



## Executive summary

The 42<sup>nd</sup> Annual Group Meeting of the All India Coordinated Sorghum Improvement Project was held at the Govind Ballabh Pant University of Agriculture & Technology (GBPUA&T), Pantnagar from April 28 - 30, 2012. About 125 participants from various SAUs, voluntary centers, private companies and other collaborating institutes participated in the group meeting.

The group meeting was held in 12 sessions spanned over three days. The first day was dedicated to scientific auditing of each center and the scientists working under the AICSIP scheme so that the shortfalls could be identified and addressed effectively. Other goal of the discussion was to enhance the spirit of team work with closer intra- and inter-institutional interaction. In the evening concurrent sessions were held to review the results and chalk out technical programme for the coming season. Second day was dedicated to formal inauguration of the workshop followed by three technical sessions. Third day was dedicated to discuss various issues related to AICSIP activities during XII Five Year Plan period.

The group meeting was formally inaugurated by Sh. MP Naithani, Minister of Agriculture, Government of Uttarakhand on the second day in presence of Sh. HC Durgapal, Minister of Labour & Employment Government of Uttarakhand and Dr. Swapan K Datta, Deputy Director General (Crop Science), Indian Council of Agricultural Research and under the chairmanship of Dr. BS Bisht, Vice Chancellor, GBPUA&T, Pantnagar. Dr. JV Patil, Director, Directorate of Sorghum Research and Project Coordinator, All India Coordinated Sorghum Improvement Project presented the research highlights of AICSIP centers and the Directorate of Sorghum Research. Dr. JP Pandey, Director Experimental Station, GBPUA&T welcomed the delegates and Dr. J Kumar, Dean, College of Agriculture, GBPUA&T, Pantnagar proposed the vote of thanks.

Dr. Swapan K Datta appreciated the initiative of DSR to popularize sorghum through the slogan "*Eat jowar and stay healthy*". He highlighted the importance of genomics assisted breeding in sorghum, particularly in view of availability of the draft sequence in sorghum and its synteny with other crops. He stressed upon the need to identify a group of 7 - 8 young scientists, who could be trained in advanced laboratories so that they could be deployed in genomics-assisted breeding. He drew the attention of the audience to the success of Brazil in harnessing the economic benefit of bio-diesel. In view of this he felt that sweet sorghum plays a very important role and the sorghum workers were needed to take an active role to harness the benefit of sweet sorghum. He called upon the need for linking more number of academic institutes to make the sorghum research more effective. Both Sh. MP Naithani and Sh. HC Durgapal expressed their concern on reduction in area under agriculture. They invited the sorghum workers to work on forage sorghum so that such varieties may reach to the remote valley of Himalaya and the hardships of the resource poor farmers are addressed. This would ensure better nutrition for the poor masses through higher milk production. Dr. BS Bisht regretted the loss of importance of sorghum in present



agriculture scenario and called upon to increase the productivity to regain the loss of ground.

Dr. JV Patil while presenting the progress in AICSIP research informed that the success rate of AICSIP trials during the period was over 90%. During the period two *kharif* grain sorghum hybrids, two dual purpose varieties and one *rabi* variety were identified. Compartmental bunding proved to be promising water conservation technique. Several cultivars with resistance against major biotic and abiotic stresses were identified. Fifty genetic stocks were registered with NBPGR and 16 with PPV&FRA. Several new promising experimental hybrids were identified. Transgenic events against stem borer are at field trial and marker assisted selection initiated for several traits. A Center of Excellence (CoE) on Value Addition has been created at the DSR to cater the need of value addition in sorghum. During the period 51 publications have been made by the DSR and AICSIP scientists. At DSR three audio-visual advertisements have been developed towards popularization of sorghum products. The advertisements were played for the dignitaries and highly appreciated.

On this occasion, the following ten publications were released by the dignitaries:

1. *Jowar Sourabh* (Vol. 2) (Hindi)
2. *Rabi Jawar Utpadan ki Unnat Takniki* (Hindi)
3. Improved production technologies for kharif sorghum
4. *Jwari Lagwadiche Sudharit Tantragyan* (Marathi)
5. District-wise sorghum cultivars in India
6. Pedigree database on sorghum elite breeding stock (AICSIP 2006-11)
7. Distribution and utilization of sorghum genetic recourses in India (2008-12)
8. Mite pest on sorghum: An emerging threat to production in South Gujarat
9. *Jola Utpadana Tantrikathegalu* (Telugu)
10. Sorghum research at Pantnagar

During the group meeting the participants deliberated on the results obtained during the last year, shortfalls and strategies to address the issues. They planned experiments for improving the productivity and profitability of sorghum. In the technical sessions discussions were made on statistical issues related to AICRP, automation of AICRP process, variety registration, IPR management and perspective of collaborative research besides issues related to reforms expected in XII Plan period.

#### **Statistical issues related to AICRP research**

There were two presentations on statistical issues. Dr. Rajendra Prasad from Indian Agricultural and Statistical Research Institute, New Delhi spoke on "Statistical issues in design of experiment and analysis of experimental data of multi-environment data". The reason for high CV in field experiments is due to high variability in the experimental field. He suggested that the CV could be minimized by adopting proper blocking. In this regard he highlighted the importance of incomplete block design, which did not require any extra effort. He appreciated the initial attempt under AICSIP to implement alpha design in conducting breeding trials. In analyzing multi-environment data he cautioned the risk



associated with pooled analysis in presence of high crossover genotype  $\times$  environment interactions. He suggested to relook the process of variety identification and stressed upon the need to be a bit relaxed at the initial level of testing and become more stringent at later stages.

Dr. A Dhandapani from National Academy of Agricultural Research and Management, Hyderabad delivered his lecture on "Automation of AICSIP data analysis - Possibilities & challenges". He detailed the efforts being made to automate the AICRP trial preparation and data analysis. The module has five levels of users, viz., Head/PD/PC, administrator, experiment in-charges, experimenters and public/general user with different level of permission to access the data. The module has wide flexibility in terms of entering entries, locations, traits to be recorded etc. The system can generate randomized sowing plan automatically and will generate auto alert at various stages for the experimenters. At any point the Head/PD/PC will be able to access the information and can obtain status report in a click of mouse. Data can be submitted on-line and experiment in-charges can validate the data before analysis. Analyzed data will be presented in a tailor made tabular form as desired by the users. The efforts to automate the AICSIP process generated much enthusiasm among the participants as it will save considerable amount of time for trial preparation, coordination, data retrieval and analysis. Efforts will be made to implement the module at the earliest.

#### **Plant Variety Registration & IPR management (PPV&FRA)**

Three presentations were made by experts in the area of plant variety registration and IPR management. Dr. HS Chawla, Head, Dept. of Genetics & Plant Breeding, GBPUA&T spoke on "Farmers' variety registration: Opportunity & challenges", while Dr. Manoj Srivastava, Registrar, PPV&FRA delivered his talk on "Present status of variety registration in India". Dr. Vilas A Tonapi, Head, Div. of Seed Science & Technology, IARI spoke on "IPR in relation to seeds and licensing"

A detailed list of varieties that could be registered as 'farmers' variety' and the materials that could be considered as 'farmers' variety' were explained by Dr. HS Chawla. It was pointed out that not only individual farmers, a registered society or even *Gram Panchayat* could register a variety as farmers' variety. Lack of awareness among the farming community regarding benefits of registration and general skepticism among the farmers seemed to be the major hurdles in the way of increasing the number of registered farmers' varieties. Dr. Manoj Srivastava informed that presently a total of 3527 applications were in place for registration, out of which rice, cotton and sorghum were maximum in number. He expressed that the breeders need to become much more proactive to take the advantage of the plant variety registration process. At the time of breeding itself the breeders need to keep in mind to incorporate some distinct trait in his/her variety so that it could be registered easily.

Dr. Tonapi discussed the certification and licensing issues including application for seed certification, benefit sharing, breeder's right and international collaboration at length. Seeds are the basic input in agriculture and in this regard licensing of seeds is going to impact the agricultural scenario in India and across the world in a big way in the coming days. Big



companies are holding major innovations in form of patent or license. Thus, they are going to influence seed market more than the public sector and breeders need to gear up immediately. He cautioned the breeders to understand the legal provisions of different Acts to protect their interests.

#### **Collaborative research: NARS, CGIAR and PPP**

Two presentations were made during the session. Dr. S Audilakshmi of DSR spoke on "AICSIP Network Project: present status and where to go?", while Dr. Srinivas Rao from ICRISAT discussed "ICAR-ICRISAT Collaborative Research: progress made".

Dr. S Audilakshmi presented the results of the AICSIP network projects which were grouped under three main sub-projects involving 40 DSR-AICSIP Scientists and four non-ICAR/SAU scientists. The sub-projects were: Enhancing resistance to biotic stresses and to enhance product quality in sorghum (with 11 activities), Accelerating development of parental lines for making better hybrids (with 4 activities) and Breeding for nutritionally improved sorghum with special reference to elimination of anti-nutritional factors and bio-fortification (with 3 activities). The projects were under operation for three years and the progresses were quite encouraging. Towards MAS for shoot fly marker assisted backcrossing is being carried out and the materials are in BC<sub>2</sub>F<sub>1</sub> generation. Under wide hybridization programme 3 crosses, viz., *S. bicolor* × *S. usumbarensis*, *S. bicolor* × *S. purpureocercium*, *S. bicolor* × *S. versicolor* have been derived and are at F<sub>2</sub> and F<sub>3</sub> generations. For midge resistance 11 crosses were raised under late sowing conditions and 27 single plants with midge score 1 were advanced to F<sub>4</sub> generation. M-35-1, DJ-6514, DSV-4 and Phule Maulee were recorded with minimum infestation of aphids. Six varieties out of 84 evaluated for two years found tolerant against mite. Five coloured lines and 2 advanced generation lines (IS 18522 × M 35-1 and IS 24996 × IS 23585) were found to be promising against grain mold. Germplasm lines varied from 71 to 100% for amylopectin content in seed (GP 118 showed 100 % amylopectin). Stover quality improved by irrigating crop 7 days before harvest (HCN was reduced - 68 ppm) when compared to (i) irrigating at 14 days (96 ppm) and (ii) irrigating at 21 days (139 ppm) before harvest, respectively. Total 225 lines belonging to F<sub>2</sub>- F<sub>5</sub> were evaluated for biomass and brix and the range of brix ranged from 11 to 22% in F<sub>2</sub>, 12 to 16% in F<sub>4</sub>, 12 to 25% in F<sub>5</sub> and 19 to 20% in F<sub>6</sub>. The genotypes E169, E172, E176 and E177 were least sensitive to salinity in root length and E169, E174, E176 and E177 were least sensitive on shoot growth. Good range for iron (36-114 ppm) and zinc (14-43 ppm) content observed among elite lines. It was felt that such projects need to be extended in XII Plan and the results were to be documented properly.

Dr. Srinivas Rao informed that under ICAR-ICRISAT collaborative research nearly 25 thousand farmers have adapted improved post-rainy technologies. Staygreen introgression programme has recorded higher grain and fodder quality. Large numbers of farmers have been trained on improved production practices of sweet sorghum. Inter specific crosses of *S. bicolor* × *S. usembarensis* and *S. bicolor* × *S. hewisonii* were developed. Over 20 joint publications have come out of the collaboration. It was felt that no serious research results were seen in 2011-12 out of the collaboration. It was further felt that the MoU between ICRISAT and ICAR needed to be reorganized so that the collaboration becomes more specific and quantifiable.



### Varietal identification

The Varietal Identification Committee meeting was held in the Conference Hall of the GB Pant University of Agriculture & Technology, Pantnagar on 29<sup>th</sup> April, 2012 under the chairmanship of Dr. Swapan K Datta, DDS (CS), ICAR. The committee critically examined 6 proposals for different zones consisting of: 4 - *kharif* hybrids, 1 - *rabi* sorghum hybrid, and 1 - *rabi* sorghum variety. The VIC after considerable deliberations identified the following for consideration of Central Variety Release Committee:

1. **SPH 1647:** *Kharif* grain sorghum hybrid from Nuziveedu Seeds Private Limited for Zone II
2. **SPH 1648:** *Kharif* grain sorghum hybrid from Mahodaya Hybrid Seeds Private Limited for Zone II
3. **SPH 1655:** *Kharif* sorghum hybrid from DSR, Hyderabad for Zone II
4. **SPH 1666:** *Rabi* sorghum hybrid from Devgen Seeds & Crop Tech. (P) Limited for all India (deep soil)
5. **SPV 2033:** *Rabi* sorghum variety from RARS-UAS Bijapur for Maharashtra, Karnataka & AP for deep soils

### New initiatives for special assistance and reforms needed in AICSIP

Dr. JV Patil called upon the AICSIP scientists to act in a cohesive manner through multi-disciplinary mode so that under XII Plan the centers may deliver more effectively and significantly. He called upon the center in-charges to review their list of equipment under XII Plan. He mentioned that vehicle purchase and major works could not be permitted under XII Plan. He also mentioned that new position could not be created but might be adjusted through re-deployment within the allotted positions. Germplasm evaluation and registration along with registration of new varieties should receive top priority and in this regard DSR will felicitate the process. Agreement with private sector should be worked out in consultation with DSR for the purpose of licensing and it should be on non-exclusive basis. Multi-authored international publications should receive top priority. Photocopy of all the released proposals should be submitted to DSR along with the photograph if available. This should be compiled into a bound document to recognize the efforts made by the crop improvement group. Value addition will continue to receive priority and efforts will be continued to popularize new value added products developed. Each center will focus on specific products rather diluting the efforts. AICSIP centres will be made partners in the national and international projects at DSR. However, this will be based on the strength of the concerned centre and the centers should gear up to take advantage of the possibility. FLD should be strengthened as this is the only mechanism of on-farm demonstration for the research technologies. FLDs on forage sorghum should also be included. Tribal sub-project will be a regular feature in XII Plan. The following centers were identified to implement this activity: Surat, Deesa, Udaipur, Palem (Amarabad), DSR/Warangal (Srisailam), Tandur, Indore, Parbhani (Nanded), Akola (Garchiroli), Coimbatore (Balmare) and Mauranipur.

### Highlights of research under different disciplines

#### *Trials and nurseries*

- During *kharif* season 41 locations were involved in execution of 11 trials, while three late *kharif* trials were dispatched to five locations.



- Four *rabi* trials were distributed among 22 locations.
- The success rate of trial execution was over 90%, which was quite encouraging.

#### Breeding

- *Hybrid trial – kharif*: SPH 1648 recorded grain yield advantage of more than 11% over CSH 16 in Zone II, while SPH 1655 had more than 12% grain yield advantage over CSH 23. Under AHT, the promising hybrids were SPH 1655, SPH 1674 and SPH 1680 (Zone I), and SPH 1648, SPH 1674, SPH 1679, SPH 1682 and SPH 1683 (Zone II).
- *Varietal trial-kharif*: The promising entries under AVT were SPV 1999 (both zones) and SPV 2083 (Zone I).
- *Late kharif trial*: SPH 1648, SPH 1679, SPH 1680 & SPV 2078 performed better than checks.
- *Hybrid trial-rabi*: Under shallow soils SPH 1665 had 17% grain yield advantage over CSH 15R.
- *Inter-institutional hybrid*: Under inter-institutional hybrid programme promising hybrid combinations, viz., CMS 10-2A × NR 486 and 70A × AKR 50 were identified.
- *Forage sorghum-single cut*: SPV 2057, SPV 2058, and SPV 2056 were promising over CSV 21F. SPV 2057 recorded the highest per day green fodder productivity of 5.77 q/ha, while SPV 2056 showed high protein and IVDMD.
- *Forage sorghum-multi cut*: SPH 1700, SPH 1697 & SPH 1698 recorded higher green and dry fodder yields over CSH 24MF. SPH 1700 had the highest per day productivity.
- *Sweet Sorghum*: During *kharif* promising entries for total biomass, fresh stalk and juice yields were SPH 1670 and SPV 2075, and SPH 1713, SPH 1711, SPV 2135 and SPV 2074 for total sugar yields and computed bioethanol yields. During *rabi* 2011-12, SPH 1670 and SPH 1669 recorded high brix and juice yield among the hybrids, while SPV 2068 had high brix and SPV 2074, SPV 2133, SPV 2137 and SPV 2069 showed >10% superiority over the check for juice yield among the varieties.
- *PGR management*: During the year 70 accessions were collected from Uttarakhand (30 acc.) and Kutch regions of Gujarat (40 acc.), and 8091 accessions were received from ICRISAT. 31746 accessions are being conserved in the MTS at present.

#### Entomology

- Promising entries identified for shoot fly under group efforts were NRCSFR08-3, NRCSFR09-3, NRCSFR11-4, SUENT 26, P 45, PFGS 45, VKG34/36, E 72, EP 57 and EP 96.
- Promising sources for stem borer tolerance were PFGS 45, P 41, PGN 61, E 20 and ELG 14.
- Seed treatment with thiamethoxam 35 FS @ 6ml/kg under on-farm IPM modules in Parbhani gave 25% increase in grain and 16% increase in fodder yield compared to non-IPM plots.
- During *rabi* season, K-8, SLR 73, SLB 50, ICSV 93046, KR 196 and Long SPS 43 were promising sources for aphids, while ICSV 93046, SLB 50, SLB 81, ICSB 323 and Long SPS 43 were promising for shoot bug.
- Towards control of shoot fly intercropping with legume (cowpea) + seed treatment with imidacloprid 70 WS @ 3 g/kg seed + spray of metasystox @ 0.07% at 45 DAE was the most cost effective treatment.
- Application of Vermi-compost (50%) + deoiled Neem cake (50%) @ 3.75 + 3.12q/ha was found to be the best to control shoot fly and aphid at Bijapur.



### Pathology

- Grain mold tolerant entries were SPH 1641, SPH 1653, SPH 1668, SPH 1635, SPH 1685, SPV 2061, SPV 2000 and SPV 1999.
- SPH 1655, SPH 1668, SPH 1675, SPH 1679, SPH 1680, SPH 1684, SPV 2079 and SPV 2061 were promising for downy mildew.
- SPV 2125 and SPH 1699 exhibited multiple resistance (grain mold and foliar diseases)
- Seed treatment with bleaching powder reduced charcoal rot incidence and increased the grain yield.

### Agronomy

- Pre-release genotypes responded significantly up to 100% RDF (80:40:40 kg NPK/ha).
- Integration of FYM 2.5t/ha + vermicompost 1.25 t/ha along with 100% RDF gave maximum grain yields of sorghum-chickpea system.
- Performance of cultivars varied with dates of planting at different locations. June sowing gave the highest yields in general, while poor yields in July sowing was due to sever attack of insect-pests (shoot fly).
- Atrazine 0.25 + Pendimethalin 0.5kg as pre emergence + 2,4-D 0.5kg/ha as post emergence gave relatively higher grain yield and B:C ratio.
- *In situ* moisture conservation practice of compartmental bunding during *kharif* and flat sowing gave the highest grain yield under *kharif*-fallow *rabi* sorghum.
- In *rabi* sorghum, application of 2 irrigations at 55 DAS (flag-leaf/boot stage) and 75 DAS (flowering stage) gave higher yields compared to irrigations at 35 & 55 DAS / 35 & 75 DAS.

### Physiology

- Nimbodi local, Halyal local, Honword 2 and Bairodagi were promising for grain yield. BJV116, RSV1420 and RSV1098 showed significantly higher photosynthesis rate than checks in medium and shallow soils.
- Promising entries with respect to drought susceptibility index were Phule Anuradha, BJV103, Phule Chitra and BJV114.
- RSV1098 recorded higher root number in both rainfed and irrigated conditions, while BJV83 recorded significantly high root mass than checks in rainfed condition.

### Seed and IPR related issues

- 33 tons of breeder and certified seed is available with DSR.
- 156.75 q breeder seed against the BSP-I allocation of 112.60 q was produced.
- A total of 824 kg nucleus seed was produced against the allocation of 657 kg.
- Top five selling varieties were: CSV 15, CSV 23, AKR 150, Phule Revati and C 43 .
- A total of 24 lakh rupees revenue was generated through seed sale under Revolving Fund Schemes.
- The trademarks - JAICAR FOODS, JAICAR PCS, JAICAR SEEDS were registered.
- Fifteen and seven candidate varieties were tested for DUS during *kharif* and *rabi* season, respectively.
- Two training programmes (Awareness-cum-training program on Plant Variety Protection and Training programme on Plant Variety Protection & Commercialization) on plant variety protection were conducted.



#### Research achievements at DSR

- Demonstration of hybrid sorghum (CSH 16) in rice-fallows by DSR has led to area increase from 1000 ha during 2008-09 to >11,000 ha in current *rabi* season.
- R&D efforts in sorghum foods and processing has lead to standardization and development of ready to cook/eat products like instant *dosa* mix, *upma* mix, *idli* mix and health mix; *Jowar lassi*, etc.
- DSR was awarded Center of Excellence on value addition and food processing in sorghum by DAC, Ministry of Agriculture, Govt. of India. Through INSIMP, food processing technology has been transferred to state governments of Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu, Gujarat, Rajasthan and Uttar Pradesh.
- So far DSR has developed 18 products and commercialized 5 of them through entering into MoUs with different companies like Britannia Industries, Kottaram Agro Foods, Bhavani SS Industries, Chandu Enterprises, etc.
- Trait improvement through MAS for shoot fly, and transgenics for stem borer, fodder quality (reduced HCN) and salinity tolerance are being attempted. One transgenic event (NRCSCRY1B 19) carrying cry1B gene for stem borer resistance is in BRL-1 confined field trial.
- Response of shoot fly to volatiles and waxes is the new area of research at DSR.
- Advanced facility like Lysimeter for drought research has been established.
- DSR has been awarded the Best DUS centre by PPV&FRA, New Delhi

#### General recommendations:

- All experimenters should take utmost care in conducting AICSIP trials so that the CV of data is within acceptable limits.
- Research activities should be multi-disciplinary and multi-institutional in nature.
- Efforts need to be focused on multi-pest and/or multi-disease resistance.
- Germplasm evaluation and utilization should receive priority. VCU of germplasm in Gene Bank should be carried out by the breeders.
- Promising materials need to be commercialized through PPP mode and licensing should be on non-exclusive basis.
- All research outcomes must be properly documented and culminate in the form of research publications and patents.

