to improve the forage quality, brown midrib genotypes may be incorporated into the crossing program. Eventhough it is a general statement that brown midrib lines are associated with high digestibility, it is always advisable to evaluate the lines for quality traits before involving them in the crossing program. Under AICSIP forages, an effort was made to collect brown midrib genotypes both from germplasm and advanced breeding nursery and evaluate these lines for yield and fodder quality. 15 brown midrib lines were collected which includes advanced breeding lines with bmr trait, germplasm lines and improved lines from ICRISAT, and they were evaluated along with the checks, HC 308, CSV 21F and SSG 59-3. A total of 18 genotypes were tested at 3 centres, i.e. at Pantnagar, Hisar and DSR, Hyderabad in RCBD with two replications. These lines were evaluated for their fodder yield components and quality. Yield and quality data could not be obtained from Hisar because of poor growth in the initial crop stage. The data from two centers was used for analysis. The performance of these hybrids is given in Tables 9-11.

For green fodder yield, PBMR 1 was in first rank with 795 q/ha of green fodder. It was followed by PBMR 3 (696 q/ha) and PBMR 4 (680 q/ha). Both these lines recorded superior fodder yield compared to all the checks (Table 12). For dry fodder yield, PBMR 5 ranked first (162 q/ha) followed by PBMR 1(161 q/ha) and PBMR 2 (153 q/ha). In general the advanced breeding lines (PBMR 1 to PBMR 8) performed better for yield traits.

Table 12. Performance of brown midrib lines for green and dry fodder yields

S. No.	Genotype	GFY (q/ha)	DFY (q/ha)	Early vigor	DF	Plant ht	Leaf no.	Leaf length	Leaf width	Leaf:Stem	Stem girth
1	PBMR 1	795.0	160.5	3.13	73.5	233.2	11.9	79.1	7.2	0.27	1.63
2	PBMR 2	644.1	153.0	3.63	67.0	222.5	12.1	75.9	7.5	0.27	1.48
3	PBMR 3	695.8	151.0	3.38	67.0	222.9	12.2	88	8.7	0.25	2
4	PBMR 4	680.0	138.3	3.63	73.5	211.8	11.6	85.7	8.5	0.28	1.73
5	PBMR 5	624.1	161.9	3.38	69.5	261.8	12.6	86.8	8.1	0.26	1.96
6	PBMR 6	625.0	152.5	3.38	70.0	205.9	11.5	83.8	7.8	0.31	1.77
7	PBMR 7	594.2	144.9	3.25	72.5	201.6	10.7	77.8	7.1	0.34	1.75
8	PBMR 8	557.5	109.7	3.76	65.5	177.9	12.7	71.7	7	0.32	1.85
9	EC 582510	347.3	79.4	2.25	72.0	179.2	9.6	64.7	7.4	0.34	1.5
10	EC 582508	351.6	85.6	2.75	71.5	171	9.7	63.5	7	0.26	1.55
11	EC 582504	339.4	81.0	2.75	69.5	180.6	11	65.8	6.4	0.3	1.48
12	BMR 233691	462.1	109.9	2.63	81.0	146.2	10.5	84.5	9.4	0.4	1.93
13	BMR 23375	396.1	85.3	3.74	79.5	142.3	10.2	88.1	8.4	0.35	1.77
14	BMR 23150	330.7	63.3	2.26	72.4	112.5	10.3	77.6	8.1	0.36	1.95
15	BMR 231581	422.3	84.7	2.24	72.4	137.1	10.8	74.4	8.4	0.34	1.69
16	HC 308	383.1	106.0	4.00	78.0	258.5	12.8	69.8	3.8	0.35	1.09
17	CSV 21F	606.6	143.3	4.00	76.5	232.2	11.3	72.8	6.6	0.3	1.32
18	SSG 59-3	496.6	116.4	3.75	72.0	242.8	12.1	70.6	6.1	0.22	1.39
	lsd 5%	118.1	33.3	0.65	2.8	24.1	1.56	6.31	0.73	0.06	0.18
	CV %	15.7	19.5	14.00	2.5	8.5	9.6	5.7	6.8	13.7	7.4

PBMR 8 was the earliest genotype to flower with 66 days to flower. PBMR 5 had more number of leaves (13). PBMR 3 and BMR 23375 had long and broad leaves.

Table 13. Performance of brown midrib lines for fodder quality traits

S No.	Genotype	Pedigree	Protein %	Protein Yield (q/ha)	IVDMD %	DDM (q/ha)
1	BMR 1	PBMR 1- UP Chari 2 x EC 582506	9.49	14.25	54.33	84.42
2	BMR 2	PBMR 2- Pant Chari 5 x EC 582508	9.55	12.49	57.39	82.29
3	BMR 3	PBMR 3- EC 582506 x Pant Chari 5-1	9.04	13.77	58.1	81.12
4	BMR 4	PBMR 4- EC 582506 x Pant Chari 5-2	9.09	12.9	58.17	73.57
5	BMR 5	PBMR 5- EC 582506 x UP Chari 2	8.32	13.13	58.95	87.22
6	BMR 6	PBMR 6- EC 582506 x UP Chari 3-1	7.73	11.54	58.56	82.81
7	BMR 7	PBMR 7- EC 582506 x UP Chari 3-2	8.29	12.93	59.25	81.62
8	BMR 8	PBMR 8- EC 582506 x UP Chari 3-3	9.15	9.83	58.86	59.63
9	BMR 9	EC 582510	8.58	8.03	58.54	46.15
10	BMR 10	EC 582508	7.75	6.21	61.52	50.17
11	BMR 11	EC 582504	8.06	6.41	63.39	48.59
12	BMR 12	BMR 233691	9.73	10.68	57.8	58.51
13	BMR 13	BMR 23375	9.37	7.14	55.47	42.84
14	BMR 14	BMR 23150	8.93	7.2	50.6	32.55
15	BMR 15	BMR 231581	9.13	8.49	59.25	47.45
16	BMR 16	HC 308	8.17	6.62	54.04	45.92
17	BMR 17	CSV 21F	9.21	11.94	58.72	79.86
18	BMR 18	SSG 59-3	9.06	9.9	52.78	56.32
	lsd 5%		1.06	3.76	3.59	18.4
	CV %		8.3	25.5	4.3	20

High protein was observed in BMR 233691 (9.73%), followed by PBMR 2 (9.55%). Four bmr lines recorded protein percent higher than the best check, CSV 21F. Protein yield was high in PBMR 1, followed by PBMR 3 and PBMR 5. High IVDMD was observed in the bmr germplasm, EC 582504 (63.4%) followed by EC 582508 (61.5%). Among the improved bmr lines, PBMR 7 (59.3%) was the best. For DDM, PBMR 5 and PBMR 1 were more promising.

Conclusions: The bmr lines, EC 582504 and EC 582508 recorded high IVDMD values and can be used in the breeding program for improvement of forage quality. The improved lines, PBMR 1, PBMR 3 and PBMR 4 were promising for fodder yield and quality.

Trial 7. Evaluation of advanced generation progenies of the crosses made across locations

Breeding program for trait based improvement of forage sorghum genotypes for quality and resistances had been initiated during kharif 2008. The crosses were made under this program by different AICSIP centers. The F₂ of these crosses were distributed to different centres during kharif 2009 and selections were made. The selections were again distributed to the centres and F₃ generation was raised during kharif 2010. 108 promising selections were made among the F₄ families at different centres during kharif 2011. Seed of ten most promising genotypes was increased during rabi 2011 and these were tested for their performance across three locations and the results were presented during AGM 13. During kharif 2013, another set of 11 advanced breeding nursery lines were evaluated across two locations, viz. Pantnagar and Hisar in RCBD with two replications. The results are presented in Tables 14 and 15.

For green and dry fodder yields, FABN 13-1 was the best genotype (719 q/ha of green and 241 q/ha of dry fodder yields) with 16% and 37% improvement over the check, CSV 21F (619 q/ha GFY; 176 q/ha). FABN 13-1 was followed by FABN 13-4 (648 q/ha GFY; 181 q/ha DFY).

Table 14. Performance of advanced progeny derivatives for green and dry fodder yields

S No.	Entry	GFY (q/ha)	R	DFY (q/ha)	R	DF	Plant ht	Leaf no.	Leaf length (cm)	Leaf:Stem	Leaf width (cm)	Stem girth
1	FABN13-1	718.7	1	241.2	1	84.9	257.2	12.58	69.67	0.32	5.86	2.91
2	FABN13-2	431.2	9	129.4	9	78.5	248.1	12.67	68	0.36	6.03	3.02
3	FABN13-3	493.7	6	135.3	8	76.6	252.5	12.17	71.17	0.27	5.33	3.32
4	FABN13-4	647.9	2	180.9	2	82.4	230.3	12.5	70.92	0.34	6.14	3.53
5	FABN13-5	381.2	10	102.3	11	76.1	246.9	12	59.33	0.24	5.54	3.23
6	FABN13-6	497.9	5	135.4	7	79.0	255.5	12.42	68.42	0.34	5.82	2.89
7	FABN13-7	472.9	7	139.4	6	78.5	254.5	12.42	57.42	0.32	5.73	3.07
8	FABN13-8	520.8	4	162.5	4	82.4	246.2	13.25	62.17	0.37	5.81	2.86
9	FABN13-9	450	8	142.8	5	77.1	234.8	12.83	67.92	0.33	5.46	3.54
10	FABN13-10	356.2	11	104.6	10	77.6	248.8	11.25	58.58	0.30	6.76	3.32
11	CSV 21F	618.7	3	176	3	84.9	263.5	13.25	62.58	0.34	5.92	3.08
	Lsd 5%	72.7		23.2		2.8	27.3	2.15	9.38	0.13	1.02	0.60
	CV (%)	9.7		10.5		2.2	7.4	11.7	9.8	27.80	11.80	12.80

FABN 13-3 was the earliest among all with 77 days to flower. FABN 13-4, FABN 13-3 and FABN 13-1 were promising for leaf traits such as more number of leaves with long and broad leaf blade. FABN 13-8 had more number of leaves (13). Long leaves were observed in FABN 13-3.

Table 15: Performance of advanced progeny derivatives for fodder quality parameters

No.	Entry	Pedigree	Centre	HCN (ppm)	TSS	Protein %	Protein Yield (q/ha)	IVDMD %	DDM (q/ha)
1	FABN13-1	PABN 1-Pant Chari 5 x PSSV 61	Pantnagar	42.1	5.52	8.64	21.07	51.77	123.70
2	FABN13-2	PABN 2- UPFS 37 x SDSL 92111	Pantnagar	66.0	6.49	8.50	10.57	55.55	75.50
3	FABN13-3	PABN 3- UPMC 8 x SDSL 92111	Pantnagar	43.5	8.44	7.88	10.25	54.01	77.50
4	FABN13-4	PABN 4- PC 23 x (SDSL 92101xUPFS 23)	Pantnagar	47.0	4.54	8.92	14.93	54.36	104.80
5	FABN13-5	HC 308 x UPMC 503	Hisar	58.0	5.03	8.12	8.13	54.18	57.20
6	FABN13-6	ICSV 700-1 x IS 3237-4	Hisar	45.0	7.47	7.92	10.60	52.31	74.70
7	FABN13-7	HJ 541 x ICSV 700-1	Hisar	41.2	4.54	8.45	10.68	51.84	80.40
8	FABN13-8	HC 308 x SSG 59-3	Hisar	43.3	7.47	7.75	12.32	50.37	86.10
9	FABN13-9	IS 651-1 x S 541-1	Hisar	48.5	5.03	8.47	11.68	48.50	73.90
10	FABN13-10	HC 308 x HJ 513-4	Hisar	57.4	6.98	8.18	8.31	52.93	57.90
11	CSV 21F			55.4	6	8.67	14.37	50.69	96.80
	Lsd 5%			11.6	2.69	0.51	1.88	3.33	14.10
	CV %			14.8	27.8	4.10	10.60	4.30	11.60

HCN of all the entries was within safe limits. High percentage of protein was observed in FABN 13-4 and FABN 13-1. FABN 13-1 was the most promising entry for protein yield also (21.1 q/ha). IVDMD was high in FABN 13-2 (55.5%) and FABN 13-4 (54.4%), while high DDM was observed in FABN 13-1 (124 q/ha) and FABN 13-4 (105 q/ha).

Conclusion: The genotypes FABN 1 and FABN 4 were more promising for fodder yield and quality traits. Both were found to have good leaf traits.

Overall conclusions

- In AVT (SC), the varieties SPV 2191, SPV 2186 and SPV 2185 were promising for fodder yield and per day productivity.
- SPV 2191 was promising for fodder quality in terms of protein yield and digestible dry matter yield. It had good level of resistance to shoot fly, stem borer and leaf diseases.
- In IVHT (SC), the entry SPH 1752 among the hybrids and SPV 2262 among the varieties were the promising genotypes for fodder yield, per day productivity and quality. SPV 2265 had better level of resistance to shoot fly.
- In IAVHT (MC), the hybrid SPH 1697 recorded more than 10% improvement for both green and dry fodder yields over the checks, CSH 20MF and CSH 24MF. Their per day productivity of green and dry fodder yields was also high compared to the checks.
- Over three years also, the hybrid, SPH 1697 showed superiority for fodder yield, per day productivity and quality in comparison to both the checks. For pest and disease resistance, it was on par with the checks.
- The multicut variety, SPV 2242 recorded significant superiority for both green and dry fodder yields over the check, SSG 59-3. It had more tiller number and high regeneration potential compared to all entries.
- In the advanced seed yield trial, the single-cut variety, SPV 2128 was found to yield more grain compared to the checks, HC 308 and CSV 21F at all India level.
- In the trial on evaluation of sudangrass germplasm lines, the genotypes CO(FS) 29 and IS 30209 were found promising for various fodder yield traits.
- More number of tillers were observed in CO(FS) 29, IS 20624, IS 869 and SGL 60.
- In the trial on evaluation of bmr lines, EC 582504 and EC 582508 recorded high IVDMD values. The improved lines, PBMR 1, PBMR 3 and PBMR 4 were promising for fodder yield and quality.
- Evaluation of advanced generation progenies of the crosses made across locations showed that the lines FABN 13-1 and FABN 13-4 to be more promising for fodder yield and quality.
- FABN 13-2 had high IVDMD values, while high DDM was observed in FABN 13-1 and FABN 13-4.

Shortfalls

- Regenerability score is very important in multi-cut genotypes and needs to be recorded by all the centres.
- Plant population per plot was not given by some centres.

Follow-up for Kharif 2014

- Promising genotypes from initial trials of both single-cut and multi-cut types will be evaluated in the advanced trials during kharif 2014
- The promising sudangrass germplasm lines and bmr lines identified in the trials will be utilized in the forage sorghum improvement program

Publications during 2013-14

Journal articles

Ankita and P.K. Shrotria (Communicated). Assessment of genetic variability in [Sorghum bicolor (L.) Moench] on the basis of SSR markers. Pantnagar Journal of Research.

Bhusal, Nabin, Pahuja, S.K. and Dharamveer. 2013. Correlation and path coefficient analysis for some DUS traits in forage sorghum genotypes. Annals of Biol. 29 (2): 127-131.

- Elangovan M, Jain SK and Patel NV. 2013. Genetic evaluation and characterization of Sorghum germplasm collected from Gujarat. *Indian Journal of Plant Genetic Resources*, 26: 42-46.
- Goyal Minal, Bajaj R K, Gill B S and Sohu R S 2013. Combining ability and heterosis studies for yield and water use efficiency in forage sorghum (*Sorghum bicolor* L.) Moench) topcrosses under normal and water stress environments. *Forage Res.* 39(3): 124-133.
- Jain SK and Patel PR. 2013. Genetic Parameters and Character Association in Single Cut Sorghum (*Sorghum bicolor* (L.) Moench). *Research and Review: Journal of Agriculture and Allied Science*, 2(4):2-11.
- Jain SK and Patel PR. 2013. Multivariate analyses in sorghum (*Sorghum bicolor* L. Moench) for fodder yield and their attributes. *Agric. Sci. Digest.*, 33(3): 215-218.
- Jain SK and Patel PR. 2013. Combining ability and heterosis for grain yield, fodder yield and other agronomic traits in Sorghum [*Sorghum bicolor* (L.) Moench]. In: *Global Consultation on Millets Promotion for Health and Nutritional Security* December 18-20, 2013 at DRR Hyderabad PP 81-82.
- Pahuja, S.K., Shrotria, P.K., Kaur, Simarjit, Ranwah, B.R., Patil, J.V. and Aruna, C. 2013. Variation among the mutagenic derivatives of SSG 59-3 for fodder yield and quality parameters. *Sorghum times* 9 (1): 4.
- S.K. Pahuja, C. Aruna, P.K. Shrotria, Simarjit Kaur, B.R. Ranwah and J.V. Patil (2013). Inducing variability in multicut forage sorghum through mutagenesis. *Plant Genetic Resources: Characterization and Utilization*, 11 (2); 114-120.
- Suneeta Pandey, P.K. Shrotria, Shivji Singh and Rajendra (2013). Combining ability for fodder yield and its components in sorghum [*Sorghum bicolor* (L.) Moench]. *Pantnagar Journal of Research*, Vol. 11(2) pp 184-190.
- Sweetey, Joshi, U.N., Sangwan, P.C. 2014: Chromium toxicity on sorghum bicolor (L.) ameliorated through soil treatment of FeSO₄ - EDTA solution. Presented at National Seminar on "Reorientation of Agricultural Research to Ensure National Food Security" held on Jan. 6-7, 2014. At CCSHAU, Hisar. (Abstract SHM 372. P.151)
- Umakanth AV, Bhat BV, Blummel M, Aruna C., Seetharama N and Patil JV. 2014. Yield and stover quality of brown mid-rib mutations in different genetic backgrounds of sorghum. *Indian J. Animal sciences*. 84 (2): 181-185.
- Yadav, R. and Pahuja, S.K. 2013. Evaluation and classification of sorghum (*Sorghum bicolor*) male sterile lines for fodder traits using multivariate analyses. *Indian J. Agric. Sci.* 83 (3): 279-286.

Technical / Popular articles

- Aruna C. 2013. Genetic improvement in kharif sorghum and latest kharif cultivars. In: Chapke RR, Bhagwat VR and Patil JV (eds.). 2013. *Sorghum cultivation for value added diversified products and sweet sorghum perspectives*. Directorate of Sorghum Research, ICAR, Hyderabad, India, ISBN: 81-89335-46-4: 175 pp. 15-21.
- Aruna C. and P Sanjana. 2013. Cytoplasmic diversification in sorghum hybrid breeding. In: S. Rakshit and JV Patil (eds). 2013. *Basics of sorghum breeding and AICSIP data management*. Directorate of Sorghum Research (DSR), Rajendranagar, Hyderabad 500 030, Andhra Pradesh, India, 121 Pp. ISBN: 81-89335-45-6; 28-34.
- Aruna C. 2013. Forage sorghum breeding. In: S. Rakshit and JV Patil (eds). 2013. *Basics of sorghum breeding and AICSIP data management*. Directorate of Sorghum Research (DSR), Rajendranagar, Hyderabad 500 030, Andhra Pradesh, India, 121 Pp. ISBN: 81-89335-45-6; 81-87.
- P Praveen Kumar, M Suguna, A Annapurna, Manish Solanki, JV Patil and Aruna C. 2013. Studies on variability and character associations for fodder yield and quality in forage sorghum. Page 325. In: *Compendium of papers and abstracts: Global consultation on millets promotion for health and nutritional security, 18-20 Dec, 2013* (Eds. S Rakshit, IK Das, G Shyam Prasad, JS Mishra, CV Ratnavathi, RR Chapke, VA Tonapi, BD Rao and JV Patil). Society for Millets Research, DSR, Rajendranagar, Hyderabad 500 030.

Presentations

- Aruna C. 2013. Forage sorghum research in India: Progress and Prospects. Presentation made in Forage Consultation meeting at ICRISAT, Patancheru, Andhra Pradesh. on 18th April 2013.
- Aruna C. 2013. Alternative CMS systems in sorghum and their utilization. Presentation made in the Fourth International Training course on sorghum hybrid parents improvement and Seed production organized by ICRISAT, Patancheru, AP during 30th Sept to 11Th Oct. 2013.
- JV Patil and C Aruna. 2013. Genetic improvement of sorghum in India. Presentation made in the Global consultation on millets promotion for health and nutritional security organized by Society for Millets Research, DSR, Hyderabad during 18-20 Dec 2013
- P. Chauhan, P.K. Pandey, P.K. Shrotria and G. Pandey (2014). SSR diversity among A, B and R lines for male sterility gene in sorghum (*Sorghum bicolor* (L.) Moench). Paper presented in National Conference on "Emerging Problems and Recent Advances in Applied Sciences: Basic to Molecular Approaches (EPRAAS-2014)." Head at C.S. University, Meerut during February 08-09, 2014.