

ANNUAL RESEARCH REPORT 2008-2009



**Nimbkar Agricultural Research Institute,
P.O. Box 44, PHALTAN-415523,
Maharashtra**

August 2009

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Report of the President

I have great pleasure in presenting the progress report of the Institute for the year 2008-09. I am happy to highlight some important achievements and developments during this year.

- (1) NARI has become a centre of the All India Coordinated Sorghum Improvement Project (AICSIP) to carry out research on sweet sorghum. This will enable us to continue our work of last nearly 40 years on this crop.
- (2) NARI has also become a sub-centre of the All India Coordinated Research Project on Goat Improvement for Osmanabadi goat. This project will be implemented at the Animal Husbandry Division (AHD) of NARI with Dr. Chanda Nimbkar as the principal investigator. Thus along with sheep NARI will also commence research on the other important small ruminant viz. goat.
- (3) Dr. Anil Kumar Rajvanshi, Director of NARI received the prestigious [Globe Award](#) in Stockholm in June 2009 at the hands of HRH Crown Princess Victoria of Sweden. This award was given to NARI for Dr. Rajvanshi's invention "[Lanstove](#)".

I would like to congratulate Dr. Rajvanshi as well as his team members for their achievements.

The work of centre for sustainable development (CSD) is progressing well and we expect the centre, to become operational from April 2010. The construction of this centre was made possible due to the generous donations from Nimbkar Seeds Pvt. Ltd., Phaltan and Bajaj Auto Limited, Pune during last year. We are extremely grateful to them and all the earlier donors.

I also wish to thank Mr. P. N. Joshi, Satara, Ms. Madhura Rajvanshi, Phaltan and Mrs. Primla Vohra, New Delhi for their donations to the corpus. Many other individuals and companies – too many to list here – have donated a total of nearly 15 lakh rupees for specific purposes. We greatly appreciate their largesse.

Dr. N. Nimbkar
August 27, 2009

AGRICULTURAL RESEARCH

SAFFLOWER

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

Funding agency : 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 major objectives of safflower improvement at NARI have been to develop high-yielding and high oil-producing spiny and non-spiny varieties and hybrids with in-built resistance to wilt (*Fusarium oxysporum*), in addition to development of suitable agro-production technology for safflower under limited irrigation conditions.

Research highlights :

- 1. Development of cytoplasmic male sterility system through interspecific crossing :**
The cytoplasmic male steriles developed through interspecific crossing as well as induced by streptomycin treatment in safflower at NARI were crossed with sib-pollinator parents which had expressed > 70% male sterility in their progenies in winter 2007-08. During winter 2008-09 about 104 pairwise crosses made with sib-pollinator parents were evaluated to identify the genotypes maintaining male sterility of the sterile cytoplasm. None of the crosses gave 100% male sterility in the sterile cytoplasm.
- 2. Evaluation of CMS-based crosses :** About 72 different germplasm lines were crossed with the CMS lines with the objective of identifying male sterility maintainer or fertility restorer genotypes in them. The evaluation of these crosses for sterility/fertility during flowering of the crop revealed that none of the 72 crosses evaluated showed complete maintenance of male sterility in them. However, four crosses exhibited complete restoration of fertility in them. To confirm the fertility restoration ability of these genotypes all the four genotypes were re-crossed with the CMS lines for evaluation of the hybrids in summer as well as in winter conditions.
- 3. Evaluation of thermosensitive genetic male sterility in safflower :** The thermosensitive genetic male sterility system developed at the center was also evaluated during winter 2008-09 to assess its stability over the years. About 180 lines out of the 1050 evaluated exhibited 100% male sterility in them. The lines showing complete male sterility in winter 2008-09 will be planted in summer 2009 for further maintenance and use in hybrid development.
- 4. Evaluation of thermosensitive genetic male sterility (TGMS)-based hybrids in safflower :** Evaluation of 38 TGMS-based hybrids along with their 38 male parents and three hybrids viz. NARI-NH-1, NARI-H-15 and MRSA-521 for sterility/fertility during flowering of the crop showed complete fertility indicating usefulness of TGMS system for hybrid development in safflower. Evaluation of the TGMS hybrids under partially irrigated conditions revealed that hybrid TGMS-H-104 recorded the significantly highest seed yield of 2122 kg/ha and oil yield of 733 kg/ha which were 102% and 139% higher than those of CMS hybrid check MRSA-521.

5. **Seed production of promising TGMS-based hybrids under nylon cages :** Seed production of four promising TGMS-based hybrids viz. TGMS-H-42, TGMS-H-81, TGMS-H-38 and TGMS-H-39 evaluated in winter 2007-08 was taken up under nylon cages by utilizing honeybee colonies. Sufficient amount of seed was obtained for further evaluation in multilocation trials. Seed production of TGMS-H-104 will also be taken up at Wellington (Tamil Nadu) in summer 2009 due to its promising performance in winter 2008-09. The temperatures at Wellington are expected to be conducive for maintaining sterility of TGMS lines.



6. **Crossing programme and advancement of segregating generations :**

- (a) Fifty eight hand crosses were produced during winter 2008-09, which comprised of two crosses made with a view to induce earliness in potential safflower varieties and 56 crosses were made between thermosensitive genetic male sterile (TGMS) lines as females and different genotypes as males to produce TGMS-based hybrids in safflower.
- (b) F_2 populations of six three-way crosses were grown each on an area of 81 m². Nearly 300 selections in each of the populations were made based upon high oil content, thin hull content and high seed yield in addition to aphid tolerance.
- (c) Out of the 71 F_6 progenies evaluated in three trials, 17 selections gave higher seed yield than the best checks in the respective trials.

7. **Development of high seed and oil-yielding safflower cultivars :**



Fourteen out of the 126 high oil-containing entries evaluated in preliminary varietal trials recorded higher seed yields than the best checks in the respective trials. Four safflower varieties viz. NARI-52, NARI-55, NARI-56 and NARI-57 which were evaluated in Initial Varietal Trial during winter 2007-08 recorded at least 10% higher seed and oil yields than the national check A-1 across the locations and were promoted to second year of evaluation in AICRP trials. In addition, NARI-48 which was evaluated in AVT-1 during 2007-08 was promoted to AVT-II for third year of evaluation.

Project 2 : To study origin of seeds with twin embryos and of fused multiple seeds, their inheritance and relationship with possible existence of polyembryony and/or apomixis in safflower.

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

Duration : 1 February 2005 to 30 January 2008

Research highlights :

- 1) The embryological studies in normal sexual genotypes showed them to contain single pistils having inferior, syncarpous, unilocular ovaries with a single basal anatropous ovule. The meiotic division of megaspore mother cell in them gives rise to a linear tetrad of megaspores revealing thereby the sexual nature of embryo sac development in them. The embryological studies of fasciated derivatives of an interspecific cross between *C. palaestinus* and *C. tinctorius* producing twin embryos and fused multiple seeds showed fusion of two to three ovaries forming uni- or bilocular structures with one to five ovules in each locule. The ovules were found to have both sexual and aposporic embryo sacs. The multiple aposporous embryo sacs were found to have originated from nucellar epidermal cells located inside the integumentary tapetum. The presence of both aposporic and sexual embryo sacs in the same ovule suggests the existence of facultative apomixis in safflower.

The embryological studies in 238-14-2 and its derivatives showed similar histological characters such as fusion of two to three ovaries, occurrence of multiple ovules in a single locule and fusion of the ovules with each other. However, frequency of occurrence of such characters in 238-14-2 was less as compared to that in fasciated interspecific derivatives described above. The pre-fertilization study of genotypes showed that mitotic division of somatic aposporous cell led to formation of multiple unreduced embryo sacs. However, occurrence of sexual plants in the genotype confirmed facultative type of apomixis in it.

The histological study of F_1 s from crosses made between fasciated and normal sexual genotypes showed single pistils with unilocular ovaries having a single anatropous ovule. Also the process of megasporogenesis to form linear tetrads was found to be normal. This reveals the recessive nature of apomixis-indicating traits in the present case. However in F_1 progenies of crosses made between genotype 238-14-2 and the genotype with normal plants, few plants with maternal-type behaviour were seen thereby suggesting apomictic development of such plants in them.

- 2) In preliminary studies it was found that the derivatives of genotype D-149 had a tendency to produce male sterile plants at a low frequency and did not produce seeds even after hand pollination. Therefore, they were considered haploids or triploids and subjected to chromosome doubling by nitrous oxide treatment at two-leaf stage of plant growth for four hours at a pressure of 2.8 kg/cm^2 in a pressure chamber. 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 the chromosome doubling could not take place or the increased ploidy level did not result in an increased number or size of stomata. However, the twin plants at maturity were similar to each other in all morphological characters thus indicating no cytological and morphological differences between twin seedlings of D-149. Also both had ploidy level $2n = 24$. Therefore, polyembryony in the genotype was ruled out.

In order to determine the ploidy level of twin-embryo seeds in different genotypes identified at the center and to confirm the existence of polyembryony and/or apomixis in them, the radicles originating from twin-embryo seeds of genotype 238-14-2 and

fasciated derivatives of an interspecific cross *C. palaestinus* X *C. tinctorius* were studied. The mitotic investigations of twin-embryo plants of 238-14-2 revealed presence of $2n + 2 = 26$ chromosomes in twin-embryo seeds indicating the presence of aneuploids and $2n = 24$ in single-embryo seeds of the genotype. However, the presence of triploids ($3n = 36$) in a few cases confirmed the tendency of this genotype to show hyperploids which suggests the presence of polyploidy and the possibility of apomictic origin of seeds in it.

Studies of meiosis to identify the plants with changed ploidy level were carried out in derivatives of an interspecific cross between *C. palaestinus* and *C. tinctorius*. The meiotic studies showed normal pairing at metaphase and exhibited 12 bi-valents both at metaphase and diakinesis. In addition, at anaphase-I equal distribution of chromosomes at both the poles with no laggards was observed. However, the pollen fertility varied from 5 to 100% in different derivatives. Meiotic studies in 238-14-2 and D-149 also showed normal chromosome configuration at metaphase and anaphase-I with absence of laggards.

Meiotic studies were carried out in F_1 crosses made between fasciated derivatives of *C. palaestinus* X *C. tinctorius* and normal safflower genotypes with some dominant traits to examine the chromosomal pattern in them. The study showed normal meiotic behaviour in F_1 crosses as is observed in normal sexual safflower genotypes. The F_1 crosses showed normal pairing at metaphase and exhibited 12 bi-valents at both metaphase and diakinesis. In addition, at anaphase-I, equal distribution of chromosomes at both the poles with no laggards was observed. This resulted in normal fertile pollens (86-100%) being produced giving 100% seed set in these F_1 crosses. Similar meiotic behaviour was also shown in F_1 crosses made between derivatives of D-149 and 238-14-2 producing twin-embryo seeds and normal safflower genotypes.

- 3) The inheritance of twin-embryo seeds and stem fasciation in interspecific fasciated derivatives was worked out to be digenic recessive with inhibitory gene action for the control of both the traits. The genes controlling the two traits were found to be closely linked in coupling phase. The evaluation of F_1 hybrids, made between 238-14-2 as female parent and normal safflower genotypes possessing dominant traits as male parent revealed the presence of mother-type plants in them, with a frequency of about 13%. This reconfirms the existence of apomixis in this genotype.
- 4) The screening of 500 safflower germplasm lines for apomixis-indicating traits resulted in identification of 23 lines having seeds with twin embryos. These lines were crossed with normal safflower genotypes with flower colour as a dominant trait so that the occurrence of maternal type of plants in F_1 could be examined to identify possible apomixis in these lines. The study revealed that all the F_1 progenies were normal and no maternal types were observed thereby ruling out possibility of apomixis in these genotypes.

SWEET SORGHUM

Project 1 : 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

Duration : December 1, 2005 to November 30, 2008

Objectives :

1. To develop photo-thermoinsensitive cultivars and hybrids of sweet sorghum suitable for grain, fodder and sugar production, so as to make it acceptable as a multipurpose agroindustrial crop in India especially for ethanol production.
2. To develop and improve the present CMS lines and pollinators suitably to exploit the potential of sweet sorghum hybrids for sugar and biomass production.
3. To generate information on factors such as irrigation requirement and harvesting and crushing periods.
4. To disseminate the agro-production technology for sweet sorghum cultivation to the farmers.

Research highlights :

The investigations undertaken in the project have been greatly successful in achieving the objectives proposed in the study. The major achievements of the scheme are described below :

- (1) In order to develop high yielding sweet sorghum cultivars, a total of 209 intervarietal crosses using diallel crossing programme were made in monsoon and post-monsoon seasons during the three year tenure of the project. Evaluation of these crosses resulted in identification of 17 promising ones giving higher sugar and grain yields than the best checks. These hybrids also possessed other desired characteristics.
- (2) Twenty three F₂ populations of promising crosses were raised to select individual plants possessing desired traits. A total of 1296 single plant selections were made during the three year duration of the project for development of sweet sorghum varieties giving high sugar and grain yield. They were suitable to grow in either monsoon or post-monsoon conditions.
- (3) About 1150 populations from segregating (F₃, F₄ and F₅) generations were evaluated during three years to identify the promising ones. They were advanced further to develop high yielding sweet sorghum cultivars. Among them 126 populations gave higher biomass yield and brix % than the respective best checks in different trials.
- (4) A study of inheritance of sugar yield and its components revealed the importance of both additive as well as non-additive gene actions in the expression of sugar yield and its

components in sweet sorghum with the predominant role of additive and additive X additive epistatic components of genetic variance which are fixable.

- (5) For development of high yielding sweet sorghum hybrids for monsoon and post-monsoon conditions about 250 CMS-based hybrids were evaluated during the three-year project period. Out of these, 27 hybrids gave significantly superior performance than the best checks for sugar and ethanol yields. Different hybrids were identified to have recorded the maximum sugar and ethanol yields under monsoon and pre-monsoon conditions.
- (6) Evaluation of promising CMS-based hybrids for sugar and ethanol yields to identify the most promising ones for multilocation testing resulted in identification of hybrid NSS-1023A X IS-14446. It gave the significantly highest total sugar index of 34.58 q/ha and estimated ethanol yield of 1845 l/ha which were respectively 45 and 46% higher than those of the best check Madhura.
- (7) Screening of most promising CMS-based sweet sorghum hybrid NSS-1023A X IS- 14446 in multilocation AICSIP trials during monsoon 2007 and 2008 seasons showed NSS-1023A X IS-14446 as giving higher grain yield and shootfly resistance as compared to the sweet sorghum hybrid check CSH-22 SS. Moreover, it also gave sugar and ethanol yield at par with CSH-22 SS. Thus the newly developed sweet sorghum hybrid NSS-1023A X IS-14446 exhibited a potential to become a suitable alternative to CSH-22 SS for commercial production.
- (8) The effect of different dates of sowing and hybrids/varieties on sugar and ethanol yields during monsoon conditions revealed that sweet sorghum hybrid NARI-SSH-45 and variety SSV-84 sown on June 15 recorded the maximum total sugar index and estimated ethanol yield. The sowings beyond June 15 in monsoon significantly reduced sugar and ethanol yields. Among the entries screened the sweet sorghum variety SSV-84 and hybrid NARI-SSH-45 were found to be the most suitable ones for production.
- (9) For production of sweet sorghum under post-monsoon conditions, sweet sorghum hybrids NARI-SSH-48 and NARI-SSH-45 were found to be the most promising giving the highest sugar and ethanol yields across the different sowing dates. The month of October was found to be the most suitable period for sowing sweet sorghum to obtain the highest biomass stripped stalk, juice and grain yields from the crop. The sowings beyond October significantly reduced the biomass, but gave highest brix and ethanol yields in sweet sorghum.

Project 2 : Breeding sweet-stalk sorghum varieties and hybrids giving high biomass, sugar, cellulose and hemicellulose with low grain

Funding agency : Nagarjuna Fertilizers and Chemicals Ltd. (NFCL), Hyderabad

Duration : October 1, 2006 to March 31, 2009

Objectives :

1. To optimize sugar content, biomass yield, cellulose content and hemicellulose content in sweet-stalk sorghum.
2. To develop early-maturing sweet-stalk sorghum genotypes.

3. To develop sweet-stalk sorghum hybrids resistant to drought and shootfly (*Atherigona soccata*).

Research highlights :

Progress of the work done in the project is presented season-wise :

(I) Kharif (Rainy season) 2008 :

- (1) One hundred and five CMS-based sweet sorghum hybrids along with three checks viz. Madhura, RSSV-9 and SSV-84 were evaluated for high biomass and sugar yield under kharif conditions in three different trials. Thirty three CMS-based sweet sorghum hybrids were evaluated in trial 1. The hybrid SSRH-11 gave both significantly highest biomass yield of 71.64 T/ha and total sugar index of 2.36 T/ha and was followed by the hybrids SSRH-6 (63.49 T/ha), SSRH-13 (62.94 T/ha) for biomass and SSRH-2 (64.74 T/ha; 2.13 T/ha) for both biomass and total sugar index. The best check for biomass was SSV-84 (54.60 T/ha) and that for total sugar index was RSSV-9 (1.83 T/ha).

In trial 2, out of 33 CMS-based sweet sorghum hybrids the hybrid SSRH-60 gave significantly highest both fresh biomass yield of 62.39 T/ha and total sugar index (2.33 T/ha). The best check for biomass was SSV-84 (50.17 T/ha) and for total sugar index it was RSSV-9 (1.6 T/ha). In trial 3 consisting of 39 CMS-based sweet sorghum hybrids the hybrid SSRH-128 gave maximum biomass yield of 59.71 T/ha which was followed by SSRH-98 (53.04 T/ha) and SSRH-99 (51.13 T/ha). Biomass yield of best check RSSV-9 was 44.82 T/ha. The maximum total sugar index of 2.59 T/ha was recorded by SSRH-109 which was followed by SSRH-108 (1.90 T/ha) with the best check RSSV-9 giving total sugar index of 1.45 /ha.

- (2) Another set of 92 CMS-based sweet sorghum hybrids were reevaluated in three different trials for high biomass and sugar yield along with three checks viz. Madhura, RSSV-9 and SSV-84. In trial 1 47 CMS-based sweet sorghum hybrids were evaluated. The maximum fresh biomass yield of 47.38 T/ha was recorded by SKH-2 with the best check SSV-84 giving 41.36 T/ha. The maximum total sugar index was given by SKH-1 (1.50 T/ha) with the best check RSSV-9 giving 0.75 T/ha SKH-1 was followed by SKH-25 (1.17 T/ha) and SKH-7 (1.0 T/ha).

Among the 27 CMS-based sweet sorghum hybrids evaluated in trial 2, significantly highest biomass was given by SKH-53 (76.75 T/ha) with the best check RSSV-9 giving 45.71 T/ha. SKH-53 was followed by SKH-67 (52.38 T/ha). The highest total sugar index was given by SKH-67 (2.78 T/ha) with the best check RSSV-9 giving 2.02 T/ha. SKH-67 was followed by SKH-53 (2.10 T/ha).

In trial 3, out of the 18 CMS- based sweet sorghum hybrids evaluated, the hybrid SKH-86 gave significantly highest biomass yield of 54.5 T/ha with the best check RSSV-9 giving 36.96 T/ha. SKH-86 was followed by the hybrids SKH-92 (51.80 T/ha), SKH-81 (48.59 T/ha), SKH-87 (47.41 T/ha) and SKH-72 (46.62 T/ha). The maximum total sugar index of 2.41 T/ha was recorded by SKH-81 which was followed by SKH-102 (1.55 T/ha) and SKH-87 (1.48 T/ha).



(3) Sixteen hand-emasculated F₁ crosses along with four checks were evaluated in kharif season to generate the information on inheritance of sugar content and its components in sweet-stalk sorghum and also to develop sweet-stalk sorghum lines. None of the entries was found to be significantly higher for fresh biomass yield and total sugar index than any of the checks used in the trial. However the cross EC-10 was on par with the check SSV-84 (26.05 T/ha) for biomass.

(4) Fifteen promising sweet sorghum genotypes along with three checks were evaluated for biomass and sugar content. The maximum fresh biomass of 46.07 T/ha was recorded by the genotype NARI-NFSS-233 which was followed by the genotypes

NARI-NFSS-210 (45.96 T/ha), NARI-NFSS-108 (44.27 T/ha) and NARI-NFSS-112 (44.23 T/ha). The highest total sugar index was recorded by the genotype NARI-NFSS-233 (3.16 T/ha) which was followed by NARI-NFSS-112 (2.15 T/ha), NARI-NFSS-27 (2.11 T/ha), NARI-NFSS-108 (2.07 T/ha) and NARI-NFSS-236 (2.03 T/ha).

- (5) Preliminary evaluation of 54 sweet sorghum genotypes along with two checks viz. Madhura and RSSV-9 was carried out in two trials. In trial 1, out of the 27 genotypes evaluated, significantly highest biomass and total sugar index were recorded by NARI-NFSS-83 (59.40 T/ha; 2.39 T/ha). Out of the 27 sweet sorghum genotypes evaluated in trial 2, the entry IS-40376 gave maximum biomass of 39.59 T/ha with that of Madhura being 33.3 T/ha. IS-40376 was followed by NARI-LC-07-81 (36.26 T/ha). Maximum total sugar index of 1.05 T/ha was recorded by NARI-NFSS-190 which was followed by NARI-NFSS-219 (1.0 T/ha) and NARI-NFSS-192 (0.93 T/ha).
- (6) Eight shootfly-tolerant genotypes were evaluated for biomass and sugar yields along with three checks Madhura, ICSV-700 and SSV-84 during kharif 2008. The maximum biomass yield was recorded by PVR-453 (51.19 T/ha) which was followed by Akola Kranti (48.92 T/ha) and Parbhani Moti (41.32 T/ha). However none of the entries evaluated recorded higher total sugar index than the best check ICSV-700 (1.84 T/ha).
- (7) Another trial consisting of 46 genotypes identified for high sugar and high shootfly tolerance along with four checks, the maximum fresh biomass yield of 41.81 T/ha was given by NARI-NFSS-130 which was followed by NARI-LC-07-6 and NARI-NFSS-210 (both 40.7 T/ha), NARI-LC-07-82 (39.6 T/ha) and NARI-LC-07-37 (39.2 T/ha) with the best check SSV-84 yielding 34.41 T/ha. The maximum total sugar index of 2.34 T/ha was recorded by NARI-NFSS-130 which was followed by NARI-LC-07-6 (1.97 T/ha). The least shootfly-affected genotype was NARI-LC-07-82 (14.04%) with the best check ICSV-700 having infestation percentage of 30.12.
- (8) Out of the 62 ICRISAT germplasm lines evaluated for desired traits along with three checks viz. Madhura, RSSV-9 and SSV-84 the maximum fresh biomass yield of 61.05 T/ha was recorded by IS-19512 with the best check Madhura giving 29.67 T/ha. IS-19512 was followed by entries IS-19476 (49.95 T/ha), IS-2162, IS-18573 and IS-14108

(all 48.1 T/ha) and IS-2269 (42.55 T/ha). The maximum total sugar index of 1.86 T/ha was recorded by IS-8100 with that of best check Madhura being (1.55 T/ha). IS-8100 was followed by the entries IS-22144 (1.85 T/ha) and IS-19512 (1.55 T/ha).

- (9) Eighty six CMS A-lines with their respective maintainer B-lines were evaluated for desired traits as well as maintained. The maximum fresh biomass yield of 24.37 T/ha was recorded by ICSB-411 which was followed by ICSB-488 (24.28 T/ha), ICSB-410 (21.48 T/ha) and ICSB-474 (20.25 T/ha). The maximum brix % of 21.2 was recorded by ICSB-487 which was followed by ICSB-439 (20.3%), ICSB-685 (19.7%), ICSB-538 (19.3%), ICSB-433 and ICSB-488 (both 19%).



- (10) Fourteen promising sweet sorghum hybrids along with three checks viz. Madhura, RSSV-9 and SSV-84 were evaluated for high biomass and sugar yields under kharif conditions. The significantly highest fresh biomass yield of 45.38 T/ha was recorded by the hybrid NARI-NFSSH-44 which was followed by NARI-NFSSH-40 (43.48 T/ha). Also the hybrid NARI-NFSSH-44 recorded maximum sugar index of 2.14 T/ha with that of the best check RSSV-9 being 1.67 T/ha. NARI-NFSSH-44 was followed by NARI-NFSSH-49 (2.01 T/ha) and NARI-NFSSH-50 (1.86 T/ha).
- (11) Total 39 land races collected during 2008 were evaluated along with three checks viz. Madhura, RSSV-9 and SSV-84. The maximum biomass yield of 53.62 T/ha was recorded by NARI-LC-K-07-2 with that of best check Madhura being 34.97 T/ha. NARI-LC-K-07-2 was followed by NARI-LC-K-07-27 (50.15 T/ha), NARI-LC-K-07-15 (46.31 T/ha) and NARI-LC-K-07-30 (44.04 T/ha). The maximum brix % of 17 was recorded by genotypes NARI-LC-K-07-20 and NARI-LC-K-07-29-4 which were followed by NARI-LC-K-07-27 and NARI-LC-K-07-28 (both 16.5%).

(II) Rabi (Post-rainy season) 2008-09 :

- (1) Total 79 CMS-based sweet sorghum hybrids along with three checks viz. Madhura, RSSV-9 and SSV-84 were evaluated in three different trials for high biomass and sugar content. In trial 1, out of 26 CMS-based sweet sorghum hybrids evaluated the significantly highest biomass yield of 53.84 T/ha was given by the hybrid SSRH-2 with that of the best check Madhura being 39.81 T/ha. However, none of the entries gave higher total sugar index than the best check RSSV-9 (2.02 T/ha). The significantly highest grain yield of 82.14 q/ha was recorded by SSRH-3 with that of the best check SSV-84 being 41.74 q/ha.

In another set of 26 CMS-based hybrids evaluated in trial 2, the significantly highest biomass yield of 58.06 T/ha was recorded by SSRH-83 with that of the best check Madhura being 46.75 T/ha. SSRH-83 was followed by SSRH-38 (58.08 T/ha), SSRH-81 (55.03 T/ha), SSRH-80 (52.92 T/ha) and SSRH-93 (52.21 T/ha). The maximum total sugar index was recorded by SSRH-80 (2.17 T/ha) which was followed by SSRH-53

(1.97 T/ha) and SSRH-93 (1.31 T/ha). Significantly highest grain yield of 78.81 q/ha was recorded by SSRH-50 with that of the best check Madhura being 56.98 q/ha.

In trial 3, 27 CMS-based sweet sorghum hybrids were evaluated. The maximum fresh biomass yield of 45.75 T/ha was recorded by SSRH-147 with that of the best check Madhura being 37.73 T/ha. SSRH-147 was followed by SSRH-129 (43.64 T/ha), SSRH-149 (43.11 T/ha), SSRH-104 (42.47 T/ha), SSRH-135 (41.93 T/ha) and SSRH-98 (41.75 T/ha). The maximum total sugar index was recorded by SSRH-125 (2.28 T/ha) with that of the best check RSSV-9 being 0.83 T/ha. SSRH-125 was followed by SSRH-98 (1.72 T/ha), SSRH-109 (1.57 T/ha) and SSRH-144 (1.50 T/ha). Significantly highest grain yield of 69.49 q/ha was recorded by hybrid SSRH-105 with that of the best check RSSV-9 being 39 q/ha. SSRH-105 was followed by SSRH-104 (65.34 q/ha), SSRH-147 (63.94 q/ha), SSRH-97 (60.46 q/ha) and SSRH-149 (58.68 q/ha).

- (2) Seven CMS-based hybrids along with three checks viz. Madhura, RSSV-9 and SSV-84 were evaluated in rabi 2008-09 for biomass and sugar content. The significantly highest biomass was recorded by SSH-R-2 (35.26 T/ha) which was followed by SSH-R-5 (34.85 T/ha), SSH-R-4 (33.78 T/ha) and SSH-R-8 (33.07 T/ha). Also another set of eight CMS-based hybrids along with the same three checks were evaluated for biomass and sugar content. Significantly highest fresh biomass yield of 34.91 T/ha was recorded by SSH-13 with that of the best check RSSV-9 being 23.05 T/ha. SSH-13 was followed by SSH-2 (34.53 T/ha), SSH-1 (31.08 T/ha) and SSH-9 (30.24 T/ha). The highest total sugar index of 1.28 T/ha was recorded by SSH-2. The significantly highest grain yield of 73.69 q/ha was recorded by SSH-3 which was followed by SSH-5 (65.79 q/ha), SSH-4 (60.86 q/ha) and SSH-13 (53.75 q/ha).
- (3) Thirty four sorghum land races collected from different areas of Satara and Sangli districts which were evaluated in kharif 2008 were also evaluated in rabi 2008-09 along with three checks viz. RSSV-9, Madhura and SSV-84 for biomass and sugar yield. The maximum fresh biomass yield of 68.80 T/ha was recorded by NARI-LC-K-07-18 with that of best check SSV-84 being 37.09 T/ha. NARI-LC-K-07-18 was followed by NARI-LC-K-07-2 (38.62 T/ha). The highest total sugar index of 1.62 T/ha was recorded by NARI-LC-K-07-2 which was followed by NARI-LC-K-07-21 (1.50 T/ha), NARI-LC-K-07-4 (1.24 T/ha) and NARI-LC-K-07-23-2 (1.19 T/ha). The maximum grain yield of 65.86 q/ha was recorded by NARI-LC-K-07-17 with that of the best check Madhura being 29.55 q/ha.
- (4) A total of 60 germplasm lines received from ICRISAT were evaluated along with three checks viz. Madhura, RSSV-9 and SSV-84 in an unreplicated trial for sugar yield and other desired traits. The maximum fresh biomass of 47.30 T/ha was recorded by IS-4663 which was followed by IS-18662 (46.45 T/ha), IS-5571 (45.60 T/ha), IS-5210 (43.36 T/ha) and IS-22144 (38.90 T/ha). The maximum total sugar index of 1.58 T/ha was recorded by IS-20510, which was followed by IS-4663 (1.51 T/ha) and IS-5566 (0.71 T/ha). The maximum grain yield of 81.06 q/ha was recorded by IS-5469 which was followed by IS-2269 (58.49 q/ha) and IS-8887 (57.16 q/ha).
- (5) One hundred CMS A-lines with their respective maintainer B-lines were evaluated for desired traits and were also maintained by hand pollination. The maximum fresh biomass yield of 31.46 T/ha was recorded by ICSB-409 which was followed by ICSB-413 (30.08 T/ha), ICSB-429 (29.61 T/ha), ICSB-415 (26.47 T/ha), ICSB-432 (25.88

T/ha) and ICSB-313 (25.18 T/ha). The maximum total sugar index of 0.68 T/ha was recorded by ICSB-468. The maximum grain yield of 38.18 q/ha was recorded by ICSB-529 which was followed by ICSB-518 (35.80 q/ha), ICSB-614 (31.27 q/ha), ICSB-410 (31.10 q/ha) and ICSB-427 (30.95 q/ha).

- (6) A total of seven hand crosses were evaluated for high biomass and sugar content along with their respective parents and three checks in rabi 2008-09. The significantly highest fresh biomass yield of 24.64 T/ha was recorded by EC-5 over best check Madhura (20.06 T/ha). The maximum total sugar index was given by EC-9 (0.70 T/ha) which was followed by EC-7 (0.57 T/ha) and EC-12 (0.25 T/ha). The significantly highest grain yield of 7.54 q/ha was recorded by EC-11 which was followed by EC-7 (7.24 q/ha).
- (7) Thirty three land races with two checks viz. Madhura and SSV-84 were evaluated for biomass and sugar yield. The significantly highest biomass yield of 16.69 T/ha was recorded by NARI-LC-07-10 over best check SSV-84 (12.22 T/ha). The maximum total sugar index was recorded by NARI-LC-07-57 (0.90 T/ha) which was followed by NARI-LC-07-16 (0.51 T/ha), NARI-LC-07-54 (0.37 T/ha), NARI-LC-07-4 and NARI-LC-07-77 (both 0.37 T/ha). The significantly highest grain yield of 6.23 q/ha was recorded by NARI-LC-07-4 which was followed by NARI-LC-07-12 (6.03 q/ha), NARI-LC-07-74 (5.58 q/ha) and NARI-LC-07-16 (5.46 q/ha).

Project staff : N. Nimbkar, Ph.D.; D. R. Bapat, Ph.D. (Consultant); V. Singh, Ph.D.; M. B. Deshpande, M.Sc.; S. V. Choudhari, J. H. Akade, M.Sc.; Anaytullah, Ph.D.; A. M. Ranaware, M.Sc., S. L. Dake, M.Sc.; R. R. Giri, M.Sc.; T. V. Kotasthane, M.Sc.; V. A. Bhagwat, M.Sc.; S. D. Zagade, R. K. Andhalkar; M. G. Shirke; D. S. Awati; V. V. Doiphode; P. P. Ahiwale; S. R. Mohite; Y. R. Mohite; A. M. Nale; A. G. Choudhari; P. S. Jadhav; R. J. Randive

RENEWABLE ENERGY RESEARCH

Project 1 : Ethanol lantern for rural areas

Funding agency : Department of Science and Technology (DST), New Delhi

Duration : April 1, 2007 to March 31, 2009

Objectives :

1. To develop an extremely efficient lantern to run on 50% (w/w) and above ethanol-water mixture.
2. To fabricate 10 such lanterns and test them in actual field applications.
3. To evaluate the use of ethanol-water mixture as a viable renewable resource for rural lighting.

Research highlights :

The project was successfully completed and a unique lanstove was designed, fabricated and tested. The salient features of the lanstove were :

- a) It provides both light and heat for cooking.
- b) It runs on low grade ethanol which is an environmentally friendly and safe household fuel.
- c) It can completely cook a meal for a family of four plus provide light equivalent to a 100 W light bulb.

Specifications of Lantern Stove (lanstove)

Sr. No.	Item	Specifications
1.	Amount of food	: 2.4 kg
2.	Time to boil	: 40 min
3.	Time for food to cook	: ~ 1.5 hrs
4.	Fuel used	: 0.252 kg/hr (58% ethanol-water)
5.	Power consumption	: 1089 W
6.	Efficiency of stove	: 27%
7.	Light output	: 1200-1325 lumens (lm)
8.	Light efficiency	: 1.1-1.2 lm/W
9.	Sound output	: 53-54 dB

Field testing of this lantern revealed that users had to pump the lantern frequently and this was cumbersome and inconvenient especially when food was being cooked. Also filling the lantern every day with 55-60% low grade ethanol mixture could lead itself to the possibility of misuse and diversion of the ethanol for drinking purposes.

Thus a new strategy was employed where the low grade ethanol was filled in a cylinder, pressurized to 5-6 kg/cm² and delivered to the user who could attach it to the lantern and use it just like the existing LPG cooking systems. Thus the lantern could be lighted at the flick of a valve and could be run continuously ([You tube video](#)) without the user having to worry about pumping. Besides the convenience of lighting, this strategy also ensures that ethanol will not be used for drinking since the user cannot access it from the system without damaging the cylinder.

Field testing of lanstove is underway and the initial results are very promising. Figure below shows lanstove with cylinder being used in a rural household where a child can easily read while the food is being cooked.



General comments of users have been :

- Light output is very bright and steady. It can replace all current light sources.
- Light output allows a family to carry out more activities during the early morning and late evening hours.
- Light output can be used to study or read.
- Lanstove is easy to setup and light with no worry of pumping it periodically.
- No smell, smoke or fumes and hence no indoor pollution.
- Less noisy than a kerosene stove and hardly any safety and smell concerns.
- Quality of food made in the cooker is good. After cooking food I can also heat and boil water.
- Cooking with the cooker is easy. I can do other work while food is being cooked since I do not have to watch it.
- Cannot use the stove for making chapatis or flat bread.
- Can also use my existing pressure cooker with the lanstove.
- Indicator telling me when the boiling has started is missing.
- Like the fact that it is possible to both cook and eat inside the house since light is available.
- Would buy the lanstove and will be willing to pay Rs. 2000 or more for it.
- Monthly costs should be equal to existing LPG or kerosene usage.

The comments from the field test showed that this stove could not make flat bread (*chapatis*) and hence it was thought prudent to attach both NARI's [low grade ethanol stove](#) and lanstove to the cylinder so as to make a system which can be used for all cooking and lighting needs. However for those areas where only rice is consumed lanstove can take care of all the cooking needs. Figure below shows one such arrangement.



The lanstove has elicited tremendous response worldwide. In June 2009 this project was given the prestigious [Globe Award](#) in Stockholm.

Website of this project : <http://www.nariphaltan.org/lanstove.pdf>

Project 2 : Setting up of Centre for Sustainable Development (CSD)

Funding agency : Generous support of Bajaj Foundation, Nimbkar Seeds Private Ltd. and other donors

Project started : March 2009

A teaching and research center with hostel facilities is being constructed at NARI premises in Tambmal. This 1225 sq. meter facility should be ready by February 2010. The architectural drawings and the model were prepared by the interns Megan Cook and Ross Karsen from New Orleans, who spent one and a half months at NARI.

One of the main activities of this center will be to bring the corporate world, NGOs and local people together for rural development. Consequently, very innovative training in renewable energy, sustainable development and environment will be given to the participants based upon the in-house R&D and that conducted at other places.

Project staff : Anil K. Rajvanshi, Ph.D., S. M. Patil, R. S. Bale, D. B. Gadhave, A. M. Pawar. Interns Vaidehi Jadeja (Waterloo University, Canada), Meenal Pore (Cambridge University, U.K.), Mariette McCampbell (Groningen University, The Netherlands), Ross Karsen and Megan Cook (architects from New Orleans, USA)

ANIMAL HUSBANDRY RESEARCH

CSIR Award : The highlight of the year was the receipt of the “CSIR Award for Science and Technology Innovations for Rural Development (CAIRD) – 2007” by NARI jointly with NCL at the hands of Dr. Manmohan Singh, the Prime Minister of India on 20 December 2008 in a specially arranged ceremony at the spacious DRDO auditorium in New Delhi. Dr. Chanda Nimbkar, the Director of the AHD of NARI, received the award on behalf of NARI, consisting of a specially designed trophy created by the National Institute of Design, Ahmedabad, a citation and Rs.5 lakh cash. This award was for the “Use of the FecB (Booroola) gene in Deccani breed of sheep to increase lamb production and thereby the incomes of shepherds”, a project implemented by the AHD over the years 1998 to 2007. The project is now continued with funding from the Department of Biotechnology of the Government of India.

Livestock related research

I. Project : Improved productivity, profitability and sustainability of sheep production in Maharashtra, India through genetically enhanced prolificacy, growth and parasite resistance

Funding agency : Unfunded one year extension of Australian Centre for International Agricultural Research (ACIAR) Project 2002/038

Duration : 1 January to 31 December 2008

Research highlights :

This project was a one-year extension of the ACIAR-funded project AH/2002/038 to increase the meat-production efficiency of Deccani sheep using genes from within the breed and other Indian breeds, particularly the *FecB* fecundity mutation from the Garole breed. During the year continued genetic improvement was carried out in the nucleus flock. Production of genetically superior, adapted rams and ewes was accelerated, rams were disseminated and shepherds were trained in techniques to derive maximum benefit from the improved genotypes. Table 1 below shows the number of ewes and rams of the three *FecB* genotypes available for breeding at the end of March 2009 compared to the animals available at the start of the project in 2003.

Table 1. Selected ewes and rams of the three *FecB* genotypes available for breeding at NARI in March 2009

	Homozygous $FecB^{BB}$		Heterozygous $FecB^{B+}$						Non-carrier $FecB^{++}$		Total	
	Garole proportion		$\leq 25\%$		50%		$\leq 25\%$		Total		$\leq 25\%$	
	Rams	Ewes	Rams	Ewes	Rams	Ewes	Rams	Ewes	Rams	Ewes	Rams	Ewes
2003 (Beginning of project)	-	2	5	65	4	51	9	116	7	375	16	493
2008* (End of project)	45	123	-	5	35	322	35	327	13	150	93	600

* The ewes and rams available in 2008 are selected for growth rate, reproductive performance, conformation and phenotype.

One of the marked changes in the ewe breeding plan in 2008 compared to earlier years from 2000 to 2007 was that more emphasis was given on increasing body weight and improving conformation and phenotype using Deccani and Madgyal rams rather than on producing a larger number of *FecB* homozygous animals. Sixty per cent of the breeding ewes were therefore inseminated with Deccani or Madgyal ram semen and the remaining with BB or B+ ram semen.

Analysis of the data generated so far indicated that one copy of *FecB^B* led to an increase in live litter size at birth per ewe lambled from 1.0 to 1.6 in the NARI flock and from 1.0 to 1.4 in smallholder flocks. This means that only about 60% and 40% respectively of the heterozygous ewes in NARI and smallholder flocks gave birth to twins at a time and the rest gave birth to singles. Less than 5% of the litters of *FecB^{B+}* ewes were triplets. This is a manageable increase under field conditions in India because of the system of management involving close personal attention to the flock by the owner at all times. This increase in litter size translates into an increase compared to non-carriers, of 0.4 and 0.3 respectively in litter size at three months per ewe lambled in NARI's and smallholders' flocks (Nimbkar et al., 2008). There is a large demand for lambs and tender lambs fetch a high price. Therefore the increase of 0.3-0.4 lambs per ewe is large enough to lead to an increase in the smallholder

shepherds' income and profit. FecB carrier and non-carrier twin-bearing ewes in both NARI and smallholder flocks weaned 0.8 more lambs than single-bearing ewes.

Second copy of *FecB^B* led to an increase of 0.07 in live litter size at birth per ewe lambled. This indicates a partially dominant or almost a dominant effect of *FecB* on live litter size at birth. About 10% of the litters of homozygous ewes were triplets or quadruplets up to the fourth parity. Results for parities > 4 are not yet available.

The average 6-month weight of 72 ewe lambs born in August 2008 in the NARI flock selected for weight and a phenotype score was 22.5 kg for singles and 21.1 kg for twins. The gross margin for twin-bearing ewes therefore worked out to be almost twice that of single-bearing ewes, including the feeding, grazing and veterinary costs of lambs for six months and of ewes for eight months.

Sixteen BB and four B+ rams were disseminated for breeding in local shepherds' flocks during the year. Out of the FecB carrier progeny of these rams born in the smallholder flocks during the year, 67 B+ female lambs and 30 B+ male lambs are being reared for further breeding. Shepherds were found to use innovative strategies to care for lambs born as twins to ewes which they thought would not be able to rear both lambs. One of the strategies was to take one lamb away at birth and suckle it to goat does in their flock whose kids had been weaned.

Results of the socio-economic survey conducted in shepherds' flocks where the FecB mutation was introduced by NARI :

1. The response of shepherds to twin lambs was generally positive. This reinforced the findings of the wider survey of 87 shepherd families in 2001-02 prior to the introduction of fecund genotypes. Shepherds recognized that additional management inputs would be necessary with increased lamb numbers, but perceived that there were net benefits accruing in terms of increased profits. There was no clear perceived increased risk associated with twin lambs so long as supplementary feeding of lambs was undertaken. These generally positive views were reinforced by the stated intention of all shepherds, bar one, to increase their FecB carrier ewe numbers.
2. The gross margin per FecB⁺⁺ breeding ewe was found to be Rs. 450 to Rs. 800 per year in shepherds' flocks. Only one of the flocks had data from a reasonable number of FecB^{B+} breeding ewes i.e. 8, 41 and 50 ewes in the years 2005 to 2008 respectively. The number of FecB⁺⁺ breeding ewes in that flock was 98, 89 and 74 respectively in the three years. In this flock, the gross margin per FecB^{B+} breeding ewe was Rs.150 to Rs.300 higher than FecB⁺⁺ ewes. This amounted to an increase in gross margin of between 37 and 50%. Twin-born lambs were sold at about Rs.100 less on average than single-born lambs and they were two to four weeks older at sale than single-born lambs.
3. There was a strong perception among shepherds that the smaller Garole-type FecB carrier rams were inferior to the larger framed and 'better looking' Deccani-type rams. However, some shepherds mentioned that the later FecB carrier rams were superior in appearance to the earlier version. This is an indication of the efforts being made at NARI to breed larger bodied FecB carrier rams that more closely resemble the phenotype of local Deccani and Madgyal types which the shepherds prefer.
4. The fact that increased twinning rates require that shepherds adopt a higher level of management and higher cost feeding strategies, means that ongoing extension support for participating shepherds must be a priority. Case studies of shepherds who have been successful and profitable in integrating the FecB carrier animals and associated

management strategies into their flocks will provide useful demonstration value for potential adopters.

5. It is important that a *FecB* extension program is targeted at those groups of shepherds who are likely to benefit from gene introgression and who can take advantage of increased lamb numbers. Shepherds who are likely to benefit include those with irrigation, access to extra labour, and who are more settled and less nomadic.
6. It is essential that extension agents understand the informal information networks that exist in the shepherd community, and take advantage of these information networks in the extension strategies they utilize.

The project culminated in November 2008 in the holding of an international workshop to consider the project findings in the light of those in other countries using the *FecB* gene, and make firm recommendations about the future direction of the work in India. Information about the Workshop is given under II below.

The example of the project AH/02/38 is increasingly cited in scientific and development publications as the only successful genetic improvement program using new developments in biotechnology for the benefit of smallholder sheep keepers. The example of this project was used recently in a position paper for the Gates Foundation for developing a strategy to invest in livestock genetic improvement for poor farmers in sub-Saharan Africa. A case study of the project has also been included in the document “Current status of application of animal biotechnologies in developing countries” to be published by the FAO soon.

II. The Helen Newton Turner Memorial International Workshop :

Funding agencies : The Australian Centre for International Agricultural Research, the Australian Academy of Technological Sciences International Science Linkages, Department of Science and Technology and Department of Biotechnology of the Government of India and Nimbkar Seeds Pvt. Ltd., Phaltan.

The Helen Newton Turner Memorial International Workshop on ‘Using the *FecB* (Booroola) gene in sheep breeding programs’ was organized jointly by the Animal Husbandry Division of NARI, the National Chemical Laboratory (NCL), Pune, Maharashtra, India and the University of New England (UNE), Armidale, NSW, Australia from 10-12 November 2008 at National Chemical Laboratory, Pune.

The Australian sheep geneticist late Dr. Helen Newton Turner of CSIRO headed the team that discovered the *FecB* gene and studied its effects. She also traced the origin of the gene to ‘Bengal’ sheep, later identified by NARI to be the prolific Garole sheep of Sundarban in West Bengal. NARI’s founder Shri B.V. Nimbkar’s correspondence with Dr. Turner led to Garole sheep being brought to NARI in 1993 and thus laid the foundation of the projects that culminated in the introduction of the gene into local Deccani sheep of Maharashtra to increase the efficiency and profitability of sheep rearing. It was therefore fitting to dedicate the Workshop to the memory of Dr. Helen Newton Turner.

The Workshop was a capstone on more than a decade of research at NARI on improved meat sheep production supported by the Australian Centre for International Agricultural Research (ACIAR). One of the major findings of the ACIAR-funded projects at NARI, based on

extensive work with participating shepherds since 2003 was that “Crossbred ewes carrying the *FecB* gene had increased prolificacy, but the increase in ovulation rate and litter size was generally lower than reported elsewhere. The increase appeared manageable under traditional management practices and of economic benefit to shepherds.” This finding was the major stimulus for this Workshop. The Workshop thus focused on the *FecB* gene in sheep and was able to bring together experts and interested participants from twelve countries and nine Indian States. The international participants were from Australia, Bangla Desh, China, France, Indonesia, Israel, Kenya, New Zealand, The Netherlands, Poland, South Africa and U.S.A. There were 82 participants in total including 17 invited speakers (five Indian and 12 from other countries) and 55 registered delegates (including seven foreign delegates and 11 students of agriculture and veterinary colleges in India).

The specific objectives of the workshop were :

1. To review current knowledge of the *FecB* gene and its worldwide application in sheep breeding
2. To present the key results of the ACIAR projects carried out by NARI and NCL related to the *FecB* gene in India from 1998 to 2007
3. To assist Indian Government policy makers to formulate policy regarding the wider dissemination of the *FecB* gene in the national flock
4. To consider the implications of the workshop findings for countries other than India.

The 19 invited scientific papers were divided into four sessions given below and covered the spectrum from the scientific aspects of the mechanism of action of the gene to the mechanics, experience, constraints and advantages of its practical use.

1. Background and history of the *FecB* mutation
2. Physiological aspects of the *FecB* gene mechanism
3. Case studies on introgression of *FecB* in local breeds
4. Introgressing *FecB* in the wider population

On 11 November, the second day of the Workshop, all the participants were brought to NARI Animal Husbandry Division’s office at Wadjal near Phaltan, 110 km from Pune. *FecB* carrier rams, ewes and lambs from NARI’s flock were displayed there. Dr. Pradip Ghalsasi of NARI gave information on all the animals displayed and answered questions. In the afternoon, the participants were taken to visit a flock belonging to Shri Dattatray Sopan Pisal of Bhadali village, 15 km from Phaltan, where *FecB* carrier rams were introduced by NARI since 2003. There are now more than 25 *FecB* carrier ewes in this flock; some of the lambed ones had twin lambs. The benefits of *FecB* under local shepherds’ management were shown to the participants and there were extensive discussions with the shepherds present.

At the end of the Workshop on 12 November 2008, there was a two hour Panel Discussion, facilitated by Prof. Stephen Walkden-Brown of UNE on “The policy implications for wider dissemination in India of sheep containing the *FecB* gene arising from the ACIAR projects”. The members of the panel were officers from the Animal Husbandry Departments of Maharashtra and Andhra Pradesh, Dr. David Notter of Virginia Tech University, U.S.A., Dr. Elisha Gootwine of Volcani Centre, Israel and Dr. Neelkantha Rath, an eminent economist of the Indian School of Political Economy, Pune.

In the panel discussion there was broad support for the view that there is a benefit in increasing fecundity in most meat sheep production systems and the value of the benefit depended on the rearing environment and management conditions. It was agreed that the benefit is likely to be the highest where the current level of fecundity is low (around 100% lambing rate) and an increase up to 160% lambing rate is likely to be the most profitable. It was recognized that the homozygous *FecB*^{BB} genotype may be undesirable in many cases. Results at NARI seem to indicate fewer problems with homozygous BB Deccani than other foreign breeds into which *FecB* was introgressed. However, there is clearly a need to confirm this with a lot more evidence. The heterozygous genotype seems to be advantageous. It was agreed that the uncertainty about the homozygous genotype should not be an impediment to use carrier rams in shepherd flocks or to start using *FecB*^{BB} rams in other centres.

The Workshop thus covered the history and discovery of the *FecB* mutation, the theory of its mechanism of action, the influence of genetic and environmental factors on its action, its consequences on the physiology of the ewe and the lamb and the application of the *FecB* mutation to increase lamb production and incomes of rearers. As a result of the Workshop farmers and shepherds have started to show interest in the newly developed 'NARI Suwarna' strain of twinning Deccani sheep.

A report of the Workshop has been submitted to *Current Science* and will be published in the 25 June 2009 issue.

Local Organizing Committee : Dr. Chanda Nimbkar, NARI (Convener), Dr. Vidya Gupta, NCL (Co-convener), Mr. B.V. Nimbkar, NARI, Dr. Pradip Ghalsasi (Treasurer), Mr. Sudhir Sapre (Logistics and travel coordinator)

Editorial Committee : Prof. Julius van der Werf and Prof. Stephen Walkden-Brown (UNE), Dr. Chanda Nimbkar (NARI) and Dr. Vidya Gupta (NCL)

III. Project : Developing a grafting technique for multiplication of NARI Nirbeeja (KX2) hybrid *Leucaena*

Funding agency : Self-funded

NARI *Nirbeeja* Subabhul is a hybrid of *Leucaena leucocephala* and *Leucaena pallida*. It is a leguminous tree having extremely vigorous growth given suitable soil conditions. It is highly palatable to most ruminant animals and has a crude protein content of around 20%. It contains 35% dry matter and is capable of producing 15 tonnes edible dry matter per hectare per year. One of the main advantages of the NARI *Nirbeeja* accession is that it is highly resistant to the small aphid-like sucking insect psyllid (*Heteropsylla cubana*). The other advantage is that it does not become a weed. It produces very little seed which has low germination percentage hence the name *Nirbeeja*. Therefore the AHD developed and standardized a method for its vegetative propagation by grafting KX2 scions on the root-stock of the ordinary subabhul K8 (*L. leucocephala*).

Training in this grafting technique is now offered at the AHD.

IV. Project : Assessment of green and dry matter yield and quality of NARI Nirbeeja (KX2 or *Leucaena leucocephala* X *Leucaena pallida*) for use as fodder for ruminants.

Funding agency : Self-funded

Duration : July 2008 to July 2011

The trial was started in July 2008 with a view to formulate recommendations for farmers on the optimum time of harvesting and the height at which to harvest the trees.

Objectives :

1. To assess yield of NARI *Nirbeeja* trees harvested at intervals of 12 weeks.
2. To compare the difference in yield of leaves at cutting heights of 1 m and 0.5 m
3. To assess the nutritive value of NARI *Nirbeeja* leaves – crude protein, acid detergent fibre (ADF) and neutral detergent fibre (NDF) after every harvest.

Research Highlights :

Preliminary Observations : Average wet weight yield (first cut made five months after planting)

- The trees cut at 1 m height from the ground yielded more than trees cut at 0.5 m. The average yield of five trees cut at 1 m height at the first, second and third cut was 1.6 kg, 3.5 kg and 4.1 kg edible leaf material while the average yield of five trees cut at 0.5 m height was 1.7 kg, 2.4 kg and 3.1 kg edible leaf material at the first, second and third cut respectively.
- Edible biomass increased almost three-fold at the third cut compared to the first cut because of more branching. After the first cut every tree grew 3 to 5 branches irrespective of the height at which it was cut.
- Flowers were observed on all trees but seeds were not produced. One tree planted at the same time as the others in the trial and left uncut produced flowers at the age of 11 months but no seeds.

Chemical composition of leaves and stems was evaluated at NARI Head office laboratory.

- The crude protein content in a pooled representative sample of *Nirbeeja* leaves and stems was estimated to be 17% at first harvest and 20% at second harvest. It is thus confirmed to be a good source of protein for ruminants and can replace expensive commercial protein concentrates.
- Cell wall constituents – Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF). High proportion of dietary NDF can suppress forage intake due to reduced rates of fibre digestion and passage through rumen. *Leucaena* being a tree legume yields ingesta with smaller particles than any grass resulting in rapid passage through rumen which is desirable. The NDF proportion of NARI *Nirbeeja* is 34% of dry matter and the ADF proportion is 14% of dry matter.

V. Project : Evaluation of yield, nutritive value and profitability of some commonly used and some new fodder species with a view to using them as fodder for ruminants

Funding agency : Self-funded

Duration : August 2008 to August 2010

Objectives :

- To compare yield and protein content of some commonly grown and some novel grass and legume species, perennially irrigated and irrigated for eight months in a year.

Species included in the trial :

Commonly grown species :

Non-leguminous

1. *Dichanthium caricosum* = Marvel
2. *Morus alba* = Mulberry

Legumes

3. *Leucaena leucocephala* = Subabhul
4. *Medicago sativa* = Lucerne
5. *Desmanthus virgatus* = Dasharath
6. *Sesbania sesban* = Shewri
7. *Stylosanthes hamata* = Stylo hamata
8. *Stylosanthes scabra* = Stylo scabra

Novel species (Non-leguminous)

1. *Brachiaria hybrid* = Mulato II
2. *Manihot esculenta* = Cassava

Most of the seeds germinated within a week and the vegetative material sprouted within two weeks. No chemical or organic fertilizer was used during the first eight months of the trial. Except for Marvel all other species were harvested twice during the initial 8 months. Marvel was harvested six times. All species were consumed readily by sheep and goats.

Livestock reared by small farmers usually have a shortage of protein in their nutrition. Therefore protein content of the above species is an important criterion for their evaluation. Stylo hamata and Stylo scabra yielded the maximum amount of protein followed closely by Mulato. Marvel gave the highest total biomass yield but the protein yield of Dasharath, Stylo and Mulato was higher although they were cut only twice compared to Marvel being harvested six times.

The per kg price of protein from different sources was calculated using the current market price of the different species included in the trial and compared to groundnut cake. The per kg price of protein obtained from feeding Marvel worked out the highest at Rs.80, followed by Rs.61 for groundnut cake, Rs.39 for Mulato and Rs.28 for Dasharath and Stylo hamata.

Results (up to March 2009) :

Average biomass and protein yield from 2m X 2m plots of 8 species during 8 months

Name of plant	First harvest		Second harvest		Total biomass in 8 months		Total protein in 8 months	Crude protein (%)
	Days from planting	Mean biomass (fresh weight) (kg)	Days from first harvest	Mean biomass (fresh weight) (kg)	Wet weight) (kg)	Dry matter (kg)	Dry matter (kg)	
Marvel	55	6	32	13	50	9.5	0.8	8
Lucerne	198	3	28	5	8	2.0	0.4	17
Dashrath	87	8	87	13	12	4.0	1.0	27
Shewri	55	10	154	5	15	3.0	0.8	27
Stylo hamata	119	12	114	9	21	6.5	1.4	22
Stylo scabra	119	15	114	11	26	6.8	1.3	19
Mulato	123	17	115	14	31	6.2	1.2	18
Cassava	123	4	50	3	11	2.6	0.5	21

Other preliminary observations :

1. **Marvel** - Harvested six times (maximum number of times among all species) in eight months. Highest biomass yield but requires fertilization to maintain the high growth rate. Biomass yield decreased by about 50% at the sixth harvest probably due to exhaustion of soil fertility. Seems to tolerate cold weather.
2. **Mulberry** - Planted late in this trial and there was difficulty in establishment. This difficulty is usually not faced by farmers.
3. **Leucaena** - KX2 did not grow to a harvestable height in eight months. Being a tree, it takes time for growth and establishment, grafting and growth of the graft.
4. **Lucerne** - Most popular and well-known fodder legume. Seed is expensive and may be contaminated with Dodder (*Cuscuta*). This crop is highly susceptible to fungus and insect damage but has the advantage of winter growth.
5. **Dasharath** - Was severely attacked by damping off (*Pythium*) and another fungus with water-logging. Gets woody if not harvested frequently. Could be grazed.
6. **Shewri** - Fastest initial growth. Needs some trials to establish correct harvest height.
7. **Stylo species** - Slow in establishment. Seed is easy to obtain.
8. **Mulato** – Promising because of high protein content. Will have to be studied to correlate protein content with stage of growth. Low growth in winter. Planting material expensive, so establishment with seed will have to be studied.
9. **Cassava** – Found to be low yielding in agro-climatic conditions on Wadjal farm

Conclusion :

Marvel is the species of choice out of the species tested if obtaining highest total edible biomass is the objective. However, if getting the highest protein biomass is the objective, Stylo and Mulato would be the species of choice.

VI. Parasitological research :

Gastro-intestinal (GI) parasites in grazing sheep and goats are perceived to be one of the major constraints to profitable production. The life cycle of parasites is continuous hence the host cannot be worm-free but the infection can be limited through proper management.

During the reporting year 800 faecal samples of sheep provided by the NGO Anthra were analyzed for faecal worm egg counts and 20 pooled samples were analyzed for detection of trematode infection. Individual egg counting (eggs per gram of faeces) of Trematode eggs i.e. Fasciola (liver fluke) eggs and para amphistome (stomach fluke) eggs was done for the first time during 2008-09 in the AHD laboratory. The trematode has an indirect life cycle and involves an intermediate host, the snail.

Research highlights

- No fluke infection was seen in samples from the Phaltan region.
- The faecal samples of sheep from Chandur village, Kolhapur region were found to be positive for fasciola and stomach fluke eggs. However, the trematode infection was too low to be reported as pathogenic. This is a preliminary finding confirming low level fluke infection.
- It is important to identify the snail species for confirming the fluke species. An additional confirmation is desirable by conducting a postmortem on infected sheep to detect the parasites at the predilection site.

During the year we carried out routine monitoring of sheep and goat faeces to assess the worm burden in flocks of Animal Husbandry Division and of Nimbkar Seeds Pvt. Ltd.

The general findings of gastro-intestinal nematode infection were :

- Recurring worm infection was seen more in grazing flocks as compared to stall-fed flocks.
- Worm infection was found more during the monsoon compared to winter and summer seasons.
- In every flock individual variations were seen in the faecal worm egg counts. There are a few animals in each flock responsible for pasture contamination as they have high faecal worm egg counts.
- The physiological status and nutrition of the animal play an important role in establishment of the parasites in the host.
- Generally mass drenching with anthelmintics was required twice a year in each flock while individual drenching was done 3 to 4 times when faecal egg count levels of a few individuals in the flock were found to be pathogenic.
- Garole sheep were found to be significantly more resistant to gastro-intestinal nematode parasites than crossbred sheep having some proportion of Garole, Deccani, Bannur and Awassi breeds. This is in accordance with our own earlier findings.

Project staff : Chanda Nimbkar, Ph.D., P. M. Ghalsasi, B.V.Sc., B. V. Nimbkar, M.Sc., P. P. Ghalsasi, B.Sc.; K. M. Chavan; S. R. Kulkarni; R. T. Khanvilkar; Dilip Bhandare; Ashok Magar; Dattatray Mulik; Neelam Raut; Rohini Jadhav, intern Kshipra Kulkarni (M.Sc. student from Bharati Vidyapeeth, Pune).

Collaborating scientists : Prof. Stephen Walkden-Brown, University of New England (UNE), Australia; Prof. Julius van der Werf, UNE, Australia; Mr. Julian Prior, UNE, Australia; Dr. Vidya Gupta, National Chemical Laboratory, Pune

New projects sanctioned by funding agencies

1. **Project title :** “Increasing profitability of sheep production by genetic improvement using the *FecB* (Booroola) mutation and improved management”.
Funding agency : Department of Biotechnology, Ministry of Science and Technology, Government of India
Collaborating Institute : National Bureau of Animal Genetic Resources of the Indian Council of Agricultural Research
Total amount : Rs. 57.72 lakh
Duration : 24 March 2009 to 23 March 2012
2. **Project title :** All India Coordinated Research Project on Goat Improvement for Osmanabadi goat
Funding agency : Indian Council of Agricultural Research, New Delhi
Total amount : Rs. 55.80 lakh
Duration : 2009-12
3. **Project title :** All India Coordinated Sorghum Improvement Project for Sweet Sorghum
Funding agency : Indian Council of Agricultural Research, New Delhi
Total amount : Rs. 41.52 lakh
Duration : 2009-12

I. PUBLICATIONS

Refereed publications :

1. Nimbkar, B. V., Ghalsasi, P. M., Chavan, K. M., Nimbkar, C., Pawar, B. M. and Khot, S. 2008. A socio-economic study of smallholder sheep rearers in Phaltan Taluka, Dist. Satara, Maharashtra, India. Abstract. P. 210. In : Proceedings of the Helen Newton Turner Memorial International Workshop on “Using the *FecB* (Booroola) gene in sheep breeding programs” held on 10-12 November 2008 at National Chemical Laboratory, Pune.
2. Nimbkar, C., Ghalsasi, P. M., Nimbkar, B. V., Ghalsasi, P. P., Gupta, V. S., Pardeshi, V. C., Maddox, J. F., van der Werf, J. H. J, Gray, G. D. and Walkden-Brown, S. W. 2008. Biological and economic consequences of introgression of the *FecB* (Booroola) gene into Deccani sheep. pp. 75-87. In : Proceedings of the Helen Newton Turner Memorial International Workshop on “Using the *FecB* (Booroola) gene in sheep breeding programs” held on 10-12 November 2008 at National Chemical Laboratory, Pune.
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6. Rajvanshi, Anil K. 2008. [“Irving Langmuir – A Pioneering Industrial Physical Chemist”](#), Resonance, Vol. 13, No. 7, July 2008.
7. Rajvanshi, Anil K. 2008. [“Langmuir Approach to Rural Development”](#), General article, Current Science, Vol. 95, No. 7, 10 October 2008.
8. Rajvanshi, Anil K. 2009. “Renewables the way forward for India” **SciDev.Net Opinions article.** <http://www.scidev.net/en/opinions/renewables-the-way-forward-for-India.html>.
9. Singh, Vrijendra, Akade, J. H. and Nimbkar, N. 2008. Identification of aposporic embryo sac development in safflower (*Carthamus tinctorius* L.). In : Knights S. E. and Potter T. D. (Eds) Safflower : Unexploited potential and world adaptability. Proceedings 7th

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Non-refereed publications :

1. Deshpande, Shrikant. 2009. Marathi article on 'Artificial insemination in goats – a business opportunity through advanced technology for rural areas' (shelyanmadhil krutrim retan: pragat tantradnyanatun gramini bhagasathi upaukta vyavasay). Special issue of magazine 'Baliraja' on business opportunities complementary to agriculture. March 2009. pp. 29-32.
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4. Kulkarni, Shyam. 2009. Marathi article on 'Sheep rearing boosted financial gain' (mendhi palanane dili arthik sath). Success story of Shri Changdeo Deokate. 'Agrowon' daily newspaper. 16 February 2009. p. 9.
5. Kulkarni, Uday. 2008. Marathi article on 'NARI's work for the benefit of farmers' (shetkaryanchya hitasathi 'NARI'). Daily 'Prahar'. 7 November 2008.
6. Nimbkar, B. V. 2008. An assessment of goat and sheep rearing in Maharashtra. (maharashtratil sheli va mendhi palan vyavasayacha sarvankash adhava). Silver Jubilee issue of magazine 'Shwetkranti'. Maharashtra Pashusamvardhak Sanghatana, Shrirampur. pp. 79-87.
7. Nimbkar, C. 2008. Marathi article on 'A new path for the prosperity of farmers – use of science and technology for goat and sheep rearing' (balirajachya unnaticha nava marg – vidnyan va tantradnyanatun sheli mendhi palan). Special supplement of newspaper 'Lokmat'. 15 May 2008. p.14.
8. Nimbkar, C. 2008. Augmenting small ruminant meat production through improvement in genetics and nutrition. Compendium of Third Convention of Indian Meat Science Association and National Symposium on "Safe Meat for Good Health and Environment" held at Veterinary College, Hebbal, Bangalore. 4-5 July 2008. pp. 35-40.
9. Nimbkar, C. 2009. Marathi article on 'New direction for goat and sheep rearing' (sheli-mendhi palanas navi disha). Daily Sakal's special issue on Phaltan taluka 'towards development' (vedh vikasacha). 21 February 2009. p. 21 and 23.
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11. Nimbkar, N. 2009. Marathi article on work being done at NARI (NARI : Phaltanchi ankhi ek olakh). Daily Sakal's special issue on 'Phaltan taluka towards development' (vedh vikasacha). 21 February 2009. p. 9 and 16.
12. Nimbkar, N. 2009. Marathi article on the 7th International Safflower Conference (kardaila ahe jagatik sandhi). 'Agrowon' daily newspaper. 24 March 2009. p. 8-9.
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14. Pawar, Bharati. 2008. Marathi article on 'Sheep rearing – permanent source of income' (mendhipalan – shashwat utpannacha marg). Special issue of weekly magazine 'Hak Mawalyachi', Aurangabad. October 2008. pp. 53-56. Nimbkar Agricultural Research Institute, Animal Husbandry Division.
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22. Singh, Vrijendra. Annual Progress Report of All India Coordinated Research Project on Oilseeds (Safflower). Submitted to Directorate of Oilseeds Research (DOR), Hyderabad. June 2008. (Pgs. 115).
23. Singh, Vrijendra. Annual Progress Report of Frontline Demonstrations in Safflower. Submitted to Directorate of Oilseeds Research (DOR), Hyderabad. June 2008 (Pgs. 71).
24. Singh, Vrijendra. Half yearly Progress Report of Ad-hoc Project on “Breeding sweet-stalk sorghum varieties and hybrids giving high biomass, sugar, cellulose and hemicellulose along with early maturity and drought and insect resistance”. Submitted to NFCL, Hyderabad. September 2008 (Pgs. 111).
25. Singh, Vrijendra. Final Report of Ad-hoc Project on “To study origin of seeds with twin embryos and of fused multiple seeds, their inheritance and relationship with possible existence of polyembryony and/or apomixis in safflower”, submitted to Indian Council of Agricultural Research (ICAR), New Delhi. February 2009 (pgs. 55).

II. TRAINING AND EXTENSION ACTIVITIES

Training

1. Four candidates were trained in two special training courses on Artificial Insemination in Goats organized on 6-8 June 2008 and 28-30 July 2008.
2. Ms. Sarah Dixon, a veterinary student from the University College Dublin School of Agriculture, Food Science and Veterinary Medicine, Dublin, Ireland worked at NARI, AHD from 4 to 26 July 2008. She carried out the breeding program of Garole ewes using artificial insemination, achieving a conception rate of 70%. Her university allowed her to use this period of training as an elective unit as a part of her veterinary degree.
3. Ms. Kshipra U. Kulkarni, a student of MSc Environmental Science from Bharati Vidyapeeth Institute of Environment Education And Research, Pune carried out a pilot study of fodder species in order to compare their biomass and protein yield on dry matter

basis. A trial was planted at Wadjal farm and Ms. Kulkarni carried out the observations under the guidance of Mr. B. V. Nimbkar from August 2008 to April 2009 when she submitted her thesis.

4. Ms. Megan M. Cook and Mr. Ross Karsen-two young architects from Wisznia Associates, New Orleans, Louisiana arrived on 4 August 2008 and interned at NARI for one and a half months. They designed the Centre for Sustainable Development (CSD), made the architectural drawings and prepared a model. The construction has started in March 2009 and both Megan and Ross have continued to give us their valuable advice.
5. Ms. Vaidehi Jadeja, a third-year environmental engineering student from University of Waterloo, Ontario, Canada came on 15 September 2008 and completed a two and a half-months training period by doing various jobs like lanstove testing, making brochure for CSD and designing the rainwater harvesting system for it.
6. Shri Santosh Bharat Bagal, At/Post Gove, Tal. Satara and Shri Nitin Ashok Dabhade, At/Post Dahitana, Dist. Osmanabad stayed at the AHD's farm from 16 November to 30 December 2008 and were given hands-on-training in goat management and artificial insemination.
7. Ms. Mee Wun Lee from Australia worked as a volunteer in AHD from 18-26 December 2008 and helped in updating the library records.
8. Prof. Tulsiram D. Mahanawar of the Savitribai Phule Ladies College, Satara approached AHD to get detailed information about the AHD's 'Sheep Improvement' project and extension work in shepherds' flocks in Phaltan taluka for his PhD thesis entitled "A study of Problems and Prospects of Sheep Farming Business with Special Reference to Satara and Sangli Districts". All the relevant information was given to him. For his study he interviewed shepherds using a questionnaire. He found that a lot of the shepherds who were interviewed were interested in "NARI Suwarna" sheep having the *FecB* gene (twinning ability).
9. Ms. Meenal pore, a chemical engineer with master's degree from University of Cambridge, U.K. completed a 1.5-months internship and worked on alcohol lantern during January/February 2009.
10. Ms. Mariette McCampbell, a fourth year human technology bachelor of engineering student from Hanzehogeschool at Groningen in the Netherlands completed her 5-month graduate internship at NARI starting from 13 February 2009. She worked on lanstove testing, CSD brochure design and Phaltan household energy data collection.

Extension

Dissemination of animals

The following *FecB* carrier breeding rams were disseminated during the year.

- One heterozygous (B+) ram supplied to Kamshet Dairy (I) Pvt. Ltd., Govitri, Dist. Pune in replacement of a ram purchased by them from AHD in the last year.
- One BB ram sold to Shri R. Venketesh, Venaduragapuram, A.P. and one BB ram sold to Dr. S. Sridhar, Bangalore during the livestock fair at Veterinary College, Bangalore.

- AHD donated two *FecB* carrier 'NARI Suwarna' rams to the Department of Livestock Production and Management, Veterinary College, Hebbal, Bangalore.

Extension among shepherds

1. A club of 17 shepherds named Birdev Shetkari Mendhpal Mandal has been formed in the village Bhadali, Dist. Satara under a scheme of National Bank for Agriculture and Rural Development. Shri K. M. Chavan and Shri Shyam Kulkarni of NARI made great efforts to form this club. The club will receive assistance from NABARD in funds for training and sheep rearing activities. A bank account has been opened in the club's name and a contribution of Rs. 50 by each member is deposited into the club's bank account as core fund of the club.
2. Central Wool Development Board and Life Insurance Corporation of India (LIC) have jointly launched a life insurance scheme for shepherds. Punyashlok Ahilyadevi Maharashtra Sheep and Goat Development Corporation is implementing this scheme in Maharashtra. NARI AHD organized the insurance of 20 shepherds under this scheme. In this scheme, children of the shepherds studying in 9 to 12 standards will receive scholarships.

Dissemination of seed and other products

During the financial year nearly 600 kg seed of various safflower varieties, hybrids and their parents was disseminated. More than 400 kg seed of Madhura sweet sorghum hybrid was distributed to various farmers and companies in India. 500 kg seed of Madhura was sent for testing to a Spanish company in Mexico. Also about 22 kg dried safflower flowers were test-marketed as herbal health tea. About 212 kg sweet sorghum syrup was test-marketed during the year.

III. TRAINING RECEIVED BY NARI STAFF

1. Ms. Andrea Kean from Claremorris, Ireland, Bachelor of Business Studies in Accountancy, visited the AHD from 4 to 26 July 2008 as an accompanying person to Ms. Sarah Dixon. During her stay she gave training in MS Word and Excel to AHD staff. She also prepared a data file of books in the AHD Library.
2. Mr. Malhari Dhembre received training in 'Goat rearing' from Shri Narayan Deshpande at 'Sheti Parivar Kalyan Sanstha', Atpadi, Dist. Sangli on 25-26 July 2008.
3. Mr. J. H. Akade attended the ICAR winter school on "Innovative approaches in increasing productivity of oilseed crops : A crop improvement perspective" from 4 to 24 November, 2008 at the Directorate of Oilseeds Research (DOR), Rajendranagar, Hyderabad.

IV. CONFERENCES / SEMINARS / MEETINGS / WORKSHOPS
ATTENDED BY STAFF AND LECTURES GIVEN
(In Chronological Order)

1. Four short scripts prepared by NARI, AHD have been broadcast frequently by the FM Radio, Satara during the year 2008-09. These were:
 - i. Cassava for nutritious fodder (sakas charyasathi sabudana kand – Cassava)
 - ii. Leafy and nutritious grass Mulato (paledar, paushtik gawat Mulato)
 - iii. Sheep rearing – a profitable complementary activity to agriculture (mendhipalan – shetis poorak kifayatshir vyavasay)
 - iv. Artificial insemination in goats : business opportunity for rural area (shelyanmadhil krutrim retan : gramin bhagasathi upayukta vyavasay).
2. Shri. Shailesh Malode and Vikrant Mandape from All India Radio (AIR), Satara visited NARI in April 2008 to interview Dr. Anil Rajvanshi and Dr. N. Nimbkar. This interview of one hour duration was broadcast on AIR on 9 and 10 May 2008 and was about NARI's renewable energy work.
3. Dr. Chanda Nimbkar attended the Scientific Advisory Committee meeting of the Krishi Vigyan Kendra, Baramati on 28 April 2008.
4. Dr. Anil K. Rajvanshi gave a talk entitled “What made me write the book” during the release ceremony of the book “1970's America – an Indian Student's Journey”. This ceremony took place on 5 May 2008 at the MCCIA auditorium in Pune, where Shri. Baba Kalyani, Chairman, Bharat Forge, Shri. Madhur Bajaj, Vice Chairman, Bajaj Auto Ltd. and Shri. Rakesh Sharma, Chief Commissioner Excise and Customs, Pune released the book.
5. An interview of Dr. Chanda Nimbkar was broadcast by Pune Akashwani Kendra on 29 May 2008. The subject was activities of AHD and her views on sheep and goat development.
6. Dr. Chanda Nimbkar delivered a speech on ‘Agriculture – opportunities and threats’ at the India Investment Show organized by IRIS Business Services (India) Private Limited at Nehru Centre, Mumbai on 7 June 2008.
7. Dr. Chanda Nimbkar attended meetings of the Research Advisory Committee (RAC) and the Institute Management Committee of the Project Directorate on Foot and Mouth Disease (FMD) held at Mukteshwar, Uttarakhand on 9-10 June 2008.
8. Dr. Anil K. Rajvanshi gave a keynote address at the Confederation of Indian Industries (CII) event “India Innovations Summit” in Leela Palace, Bangalore on 21 June 2008. This is a major yearly event organized by CII. This year it was organized by Mr. S. Gopalkrishnan, CEO and M.D. of Infosys. Around 250 key officials of IT industry from all over the world and Government of Karnataka attended the talk entitled “Rural Innovations for Sustainable Development”.

9. Dr. Anil K. Rajvanshi attended the Jamnalal Bajaj Award committee meeting in Mumbai in July 2008. This meeting was held to select the 2008 award winners.
10. Dr. Chanda Nimbkar presented a paper on 'Augmenting small ruminant meat production through improvement in genetics and nutrition' at the 3rd Convention of Indian Meat Science Association and National Symposium on "Safe Meat for Good Health and Environment" held at Veterinary College, Hebbal, Bangalore on 4-5 July 2008. She also visited the Vetcare Division of Tetragon Chemie Pvt. Ltd., Bangalore on 5 July 2008.
11. Shri. K. M. Chavan gave a lecture on 'Crossbreeding for improvement of local goats' in the 'Goat rearing' workshop organized by Agriculture and Animal Husbandry Division of Pune Zilla Parishad at village Palasdeo, Tal. Indapur, Dist Pune on 16 August 2008.
12. Dr. Nandini Nimbkar gave a Marathi speech entitled "Role of Nimbkar Agricultural Research Institute in the Development of Farmers and Farm Labourers", as the chief guest in the workshop on the rights awareness and personality development of farmers and farm labourers. This workshop on 23 August 2008 was jointly organized by the Yashwantrao Chavan Institute of Science, Satara and University Grants Commission, New Delhi.
13. Dr. V. Singh, Mr. M. B. Deshpande and Mr. A. M. Ranaware attended the Annual Rabi Oilseeds Research Workers' Group Meeting held at Birsa Agricultural University, Ranchi from 28-30 August 2008.
14. A speech on 'Boer goat' by Dr. Chanda Nimbkar was broadcast on Akashwani Pune on 10 September 2008.
15. Shri K. M. Chavan and Shri Shyam Kulkarni attended the book release function of the NGO Anthra's new book on 'Sheep rearing on the Deccan Plateau (dakkhan patharavaril mendhipalan)' and inauguration program of Anthra's 'SMS service to organic farmers' at BAIF Development Research Foundation, Pune on 22 September 2008.
16. In November 2008, Dr. Anil K. Rajvanshi attended the advisory committee meeting of Maharashtra Electricity Regulatory Commission (MERC) in Mumbai.
17. Mr. M. B. Deshpande and A. M. Ranaware surveyed Satara and Sangli districts on 19 November 2008, 2 January 2009 and 16 February 2009 for safflower disease assessment.
18. Dr. Chanda Nimbkar attended a preliminary meeting of the Institutional Animal Ethics Committee of Vidya Pratishthan's School of Biotechnology, Baramati held on 1 December 2008.
19. Dr. Chanda Nimbkar delivered a lecture on "Increasing profitability of sheep production by genetic improvement using the *FecB* mutation and improved management' in the UGC-sponsored Refresher Course in Life Sciences organized at Vidya Pratishthan's School of Biotechnology, Baramati on 8 December 2008. Twenty five teachers were present from Pune, Aurangabad, Nipani, Nandurbar and other parts of Maharashtra.
20. Dr. Chanda Nimbkar attended the 26th meeting of the Board of Management of National Dairy Research Institute (NDRI), Karnal on 16 January 2009 and the Seventh Convocation of the NDRI Deemed University on 17 January 2009.

21. Dr. Vrijendra Singh attended the meeting of the Quinquennial Review Team (QRT) under the chairmanship of Dr. S. L. Mehta on 17 January 2009 at the Panjabrao Deshmukh Krishi Vidyapeeth, Akola. He presented the research accomplishments of AICRP safflower NARI during the tenth plan period.
22. Dr. P.M. Ghalsasi attended a seminar on “Promotion of goat rearing in Maharashtra, as a tool for drought proofing rural communities dependent on rainfed agriculture’ organized by Bosco Gramin Vikas Kendra, in conjunction with Sir Dorabjee Tata Trust on 20-21 January 2009 at Ahmednagar. He delivered a lecture on NARI’s sheep and goat research and development activities.
23. Dr. Vrijendra Singh attended the National Symposium on “Vegetable Oils Scenario : Approaches to Meet the Growing Demands”, held at the Directorate of Oilseeds Research, Rajendranagar, Hyderabad from 29-31 January, 2009.
24. Dr. Anil K. Rajvanshi was the chief guest at the National Program on Renewable Energy Training organized by G. B. Pant University of Agriculture and Technology on 4 February 2009. He gave an inaugural address entitled “Sustainable Energy Development for Rural Areas”. This address was attended by the Vice Chancellor, Deans and Heads of Department at the University and was widely covered in the Uttarakhand press. Dr. Rajvanshi also gave an invited talk to the students entitled “R&D for Sustainable Energy”.
25. AHD participated in the exhibition “Januvaru-Matsyamela-2009” organized by Karnataka Veterinary, Animal and Fisheries Sciences University (KVAFSU), at Veterinary College, Hebbal, Bangalore on 21-22 February 2009. Thirty three Boer bucks and four NARI Suwarna rams were exhibited in this Mela. Some of AHD’s animals were sold in the Mela.
26. Shri Shyam Kulkarni participated in the Livestock Exhibition organized by the Veterinary Hospital at Pandharpur on 23 February 2009. AHD exhibited two *FecB* carrier rams along with four Boer bucks of Nimbkar Seeds Pvt. Ltd.
27. Dr. Chanda Nimbkar attended three meetings of the Governing Body and the 80th Annual General Meeting of Indian Council of Agricultural Research Society during the year.
28. Dr. Vrijendra Singh attended the Annual Sorghum Meeting held at the College of Agriculture, Rajmata Vijayaraje Krishi Vishwavidyalaya, Indore, M.P. from 26-28 February, 2009.
29. Mr. J. H. Akade attended the Safflower Germplasm Field day at DOR, Hyderabad on 27 February, 2009.

V. IMPORTANT VISITORS

Large number of visitors which included farmers, students and researchers came to the Institute seeking information on agriculture, renewable energy, animal husbandry and sustainable development. Some of the important visitors who visited the institute were as follows :

1. Dr. Lorna Brown, Veterinarian, expert in sheep and goat reproduction from Wales, U.K. visited AHD on 7 April 2008. This was her second visit after 10 years. She appreciated the progress made by AHD in sheep and goat improvement and extension activities.

2. Mr. P. C. Verma former CCIT, Pune visited on 26 April and 11 October 2008 and advised us on various matters related to management of NARI.
3. Dr. Janardan Kadam, Chief Scientist and ADR, Solapur visited NARI on 2 May 2008.
4. Dr. Sachin A. Joshi, Team Leader, Vet. Service, Training and Extension, Sahyadri Agro Produce and Dairy Pvt. Ltd., Baramati visited AHD on 6 May 2008 to discuss about fodder development for cattle with Dr. P. M. Ghalsasi and Dr. Chanda Nimbkar.
5. Dr. D. B. Sarode, Dean, Faculty of Higher Education, Maharashtra Animal and Fisheries Sciences University, Nagpur and Dr. Ashok Dharmik visited on 10 May 2008 to see the research and development activities of AHD.
6. Shri Shyam Holkar, Nano Bio Chemicals India Pvt. Ltd., Bangalore residing at Pune visited AHD on 16 May 2008 to discuss his goat project with Shri B.V. Nimbkar.
7. Dr. Chintalapani Ravinder Reddy (visiting scientist) and R. Saivenkatkumar from ICRISAT visited on 27 May 2008 to discuss with Dr. Anil K. Rajvanshi and Dr. Nandini Nimbkar about syrup production from sweet sorghum.
8. Dr. B. R. Patil, Vice President, BAIF and Dr. Suresh Lakade, BAIF Development Research Foundation, Urulikanchan, Pune visited AHD on 30 May 2008 under their project South Asia Pro Poor Livestock Policy Programme. Dr. Chanda Nimbkar and Dr. Pradip Ghalsasi gave them information on good management practices in goat rearing.
9. Mr. Rajkumar Daga, Vice President, Supply Chain of Laxmi Organic Industries Ltd., Pune visited on 3 June 2008 to get information on sweet sorghum for ethanol production.
10. Mr. Bart Bonsall and his colleague Mr. Vincent from Biodiesel Production Ireland Ltd. Dublin came along with Mr. Bhavesh Shah of Praj Ltd., Pune to get information about sweet sorghum work of NARI on 9 July 2008.
11. Dr. Suresh Joshi, Chief Information Commissioner, Maharashtra State, Mumbai visited the NARI head office and AHD on 14 July 2008.
12. Shri Bharat Tandon, Managing Director, Vetcare Division of Tetragon Chemie Pvt. Ltd., Bangalore and Dr. Umesh Joshi, Managing Director, AURO Pharmaceuticals And Fine Chemicals Pvt. Ltd., Mumbai visited on 23 July 2008. Dr. Chanda Nimbkar gave a presentation on research activities of AHD.
13. Shri Arun Salokhe, Chairman, Khadi Gramodyog Mandal, Kolhapur visited AHD along with four other persons on 26 July 2008 to get information on goat and sheep rearing.
14. Dr. Madhav Gadgil, renowned Environmental Scientist at present working in the Agharkar Research Institute, Pune visited AHD on 28 July 2008.
15. Shri Hanwantsinh Rathod, Marwad, Rajasthan visited AHD on 28 July 2008 to get information about goat and sheep rearing.

16. Mr. Vijay Parmar and Bhimsi Ahir from Ahmedabad visited NARI on 31 July 2008 to see the renewable energy work.
17. A team of nine general managers and vice presidents of Cummins India Ltd. (CIL) led by Mr. Dinesh Castellino (Vice President, Company Secretary and incharge of Cummins Megasite near Phaltan) visited NARI on 8 August 2008. They held detailed discussions with Dr. Rajvanshi on what CIL should do in Phaltan area. They also gave an overview of the plans for Cummins megasite.
18. Dr. Ran Vir Singh, Sr. Scientist, Animal Genetics Division, Indian Veterinary Research Institute, Izatnagar, U.P. visited the AHD on 15 August 2008. He was taken to visit one of the shepherds' flocks involved in NARI's sheep improvement project to see the *FecB* gene carrier ewes.
19. Shri A. K. Saxena, Director Venchi Agrofarms Pvt. Ltd., Hyderabad and his colleague Shri Lingappa visited AHD on 26 August 2008.
20. Shri Rana Jagjitsingh Patil, Hon. State Minister for Agriculture of Maharashtra visited AHD on 28 August 2008. Dr. P.M. Ghalsasi gave information about the activities of the AHD and showed animals to him.
21. Shri C. N. Raorane, Chief Executive Officer of Amiantit Oman, Sultanate of Oman visited AHD to discuss the implementation of a goat project in Oman with Dr. Chanda Nimbkar.
22. Dr. Ajit Ranade, Dr. M. B. Patil and Dr. N. R. Dagli from Bombay Veterinary College, Mumbai visited AHD on 11 September 2008. They purchased Boer buck frozen semen doses and Sirohi goats.
23. Dr. N. G. Hegde, President, BAIF Development Research Foundation, Urulikanchan, Warje, Pune along with Dr. Kristina Toderich, Plant Scientist, International Center for Biosaline Agriculture, Uzbekistan visited NARI head office and AHD on 22 September 2008. Dr. Chanda Nimbkar gave them information about the AHD's research and development activities, while Dr. Anil Rajvanshi and Dr. Nandini Nimbkar discussed various issues regarding sweet sorghum.
24. Dr. B. S. Rana and Dr. G. V. Seshaiyah from the Nagarjuna Fertilizers and Chemicals Ltd. (NFCL), Hyderabad visited NARI on 20 October 2008 to evaluate the ongoing sweet sorghum project sponsored by NFCL.
25. Mr. Rafael Fernandez, Vice President RJS Group and Mr. Angel R. Castillo from the Dominican Republic visited NARI on 22 October 2008 to get information about sweet sorghum.
26. Dr. Avinash Deo, Technical Officer, Punyashlok Ahilyadevi Maharashtra Mendhi Va Sheli Vikas Mahamandal, Pune visited on 6 November 2008 to get information about the International Booroola Workshop organized by AHD.
27. Mr. M. A. Helm from South Africa visited NARI on 6 November 2008 to see the renewable energy work being carried out at NARI.

28. Mr. Shankar Shinde, Satara district president of Shetkari Sanghata came with five farmers to discuss about the ethanol stove on 4 December 2008. They were sent by Shri. Sharad Joshi to explore the possibility of using stove in their area.
29. Dr. Nadeem Fairoze, Prof. and Head, Dept. Livestock Products Technology, veterinary college, Hebbal, Bangalore along with a team of five veterinary officers of government of Karnataka visited on 6 December 2008. They paid a visit to Mr. D.S. Pisal's sheep flock to see the *FecB* gene carrier ewes. Dr. Chanda Nimbkar gave information about activities of AHD. Ms. Padmaja Ghalsasi gave information about the *FecB* gene genotyping and 'Nari Nirbeeja' a new psyllid-resistant hybrid variety of Subabul.
30. A team of four members from the Corporate Social Responsibility (CSR) section of Cummins India Ltd. (CIL) visited NARI on 10 December 2008. Discussions were held with Dr. Anil Rajvanshi on how CIL can help Phaltan in social areas.
31. Ms. Nilanjana Ghosh and Varsha Welankar from the newspaper DNA visited NARI on 23 December 2008 to interview Dr. Anil K. Rajvanshi for a news report published in Pune edition.
32. A monitoring team comprising of Dr. R. D. Prasad, Senior Scientist (Plant Pathology), DOR, Hyderabad, Dr. S. K. Shinde, Breeder, and Dr. S. V. Khadtare, Jr. agronomist, AICRPO, Solapur and Mr. L. Hanumantharaya, Jr. entomologist, AICRPO, ARS, Annigeri visited on 28 December 2008 to evaluate the Rabi 2008-09 safflower research programme.
33. Shri N. Raghu Ram, Managing Consultant, Sampada, Secunderabad, Andhra Pradesh visited on 23 January 2009 to get information about goats and sheep and services provided at AHD.
34. Prof. Anagha Paranjape and Ar. Kirti Pabrekar along with four students of Dr. B. N. College of Architecture, Pune visited on 7 and 9 February 2009 and held discussions on NARI's work in renewable energy.
35. Mr. A. S. Tomer, ASO, National Seeds Corporation, Pune visited NARI on 13 February 2009 for the inspection and certification of seed production plots.
36. Mr. S. B. Tiloo, Managing Director of DGP Hindray Industries Ltd. (Formerly Morris Electronics), Pune visited to discuss various issues in energy with Dr. Rajvanshi.
37. Dr. D. M. Hegde, Director, DOR, Hyderabad and Dr. S. K. Shinde, Breeder, AICRPO, Solapur visited the safflower programme on 18 February 2009.
38. Dr. Satyadev and Mr. N. M. Kolekar from Advanta India Ltd. Secunderabad visited NARI on 17 March 2009 to discuss regarding collaboration in sweet sorghum research.
39. Dr. N. Kandasamy, Prof. Animal Genetics (Retd), Tamil Nadu Veterinary and Animal Sciences University, Coimbatore visited on 22-24 March 2009 to see research and development activities of AHD.

40. Dr. Vincent Ducrocq, Quantitative and Applied Geneticist from the National Institute of Agricultural Research (INRA), France visited the AHD on 27-28 March 2009. He inspected AHD's nucleus flock of FecB carrier ewes at Lundy farm and held discussions with Drs. Chanda Nimbkar, Pradip Ghalsasi and B.V. Nimbkar.

Visits by groups during the year

1. Mr. S. T. Umrani with 24 persons from Maharashtra Scooter Ltd., Satara visited NARI on 19/4/2008 and were shown the activities of NARI by Dr. Anil K. Rajvanshi.
2. Excellence Agrotech Pvt. Ltd., Hingni, Solapur. Twenty farmers visited on 21/5/2008.
3. Under the "Agri Clinics and Agri Business" Training program conducted by MITCON, Pune, 70 agricultural graduate participants of the program visited on 23/5/2008 and 23/7/2008.
4. Yerala Project Society, Jat, Sangli. Thirty farmers visited on 30/5/2008.
5. Prithviraj White Revolution, Nagpur. Fifty women visited on 3/6/2008 and 4/6/2008.
6. Padmabhushan Dr. Sukhatme Institute of Agriculture, Phaltan. Sixty students visited on 23/6/2008.
7. Balasaheb Langad Krishna Valley Agricultural Foundation. Nineteen Students visited on 6/7/2008.
8. Adhyapak Vidyalaya, Girvi, Tal. Phaltan. Eighty students visited on 12/7/2008
9. Students from the agricultural college, Baramati and Shrimant Shivajiraje College of Horticulture, Phaltan visited in July, September and October 2008 to collect the weather data from records at NARI.
10. Yashwantrao Chavan School of Social Work, Satara. Sixty six MSW students visited on 25/7/2008 and 19 BSW students visited on 12/1/2009.
11. Maharashtra Arogya Mandal, Pune's Bhimashankar Adivasi Vikas Prakalpa, Dimba, Dist. Pune. One hundred ten farmers visited on 30/8/2008.
12. A group of 36 students along with their instructor Blaise D'Souza from Tata Institute of Social Science (TISS) came to the Institute on 4/9/2008. All these students were employees of UNICEF and were interested in the issues of rural development.
13. Twenty seven women farmers from Mazgaon in Satara district visited on 16/9/2008 along with the Taluka Agricultural Officer as a part of their tour.
14. Prof. A. B. Rao and a group of 22 M.Tech (T&D) and Ph.D. students from CTARA of IIT Bombay came on 20/9/2008 to see the Institute and have discussions on rural development with Dr. Rajvanshi.
15. On 10/10/2008, 50 farmers from Tasgaon along with the Taluka Agricultural Officer Mr. R. S. Patil visited NARI to see the research being carried out.
16. Shri Ganesh Vidya Mandir Highschool, Dharavi, Mumbai. Principal and teachers visited on 8/12/2008.
17. Fifty students of Padmabhushan Dr. Sukhatme Institute of Agriculture, Phaltan along with their teacher Mr. Rajendra Sitaram Pawar visited NARI on 7/1/2009.
18. Forty two third year students Shrimant Shivajiraje College of Horticulture, Phaltan. visited NARI on 26/1/2009 to see the ongoing breeding programme of safflower and sweet sorghum.
19. Lal Bahadur Shastri College, Satara. Seventy four BSc students visited on 7/2/2009.

20. Taluka Agricultural Officer along with 45 farmers from Degloor, dist. Nanded visited NARI on 21/2/2009 to see the activities being carried out.
21. Akulj Taluka Agricultural Promoter had organized visit of 50 women from 25 Self Help Groups under their training program in agriculture on 3/3/2009.
22. Sub-Divisional Agricultural Officer, Kinwat, Nanded. Forty eight farmers visited on 5/3/2009.

VI. HONOURS RECEIVED BY STAFF

1. A Marathi article 'Boer' goat rearing ('boer' sheli palan) written by Dr. Chanda Nimbkar and published in 'Baliraja' magazine in March 2008, won the first prize for 'Best Article on complementary activities to agriculture' during 2008-09.
2. Dr. Pradip M. Ghalsasi, Associate Director of AHD was given the 'Best Veterinarian' award of Jyeshtha Pashuvaidya Pratishthan (Senior Veterinarians' Foundation), Pune for his excellent work for the development of goats and sheep. The award was given on 25/5/2008 at the hands of Dr. Umesh Sarangi, Chairman, National Agricultural and Rural Development Bank, Mumbai.
3. Dr. N. Nimbkar was invited as a keynote speaker for the 7th International Safflower Conference held in Wagga Wagga, Australia from the 3rd to 6th November, 2008. Her involvement in the conference was fully sponsored by the Australian Grains Industry Research and Development Corporation. Her speech and interview were widely covered on the radio and TV channels of the Australian Broadcasting Corporation and in [newspapers and magazines](#) like Australian Grain and Weekly Times Now.
4. I.I.T. Kanpur is celebrating its 50th year of existence in 2009. For these celebrations two main events are being organized. One is the preparation of oral and written history of IITK. Thus a book entitled "An Eye for Excellence – 50 glorious years of IIT Kanpur", Published by and written by Dr. E. C. Subbarao, the first dean of R&D at IITK and now Director Emeritus of Tata Research and Development Center (TRDC), Pune. Dr. Anil K. Rajvanshi who is an alumnus of IITK is prominently featured in this book as one of the pioneers in social science sector.

The second event is the release of a feature film of IITK with interviews of its distinguished alumni from all over the world. Thus the filming crew led by the famous film director Mr. Sunil Shanbag carried out shooting at NARI on 21 January 2009. He interviewed Dr. Rajvanshi and also filmed the activities at NARI. This film will be shown in IIT Kanpur in August 2009 when the yearlong 50th anniversary celebrations commence.

5. Dr. Anil K. Rajvanshi was honoured at the IITK alumni meet in Pune in February 2009 for his accomplishments. Others honored at this meet were Dr. Sivaram, Director of NCL and Arvind Gupta of IUCCA, Pune.

VII. OTHER ACTIVITIES

1. NARI is registered with the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA), Ministry of Environment and Forests, Government of India, New Delhi on 26 November 2007. The Institutional Animal Ethics Committee (IAEC) is formed as per rules and regulations and approved by CPCSEA.

The first meeting of the IAEC was held on 16 October 2008. In this meeting the Research and Development Project proposal submitted by NARI to the Department of Biotechnology, Govt. of India was recommended by the IAEC for further submission to the CPCSEA.

2. AHD supplied eight 'Nari Nirbeeja' plants free of charge to the following
 - a) One plant to Rural Agricultural Institute, Narayangaon, Pune.
 - b) One plant to a shepherd, Dattatray Sopan Pisal, Bhadali, Tal. Phaltan.
 - c) Five plants to Veterinary College, Hebbal, Bangalore on request of Dr. U. Krishnamoorthy, Associate Professor, Dept. of Livestock Production and Management.
 - d) One plant to Dr. M.S. Palegar, Deputy Director (AH & VS), Belgaum, Karnataka.

Apart from these AHD sold 149 plants to farmers in Maharashtra, Madhya Pradesh and Andhra Pradesh.

VIII. STAFF APPOINTMENTS TO PRESTIGIOUS POSITIONS

1. The Hon'ble Agriculture Minister and the President of the ICAR Society Mr. Sharad G. Pawar nominated Dr. Chanda Nimbkar as a member of the ICAR Society and the Governing Body of the ICAR Society for a period of three years from 9.6.2008 as a representative of rural interests.
6. The Union Minister of Agriculture and President of ICAR nominated Dr. Chanda Nimbkar as a member of the Board of Management of National Dairy Research Institute (NDRI), Karnal for a period of two years from 20.6.2008.
7. The Union Minister of Agriculture and President of ICAR nominated Dr. Chanda Nimbkar as a member of the Board of Management of Indian Veterinary Research Institute (IVRI), Izatnagar for a period of two years from 8.7.2008.
8. Dr. Chanda Nimbkar was nominated as a member of the Institutional Animal Ethics Committee of Vidya Pratishthan's School of Biotechnology for three years 2009-2011.