

# Nimbkar Agricultural Research Institute (NARI), Phaltan

## ANNUAL RESEARCH REPORT 2005-2006

### Report of the President



Firstly, I thank all of you associated with NARI in your various capacities for your support and enthusiasm as we move forward to fulfill our mission. We are especially grateful to Shri. Madhur Bajaj, Vice Chairman, Bajaj Auto Ltd., Pune for his generous support and substantial financial contribution through the DAL trust and the Gopuri Charitable Trust for our “Center for Sustainable Living”. Mr. Bajaj has been a well wisher of our Institute and has taken great interest in our activities. In addition to this other well wishers have also given donations and we accept them with gratitude.

I am very happy to report that Shri. B. V. Nimbkar, Founder of NARI and its first president for 22 years was honored this year with the Padma Shri by the Government of India. The announcement of the award was made on 26 January 2006 (Republic Day) and the award was conferred upon Shri. Nimbkar by the President of India, Shri. A. P. J. Abdul Kalam during the investiture ceremony held at the Rashtrapati Bhawan, New Delhi on 29 March 2006. I was lucky enough to be present at this glittering function and be a witness to my father getting an award, which he so richly deserved. With return of Dr. Chanda Nimbkar from Australia after submitting her thesis in October 2005 and taking over as the director of the Animal Husbandry Division, Mr. Nimbkar has reduced his active participation in day-to-day affairs, but still remains very much involved with the various activities. He will continue to be a great source of inspiration to all of us.

Another landmark event was the completion of the new building which will house the “Livestock Research and Development Center” of the animal husbandry division of NARI. The building was inaugurated by the Union Minister of Agriculture, Shri. Sharad Pawar on 7 February 2006. Mr. Nimbkar has dedicated the new building to his late parents Kamala and Vishnu Nimbkar who inculcated in him the spirit of nationalism and service to the nation. We are grateful to Mr. Zia Quraishi, the chairman and managing director of Nimbkar Seeds Pvt. Ltd. for the substantial cash donation which made the building possible and for the donation of large quantities of furniture, computers and accessories.

One new research project was sanctioned during this year. This project entitled “Development of photo-thermoinsensitive sweet-stalk sorghum variety and hybrid having attributes desired by ethanol industry” has been funded by the Indian Council of Agricultural Research (ICAR), New Delhi. The ACIAR-funded project to improve sheep productivity through the use of the FecB gene has been granted two years’ extension though at a substantially reduced budget.

One of our substantial achievements this year was the ethanol stove developed by our Director Dr. Anil K. Rajvanshi and his colleagues. Though there is widespread interest among people in manufacturing and using it, we cannot disseminate it in India till the

government policy and excise laws are changed. We have also received inquiries about this stove from countries such as Brazil and South Africa and hope to spread it all over the world once its patenting procedure is completed.

A lot of interest has been evinced by corporations such as Reliance, Tata Chemicals and Nagarjuna Fertilizers and Chemicals in our sweet sorghum breeding program and we hope for some fruitful collaboration with them during the coming year.

We are committed to research that will enable us to learn more about sustainability in all fields and to bringing that learning to our partners and collaborators.

*Dr. N. Nimbkar*  
August 6, 2006

## AGRICULTURAL RESEARCH

Our agricultural research work continues to be focussed on two crops viz. safflower and sweet sorghum, along with the continuing project on grapes.

### ***SWEET SORGHUM***

**Ad-hoc Project** : Development of photo-thermoinsensitive sweet-stalk sorghum variety and hybrid having attributes desired by ethanol industry

**Funding agency** : Indian Council of Agricultural Research (ICAR), New Delhi

**Project duration** : February 1, 2006 to January 31, 2009

#### **Thrust of research activities on sweet sorghum at NARI :**

1. To develop photo-thermoinsensitive cultivars and hybrids suitable for grain, fodder and sugar production.
2. To develop and improve the present CMS lines and pollinators suitably to exploit the potential of sweet sorghum hybrids in terms of sugar and biomass production.
3. To disseminate the agroproduction technology for sweet sorghum cultivation to the farmers.
4. To develop technology for economical, good quality syrup production from sweet sorghum and popularize it among rural communities to encourage them to set up their own units.

#### **Research activities carried out in sweet sorghum during Kharif 2005 and Rabi 2005-06 at NARI are as follows :**

##### **(I) Kharif 2005**

1. ***Evaluation of CMS-based hybrids*** : Thirteen CMS-based sweet sorghum hybrids were evaluated along with their parents and checks for sugar production during kharif 2005. Six hybrids of the 13 evaluated showed significantly higher total sugar index (TSI) than the hybrid check Madhura. The sweet sorghum hybrid NSSH-7 recorded the highest TSI of 52.79 q/ha which was 20% higher than that of the hybrid check Madhura (43.88 q/ha), and was closely followed by the hybrids NSSH-6 (52.66 q/ha), NSSH-5 (50.63 q/ha) and NSSH-4 (49.62 q/ha).
2. ***Evaluation of F<sub>6</sub> selections*** : Ten F<sub>6</sub> selections from different crosses were evaluated along with the checks for assessing their suitability for commercial production. None of the selections out of the ten evaluated showed higher TSI than the hybrid check Madhura. However selection nos. 4, 5 and 9 of the 10 tested showed an increase of 21%, 11% and 2% respectively in TSI over the sweet sorghum varietal check SSV-84. The selection

nos. 3 and 8 were found to be uniform for different traits and recorded an increase of 95% and 77% respectively in grain yield over the hybrid check Madhura.

3. ***Evaluation of F<sub>3</sub> populations*** : Forty seven F<sub>3</sub> populations of different crosses were evaluated along with the checks to identify the promising populations for making selections of desirable types in order to develop cultivars giving high TSI. Of these, eight populations showed higher TSI than all the checks evaluated in the trial. These eight populations also showed uniformity for stem girth, plant height, panicle characteristics, stay green nature and brix of juice.
4. ***Advance sweet sorghum varietal trial*** : Advance sweet sorghum varietal trial of All India Coordinated Sorghum Improvement Project (AICSIP) comprising of 14 entries along with the local check Madhura was carried out during Kharif-2006. The results of the trial showed significant differences between the entries for TSI. None of the entries evaluated recorded significantly higher TSI than the local hybrid check Madhura (34.57 q/ha) in the trial. However, three entries viz. RSSV 106, NSSV 13 and ICSV 700 recorded TSI on par with Madhura. The entry NSSV 13 exhibited the highest TSI of 38.37 q/ha which was followed by the entries ICSV 700 (36.74 q/ha) and RSSV 106 (34.66 q/ha).
5. ***Syrup from sweet sorghum hybrid Madhura*** : A total quantity of 250 kg syrup from sweet sorghum hybrid Madhura was produced during 2005-06. In addition, syrup was also produced from the sweet sorghum crop grown organically with the use of vermicompost applied @ 1500 kg/ha and it was compared with the syrup produced from the crop to which regular chemical fertilizers @ 100:50:50 kg/ha of N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O were applied. The results revealed that the brix of juice of organic sweet sorghum was higher than that of the crop grown with chemical fertilizers. The quality of syrup made from organic crop was also found to be better than that of the crop raised with chemical fertilizers. However, biomass yield of organic crop was recorded to be 13.3 t/ha as compared to 15.85 t/ha recorded from the crop grown with the use of chemical fertilizers.

In addition, sweet sorghum hybrid Madhura was also grown with the use of Amrutpani-an organic formulation, to know its effects on quality of juice and syrup of sweet sorghum. The application of Amrutpani to sweet sorghum gave higher values of brix of juice than the regular crop raised with the chemical fertilizers. The quality of syrup produced from the crop raised with Amrutpani was found to be better than that from the chemically fertilized sweet sorghum crop. The biomass yield in crop to which Amrutpani was applied was found to be 20.51 t/ha as compared to 26.87 t/ha recorded from the chemically fertilized crop. Thus the results indicated that though the quality of juice and syrup from sweet sorghum grown with organic formulations was enhanced significantly as compared to that of the syrup from a crop grown with chemical fertilizers, overall production of syrup from the organically grown crop was reduced considerably compared to the chemically fertilized crop.

## (II) **Rabi 2005-06**

1. ***Evaluation of CMS-based hybrids*** : Eleven CMS-based hybrids were evaluated along with three checks during rabi 2005-06. The results of the trial showed that the hybrid NSSH-6 gave the highest grain yield of 4733 kg/ha which was found to be 92% higher than that of the hybrid check Madhura. Hybrids NSSH-4, NSSH-1 and NSSH-10 also showed a significant increase of 52%, 46%, and 42% respectively in grain yield over the

hybrid check Madhura. All the hybrids showed higher TSI over the hybrid check Madhura, the highest being recorded by NSSH-5 (10.83 q/ha). Based on the overall performance in both kharif and rabi seasons, hybrids NSSH-6 and NSSH-4 were found to be promising for grain and sugar production.

2. ***Effect of irrigations and spacing on sweet sorghum*** : A trial comprising of five treatments of irrigation and two spacings of 45 X 15 cm and 45 X 30 cm was carried out in sweet sorghum in order to determine the critical stages of crop growth for irrigation and optimum plant population level for getting the highest amount of grain as well as sugar from the crop. The results of the trial showed that the differences due to irrigation levels were significant only for grain yield suggesting that irrigations at flowering and grain development stages are necessary for proper development of grain to obtain maximum grain yield, however irrigation levels do not seem to have any impact on the fodder yield once the plant has attained an optimum height. Spacings between plants showed significant differences due to treatments for grain and fodder yields. The spacing of 45 X 15 cm showed higher grain and fodder yields as compared to spacing of 45 X 30 cm. The interaction of irrigation levels and plant spacings showed that the treatment of five irrigations in combination with spacing of 45 X 15 cm recorded the maximum grain yield of 27.30 q/ha which was found to be at par with the treatments having a spacing of 45 X 15 cm and provided with six or seven irrigations. Thus the results of the trial suggested that to obtain the maximum grain and sugar during rabi season, sweet sorghum should be grown with a spacing of 45 X 15 cm and provided with a minimum of five irrigations given at critical stages of crop growth.
3. ***Crossing program*** : Hybrid seeds of 14 promising hybrids were produced during the season to evaluate them in kharif 2006 to identify the most promising one for evaluation in sweet sorghum coordinated varietal trial so that its suitability for commercial production in the country can be found out.
4. ***Crossing program for Ad-hoc project on sweet sorghum*** :
  - (i) ***Varietal improvement program*** : Ten parents based on the presence of desired traits in them were selected from the germplasm lines maintained at the Institute. These 10 parents were crossed in a diallel manner excluding reciprocals to produce 45 hybrids. The parents used in the diallel crossing program were : (1) IS-20510, (2) RSSV-34-2, (3) NSS-201-4, (4) NSS-216, (5) IS-3552, (6) William, (7) IS-9705, (8) Bj-248, (9) Keller and (10) Wray.
  - (ii) ***Hybrid development program*** : Ten CMS lines and five fertile genotypes were selected on the basis of their high brix and stable performance for desired traits in both rabi and kharif seasons as assessed from previous years' data available with the institute. Fifty crosses following line X tester design were produced by using 10 CMS lines as females and five fertile genotypes as males. The details of female and male parents used in the crossing program are as follows : Female parents : (1) 2219A, (2) 296A, (3) NSS-1015A, (4) NSS-1017A, (5) NSS-1021A, (6) NSS-1018A, (7) NSS-1019A, (8) NSS-1023A, (9) 7A and (10) 623A. Male parents : (1) RSSV-30-2, (2) RSSV-49-2, (3) NSS-209, (4) NSS-218 and (5) IS-14446.
5. ***Madhura hybrid seed production*** : Eight quintals of hybrid seed of Madhura was produced during rabi 2005-06.

6. **Jaggery preparation by using a mixture of sweet sorghum and sugarcane juice** : Jaggery preparation by using sweet sorghum and sugarcane juice in a proportion of 1:9, 2:8, 3:7, 4:6, 5:5 and 6:4 respectively was carried out to assess the quality of jaggery prepared from them in order to promote the use of sweet sorghum for jaggery production. Forty eight bhelis of 1 kg each were produced from the combinations of sugarcane and sweet sorghum juice. This jaggery was subjected to organoleptic test. Jaggery produced from sweet sorghum and sugarcane juice mixed in a proportion of 1:9 respectively, scored the highest points which was followed by jaggery prepared from sweet sorghum and sugarcane juice mixed in the proportion of 2:8 respectively. Similar proportions of sweet sorghum and sugarcane juice were also screened for preparation of syrup. The organoleptic tests showed that Madhura syrup produced from 100% sweet sorghum juice scored the highest rating which was followed by the sweet sorghum and sugarcane juice mixed in the proportion of 1:9 respectively.

Pure sugarcane juice was also used to prepare 960 bhelis of jaggery weighing 1 kg each. In the preparation of this jaggery only an extract of okra (*Abelmoschus esculentus*) plants or fruits was used to facilitate scum removal. No other additives used by conventional jaggery producers were used in the process.

7. **Maintenance of station germ plasm** : A total of 203 station germ plasm lines were sown and selfed for maintenance. The line S-11-1-1 gave the highest biomass and stripped stalk yields of 90 and 74 t/ha, respectively.

## **SAFFLOWER**

### **Project 1 : All India Coordinated Research Project (AICRP) on Oilseeds (Safflower)**

Funded by the Indian Council of Agricultural Research (ICAR), New Delhi.

NARI is one of the All India Coordinated Research Project (AICRP) centers of safflower research for limited irrigation since 1980. The thrust area of safflower improvement at NARI is development of high yielding and high oil producing spiny and non-spiny varieties and hybrids with inbuilt resistance to wilt (*Fusarium oxysporum*). In addition, development of suitable agro-production technology for safflower under limited irrigation conditions is also under progress.

The major findings of safflower research carried out under the AICRP during 2005-06 are as follows:

1. **Development of new spiny hybrid NARI-H-15**: In its endeavor to further increase the productivity of the crop, the center has developed non-spiny Genetic Male Sterility (GMS)-based spiny hybrid NARI-H-15 during 2005-06. NARI-H-15 has been identified for release to all safflower growing areas of production under limited irrigated conditions in the country. NARI-H-15 gives an average seed yield of 2200



kg/ha, which is 19% higher than that of the non-spiny hybrid NARI-NH-1. Popularization of this hybrid would certainly enhance the productivity of safflower in the country.

2. ***Dissemination of technology of seed production of non-spiny hybrid NARI-NH-1*** : In order to disseminate the technology of hybrid seed production in safflower, the seeds of parental lines of newly developed non-spiny hybrid NARI-NH-1 and the technical bulletin giving information on seed production were supplied to both public and private seed producing agencies in the country. The agencies involved in seed production of NARI-NH-1 during rabi 2005-06 were National Seeds Corporation, Pune; State Farms Corporation of India, Raichur; Mahabeej, Akola and Nimbkar Seeds Pvt. Ltd., Phaltan.
3. ***Development of high yielding and high oil-containing safflower cultivars*** : The high oil containing safflower variety NARI-36 which gave 11% increase in oil yield over the national check A-1 in initial varietal/hybrid trial carried out during winter 2003-04, recorded oil yield on par with that of the National check A-1 in Advanced varietal/hybrid trial-1 carried out during 2004-05. In addition, NARI-36 showed tolerance to wilt under wilt-sick plot screening carried out for two successive years at the Directorate of Oilseeds Research, Rajendranagar, Hyderabad. Apart from NARI-36, safflower varieties NARI-38 and NARI-42, based upon their performances in initial varietal/hybrid trial during 2004-05 were promoted to advance varietal trial-1 for second year of AICRP evaluation during 2005-06.
4. ***Breeding for wilt resistance in safflower*** : Safflower wilt is one of the major diseases affecting irrigated safflower and is considered to be a major bottleneck in producing safflower in the wilt-affected areas. Therefore, in order to overcome the wilt problem, a breeding program to transfer wilt resistance from a stable source identified in the AICRP system into a high yielding but wilt-susceptible cultivar Nira has been initiated at the institute by adopting the backcross method of breeding. During rabi 2005-06, out of the 148 wilt-resistant populations evaluated in BC<sub>4</sub>F<sub>5</sub> generation, 31 populations were found to be promising for seed yield over the best check.
5. ***Development of cytoplasmic male sterility system through interspecific crossing*** : The development of cytoplasmic male sterility in safflower through interspecific crossing is being carried out at the Institute. In order to identify a suitable maintainer to the male sterile cytoplasm identified in the ongoing program, an evaluation of 680 crosses made between male sterile and male fertile sib counterparts was carried out. This resulted in identification of two crosses giving >90% male sterility in them. The male sterile plants in each entry were crossed individually with the corresponding pollinator parent to get 100% male sterility in the sterile cytoplasm in safflower.
6. ***Identification of thermosensitive male sterility in safflower*** : In the course of cytoplasmic male sterility development in safflower, it was observed that some of the crosses as well as their respective pollinator parents showed >75% male sterility in them during winter 2003-04. However, in subsequent sowing in summer 2004 these showed 100% fertility. Of the 116 individual selections obtained from summer 2004 crop, five selections exhibited complete male sterility when raised during winter 2004-05. These upon subsequent screening in summer 2005, gave 100% fertility. Further screening and testing of genotypes showing thermosensitive nature of male sterility during winter 2005-06 resulted in identification of 19 selections out of 633 evaluated as showing 100% male sterility. These male sterile selections were crossed with different safflower genotypes for

development of high yielding hybrids. The studies on determination of critical temperatures inducing fertility and sterility in thermosensitive male sterile lines are underway.

7. ***Evaluation of advanced generation selections*** : Out of the 28 advanced generation entries (F<sub>7</sub> and F<sub>8</sub> progenies) evaluated, nine selections gave higher seed yield than the best checks. Also out of the 787 high oil-containing and non-spiny F<sub>3</sub> populations of eight crosses which were evaluated, 137 populations gave at least 10% increase in seed yield over the best checks in respective trials carried out during rabi 2005-06.

**Project 2 : Biometrical investigations of flower yield and its components and their maximization in safflower**

Funded by Indian Council of Agricultural Research (ICAR), New Delhi.

**Project Duration** : October 1, 2001 to March 31, 2005

The progress made under the scheme during 2004-05 is described below :

1. ***Variability for flower yield and its components in spiny and non-spiny genotypes in trial-1*** : The evaluation over two years of spiny and non-spiny genotypes for flower yield and its component traits revealed significant differences due to genotypes and years for all the traits except seed yield/plant for genotypes and flower yield, number of seeds/capitulum and 100-seed weight for years indicating thereby the existence of high variability among the genotypes for different traits and also in the environments of the two years. The maximum average flower yield of 282 kg/ha was recorded by the genotype 694, which was followed by the entry MSN-3-8-5 (197 kg/ha). The components of variability indicated that the traits such as flower yield/plant, seed yield/plant, number of primary branches/plant, number of capitula/plant, number of seeds/capitulum and 100-seed weight which recorded high GCV, PCV and heritability coupled with high genetic advance (as percent of mean) may be considered for selection to bring about desired genetic improvement in the crop.
2. ***Variability for floral traits in spiny and non-spiny genotypes in trial-1*** : The evaluation of spiny and non-spiny genotypes for floral traits showed differences due to genotypes to be highly significant for all the floral traits in two years' of investigation indicating thereby the presence of a wide variability for concerned traits in safflower. Among the floral traits studied, number of flowers/capitulum showed high estimates for genotypic and phenotypic variances, genotypic and phenotypic coefficients of variation, heritability and genetic advance as percent of mean in both the years of investigations and hence can be considered as an important parameter to bring about desired improvement in flower yield in safflower.
3. ***Studies of correlation between flower yield and its components in spiny and non-spiny genotypes of safflower in trial-1*** : The studies of correlation between flower yield and its components revealed that flower yield/plant was significantly and positively associated with number of flowers/capitulum and seed yield/plant in both the years and with number of primary branches/plant in second year of study. The lengths of floral parts in a given flower were in a definite proportion to each other.



4. ***Evaluation of spiny and non-spiny genotypes for flower yield and other physiological traits in trial-2*** : Wide variability was observed among the safflower entries evaluated for flower yield and different physiological traits. The maximum flower yield of 335 kg/ha was recorded by the genotype 694, which was followed by the entries GMU-3418 (261 kg/ha) and BLY-1035-3 (259 kg/ha). The components of variability studied indicated that the traits such as flower yield/plant, seed yield/plant, number of primary branches/plant, number of capitula/plant, number of seeds/capitulum, number of flowers/capitulum and oil yield/plant, which recorded high GCV, PCV and heritability coupled with high genetic advance as percent of mean, may be considered for selection to bring about desired genetic improvement in the crop.
5. ***Variability for flower yield and physiological traits in F<sub>1</sub> and F<sub>2</sub> generations*** : Forty five hybrids along with their parents and their F<sub>2</sub>s were evaluated to examine variability for flower yield and its components. The cross MSN-3-8-5 X CO-1 recorded the maximum flower yield of 285 kg/ha and 230 kg/ha in F<sub>1</sub> and F<sub>2</sub> generations respectively. The results suggested the presence of considerable amount of diversity for different traits in F<sub>1</sub> and F<sub>2</sub> generations. The variability parameters viz. GCV, PCV, heritability and genetic advance as percent of mean were observed to be high for flower yield/plant, number of primary branches/plant, number of capitula/plant, number of flowers/capitulum, and oil yield/plant in F<sub>1</sub> and flower yield/plant, seed yield/plant, number of capitula/plant, number of seeds/capitulum and oil yield/plant in F<sub>2</sub> generation, which indicated thereby that the selection for these traits can be expected to bring about considerable genetic improvement in the crop.
6. ***Studies of correlation between flower yield and floral traits in F<sub>1</sub> and F<sub>2</sub> generations*** : The studies of correlation between flower yield and its components in F<sub>1</sub> hybrids showed that flower yield was significantly and positively associated with number of primary branches/plant, number of capitula/plant, capitulum diameter, number of seeds/capitulum, number of flowers/capitulum, petal length, anther length, stigma length, petal area/flower and seed yield/plant. In F<sub>2</sub> generation, flower yield/plant was significantly and positively associated with number of capitula/plant, seed yield/plant and oil yield/plant.
7. ***Inheritance of flower yield and its components*** : The study of inheritance of flower yield and its components in F<sub>1</sub> and F<sub>2</sub> generations indicated that both additive and non-additive gene actions are responsible for the inheritance of different traits in safflower. However, the additive gene action was noticed to be predominant for all the traits except flower yield/plant in F<sub>1</sub> of 2002-03 and seed yield/plant and oil yield/plant in F<sub>2</sub> generation where non-additive gene action was found to be important. These results suggest that hybrid vigour can be exploited for flower and seed yield either by using genetic male sterility system existing in the crop or resorting to biparental mating in the crosses exhibiting dominant X recessive gene action. Individual plant selections may be followed in the crosses showing additive gene action.
8. ***Heterosis for flower yield and its components in safflower*** : Heterosis studies for flower yield and its components indicated the presence of very high heterosis for flower yield/plant (147.46%) and seed yield/plant (155.54%). Promising safflower hybrids have been identified which may be considered for commercial exploitation of heterosis for both the traits. The crosses which showed high heterosis for flower yield and its components have also exhibited high inbreeding depression. This may be attributed to non-allelic interaction of genes in the inheritance of different traits in safflower. The promising cross

combinations with non-allelic interaction for flower and seed yields may yield better results following biparental mating in subsequent generations.

9. **Maximization of flower yield** : Altering of cultural practices like dates of sowing, fertilizer levels and plant spacings to maximize flower yield showed that maximum flower and seed yield from the non-spiny safflower hybrid NARI-NH-1 could be obtained by planting in the first week of October either with a spacing of 45 X 10 cm and an application of 100% or 150% recommended dose of fertilizer or with a spacing of 45 X 20 cm with 150% recommended dose of fertilizers.
10. **Evaluation of flowers of released safflower cultivars for safflower yellow** : The range of safflower yellow pigment in flowers is observed to be 5.12 to 30.03%. Entries like NARI-6 and CO-1 showing dark red color of flowers at maturity gave high amounts of yellow pigment of 30.03 and 28.14% respectively. For commercial extraction of color from safflower flowers, non-spiny varieties like NARI-6 and CO-1 and hybrid NARI-NH-1 may be considered promising, as not only do they contain high amounts of pigment in their flowers, but their non-spiny nature makes them highly suitable for flower collection.
11. **Evaluation of flowers of safflower hybrids and their parents for safflower yellow** : The maximum amount of yellow pigment of 52.21% was recorded in the hybrid 126-8-2 X GMU-2937 which was followed by the hybrids CO-1 X GMU-2937 (44.24%) and GMU-2937 X GMU-3195 (43.14%). Among the parents, the maximum concentration of yellow pigment was exhibited by the entry GMU-4808 (45.29%) which was followed by the parents CO-1 (42.47%) and NARI-6 (35.17%). The hybrids identified as giving high standard heterosis for flower yield and producing high amounts of color respectively were NARI-6 X GMU-4808 (147.46%, 37.83%), C 2708-2 X GMU-3195 (100.92%, 34.29%) and GMU-2937 X GMU-3195 (99.43%, 43.14%). These may be advanced further to develop cultivars producing high yield of flowers containing high content of color in them.

**Project 3 : To study origin of seeds with twin embryos and of fused multiple seeds, their inheritance and relationships with possible existence of polyembryony and/or apomixis in safflower**

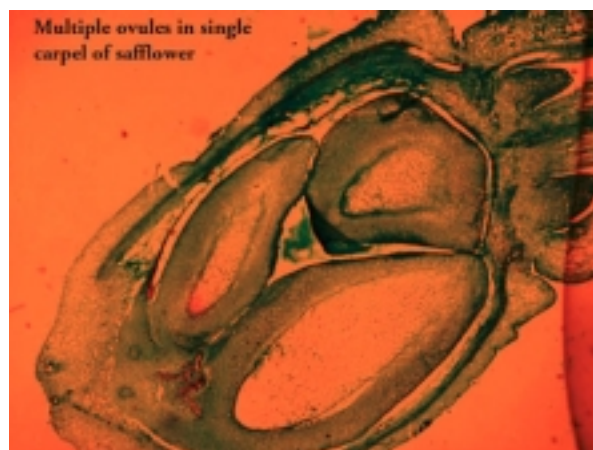
Funded by Indian Council of Agricultural Research (ICAR), New Delhi.

**Project Duration** : January 1, 2005 to December 31, 2007

Cytomorphological studies were carried out to identify polyembryony and apomixis in present safflower material under study. The results of the studies carried out objective wise in the first year of the project are as follows :

1. To study the origin of seeds with twin embryos and of fused multiple seeds in different genotypes, embryological investigations of normal sexual plants were carried out first to establish the normal process of embryo sac and embryo development in safflower. These investigations revealed the presence of megaspore mother cells (2n) forming linear tetrads. The normal plant pistil produced a single ovule in a single carpel giving rise to normal caryopses. The embryological studies of derivatives of an interspecific cross between *C. palaestinus* and *C. tinctorius* showed that single pistils contained two separate ovules that resulted in fused caryopses. Efforts are underway to study the initial stages of

embryo sac development in caryopses containing twin and triplet ovules in them. This will help in determining whether the embryo sacs in these ovules are of sexual or asexual nature.



2. The mitosis and meiosis in each counterpart of a twin seedling set originating from a seed as well as in seedlings from fused multiple seeds is being studied in order to determine whether the plants produced from such seeds are haploid, diploid or aneuploid.

This will help to confirm the existence of polyembryony and/or apomixis in them.

- (i) In order to determine the ploidy level of twin embryo seeds in different genotypes identified at the institute and to confirm the existence of polyembryony and/or apomixis in them, the radicles originating from twin embryo seeds of safflower entry 238-14-2 were studied. The mitotic investigations of twin embryo plants revealed the presence of 24 and 36 chromosomes in the somatic cells of the roots. Presence of 36 chromosomes indicated the triploid nature of a plant, which suggests the presence of polyploidy in the genotype thereby indicating the possibility of apomictic origin of seeds in it.
  - (ii) Meiotic studies of fasciated safflower plants derived from an interspecific cross between *C. palaestinus* and *C. tinctorius* were carried out to study the ploidy of such plants in safflower. These studies showed normal pairing at metaphase and exhibited 12 bi-valents both at metaphase and diakinesis. In addition, equal distribution of chromosomes at both the poles with no laggards was observed at anaphase-I.
  - (iii) The derivatives of genotype D-149 have a tendency to produce male sterile plants at a low frequency. Also they do not produce seeds even after hand pollination and thus are considered as haploids or triploids. These derivatives were subjected to chromosome doubling by nitrous oxide treatment at a pressure of 2-8 kg/cm<sup>2</sup> for four hours in a pressure chamber at two-leaf stage of plant growth. The observations on number and size of stomata of treated and untreated plant leaves did not show any difference between them, which indicated that either chromosome doubling did not take place or the increased ploidy level did not result in an increased number and size of stomata in the present case. The technique of chromosome doubling and the effect of chromosome doubling on stomatal size and number will be scrutinized further to draw some valid conclusions from the study.
3. The study on inheritance of seeds with twin embryos and of fused multiple seeds, as well as of polyembryony and apomixis and possible association between them is underway at the institute.

## ***GRAPES***

**Title of the project** : Introduction, evaluation and distribution of plant material of grape varieties suitable for export (table grapes)

Funded by Agricultural and Processed Food Products Export Development Authority (APEDA), New Delhi.

**Project Coordinator** : National Research Center for Grapes (NRCG), Pune

**Project Duration** : January 1, 2003 to December 31, 2006

Two years after grafting of three varieties viz., Redglobe, Crimson seedless and Italia on Dogridge rootstock was carried out, flowering took place on Redglobe. From a total of 240 vines about 160 kg grapes were produced. The average weight of each bunch was 238 g with 36 berries per bunch. This year we expect to get flowering in Crimson seedless and Italia as well.

**Project staff** : N. Nimbkar, Ph.D.; Dr. D. R. Bapat, Ph.D. (Consultant); V. Singh, Ph.D.; M. B. Deshpande, M.Sc.; S. R. Deshmukh, M.Sc.; N. M. Kolekar, M.Sc.; J. H. Akade, M.Sc.; R. Sumitha, M.Sc.; S. V. Choudhari, B.Sc.; V. L. Nimbalkar, R. K. Andhalkar, N. T. Madkar, M. G. Shirke, M. M. Bhujbal, V. T. Dhere

## **RENEWABLE ENERGY RESEARCH**

### **Project 1 : Development of ethanol stoves for rural areas**

Funded by Ministry of Non-conventional Energy Sources (MNES), New Delhi

**Project duration** : 1/2/2004 to 31/1/2006

#### **Aim and Scope of the Project :**

- 1) To develop an efficient ethanol stove for rural areas and test 10 of them in rural households.
- 2) To establish the techno-economic viability of the ethanol stove for rural areas

#### **Main Problem :**

The main problem was to vaporize the 50% water present in the fuel mixture and use heat from the combustion of ethanol vapors efficiently. Secondly, it had to be ensured that the CO emissions from the stove would be within acceptable limits. In addition, the stove had to be an economically viable option when compared to the conventionally used LPG and kerosene stoves.

#### **Development :**

A number of problems were tackled during the development of the ethanol stove in the past one year. The developmental achievements are summarized below:

- (i) A new brass burner that runs efficiently under variable climatic conditions has been developed. This burner can function efficiently in ambient temperatures ranging from 10 to 40°C and relative humidity even up to 100%.
- (ii) A jacket enabling efficient combustion of the ethanol vapors has been developed. With this jacket, the overall stove efficiency is around 50% and Carbon monoxide (CO) values near the cook are around 10 to 12 ppm.
- (iii) A specialized fluid flow regulator for the ethanol stove has been successfully developed. It is a diaphragm-type pressure regulator and gives satisfactory operation for tank pressures ranging from 50 to 150kPa.
- (iv) A flame-regulating valve (FRV) has been developed to enable easy flame regulation. The kind of flame regulation provided by the FRV is very similar to that in the LPG stove.

#### **Results:**

- (i) A stove running on 50% w/w ethanol-water mixture was successfully developed at NARI. To the best of our knowledge this is the first stove of its kind developed anywhere in the world. The stove capacity ranges from 0.9 to 2.45kW (or a turn down

ratio of 1:2.7) with an overall efficiency of 50%. The CO emission by the stove is of the order of 10 to 12 ppm (near the cook sitting on the ground) at maximum capacity. It gives useful output energy very similar to that from the current LPG and kerosene stoves.

- (ii) Sixty-seven field tests involving 16 women were conducted at NARI during the course of the research project. These include six tests conducted with a kerosene stove and two tests conducted with an LPG stove for the purpose of performance comparison with ethanol stove. The tests showed that the ethanol stove required less specific energy to cook food as compared to kerosene and more as compared to LPG stove.



- (iii) From the general comments of the women, it was concluded that the ethanol stove was preferred over the kerosene stove for the reasons of less pumping required, less noise made and no chemical odor imparted to the food. In addition, the stove capacity and flame regulation provided by the stove were generally found to be satisfactory.
- (iv) Economic analysis showed the cost of using the ethanol stove was comparable to that of both LPG and kerosene stoves.

## **Project 2 : Development of a mini plot thresher running on renewable energy for safflower**

**Funded :** internally

### **Problems in safflower threshing :**

- (1) Threshing of safflower trial plots is tedious, time consuming and labor intensive work due to spiny nature of the crop.
- (2) Declining labor availability and their reluctance to work with a spiny crop have aggravated the problem of threshing safflower trial plots.

In view of the above it was decided to mechanize the threshing of safflower trial plots.

### **A. Development of a hand-operated single plant thresher for safflower :**

1. Initially a hand-operated single plant thresher was designed and built to see its suitability for threshing safflower trial plots.
2. Testing of the hand-operated machine showed that continuous manual hand operation of the machine throughout the day for 6-8 hours was not feasible for a person to do.
3. In addition, it was felt that the machine should also have a mechanism to clean the threshed material since this activity is also quite laborious and time consuming.

4. Therefore, in view of the above it was decided that the development of a pedal-operated machine would be a better alternative, as the required power to operate the machine could be generated more effortlessly.

#### **B. Development of pedal-operated mini plot thresher for safflower :**

1. NARI has developed an efficient pedal-operated machine for threshing safflower with a mechanism to clean the seed to a considerable extent.
2. The pedal-operated thresher is easy to use and has been found to be 40-50% more efficient in threshing safflower as compared to manual threshing.

However, continuous operation of the machine showed practical limitations as six to seven hours/day of continuous pedaling was found to cause heavy strain on a laborer and therefore running the machine for more than two to three days at a time was not possible for a laborer. This required frequent replacement of the laborers which is not practically feasible due to shortage of male laborers in the region.

However we feel that the problem of pedaling of the machine can be suitably overcome out by installing a battery-powered motor in the pedal-operated thresher.

#### ***Future plan of work :***

#### **C. Development of battery-operated mini plot thresher for safflower :**

It is planned to develop a battery-operated, portable, mini plot thresher for safflower which includes :

- (1) Modification of the pedal-operated thresher for running on a battery-powered motor.
- (2) To optimize the threshing efficiency of the machine.
- (3) To optimize the cleaning efficiency of the machine to get clean seed free from inert matter.

Initial tests have shown promise. It is expected that the battery-operated machine would be three to four times more efficient in threshing safflower as compared to hand threshing and will give clean pure seed.



#### **Project 3 : Development of a completely motorized vehicle for physically challenged**

**Funded :** internally

There has been a tremendous response to NARI's completely motorized tricycle for physically challenged. Consequently R&D has been continued to make it very easily maneuverable in city traffic conditions. Thus a new gear box is being designed so that it can

be used on steep slopes (> 10%). Also the motor is being redesigned to take the extra torque for slopes and to also ascertain that the speed does not drop drastically under high loads.

**Project 4: Center for Sustainable Living. Funded: Internally**

Efforts are on to raise the money through donations so that seminar hall, conference room and small hostel facilities can be built for holding workshops and seminars. A [small workshop](#) on this theme is scheduled to be held in October/November in the existing facilities. Detailed modules for energy, water, agriculture and environment have been developed.

**Project staff :** Anil K. Rajvanshi, Ph.D.; S. M. Patil; B. Mendonca, B.Tech.; Y. Shaikh, B.E.; D. B. Gadhave, A. M. Pawar, R. S. Bale

## ANIMAL HUSBANDRY RESEARCH

**Title of the project :** “Improved productivity, profitability and sustainability of sheep production in Maharashtra, India through genetically enhanced prolificacy, growth and parasite resistance”

Funded by the Australian Center for International Agricultural Research (ACIAR), Canberra

**Duration** : January 1, 2002 to December 31, 2004

**Extension** : January 1, 2006 to December 31, 2007

The salient achievements of the project are given below objective wise.

(Note: Animals homozygous for the *FecB* mutation are denoted as *FecB<sup>BB</sup>*, heterozygous as *FecB<sup>B+</sup>* and wild-type homozygous as *FecB<sup>++</sup>*.)

**Objective A : Production of appropriate genotypes for testing in shepherds’ flocks (India)**

The breeding program at NARI is now based on a selection index derived from estimated breeding values (EBV) and economic values for four traits namely three-month weight, fertility, litter size and lamb survival. Using this index some 25% of mature ewes were culled during the year (161/660). Matings for 2006 will be designed using the TGRM software. In February-March 2005, 297 lambs were born at NARI from an AI program in September-October 2004. From 94 *FecB<sup>B+</sup>* ewes inseminated, 102 live lambs were produced (109% lambing) and 96 lambs reached three months’ of age (102% weaning). From 247 *FecB<sup>++</sup>* ewes inseminated, 195 live lambs were produced (79% lambing) and 190 lambs reached three months’ of age (77% weaning). Overall lamb mortality to three months was 3.7% which is very low. Two AI programs took place at NARI during 2005. In February-March 2005, 213 ewes were inseminated producing 190 lambs born and 172 lambs reared to three months.



Overall lamb mortality of 9% was moderate. Lambing % for *FecB<sup>BB</sup>* (n=4), *FecB<sup>B+</sup>* (n=93) and *FecB<sup>++</sup>* (n=116), ewes respectively was 100%, 100% and 80%. Weaning % (to three months' of age) was 100%, 88% and 75% respectively. A further 258 ewes were inseminated in September- October 2005; 182 of these conceived and 169 lambs were born in February 2006.

A total of 656 lambs was born during the year. Out of the 487 lambs born up to September 2005, 70 were *FecB<sup>BB</sup>*, 315 were *FecB<sup>B+</sup>* and 102 were *FecB<sup>++</sup>*. It is pleasing that 79% of all lambs born contained the *FecB* mutation. Lamb mortality to six months' of age was a relatively high 20% due to an outbreak of bluetongue disease in the district. By comparison mortality in 2004 was 9%. Total sheep numbers at NARI at the end of 2005 were 845. Amongst the crossbred ewe population there were 14 *FecB<sup>BB</sup>*, 111 *FecB<sup>B+</sup>* and 93 *FecB<sup>++</sup>* ewes available for breeding in February 2006. During the year 354 DNA samples from NARI and 155 from shepherds' flocks were genotyped for the *FecB* mutation at National Chemical Laboratory (NCL), Pune.

### **Objective B : Testing of improved genotypes in shepherds' flocks and development of appropriate management technologies**

To date 60 *FecB<sup>B+</sup>* and 60 *FecB<sup>++</sup>* ewes from NARI have been distributed to 22 smallholders. In addition 20 AI programs using semen from rams carrying the *FecB* gene have been carried out and multiple ram introductions made using NARI rams carrying the *FecB* mutation. Currently there are 21 smallholders with 1200 breeding ewes involved in this objective. Data from the 2004 and 2005 lambings of distributed ewes indicate that one copy of the *FecB* mutation confers an additional 0.3 lambs per ewe born and 0.14 additional lambs reared to six months' of age.

Detailed records are maintained of participating flocks and NARI provides significant inputs to the shepherds in the form of sheep husbandry extension and routine monitoring of worm burdens. Worm burdens in the flocks and at NARI peak during the monsoon months. An anthelmintic efficacy test of a local brand of the anthelmintic Closantel during 2005 revealed reduced duration of efficacy against *Haemonchus contortus*. However, worms remain fully susceptible to Levamisole and Albendazole. NARI produced a DVD on the care and management of ewes with multiple births during the year and a major field day for shepherds was held.

### **Objective C : Regulation of expression of *FecB* in Indian and Australian breeds of sheep**

Studies at NCL have shown that the *FecB* mutation was not detected in the main five Deccani sheep sub-types, so it can be assumed that the gene is being introgressed into a population from which it is absent. At NARI the purebred Garole flock was divided into "High" and "Low" groups for litter size EBV and samples sent to NCL for examination to ascertain a genetic basis for the differences. Two approaches were taken and appropriate methods developed at NCL. One was to look for an additional mutation within the BMPR-1B gene (location of the *FecB* mutation), while the other was to look at variation in the flanking region of the gene. Polymorphism in both was observed and will be investigated further. In Australia, data from a large outbred commercial flock indicates that one copy of the *FecB* mutation confers a large increase in ovulation rate (~1.4), scanned litter size (~0.92) and lambs marked per ewe mated (~0.37). However while an additional copy of the mutation

increases ovulation rate almost linearly (1.1 over heterozygote), ewe conception rate is significantly reduced relative to the heterozygote (~-13%), as is scanned litter size (~-0.26%) and lambs marked per ewe mated (~-0.37%). This is a previously unreported phenomenon and requires further investigation. Endocrinology of plasma samples collected throughout the oestrus cycle in Merino and Garole sheep carrying the *FecB* mutation revealed significant differences in FSH, progesterone and LH profiles, with the Garole not matching either the Booroola Merino or the normal Merino. It is possible that the large differences in ovulation rate and litter size between these sheep types may be explained in part by these differences in hormone profiles.

#### **Objective D : Development of extension and genetic models for the dissemination of proven genotypes (India and Australia)**

With the benefit of three years' of dissemination activity we are now firmly of the view that dissemination should be of rams or of semen from nucleus flocks rather than of ewes which can have problems with adaptation. Dissemination should be from sheep phenotypes similar to those in the target population. Models for the introgression of the *FecB* gene have been developed during the year.

**In summary**, a successful sheep breeding program incorporating the *FecB* gene conferring prolificacy is under way at NARI with about 700 breeding ewes and 100 breeding rams. Sophisticated genetic methods are applied for selection of sheep to maximize genetic gain and control inbreeding. The improved genotypes (rams and ewes) are being disseminated into flocks of local shepherds as well as to NGOs and private flocks in Maharashtra and other states.

**Project staff** : C. Nimbkar, Ph.D.; B. V. Nimbkar, M.Sc.; P. M. Ghalsasi, B.V.Sc.; P. P. Ghalsasi, B.Sc.; M. H. Nalawade, B.Sc.; A. H. Magar, B.A.; K. M. Chavan, H.S.C., LSS; R. T. Khanvilkar, H.S.C., LSS; D. D. Mulik, S.S.C.

## **I. APPOINTMENTS**

- A. Dr. Chanda Nimbkar formally joined in October 2005 as a part-time member of the National Commission on Farmers appointed by the Ministry of Agriculture, Govt. of India.
- B. Shri B. V. Nimbkar was appointed on 28 November 2005 as a member of the Working Group on Animal Husbandry, Dairying and Fisheries of the Sub-Committee of the National Development Council (NDC) on Agriculture and Related Issues. Shri Nimbkar was asked to prepare an action plan for the development of sheep, goats and backyard poultry.

## **II. MEETINGS ORGANIZED**

- A. The Third coordination meeting of the ACIAR-funded project was held from 13-17 November 2005 at Animal Husbandry Division (AHD). Indian and Australian

collaborators of the project attended the meeting. They included Associate Professors Stephen Walkden-Brown and Julius van der Werf from the University of New England, Dr. Vidya Gupta and Ms. Varsha Pardeshi from NCL and Dr. Nandini Nimbkar, President of NARI.

Dr. Peter Rolfe, Research Program Manager, ACIAR, Australia and the following three reviewers of the project also attended the meeting.

1. Dr. David Emery, University of Sydney, Australia
2. Dr. Wayne Pitchford, University of Adelaide, Australia
3. Dr. D. V. Rangnekar, India

Invitees : Dr. Arjava Sharma, Dr. J. R. Rao and Dr. Ran Vir Singh, Indian Veterinary Research Institute, Izzatnagar.

- B.** An expert committee comprising of Dr. D. R. Bapat, Former Director of Research, Mahatma Phule Krishi Vidyapeeth, Rahuri; Dr. J. V. Goud, Former Vice Chancellor, University of Agricultural Sciences, Dharwad and Dr. K. B. Saxena, Principal Scientist (Pigeonpea Breeding), ICRISAT, Patancheru visited NARI on 23/1/2006 to critically review the program of cytoplasmic male sterility (CMS) development in safflower. The committee expressed satisfaction over the progress of work and made valuable suggestions to facilitate speedy recovery of maintainer genotypes capable of imparting 100% male sterility to the male sterile cytoplasm in safflower. The committee also suggested that the dwarf male steriles developed at NARI be used for developing hybrids, as this marker trait is identifiable at an early stage of plant growth.

### III. PUBLICATIONS

#### A. Booklets published

1. A booklet “Harnessing genetics to increase meat production from sheep”. June 2005. It was prepared to give information about the discovery of the *FecB* gene, its introduction into Deccani sheep and achievements of ACIAR projects 1994/22 and 2002/38. This booklet has been distributed widely in India and abroad.
2. The Marathi version of the above booklet ‘Mendhi palanatla phayda vadhavnyacha ek nava marg’ published by NARI in 2004 was reprinted in several leading magazines for farmers including ‘Shetkari’ April 2005. pp. 34-36 and 43.

#### B. Articles published in magazines and journals (in alphabetical order)

1. Ghalsasi, P.M. 2005. Fecundity B gene in shepherds’ flocks to increase productivity. Vetline. News Bulletin of the Bombay Veterinary College Alumni Association, Mumbai. Cover page.
2. Nimbkar, B.V. 2005. Hair sheep. Current Science: 89(2) : 242.
3. Nimbkar B.V. 2005. Marathi article on “Sheep and goat rearing for increasing meat production” (Masotpadan wadhisathi sheli-mendhi palan) published in a Special

supplement of a local newspaper for farmers. 12 October 2005. This article was then reprinted in several other Marathi weeklies and magazines.

4. Nimbkar, C. 2005. Importance of genetic resistance to gastro-intestinal nematodes in sheep in developing countries with special reference to the Garole breed. Proceedings of the FAO Symposium on “Integrated Animal Parasite Management: From Academic Interest to Reality” held at Indira Gandhi Agricultural University, Durg, Chhattisgarh, India. December 8, 2005. pp. 34-40. Food and Agriculture Organization
5. Nimbkar, C and Nimbkar, B.V. 2006. Status and prospects of commercial sheep farming in India. In Souvenir-cum-Proceedings of the National Workshop-cum-Seminar on “Commercial Goat and Sheep Farming and Marketing: Farmer-Industry-Researcher Interface” held at the Central Institute for Research on Goats, Makhdoom, U.P. on March 4-5, 2006. pp. 31-34. Indian Society for Sheep and Goat Production and Utilization.
6. **Nimbkar, C.** Pardeshi, V.C. and **Ghalsasi, P.M.** 2005. Evaluation of the utility of the *FecB* gene to improve the productivity of Deccani sheep in Maharashtra, India. In Applications of gene-based technologies for improving animal production and health in developing countries. Ed. H.P.S. Makkar and G.J. Viljoen. FAO-IAEA. Springer. pp. 145-154.
7. Pardeshi, V.C., Sainani, M.N., Maddox, J.F., **Ghalsasi, P.M.**, **Nimbkar, C.** and Gupta, V.S. 2005. Assessing the role of *FecB* mutation in productivity of Indian Sheep. *Current Science*. **89 (5)** : 887-890
8. Rajvanshi, A. K. 2005. Rocket Science for rural development : Ideas for implementation, In Proceedings of the 10th Annual meeting of NCIIA, held in Portland, Oregon, U.S.A. April 2005, pp. 291-294. [http://www.nciia.org/conf\\_06/papers/pdf/rajvanshi.pdf](http://www.nciia.org/conf_06/papers/pdf/rajvanshi.pdf).
9. Rajvanshi, A. K. 2005. Sustainable development of India – A Gandhian approach, Anasakti Darshan, Vol. I, No. 1, January-June, 2005. Published by Gandhi Smriti and Darshan Samiti, New Delhi.
10. Lindner, Angela, S., Stanfill, R. Keith, Hodges, Mark and **Rajvanshi, Anil K.** 2006. “Expanding the boundaries of design of products and progress for solution to the problems in developing world”, Accepted for publication in the Proceedings of the 9<sup>th</sup> International Conference on Engineering Education, San Juan, Puerto Rico, July 23-28, 2006. <http://fic.eugrng.pitt.edu/icec2006/papers/3468.pdf>.
11. Rajvanshi, A. K., “Can we switch over to CFL lighting”, Face-off interview in Economic Times, June 13, 2005.
12. Rajvanshi, A. K., “Electricity and water revolution for rural India”, Editorial article in Times of India, July 27, 2005.
13. Rajvanshi, A. K., “The rural electricity and water revolution”, REPSOVISION, Vol. 31. July 2005. Published by Winrock International (India).
14. Rajvanshi, A. K., “Sustainable development for rural poor”, Op-Ed in Project Monitor, August 29, 2005.

15. Rajvanshi, A. K., “Village of my dream”, Editorial article in Times of India, October 19, 2005.
16. Rajvanshi, A. K., “Karma and the fine art of remapping our memories”, Editorial article in Times of India, November 10, 2005.
17. Rajvanshi, A. K., “Presence of a great soul”, Published in www.boloji.com, January 2, 2006.
18. Rajvanshi, A. K., “Strategy for rural electrification”, REPSOVISION, Vol. 33, January-March 2006. Published by Winrock International (India).
19. Rajvanshi, A. K., “The happiness factor in natural evolution”, Editorial article in Times of India, February 18, 2006.
20. Rajvanshi, A. K., “Development of low concentration ethanol stove”, Final project report submitted to Ministry of Non-conventional Energy Sources (MNES), New Delhi, April 2006. 119 pp.
21. Rajvanshi, A. K., Patil, S. M. and Mendonca, B, “Development of low concentration Ethanol Stove”, Accepted for publication in J. of Sustainable Energy.
22. Singh, Vrijendra, 2005. Status of safflower improvement in India. In the Proceedings of VIth International Safflower Conference, Istanbul, Turkey, June 6-10, 2005 : xiii-xv.
23. Singh, Vrijendra, M. B. Deshpande and N. Nimbkar. 2005. Polyembryony in safflower and its role in crop improvement. In the Proceedings of VIth International Safflower Conference, Istanbul, Turkey, June 6-10, 2005 : 14-20.
24. Singh, Vrijendra, N. Nimbkar and S. R. Deshmukh. 2005. First non-spiny safflower hybrid in India : NARI-NH-1, Baliraja. August 2005. P 71.

### **C. Book Chapter :**

Singh, Vrijendra and N. Nimbkar, 2006. Safflower. In : Singh, R. J. (Ed.). Genetic Resources, Chromosome Engineering and Crop Improvement : Oilseed Crops. Vol. 4. CRC Press, Boca Raton, FL 33431-9868, USA (Scheduled for publication in November 2006).

### **D. PhD Thesis**

Nimbkar, C. 2005. Genetic improvement of lamb production efficiency in Indian Deccani sheep. PhD thesis. University of New England. 209 p.

## **IV. TRAINING AND EXTENSION ACTIVITIES FOR FARMERS, SHEPHERDS AND INDIAN AND INTERNATIONAL STUDENTS**

1. Dr. P. M. Ghalsasi delivered a lecture on ‘Introduction of fecundity B gene in shepherds’ flocks to increase productivity’ in the UGC–sponsored refresher course for University

teachers 'Converging trends in Life-Sciences – Biotechnology' organized at Vidya Pratishthan's Arts, science and commerce College, Baramati on 6 April 2005.

2. Dr. Pushpendra Kumar, Postgraduate student of Animal Genetics Division, Indian Veterinary Research Institute collected 53 blood samples of NARI Garole ewes for molecular characterization on 26 April 2005. NARI provided him the necessary data of these Garole ewes. He amplified genomic DNA of Garole and did polymorphism and sequencing study of the *FecB* gene. The title of his MVSc thesis based on this work was "Genetic polymorphism of Booroola fecundity (*FecB*) gene in Garole sheep".
3. The secretariat of the International Atomic Energy Agency (IAEA) sponsored the training in animal reproduction of Dr. Julius Awah Ndukum, Senior Lecturer, The University of De Dschang, Cameroon at NARI from 17 May to 15 August 2005.
4. K.R. Deokate, Postgraduate student of the Department of animal reproduction, College of veterinary and animal science, Parbhani, Maharashtra was given one day training in May 2005 in the technique of early pregnancy diagnosis in goats using ultrasonography.
5. S. B. Nimbalkar, Postgraduate student of Postgraduate institute of Veterinary and animal sciences, Akola, Maharashtra was provided the information he required for his thesis on Deccani sheep.
6. Several workshops were conducted for shepherds by AHD to create awareness of the new composite sheep breed developed by NARI.
7. Many farmers visited NARI throughout the year to get information about safflower and sweet sorghum.
8. NARI supplied about 1050 kg of high quality seeds of spiny and non-spiny safflower varieties and hybrids and 1900 kg seed of sweet sorghum hybrid Madhura for testing purposes during 2005-06 in addition to the complete production technology of safflower and sweet sorghum cultivation.
9. NARI also supplied about 25 kg safflower flowers as herbal health tea and for other uses and 90 kg sweet sorghum syrup during 2005-06.
10. NARI conducted 20 frontline demonstrations in safflower on farmers' fields in districts Satara and Pune during 2005-06 to demonstrate the latest technology developed in the crop to the farmers for adoption by them.
11. Five lanterns were given to Dnyan Prabodhini, Pune for testing in tribal areas of Maharashtra.

## V. TRAINING RECEIVED BY NARI STAFF

- A. Ms Padmaja Ghalsasi visited NCL, Pune six times during the year to carry out the direct PCR-RFLP DNA test for the *FecB* (Booroola) mutation together with Ms. Varsha Pardeshi of NCL. Dr. Vidya Gupta kindly granted permission and allowed Ms. Ghalsasi to carry out the test for NARI. After every *FecB* exercise, the gel pictures were scanned

and emailed to Dr. Jill Maddox at the University of Melbourne (Australia) for her expert comments. The explanations and practical hints given by Jill were very useful and we tried to follow them closely in our exercises.

- B. Ms. Chanda Nimbkar submitted her PhD thesis “Genetic improvement of lamb production efficiency in Indian Deccani sheep” in August 2005. She completed this thesis at the University of New England, Armidale, NSW, Australia on a John Allwright Fellowship from ACIAR. Her supervisors were Prof. Brian Kinghorn and A/Prof. Julius van der Werf with co-supervision by A/Prof Stephen Walkden-Brown.

## VI. IMPORTANT VISITORS

Around 500 farmers, researchers and other visitors visited the head office during the year. Among some of the important visitors were the following :

1. Dr. M. P. Yadav, Director, Indian Veterinary Research Institute (IVRI), Izzatnagar visited NARI to see the research and development work in sheep and goats on 20 June 2005.
2. Shri. Madhur Bajaj, Vice Chairman, Bajaj Auto Ltd., Pune visited NARI in June 2005 with five students of Amity School of Business Management to see the various projects underway at the institute.
3. Dr. Ralph A. van Gelder, Livestock Marketing and Agribusiness Consultant, Meat and Livestock Australia visited AHD on 19-20 June 2005, to conduct a market supply chain survey of the sheep meat industries of India.
4. Shri. Pawan Kumar, founder of vMoksha a major I.T. company in Bangalore visited NARI on 10 July 2005 to see the work being carried out in various disciplines.
5. Dr. G. S. Karibasappa, Senior Scientist (Horticulture) and D. J. Satisha, Scientist (Horticulture) from the National Research Center for Grapes (NRCG), Pune visited on 20 July 2005 and 9 September 2005 to monitor the trials of exotic grape varieties which are underway at NARI. They gave many valuable suggestions about trial-related practices to be followed.
6. Dr. Nadim Fairoze, Associate Professor, Dept of Livestock Production and Management, Veterinary College, Karnataka Veterinary, Animal and Fisheries Science University, Bangalore visited in August 2005 and February 2006 to advise NARI on meat quality of fattened lambs.
7. Dr. M. N. Reddy, Director (Agricultural Extension and Communication), National Institute of Agricultural Extension Management (MANAGE), Hyderabad visited NARI on 27 August 2005 to discuss about the dissemination of FecB gene in shepherds' flocks.
8. Shri. P. B. (Nanasaheb) Chitale, Partner, M/s. B. G. Chitale (Chitale dairy), Bhilawadi-Station visited NARI on 12/9/05 to see the work being carried out in various disciplines. He took some seed of 'Madhura' sweet sorghum so that 'Madhura' could be tested as a fodder for their buffaloes.

9. Dr. P. G. Adsule, Director, NRCG, Dr. G. S. Karibasappa and Dr. R. G. Somkuwar, Senior Scientist (Horticulture) visited NARI on 24 October 2005 to monitor the progress of grape trial.
10. Shri J.P. Dange, Chief Secretary, Animal Husbandry, Dairy and Fisheries Department, Maharashtra State visited AHD on 13 November 2005. He was given information on the activities of the Institute.
11. Dr. John Copland, former Research Program Manager (Animal Science), ACIAR visited NARI on 8-10 December 2005 and gave valuable advice for its future plans.
12. Dr. Arun Majumdar, Dean of Research, Indian Institute of Technology, Kharagpur and his wife Dr. Vandana visited NARI on 25 December 2005 to see the work being carried out in various disciplines.
13. Dr. D. M. Hegde, Director, Directorate of Oilseeds Research (DOR), Hyderabad visited NARI on 8 January 2006 for the assessment of safflower research trials planted in rabi 2005-06 season. He was accompanied by Dr. V. B. Akashe, Jr. Entomologist, AICRP (Oilseeds), MPKV, Solapur.
14. The monitoring team comprising of Dr. R. D. Prasad, Senior Scientist (Plant Pathology), DOR, Hyderabad, Dr. S. N. Deshmukh, Breeder, AICRP (Oilseeds), PDKV, Akola, Dr. C. Sudhakar, Junior Agronomist, AICRP (Oilseeds), ANGRAU, Tandur and Dr. V. B. Akashe visited NARI on 18 January 2006 for the review of rabi 2005-06 safflower trials in breeding and agronomy. They found the program to be satisfactory.
15. Dr. Banibrata Pandey, Business head (P.B.) of Nagarjuna Fertilizers and Chemicals Ltd., Hyderabad visited on 30 January 2006 for discussions on sweet sorghum research and development.
16. Mr. Rakesh Sharma, Chief Commissioner of Customs and Excise, Pune visited NARI on 13 February 2006 to see the work being carried out in various disciplines.
17. Mr. Phil Larocco, former Director of New York Port Authority and Executive Director of E & Co. an energy company in New Jersey visited NARI in February 2006 to see the energy activities and also to discuss various issues of collaboration and mutual interest.
18. Dr. C. R. Ramesh, Senior Scientist, NRC for onions and garlic, Rajgurunagar (formerly senior scientist, IGFRI, Dharwad center) visited on 26 March 2006 in order to finalize the proposal on *Stylosanthes seabrana* being prepared by NARI, for submission to ICAR.
19. Prof. Bert J. H. de Vries from Copernicus Institute, University of Utrecht, Netherlands visited NARI with his graduate student on 31 March 2006 to discuss collaboration on renewable energy.



## VII. CONFERENCES/SEMINARS/MEETINGS ATTENDED BY STAFF AND LECTURES GIVEN

1. Dr. Anil K. Rajvanshi attended the meeting of the selection committee of Jamnalal Bajaj Awards in Mumbai on 6 July 2005. It was held to select the 2005 awardee of the “Application of Science and Technology for Rural Areas” award.
2. Dr. Vrijendra Singh and Mr. M. B. Deshpande attended the Annual Group Meeting of Safflower and Linseed held at the CSKHPAU, Palampur from 22-24 August 2005 and gave presentations on safflower research carried out under AICRP.
3. Dr. Anil K. Rajvanshi attended the conference of the International Solar Energy Society held in Orlando, Florida, U.S.A. from August 8-12, 2005 and gave a presentation entitled “Nature Conservation + Spirituality = Sustainable Development”.
4. Dr. Anil K. Rajvanshi and Dr. N. Nimbkar attended a meeting on National Agricultural Innovation Program (NAIP) at Bharatiya Agro Industries Foundation in September 2005.
5. Dr. Anil K. Rajvanshi and Dr. N. Nimbkar attended the meeting of district electricity advisory committee formed by the Maharashtra Electricity Regulatory Commission at Satara in September 2005.
6. Dr. P. M. Ghalsasi participated in the Technical seminar cum discussion conducted by Whatman Asia Pacific Ltd. - India Liaison Office, Mumbai at the National Chemical Laboratory, Pune on 2 September 2005. The company gave technical information on use of FTA cards for extraction of DNA. The information given proved useful for the Institute for collecting blood samples on FTA papers.
7. Dr. Anil K. Rajvanshi attended the conference entitled “Alternative Fuels for Sustainable Future” in New Delhi organized by the Administrative Staff College of India in October 2005. He made a presentation on NARI’s work on ethanol from sweet sorghum.
8. Dr. Anil K. Rajvanshi gave an invited lecture to MBA students at Institute of Management Technology (IMT) at Nagpur in October 2005.
9. Dr. P. M. Ghalsasi attended the technical discussions organized by the Animal Husbandry Department of the Satara Zilla Parishad on ‘Measures for control of goat and sheep diseases and eradication of foot and mouth disease’ on 21 October 2005. He delivered a lecture on ‘Bluetongue disease in sheep and goats’.
10. Dr. Chanda Nimbkar and Ms. Padmaja Ghalsasi attended the XVI National Congress of Veterinary Parasitology and FAO symposium on “Integrated Animal Parasite Management: From Academic Interest to Reality” held at Indira Gandhi Agricultural University, Durg, Chhattisgarh from 6-8 December 2005. Dr. Nimbkar presented a plenary paper at the FAO symposium “Importance of genetic resistance to gastrointestinal nematodes in sheep in developing countries with special reference to the Garole breed”.

11. Mr. J. H. Akade attended the meeting on 7 December 2005 arranged by Prasar Bharati, Satara in order to discuss the present status, changes required and how to bring them about in the farmers' program 'Kisanvani' which is broadcast by Satara radio station.
12. Dr. Anil K. Rajvanshi and Dr. N. Nimbkar delivered lectures at the University of Florida in December 2005. Dr. Nimbkar gave a talk to the agronomy club and delivered a GEAP and Farming Systems Seminar on "Agricultural Research at NARI". Dr. Anil K. Rajvanshi gave a lecture to an Environmental Engineering class and an invited lecture on "R&D for Sustainable Development".
13. F. M. Channel of Satara radio recorded the lectures of Mr. N. M. Kolekar on "Sweet sorghum planting and production" and of Mr. M. B. Deshpande on "New technology for improved safflower on 19 December 2005.
14. Dr. P. M. Ghalsasi delivered a lecture on "Fecundity B gene in shepherds' flocks to increase productivity" at the discussions organized by the veterinary council at Baramati on 20 December 2005.
15. Dr. Anil K. Rajvanshi and Dr. N. Nimbkar attended the seminar on Organic Agriculture organized in Pune by UNEP (Paris and Geneva) AGROINNOVA (Univ. of Turin, Italy) and MADHYAM (Pune) from 4-6 January 2006.
16. Dr. Chanda Nimbkar attended the second meeting of the Central Advisory Committee for the development of sheep, goats and rabbits under the chairmanship of Union Agriculture Minister, Shri Sharad G. Pawar.
17. On February 28, 2006 on the occasion of National Science Day Dr. Anil K. Rajvanshi was invited as the chief guest at R & DE (E), a DRDO Laboratory in Pune and gave an invited lecture on the work at NARI. Around 200 faculty and staff of the Institute were present for the lecture.
18. Mr. S. R. Deshmukh attended the National Workshop on Biological Control of Insect Pests organized by the Department of Zoology, Shivaji University, Kolhapur on 1-2 March 2006.
19. Shri B. V. Nimbkar attended two meetings of the Working Group on Animal Husbandry, Dairying and Fisheries of the National Development Council (NDC) on Agriculture and Related Issues. Shri Nimbkar was asked to prepare an action plan for the development of sheep, goats and backyard poultry. This Working Group submitted their interim report to the Planning Commission in March 2006.
20. Dr. Chanda Nimbkar attended, as part-time member, six meetings of the National Commission on Farmers from 28 October 2005 to 6 March 2006. She also contributed to the chapter on Animal Husbandry of the Draft National Policy on Farmers.
21. Dr. Chanda Nimbkar participated in the National Workshop-cum-Seminar on 'Commercial goat and sheep farming and marketing: Farmer-industry-research interface' organized by the Indian Society for Sheep and Goat Production and Utilization on 4-5 March 2006 at the Central Institute for Research on Goats, Makhdoom. Dr. Nimbkar presented an invited paper 'Status and prospects of commercial sheep farming in India'.

22. Dr. Chanda Nimbkar participated in the International workshop on ‘Livestock keepers, livestock biodiversity, indigenous knowledge and intellectual property rights: Opportunities and threats’ organized by the League for Pastoral Peoples and sponsored by the Rockefeller Foundation. It was held at the Foundation’s Bellagio Conference Center in Italy from 27 March to 2 April 2006. Dr. Nimbkar presented a paper on “Garole sheep of Sunderban, India and Intellectual Property Rights issues”.

## VIII. OTHER ACTIVITIES

1. Shri. B. V. Nimbkar gave an interview to the Vasundhara Channel (for farmers) of Baramati radio on “Research activities of Nimbkar Agricultural Research Institute in sheep and goats” on 26 August 2005. On the same day lectures of Dr. P. M. Ghalsasi on “Introduction of fecundity B gene in shepherds’ flocks to increase productivity” and of Mr. N. M. Kolekar on “Sweet sorghum planting and production” were recorded for broadcasting.
2. A news item on NARI’s energy activities was published in Times of India on May 11, 2005.
3. A lead story on NARI’s renewable energy activities was published in TERRAGREEN, in Issue 87, 30 June 2005.
4. A short film (CD) in Marathi “Narichi kimaya nyari, juli kokre lai bhari” and English “Sheep rearing: Increasing profits with twin lambs” was prepared by NARI in November 2005. This has been shown to several gatherings of shepherds and is shown regularly to visitors to make them aware of NARI’s pioneering work in the development of prolific Deccani sheep and of protocols for management of ewes and twin lambs.
5. The inauguration function of the new building of AHD took place on 7 February 2006, at the hands of the Union Agriculture Minister, Shri. Sharad G. Pawar. Mr. David Ingham, Australian High Commission, New Delhi attended the function and made a speech praising the AHD’s achievements in the ACIAR-funded project. Ms. Simrat Labana from the ACIAR, New Delhi office also attended the function. Several other dignitaries such as the Collector of Satara District Shri Subrao Patil, the Chairman and Managing Director of Baramati Agro Ltd. Shri Rajendra Pawar and Smt. Nanda Pawar, Dr. A. D. Karve of the Appropriate Rural Technology Institute, Phaltan, Dr. V.K. Singh, the Director of the Central Sheep and Wool Research Institute of the ICAR, local elected representatives to the Lok Sabha and Vidhan Sabha, government officials and journalists were also present at the occasion.
6. In March 2006 Dr. Anil K. Rajvanshi had meetings with Shri. Jairam Ramesh, Minister of State, Commerce Ministry, Government of India and Shri. Montek Singh Ahluwalia, Deputy Chairman, Planning Commission regarding renewable energy policy for India.
7. A TV team carried out one day shooting of NARI’s rickshaw development project for a program on Doordarshan called “Khel khel me badlo duniya”. This program was broadcast on Doordarshan (the National TV network) on 26 July 2006.

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