Nimbkar Agricultural Research Institute (NARI), Phaltan

ANNUAL RESEARCH REPORT 2006-2007

Report of the President

Innovative activities and capabilities are essential for economic growth and development of a country. Empirical studies point towards a direct relationship between R&D and growth. Science and Technology have always been an integral part of Indian culture and Government of India (GOI) is a major force behind the R&D in India. However, strengthening the institutional system is a must to strengthen the innovation system and NGOs are expected to play an increasingly important part in science and innovation in India. GOI is praiseworthy for having taken certain steps in recent times to strengthen the NGOs.

One of them was the streamlining last year by CBDT of procedure for approval of scientific research institutions under section 35(1)(ii) of the Income Tax Act. NARI has been approved under this section since 1970, but it was necessary to renew this approval by applying every three years. In addition to this time-consuming process, the approval was always delayed by at least one year causing a lot of hardships. Now provision has been made for one-time approval which can be withdrawn only if GOI is satisfied that the scientific research institution has ceased its activities or its activities are not genuine. The amended provisions take care of the long-standing need of scientific research institutions in raising funds for scientific research, and will enable enhanced investment in R&D activity in the country. We urge all our well-wishers to donate generously, especially for the planned building of the center for sustainable development.

I would also like to congratulate Dr. Vrijendra Singh and his associates for the release of "NARI-H-15", a high-yielding spiny safflower hybrid for commercial production in India. This is the fourth varietal release from our center.

I wish to congratulate Dr. Chanda Nimbkar and the staff of animal husbandry division for the development of the "NARI Suwarna" strain of Fecund Deccani sheep. I hope this strain and the 'Fecund Composite' strain are registered soon with the appropriate GOI authority and adopted by sheep rearers on a large scale. The ACIAR-funded project of AHD is expected to end with this year and it is a pity that the good work being done by AHD is not considered good enough for funding by certain GOI agencies. We hope this changes during the next year.

Dr. Anil Rajvanshi and his team have developed an ethanol stove which runs on 50%(w/w) ethanol water mixture. This is the first such stove developed anywhere in the world and has elicited huge interest worldwide. Nagarjuna Fertilizers and Chemicals Ltd (NFCL), Hyderabad has expressed interest in buying up this technology from NARI.

Dr. Anil K. Rajvanshi, the NARI director gave a public lecture in the Globalization series at the prestigious Patel Center for Global Solutions in University of South Florida in Tampa, U.S.A. in March this year. In the past, speakers in this lecture series have been Nobel Laureate Wangari Maathai, Jared Diamond, Dr. Gro Brundtland and Dr. Jagdish Bhagwati among others. Hence it is a matter of great pride for NARI that Dr. Rajvanshi was invited to speak in this series. His speech entitled "Energy for Rural Poor-Challenge for Global

Community" was very well received and is now being published as a general article in Current Science Journal.

Dr. Rajvanshi has written a book entitled "1970s America-An Indian Student's Journey". He has posted it on the net and it is also being serialized on the U.S.-based website "Boloji.com". This book has risen very high in Google rankings and is being read by a large number of people worldwide. The reactions pouring in from the readers all over the world are very gratifying. Sakal, the Marathi newspaper has shown an interest in getting it translated in Marathi. Dr. Rajvanshi's writings on sustainable development are carried in various blogs and are recommended readings on various international internet sites which are involved in these issues.

NARI has been working on sweet sorghum for last 25 years often more or less in wilderness. However, suddenly the interest in this crop world over has increased and we are getting continuous inquiries from researchers, venture capitalists, companies etc. from all over the world.

An MOU was signed by NARI with the Nagarjuna Fertilizers and Chemicals Ltd. (NFCL), Hyderabad for breeding sweet sorghum as an energy crop. We hope this partnership between NFCL and NARI boosts the future development in India of ethanol from sweet sorghum juice and cellulose material. This long terms cooperation is a shining example of NGO-corporate partnership in rural development.

I would like to thank Dr. Chanda Nimbkar, Smt. Jai Nimbkar and N. J. Wadhwani and G. R. Waddington (U.S.A.) for their donations for NARI's work. A lot of our work is made possible by such largesse.

Dr. N. Nimbkar
August 1, 2007

AGRICULTURAL RESEARCH

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.

Project 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 agro-industrial 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 :

(I) **Kharif (Rainy season) 2006 :**

(1) **Evaluation of F_1s of diallel crosses for varietal improvement :** Forty-five, 10-parent diallel (F_1) crosses were evaluated along with their parents for sugar yield and its components during kharif 2006. Twelve crosses out of the 45 evaluated recorded higher total sugar index than the parent NSS-216 which gave the highest sugar index (23.79 q/ha). The maximum sugar index was recorded by the hybrid NSS-201-4 X Keller (32.73 q/ha), which was followed by the crosses NSS-216 X William (31.22 q/ha), IS-3552 X Keller (29.99 q/ha) and IS-20510 X IS-9705 (28.94 q/ha).

(2) **Evaluation of CMS-based hybrids for sugar yield and its components** : Forty-eight CMS-based sweet sorghum hybrids were screened along with their parents and checks for sugar production during kharif 2006. The results revealed that out of the 48 hybrids evaluated, 19 hybrids recorded higher total sugar index (TSI) than the best check Madhura. The maximum TSI was recorded by the hybrid NSS 1023 X IS 14446 (40.65 q/ha) which was about 47% higher than that of the best check Madhura (27.69 q/ha) and was closely followed by that of the hybrids NSS 1023A X NSS 209 (37.35 q/ha), NSS 1015 X IS 14446 (36.66 q/ha) and NSS-1019A X NSS 218 (35.94 q/ha).

(3) **Effect of dates of sowing on sugar yield and other characteristics of sweet sorghum during rainy season :** The effect of dates of sowing on sweet sorghum was studied by sowing six promising sweet sorghum cultivars on four dates at fortnightly intervals

starting from June 1 upto July 15. The results of the trial showed significant differences due to sowing dates and genotypes for all the traits except brix %, in case of sowing dates and stem borer dead heart (%) at 40 days after sowing and stem borer damage at harvest, in case of genotypes. The sweet sorghum sowing on June 15 recorded the maximum fresh biomass yield, stripped stalk yield, juice extractability, grain yield and total sugar index. Among the different genotypes evaluated, the sweet sorghum variety SSV-84 recorded the maximum total sugar index (average over sowing dates of 29.22 q/ha), which was followed by the hybrid NARI-SSH-45 (26.22 q/ha). Thus for obtaining the maximum sugar production, the sweet sorghum cultivars SSV-84 or NARI-SSH-45 may be considered for sowing on June 15, since both the cultivars recorded the maximum total sugar index of 37 and 36 q/ha respectively when planted on this date.

(4) **Evaluation of promising sweet sorghum hybrids for sugar yield and its components :** Fourteen promising sweet sorghum hybrids along with three checks were evaluated for sugar yield and other characteristics during kharif 2006. The results showed that the hybrid NARI-SSH-15 recorded the maximum total sugar index of 41 q/ha as compared to the 38 q/ha exhibited by the best sweet sorghum check SSV-84.

(5) **Evaluation of advanced generations selections for sugar yield and its components :** Forty-two advanced generation selections from F_5 and F_8 generations were evaluated for their sugar producing ability. The screening showed that out of the 42 selections screened, 18 exhibited higher total sugar index than that of the best sweet sorghum check SSV-84. The maximum total sugar index of 27 q/ha was recorded by the entry NARI-SS-21-1, which was followed by the entries NARI-SS-22-1 (24 q/ha) and NARI-SS-26-3 (22 q/ha).

(II) **Rabi (Post-rainy season) 2006-07 :**

(1) **Evaluation of F_1 diallel crosses for varietal improvement :** Thirty-six crosses made by following diallel crossing programme were evaluated along with their parents for sugar yield and other characteristics during rabi 2006-07. The results of the trial showed that two hybrids out of the 36 evaluated, showed higher total sugar index than the highest sugar yielding parent RSSV-43-2. Hybrids giving the maximum total sugar index were identified as RSSV-43-2 X NSS-209 (14.58 q/ha) and NSS-209 X IS-20510 (14.15 q/ha).

(2) **Evaluation of CMS-based hybrids for sugar yield and other characteristics :** Fifty CMS-based hybrids along with their parents and two checks were evaluated for sugar production in a replicated trial. The results showed that three hybrids viz. NSS-1019A X NARI-SS-41 (18.93 q/ha), NSS-1021A X NARI-SS-41 (18.32 q/ha) and NSS-1017A X NSS-216 (15.22 q/ha) recorded higher total sugar index than the best parent NARI-SS-41.

(3) **Evaluation of advanced generation selections for sugar yield and its components :** Fourteen advanced generation selections along with sweet sorghum hybrid Madhura as a check were evaluated for sugar yield and other characteristics. The results showed that the entry NARI-SS-30-1 recorded the highest total sugar index of 10.39 q/ha as compared to the 6.38 q/ha recorded for the check Madhura.

(4) **Effect of dates of sowing on sweet sorghum for sugar yield and other characteristics during winter season :** The study on the effect of different dates of sowing on sweet sorghum during winter revealed significant differences due to dates of sowing and genotypes for all the characters. The study showed that fresh biomass and stripped-stalk yields were reduced when the sowing of the crop was delayed beyond first fortnight of October. A similar trend was noticed for other characteristics. However, total sugar index was observed to have increased with the delay in sowing time from the stipulated sowing period. This may be attributed to increased brix in some of the entries due to poor grain yield in the late-planted crop. Among the different genotypes evaluated, sweet sorghum hybrid NARI-SSH-45 recorded the maximum total sugar index of 17.50 q/ha averaged over sowing dates which was at par with the total sugar index of hybrid NARI-SSH-48 (17.49 q/ha). However, sweet sorghum hybrid check Madhura recorded a total sugar index of only 12.73 q/ha. Therefore, the newly developed hybrids NARI-SSH-45 and NARI-SSH-48 can be considered to be suitable for commercial production of ethanol during winter season.

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

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

Project duration : October 1, 2006 to September 30, 2011

Objectives :

1. To optimize sweet-stalk sorghum sugar content.
2. To optimize sweet-stalk sorghum biomass yield.
3. To optimize contents of cellulose and hemicellulose in sweet-stalk sorghum.
4. To develop early maturing sweet-stalk sorghum genotypes.
5. To develop sweet-stalk sorghum hybrids resistant to drought.
6. To develop sweet-stalk sorghum hybrids resistant to shootfly (*Atherigona soccata*).

Research highlights :

The following work was carried out in the post-rainy season 2006-07.

(1) Evaluation of 46 sweet and fiber sorghum germ-plasm lines along with three checks for sugar, grain and fiber yields and their components.
(2) Evaluation of 16 CMS lines along with their maintainer parents for various sugar and grain parameters.
(3) Production of 60 sweet sorghum hybrids for high sugar and biomass yields.
(4) Maintenance and evaluation for sugar, grain and fiber yields of 235 sweet and fiber sorghum germplasm lines of exotic and indigenous origin.
(5) Collection of sorghum land races from winter-sorghum growing areas in Maharashtra and Karnataka. A total of 88 panicle samples were collected from plants of varied characteristics. Eight of the collections were from plants with juice brix values ranging from 16 to 20.

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.

The major findings of safflower research carried out under the AICRP during 2006-07 are as follows :

1. **Release and notification of new spiny hybrid NARI-H-15 :** The spiny safflower hybrid NARI-H-15 developed at the center was released and notified by "Central Sub Committee on Crop Standards, Notification and Release of Varieties" for commercial production in all safflower growing areas under limited irrigated conditions in the country during 2006-07. NARI-H-15 gives an average seed yield of 2200 kg/ha which is 19% higher than that of the non-spiny hybrid NARI-NH-1. The spiny hybrid NARI-H-15 is based on non-spiny genetic male sterility system.

2. **Dissemination of technology of seed production of non-spiny hybrid NARI-NH-1 :** To disseminate the technology of hybrid seed production in safflower, the seeds of parental lines of non-spiny hybrid NARI-NH-1 and the technical bulletin giving information on seed production were supplied to both public and private seed producing agencies in the country. The agencies involved in seed production of NARI-NH-1 during winter 2006-07 were Mahabeej (Akola), National Seeds Corporation (Pune) and State Farms Corporation of India Ltd. (Raichur).

3. **Development of high yielding safflower cultivars :** The high yielding safflower varieties NARI-38 and NARI-42 which had recorded 21 and 11% increase in oil yield respectively over the national check A-1 in Initial Varietal Trial conducted during winter 2004-05, exhibited an increase in oil yield of 12% in case of NARI-38 and 14% in case of NARI-42 over national check A-1 in Advance Varietal Trial-I carried out during winter 2005-06. In addition both the varieties showed high tolerance to wilt under wilt-sick plot conditions in both the years' of screening. Apart from these two varieties, two new safflower varieties NARI-44 and NARI-45, based upon their performances in Initial Varietal/Hybrid Trial during 2005-06 were promoted to Advance Varietal Trial-1 for second year of multilocation evaluation during winter 2006-07.

4. **Breeding for wilt resistance in safflower :** Safflower wilt is one of the major diseases of irrigated safflower and is the major bottleneck in producing safflower in the wilt-affected areas. Therefore, a breeding programme to transfer wilt resistance from a stable source identified in the AICRP material into a high yielding but wilt-susceptible cultivar Nira was initiated at the center by adopting the backcross method of breeding. During winter 2006-07, two trials of BC_4F_6 generation were carried out under wilt-sick plot conditions.

Out of the 51 lines evaluated, 21 entries recorded higher seed yield than the best check A-1. However, 18 of the entries recorded significantly lower seed yield than the best wilt-resistant check.

5. **Development of cytoplasmic male sterility system through interspecific crossing :** The development of cytoplasmic male sterility in safflower through interspecific crossing is being carried out at the Institute. In order to find a suitable maintainer to the male sterile cytoplasm identified in the ongoing programme, an evaluation of 1099 crosses made between male sterile and male fertile sib counterparts was carried out. This resulted in identification of seven crosses giving > 75% male sterility in them. The male sterile plants in each entry were crossed individually with the corresponding pollinator parent to get 100% male sterility in the sterile cytoplasm of safflower.

6. **Identification of thermosensitive genetic male sterility (TGMS) in safflower :** During the investigations of CMS system in safflower some of the crosses with their respective pollinator parents showed > 75% male sterility during winter 2003-04, but surprisingly they were found to be 100% fertile in summer 2004. However, during winter 2004-05 only five selections out of 116 made in summer 2004 crop exhibited complete male sterility. These upon subsequent screening gave 100% fertility in summer 2005 and were found to be 100% male sterile in winter 2005-06, thereby showing thermosensitive nature of genetic male sterility in these genotypes. The 19 selections out of 633 evaluated during winter 2005-06 gave 100% male sterility. These lines were crossed with different safflower genotypes for development of TGMS hybrids. In summer 2006, TGMS lines were evaluated for fertility restoration and yielding ability to select the most promising one for hybrid development. It was observed that all the female lines showed 100% fertility giving sufficient quantity of seed required for hybrid seed production in winter 2006-07. The studies on determination of critical temperature regimes inducing fertility and sterility in TGMS lines identified are underway.

7. **Evaluation of thermosensitive genetic male sterility(TGMS)-based hybrids in safflower :** Twenty-three safflower hybrids based on TGMS lines were evaluated in RBD with two replications during summer 2006 and winter 2006-07 along with two hybrid checks NARI-NH-1 and NARI-H-15. It was seen that out of the 23 TGMS-based hybrids evaluated, the best was TGMSH-23. It gave 43 q/ha seed yield which is 15% higher than that of the best hybrid check NARI-NH-1. Seed production of this hybrid was done in winter 2006-07 for multilocation evaluation in coordinated varietal trials during winter 2007-08.

8. **Evaluation of advanced generation selections :** Out of the eight advanced generation entries (F_8 progenies) evaluated, six selections gave higher seed yield than the best

checks. Also out of the 183 high oil-containing and non-spiny F_4 populations studied, 36 populations gave at least 10% increase in seed yield over the best checks in respective trials carried out during winter 2006-07.

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

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

Project duration : January 1, 2005 to December 31, 2007.

Histomorphological studies were carried out to confirm presence of polyembryony and type of apomixis in present safflower material showing cyto-exomorphic apomictic indicators. The results of the studies carried out objectivewise in the second year of the project are as follows :

1. The embryological studies carried out in normal sexual genotypes at different pre- and post-fertilization stages showed them to contain single pistils having inferior, syncarpous, unilocular ovaries with a single basal anatropous ovule. The megaspore mother cell (MMC) showed the normal process of megasporogenesis forming a linear tetrad of megaspores during first meiotic division of MMC which further followed the normal path of gametophyte and embryo development post-fertilization. However, the embryological studies of fasciated derivatives of an interspecific cross between *C. palaestinus* and *C. tinctorius* showed different embryological development. The single pistils of these fasciated derivatives contained two separated ovules which resulted in fused caryopses. The ovule primordium was observed to originate from the placental area of the ovarian cavity. Also the initial stages of MMC did not show any meiotic division, instead the aposporous initials at the chalazal end gave rise to multiple unreduced (aposporous) embryo sacs originating from nucellar epidermal cells located inside the integumentary tapetum. Thus the study indicated the presence of apomictic (aposporous) embryo development in safflower. However, some of the embryos from reduced embryo sacs gave rise to normal sexual plants thereby indicating facultative nature of apomixis in safflower.

2. The embryological study carried out in F_1s from crosses made between fasciated plants and normal sexual genotypes showed single pistils with unilocular ovaries, with each 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 safflower material being studied. The embryological investigations in other genotypes such as 238-14-2 and D-149 are underway.

3. The meiotic studies were also carried out in F_1 crosses made between fasciated derivatives of *C. palaestinus* X *C. tinctorius* and normal safflower genotypes with dominant traits, to examine the chromosomal behavior in them. The study showed a normal meiotic behavior in F_1 crosses as is observed in sexual safflower genotypes. The F_1 crosses showed normal pairing at metaphase and exhibited 12 bi-valents at both metaphase and diakinesis. In addition, equal distribution of chromosomes at both the poles with no laggards was observed at anaphase I, resulting in production of normal

fertile pollens (86-100%) giving 100% seed set in these F_1 crosses. Similar comparisons of behavior were also made in F_1 crosses carried out between derivatives of genotype D-149 producing twin-embryo seeds and normal safflower genotypes.

4. A crossing programme involving genotypes producing twin-embryo seeds and those producing single-embryo seeds has been undertaken to study the inheritance of twin-embryo seeds in safflower. The F_1s have been evaluated during winter 2005-06 to see the occurrence of maternal types. On evaluating all the F_1s for exomorphic characters, it was found that all of them showed normal-stemmed plants producing single seeds. None of the F_1 plants in any of the crosses, showed apomixis-indicating traits like, twin-embryo seeds, multiple fused seeds or flattened stems. This reveals recessive nature of exomorphic apomixis-indicating traits which are associated with the fasciated genotype. The selfed progenies of all the F_1 crosses along with their parents were planted in winter 2006-07 in order to know the segregation pattern for both exomorphic and histological traits in F_2 generation. The recording of observations related to different parameters of F_2 progenies is underway. Also a wide crossing programme has been undertaken to examine the occurrence of maternal type of plants in F_1 to identify possible presence of apomixis in other genotypes of safflower showing apomicitic traits.

GRAPES

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

Funding agency : Agricultural and Processed Food Products Export Development Authority (APEDA), New Delhi.

Project duration : January 1, 2005 to December 31, 2006

Research highlights :

Three years after grafting of the three varieties viz. Redglobe, Crimson seedless and Italia on Dogridge rootstock was carried out, only Redglobe produced a yield of fruits of about 4.6 T ha^{-1}. Italia produced only 667 kg ha^{-1}, which may be due to late grafting. However, Crimson seedless produced a negligible 49 kg ha^{-1}, and does not seem to be suitable for planting in Phaltan. It will be tested for one more season i.e. 2007-08 and if is still found to be non-performing will be replaced with either Redglobe or Italia.

Project staff : N. Nimbkar, Ph.D.; D. R. Bapat, Ph.D. (Consultant); V. Singh, Ph.D.; M. B. Deshpande, M.Sc.; S. R. Deshmukh, M.Sc.; N. M. Kolekar, M.Sc.; J. H. Akade, M.Sc.; R. Sumitha, M.Sc.; P. Jhariya, M.Sc.; S. V. Choudhari, B.Sc.; S. W. Zagade, B.Sc.; R. K. Andhalkar; N. T. Madkar; M. G. Shirke; M. M. Bhujbal; H. H. Nale

RENEWABLE ENERGY RESEARCH

Project 1. Development of a mini plot thresher running on renewable energy for safflower
Funded : internally

Problems in safflower threshing :

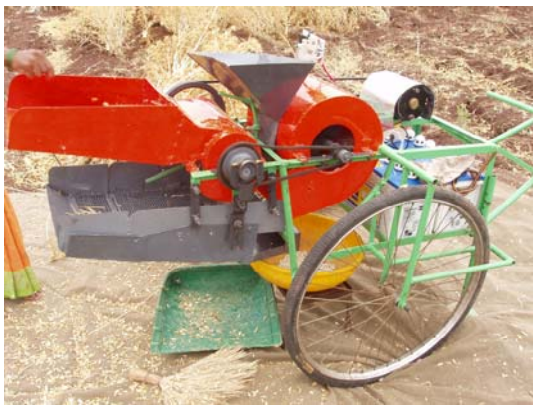
(1) Threshing of safflower trial plots is tedious, time-consuming and labour-intensive work due to spiny nature of the crop.
(2) Declining labour availability and their reluctance to work with a spiny crop have aggravated the problem of threshing safflower trial plots.

In view of the above it was decided to mechanize the threshing of safflower trial plots by developing a mini plot thresher. Earlier, a hand-operated single plant thresher was designed and built to see its suitability for threshing safflower trial plots and later on a pedal-operated system was incorporated in the thresher for reducing the human effort required to run it.

However, since the machine is expected to be operated continuously for 7-8 hours daily, hand or pedal-operated threshers can prove to be very strenuous for a labourer. Also there are practical limitations to a frequent replacement of the labourers, so it was decided to design a mini plot thresher running on a battery-powered motor.

A number of problems were tackled during the development of the mini plot thresher in the past one year and the results are :

(i) A mini plot thresher running on a battery-powered motor was successfully designed and developed at NARI. The two fully charged batteries of 12 V capacity each keep the motor of the thresher operating for the whole day when used intermittently for seven hours per day.



(ii) It can thresh 2 kg of safflower seed per hour.

(iii) About 32 field tests involving different women labourers operating the machine in each test time were conducted at NARI and comparison was made with the hand-threshing operation carried out by different labourers simultaneously. The tests showed that the threshing efficiency of the machine is 2.5 times that of the hand-threshing operation. Also the cleaning efficiency of the machine is as good as that of hand cleaning in getting seed free from inert matter.

(iv) From the general comments of the labourers, operating the machine for threshing was easy and it was concluded that machine-threshing was preferred over hand-threshing for the reasons of less fatigue, ease of dealing with spiny material for a longer period of time and lack of cleaning requirement. In addition, the work satisfaction of getting twice the amount of cleaned produce as compared to hand-threshing was a big factor in labourers favoring the machine-threshing over hand-threshing.

iv) Economic analysis showed that cost of machine-threshing of safflower was comparable to that of hand-threshing.

Project 2. Development of ethanol stove for rural areas

Funding agency : Ministry of New and Renewable Energy (MNRE), New Delhi.

Project completed and report submitted in May 2006

Highlights of the project :

1. A stove running on 50% (w/w) ethanol-water mixture was successfully developed at NARI. To the best of our knowledge this is the first stove of its kind anywhere in the world.

2. The stove capacity ranges from 0.9 to 2.45 kW with efficiencies ranging from 44 to 46%.

3. Carbon monoxide emission by the stove is of the order of 8-10 ppm.

4. Sixty seven field tests involving 16 women farm labourers were conducted. They cooked their afternoon meals on this stove. All these women preferred the ethanol stove over kerosine and wood-burning stoves.

5. 50% (w/w) ethanol-water mixture is a very safe mixture for household purposes.

A patent has been filed on the stove. Quite a number of organizations all over the world have shown interest in introducing these stoves on a large scale in rural areas of their countries.

Project 3. Ethanol lantern for rural areas

Funding agency : Department of Science and Technology (DST), Science and Society Division, Ministry of Science and Technology, New Delhi.

Project duration : April 1, 2007 to September 30, 2008

Objectives : To develop an efficient lantern running on 50% (w/w) ethanol-water mixture and capable of producing light equivalent to that from a 100 W bulb.

Project staff : Anil K. Rajvanshi, Ph.D., Brendon Mendonca, B.Tech., S. M. Patil, D. B. Gadhave, A. M. Pawar, R. S. Bale

ANIMAL HUSBANDRY RESEARCH

Research and Extension activities of the Animal Husbandry Division (AHD)

There was only one funded project implemented by the AHD during 2006-07 and that was the extension of the project funded by the Australian Centre for International Agricultural Research (ACIAR).

"Improved productivity, profitability and sustainability of sheep production in Maharashtra through genetically enhanced prolificacy, growth and parasite resistance"

One of the major achievements of AHD under the project is the development of the 'NARI Suwarna' strain of the Deccani breed which has the characteristic of twinning and a very small (<10%) proportion of the Garole breed. These sheep are adapted to the dry, monsoonal climate of the rain-shadow areas of the Deccan plateau and yield at least 20% more weight of lamb per ewe lambed than the Deccani. Other achievements of the project are listed below.

Progress summary of project

Objective A : Ongoing production of appropriate genotypes for testing in shepherds' flocks

During 2006, two AI programs were carried out in the NARI sheep flock; 531 ewes were inseminated, 356 ewes lambed, 486 lambs were born and 421 were weaned. The average litter size of the NARI flock increased from 1.2 in February to 1.5 in September 2006. Twenty-six rams were used in the first program; 19 of these and an additional 15 young rams were used in the second program. The primary selection of rams and ewes was done using a selection index of EBVs for reproduction and growth traits. Conformation and facial features preferred by local shepherds were also considered as selection criteria. Allotment of rams to ewes (mate selection) was done using the TGRM program to maximize genetic merit while minimizing relationships in the flock. During the year, 263 DNA samples from NARI and 107 from shepherds' flocks were genotyped by NARI and NCL staff members jointly.

All lambing records at NARI since 1996 were analyzed (3912 records of $FecB^{+}/FecB^{+}$ ewes, 1167 of $FecB^{B}/FecB^{+}$ ewes and 37 of $FecB^{B}/FecB^{B}$ ewes). The number of lambs born alive and weaned per ewe inseminated (and per ewe lambed) was estimated to be 0.97 and 0.90 (1.02 and 0.95) for F$ecB^{+}/FecB^{+}$ ewes, 1.43 and 1.24 (1.56 and 1.35) for $FecB^{B}/FecB^{+}$ ewes and 1.63 and 1.33 (1.72 and 1.40) for $FecB^{B}/FecB^{B}$ ewes. At the end of 2006 there are 510 ewes available for breeding. For the first time, more of these (i.e. 270) are $FecB^{B}/FecB^{+}$ ewes than F$ecB^{+}/FecB^{+}$ ewes (200) and there are 40 $FecB^{B}/FecB^{B}$ ewes.

A nucleus Garole flock of 58 ewes and 40 rams is being maintained at NARI. Sixty-seven new lambs were born during December 2006 and 57 of these (24 males and 33 females) were alive at the end of 2006. The Garoles have now adapted well to conditions at NARI.

Objective B : Ongoing dissemination of improved *FecB* carrier rams and semen into shepherds' flocks and evaluation of performance data

Ten homozygous and two heterozygous *FecB* carrier rams were introduced into eight shepherd flocks for breeding. Oestrus synchronization and artificial insemination were carried out using homozygous *FecB* carrier ram semen in nine flocks. These flocks with 818 ewes in total are intensively monitored. Additionally, 11 *FecB* carrier rams were introduced into 11 'less intensively monitored' flocks with 442 breeding ewes in total. NARI's rams have sired a total of 260 lambs in these flocks during the year, lambing is in progress in six flocks and will commence in the next two months in six flocks. The proportion of *FecB* carrier adult breeding ewes in intensively monitored participating flocks has increased from 13% to 20% over the reporting period. The number of lambs born alive and weaned per ewe lambing was 1.02 and 0.92 for $FecB^{+}/FecB^{+}$ ewes and 1.48 and 1.09 for $FecB^{B}/FecB^{+}$ ewes in 16 flocks. The figures for 10 of these flocks which were better managed were similar for $FecB^{+}/FecB^{+}$ ewes but for $FecB^{B}/FecB^{+}$ ewes, they were 1.55 lambs born and 1.26 lambs weaned per ewe lambing.

Four workshops were conducted at NARI's Lundy farm for dissemination of project results with about 25 shepherds participating in each one. The workshops were organized when there were 2-3 month old lambs in the NARI flock to show to the shepherds how the ewes and lambs are managed at NARI.

A meeting of 60 government animal husbandry officers from the 32 districts of Maharashtra State organized in Pune by the Commissioner, Animal Husbandry was addressed by Dr. P. Ghalsasi. He informed them about the effect of the *FecB* gene on the reproductive performance of the two new strains of sheep being developed at NARI and the proper way to manage carrier ewes with a higher twinning percentage than the Deccani.

Objective C : Socio-economic analysis of the FecB dissemination program implemented in local smallholder flocks from 2003-06

A draft survey questionnaire was prepared in September 2006 in consultation with two agricultural extension specialists, Mr. Julian Prior from the University of New England, Australia and Dr. D. V. Rangnekar from Ahmedabad, India for interviewing the shepherd households where *FecB* carrier rams/semen and/or ewes were introduced. The questionnaire was modified by NARI researchers, translated into Marathi and nine of the participating shepherds were interviewed from November 2006 to January 2007. Shepherds' general perception is that they can get one and a half times as much income if a ewe has twin lambs rather than a single. They realize, however, that extra feed has to be given to twin-bearing ewes and to twin-born lambs.

Project impacts

Community impact

1. The project is bringing about a change in the attitude of participating shepherds towards sheep rearing, resulting in a change in their methods of management. Whereas previously most of them experienced heavy sheep mortality, now they realize that if they protect their sheep from diseases and parasites, have ewes that give twins, give the ewes extra feeding around lambing and manage lambs properly, they can make substantial profits.

2. Eight of the participating shepherds have started to keep lambs behind when the ewes go grazing and feed them good quality leguminous forage as they have realized it is profitable to do so.

3. In the beginning, participating shepherds used to think that lambs sired by NARI rams are smaller than those sired by their own rams and they would remain smaller even as adults. Now, however, after seeing the *FecB* carrier adult ewes born in their own flocks, they admit there is no difference in size compared to their own ewes.

4. Demand has started to come from local sheep-rearers for *FecB* carrier rams and ewes.

Workshop for shepherds

A workshop on "Harnessing genetics to increase productivity of sheep in India and bluetongue disease of sheep" was organized on 8 November 2006 for shepherds in and around Phaltan. Around 500 shepherds attended the workshop. Ms. Leena Mehendale, Principal Secretary, Animal Husbandry and Dairy Development Department of Government of Maharashtra inaugurated the workshop. A grant from the National Bank for Agriculture and Rural Development (NABARD) provided some of the funding for the workshop. Dr. R. R. Pharande from the Department of Veterinary Microbiology and Dr. B. V. Nardalkar, Associate Professor, Department of Parasitology, College of Veterinary and Animal Science, Parbhani gave presentations at the workshop. Dr. Chanda Nimbkar and Dr. P. M. Ghalsasi of NARI also gave presentations. The Deputy Commissioner and District Animal Husbandry Officer, Satara District and Government Livestock Development Officers from Phaltan region were present at the workshop. A Marathi booklet on "Bluetongue disease in sheep and goats" prepared for this workshop was released by Ms. Leena Mehendale and provided free of cost to all participants in the workshop. Specially prepared posters giving information on bluetongue disease were exhibited at the workshop.

Scientific impact

1. The new generations of ewes and rams of the 'Fecund Deccani' strain at NARI have superior production characteristics as well as color, conformation and facial features preferred by local shepherds, as conscious emphasis is placed on these for selection. NARI has also established the technology for rearing twinning ewes and their lambs.

2. NARI wishes to start the process for registering the two new strains, 'Fecund Deccani' and 'Fecund Composite' with the appropriate Indian government authority.

3. Demonstration of significant improvements in productivity in heterozygous ewes in NARI and shepherds' flocks has been done.

4. There is increasing interest in the new sheep genotypes developed at NARI. The Balasaheb Sawant Konkan Agricultural University at Dapoli in the coastal zone of Maharashtra State has taken two *FecB* carrier rams from NARI. The Sardar Krushinagar Agricultural University in North Gujarat has expressed interest in using *FecB* carrier sheep from NARI to improve the superior carpet wool type Patanwadi sheep at their research station.

5. Dr. Chanda Nimbkar was invited to present results of NARI's *FecB* introgression program at a 3-day workshop on "Sustainable use and conservation of Deccani sheep (meat and wool)" organized by two NGOs Anthra and Jan Jagaran in Hyderabad in February 2007.

6. There is increasing awareness of NARI's expertise in accurate scientific assessment of gastro-intestinal parasites and an NGO Anthra brought pooled faecal samples from 80 migratory sheep flocks to NARI during 2006. Anthra is doing extension work with these flocks.

7. NARI conducted trials on two commercial anthelmintics and found that the short-acting anthelmintic tested was not fully effective and the long-acting anthelmintic was effective for a period of time considerably shorter than that claimed by the manufacturer.

Capacity impact

1. NARI's extension officers have learnt the proper interviewing technique.

2. NARI staff has learnt techniques of working with shepherds successfully.

3. NARI staff organized a workshop for 500 shepherds successfully.

4. NARI's Ms. Padmaja Ghalsasi can now carry out all the activities needed for *FecB* genotyping independently. She can operate the PCR and other machines in the National Chemical Laboratory (NCL) and The Vidya Pratishthan School of Biotechnology (VSBT) laboratories and interact efficiently with the staff of those laboratories.

A research project on vegetative propagation of KX2 hybrid of *Leucaena leucocephala* was also carried out. This hybrid is preferred to the most commonly planted variety K8 because it does not produce seed and is resistant to psyllid (*Heteropsylla cubana*). In addition, it has a higher forage yield and fast growth rate which would be useful to supplement ruminant livestock feed. Vegetative propagation trials were conducted by rooting two node cuttings. These trials were partially successful.

For further multiplication, we tried to graft KX2 buds on K8 variety, plants of which are available in abundance. AHD approached Baramati Agricultural Development Trust to permit their employee Mr. Balbhim Ladkat to teach the grafting technique to their staff. On 23 August 2006 he came and grafted 20 plants of K8 onto KX2 hybrid. Wedge grafting and eye budding were carried out. About 45% of the grafts succeeded.

In order to get more hands on training, Mr. Sitaram Dashrath Dandile, an expert in grafting technique from Phaltan was called on 21 February 2007. He grafted 25 plants and trained AHD staff members, who are now more confident and are able to do the grafting themselves. It has been observed that proper selection of the nodes from where cuttings are taken is important for the survival of the grafted material.

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

I. PUBLICATIONS

A. **Book chapter :**

Singh, Vrijendra and Nimbkar, N. 2007. Safflower (*Carthamus tinctorius* L.) P. 167-194. In **Genetic Resources, Chromosome Engineering, and Crop Improvement. Volume 4**: Oilseed Crops (Singh, Ram J., ed.) CRC Press, Taylor & Francis Group, Boca Raton, Florida, U.S.A.

Two Marathi booklets were published as follows :

- Bluetongue disease in sheep and goats. 2006. Marathi booklet released at the time of the Seminar of shepherds held at Nimbkar Agricultural Research Institute, Animal Husbandry Division, Phaltan on 8 November 2006. 13 p.

- Boer and Damascus goats for improvement of local goats. November 2006. 8 p.

B. **Articles published in magazines and journals (in alphabetical order by author name)**

1. Ghalsasi, P.M. 2006. Marathi article on 'Goat improvement by artificial insemination' ('Krutrim retanadware sheli sudharna'). Published in Marathi compendium 'Jeshtha Pashu Vaidya Pratishthan', Pune, India. May 2006. pp. 50-54.

2. Ghalsasi, P.M., Ghalsasi, P.P. and Nimbkar, C. 2006. Reduced time duration of efficacy of a long acting anthelmintic in sheep and goats. In "Strengths, Challenges and Opportunities in Veterinary Parasitology". **Proceedings** of the XVII National Congress of Veterinary Parasitology and National Symposium. Rajiv Gandhi College of Veterinary and Animal Sciences, Kurumbapet, Puducherry, India. November 15-17, 2006. pp. 112-113.

3. Ghalsasi, P.M. and Nimbkar, C. 2006. Experiences of assessment and control of bluetongue in Satara district in Maharashtra. In Lead papers and Abstracts of National Seminar on "Strategies for control of bluetongue" held at College of Veterinary Science, Tirupati, Andhra Pradesh, India. May 24-25, 2006. p. 122.

4. Ghalsasi, P.M. and Nimbkar, C. 2006. Use of new reproductive technologies in sheep and goats under field conditions. In **Souvenir** of National Seminar of the Indian Society for Sheep and Goat Production and Utilization (ISSGPU) on "Innovations and Recent Advances in Reproduction for Augmenting Small Ruminant Production". Central Sheep and Wool Research Institute, Avikanagar, Rajasthan, India. December 28-30, 2006. pp. 239-243.

5. Ghalsasi P.M. and Nimbkar C. 2007. Experiences of assessment and control of bluetongue in Phaltan Maharashtra. In **Souvenir** of National Seminar of the Indian Society for Sheep and Goat Production and Utilization (ISSGPU) on "Emerging diseases of small ruminants and their containment under WTO regime". Central Institute for Research on Goats. Makhdoom, UP, India. February 3-5, 2007. pp. 40-41.

6. Jacob, A. and Rajvanshi, Anil K. "Long-term weather trends in western Maharashtra", **http://nariphaltan.virtualave.net/weather.pdf** (October 2006).

7. Kolekar, N. M. and Nimbkar, N. 2006. Marathi article on 'Sweet sorghum cultivation and production' ('Goad jwari lagvad wa utpadan'). Published in Marathi magazine 'Baliraja'. May 2006. pp. 76-78.

8. Lindner, A. and Rajvanshi, Anil K. "Fostering engineering innovation and education across boundaries; A proposed model for collaboration between a U.S. university and a developing country NGO", **Proceedings** of National Collegiate Inventors and Innovators Alliance (NCIIA) 11th Annual Meeting, March 22-24, 2007, Tampa, Florida, p. 215. www.nciia.org.

9. Lindner, A., Stanfill, K., Hodges, M. and Rajvanshi, Anil K. "Expanding the Boundaries of Design of Products and Processes for Solutions to Problems in Developing World", **Proceedings** of 9th International Conference on Engineering Education (ICEE), Paper R3F-16, San Juan, PR, USA. July 23-28, 2006. **http://fie.engrng.pitt.edu/icee2006/papers/3468.pdf .**

10. Marathi article 'Sheep rearing – profitable enterprise' ('Mendhipalan ek phaydeshir udyog'). 2007. **Annadata** magazine. February 2007. pp. 26-27.

11. Nimbkar B.V. 2006. Marathi article on 'Pastoralism-the agricultural activity of the future in semi-arid Maharashtra'. (Avarshangrast bhagasathi mendhpal (kurani) sanskrutila bhavishyat pradhanya). Published in Marathi magazine "Ajacha Sudharak". May 2006. pp. 71-78. It was also published in Marathi compendium 'Jeshtha Pashu Vaidya Pratishthan', Pune, India. May 2006. pp. 30-33.

12. Nimbkar, B.V. 2006. Marathi article on 'Import-export of livestock for prosperity of animal husbandry' ('Pashudhanachi khuli ayat-niryat mhanjech pashusanvardhan kshetrachi bharbharat'). Published in **Agrowon** daily agricultural newspaper. September 8, 2006. p. 15.

13. Nimbkar, B.V. 2006. Marathi article on 'Cassava' ('Anna va starch nirmitisathi kasava'). Published in "**Agrowon**" daily agricultural newspaper. September 24, 2006. p. 15.

14. Nimbkar C. 2006. Conservation of livestock biodiversity. In "Animal Genetic Resources and Conservation" **Compendium** of lectures of biodiversity awareness workshop held at National Bureau of Animal Genetic Resources, Karnal, India. April 22-23, 2006. pp. 108-112. National Bureau of Animal Genetic Resources, Karnal, India. April 22-23, 2006. pp. 108-112.

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16. Nimbkar, C., Ghalsasi, P.M., Chavan, K.M., Nalawade, M.H., Walkden-Brown, S.W., Gupta, V.S., Pardeshi, V.C. and van der Werf, J.H.J. 2006. Lamb production by *FecB* heterozygous carrier and non-carrier ewes in smallholder flocks in Maharashtra State of

India. **Proceedings** of the 8th World Congress on Genetics Applied to Livestock Production. Belo Horizonte, Brazil. August 13-18, 2006. CD-ROM Communication No. 04-03.

17. Nimbkar C., Ghalsasi, P.M. and Nimbkar B.V. 2007. Genetic improvement of Deccani sheep for increased profit. Paper submitted for the **Proceedings** of the Seminar on "Sustainable Use and Conservation of the Deccani Sheep (Meat and Wool)" Anthra, Hyderabad, India. February 20-22, 2007.

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19. Nimbkar, N. and Nimbkar C. 2006. Marathi article on 'Globalization and Agricultural Research' ('Jagatikikaran ani krishi sanshodhan'). In a special issue on 'Globalization and Agricultural Development' published by **Vanarai** magazine. November 2006.

20. Rajvanshi, Anil K. "Go for ethanol", Editorial article in **Times of India**, 9 June 2006.

21. Rajvanshi, Anil K. "Agricultural policy for energy security", Op-Ed in **Project Monitor,** 28 August 2006, p. 9.

22. Rajvanshi, Anil K. "Sustainable energy for rural development", Invited talk given at **PAN-IIT** 2006 conference, 23-25 December, 2006 in Mumbai. Published in Proceedings of PAN IIT lectures. p. 95.

23. Rajvanshi, Anil K. "Rural research priorities", **Pi Tech** (a Pan IIT Tech Review Magazine), Vol. 1, Issue 3 (December 2006), p. 68.

24. Rajvanshi, Anil K. "How NRIs can help in poverty alleviation", **Catalyst for Human Development,** January 2007, p. 44.

25. Rajvanshi, Anil K. "Nikola Tesla – The creator of electric age", **Resonance**, Vol. 12, No. 3, March 2007. pp. 4-12.

26. Rajvanshi, Anil K., Patil, S. M. and Mendonca, B. "Development of stove running on low ethanol concentration", **Proceedings** of NCIIA 11th Annual Meeting, March 22-24, 2007, Tampa, Florida, p. 223.

27. Rajvanshi, Anil K., Patil, S. M. and Mendonca, B. "Low concentration ethanol stoves for rural areas in India", **Energy for Sustainable Development,** Vol. XI, No. 1, March 2007, pp. 94-100. (A picture of the stove was put on the cover of the journal).

28. Rajvanshi, Anil K., Singh, V. and Nimbkar, N. "Biofuel-Promise and Prospects", A thematic lecture given at National Conference entitled "Changing Global Vegetable Oils Scenario : Issues and Challenges before India", January 29-31, 2007, Hyderabad, and organized by Indian Society of Oilseeds Research. Paper published in **Proceedings** of the conference (D. M. Hegde Editor), pp. 247-262.

29. Singh, V., Akade, J. H., and Nimbkar, N. 2007. Existence of apomixis in safflower. In, ISOR, 2007. Extended Summaries : National Seminar on Changing global vegetable oils scenario. Issues and challenges before India, January 29-31, 2007. Indian Society of Oilseeds Research, Hyderabad. pp. 110-111.

30. Singh, V., Deshpande, M. B. and Sumitha, R. Annual Progress Report of "All India Coordinated Research Project on Oilseeds (Safflower), June 2006. p. 129.

31. Singh, V., Kolekar, N. M. and Nimbkar, N. Final Report of Project on "Biometrical investigations of flower yield and its components and their maximization in safflower". Submitted to the Indian Council of Agricultural Research (ICAR), New Delhi. July 2006. p. 106.

II. TRAINING AND EXTENSION ACTIVITIES

1. Mr. Vishal Sudhakar Nirmal from Kopargaon, Dist. Ahmednagar came to gain work experience in goat and sheep management, feeding, medication and artificial insemination from 10-26 April 2006.

2. Mr. Adrien Jacob spent about 5 months (April-September 2006) doing his internship at NARI to finish his Master's degree in general engineering from Ecole Centrale de Lyon, France. This internship also validated a non-technical Master's degree in "Ethics and Sustainable Development".

3. Dr. H. D. Kadam, veterinarian from Sadhu Vaswani Mission, Pune was given training in artificial insemination in goats and sheep at the Institute's farm at Wadjal from 15-18 May 2006.

4. Mr. Krishna Sudhakar Ghawate, student of College of Agricultural Biotechnology, Loni, Dist. Ahmednagar, Maharashtra, was given theoretical and practical training on semen collection and artificial insemination in goats and sheep. He was also allowed to use the institute's library for references during his stay of two weeks from 22 May to 7 June 2006.

5. Ms. Sanjivani Lad, MVSc student of Anand Veterinary College, Gujarat visited NARI in the last week of May 2006 to gain more knowledge about animal nutrition and the fodder *Stylosanthes seabrana*. She gave a presentation on animal nutrition to the staff of the AHD.

6. Ms. Elise Levasseur completed a 3-month (June-September 2006) training period in the field of agronomy as a third year placement student of Ecole d' Ingenieur Agro-Development International, Cergy-Pontoise cedex, France. She carried out an economic analysis of syrup production from sweet sorghum.

7. Ms. Anushka Lobo, veterinary science student studying at St. Petersburg University in Russia did her one month internship at AHD from 22 June to 28 July 2006. During her stay she studied diagnosis of disease in sheep and goats and data recording. She studied

the epidemiology of Conjunctivitis outbreaks at NARI's various farms during the last several years. Her stay was self-funded.

8. Dr. N. Arulnathan was given hands on training at Institute's Wadjal Farm on 'Artificial insemination in goats' from 27–29 July 2006. He was given detailed theoretical and practical knowledge in this subject and purchased an A.I. kit from NARI.

9. Mr. Ashok Sadu Kharade from Malewadi, Dist. Ahmednagar was given 40 days' training from 6 September 2006 to 15 December 2006 in goat and sheep management, feeding, medication and artificial insemination. During this period he lived on Institute's Dhuldeo farm and participated in the day-to-day management of sheep and goats.

10. Mr. William Lucas, a Rural Science Graduate from University of New England, Armidale, Australia spent about six weeks (9 November-22 December 2006) at the AHD as a volunteer to obtain knowledge of livestock rearing in India. His visit was self-funded.

11. Mr. Sanjay Kachare and Mr. Avinash Sonalkar, first year students of the Master of Social Work at the Yashwantrao Chavan Institute of Social Sciences, Satara did their field placement training at the AHD. They spent two days a week at the AHD from 18 September to 8 November 2006. They worked on the extension aspect of the ACIAR-funded project with shepherds, participated in the development of a questionnaire for interviewing participating shepherds and conducted one interview.

12. Mr. Ayyaj Memon and Mr. Elmuddin Mujawar from Pune stayed at NARI from 23-27 February 2007 to obtain work experience in goat and sheep management, feeding, medication and artificial insemination in sheep and goats.

13. One technical training course in 'Artificial insemination in goats' was conducted from 19-21 February 2007. Five trainees (two from Satara, two from Pune and one from Udgir district) participated in the training program.

14. Mr. Sebastian Steinfeld who has done his M.Sc. in Physics from Oxford University, U.K. came for a short internship and spent one month (February-March 2007) at NARI developing a silencer for the ethanol lantern.

III. TRAINING RECEIVED BY NARI STAFF

1. An AHD farm supervisor, Shri Malhari Dhembare was trained to shear sheep using a shearing machine by two shearers of the Punyashlok Ahilyadevi Maharashtra Goat and Sheep Development Corporation. Shri Dhembare can now confidently shear sheep on his own. His skill will be of immense use to AHD.

2. Dr. Anil K. Rajvanshi attended the first DST workshop on "Dimensions of Nanotechnology : Science, Technology and Society" at the National Institute of Advanced Studies at Bangalore from June 26 to July 1, 2006. This was sponsored by DST.

3. Ms. R. Sumitha attended the training program "Project formulation, implementation and evaluation" at the Administrative Staff College of India at Hyderabad from May 8-19, 2006. This training was sponsored by DST.

IV. CONFERENCES / SEMINARS / MEETINGS WORKSHOPS ATTENDED BY STAFF AND LECTURES GIVEN (Chronologically)

1. Dr. Chanda Nimbkar, as part-time member, attended meetings of the National Commission on Farmers held during 2006-07. She contributed to the chapter on Animal Husbandry of the Draft National Policy on Farmers.

2. Dr. P. M. Ghalsasi attended the 'Research Review Committee' meeting of the Department of Animal Science and Dairy Science of the MPKV, Rahuri on 12 April 2006. He participated in the discussions of the review committee.

3. Dr. Chanda Nimbkar attended the Biodiversity Awareness Workshop on "Animal Genetic Resources and Conservation" held at National Bureau of Animal Genetic Resources, Karnal, Haryana on April 22-23, 2006. She presented a paper 'Conservation of Livestock Biodiversity'.

4. Dr. V. Singh attended the 36th Annual Sorghum Meeting held at the Marathwada Agricultural University (MAU), Parbhani from May 11-13, 2006.

5. Dr. P.M. Ghalsasi and Ms. P.P. Ghalsasi attended the National Seminar on "Strategies for control of bluetongue" held at College of Veterinary Science, Tirupati, Andhra Pradesh on May 24-25, 2006. Dr. P. M. Ghalsasi presented a paper 'Experiences of assessment and control of bluetongue in Satara district in Maharashtra'.

6. Dr. Chanda Nimbkar delivered a lecture in Marathi at Phaltan on "Sheep: way to increase the income from this neglected resource" (durlaxit mendhya: utpannavadhicha marg) on 27 May 2006 in a series of lectures organized by Appropriate Rural Technology Institute, Phaltan.

7. Dr. P. M. Ghalsasi attended the workshop organized by Vikram Milk and Milk Products, Phaltan and American Soya Association on "Animal Nutrition" at Phaltan on 16 June 2006.

8. Dr. Chanda Nimbkar gave a presentation on "National Policies and Small Ruminants" in a training course organized by the NGO Anthra in Pune on 17 July 2006.

9. Dr. Chanda Nimbkar presided at the meeting organized by Rasik Kala Krida va Sanskrutik Manch, Rajale, Tal Phaltan in collaboration with Nimbkar Agricultural Research Institute, Phaltan, Agricultural College, Baramati and Marathwada Veterinary, Feed and Milk Development Pvt. Ltd., Ashti, Maharashtra on 18 July 2006. The topic was "Control of mastitis in cattle" ('dubhtya janawaranmadhye stanadaha rogache nirmoolan').

10. Dr. V. Singh, Mr. M. B. Deshpande and Ms. R. Sumitha attended the Annual Rabi Oilseeds Research Workers' Group Meeting held at Narendra Dev University of

Agriculture and Technology, Faizabad, U.P. from 10-12 August 2006 and presented the results of their research programmes.

11. Dr. Chanda Nimbkar attended the 8th **World Congress** on "Genetics Applied to Livestock Production" held at Belo Horizonte, Brazil on 13-18 August 2006. Dr. Nimbkar presented a paper 'Lamb production by *FecB* heterozygous carrier and non-carrier ewes in smallholder flocks in Maharashtra State of India'.

12. Dr. Anil K. Rajvanshi gave a prestigious Institute lecture at **I.I.T. Bombay** on 16 August 2006. The lecture titled "Nation Building, I.I.Tians and Happiness" was very well received. Around 350 faculty including the Director, I.I.T. Bombay and students attended the lecture. It was also widely reported in the mass media and was broadcast to many engineering colleges in Maharashtra.

13. Dr. P. M. Ghalsasi attended a State Level Workshop on "Sheep Breeding Policy for Andhra Pradesh" in Hyderabad on 28-29 August 2006. He presented a paper 'Sheep genetic improvement initiatives at Nimbkar Agricultural Research Institute (NARI), Phaltan, Maharashtra'.

14. Dr. Anil K. Rajvanshi attended the State Advisory Committee Meeting of Maharashtra Electricity Regulatory Commission (MERC) on 9 October 2006. The discussion was centered on Dr. Rajvanshi's strategy for rural electrification in Maharashtra.

15. Dr. P. M. Ghalsasi gave a presentation on 'Use of the FecB gene to increase sheep productivity' to all District Deputy Commissioners and District Animal Husbandry Officers of the Government of Maharashtra, whose meeting was organized by the Commissioner, Animal Husbandry, Maharashtra State at Central Building, Pune on 11 October 2006.

16. Dr. Chanda Nimbkar attended a workshop on "Goats – an Undervalued Asset in Asia" jointly organized by Animal Production and Health Commission for Asia and the Pacific (APHCA) and International Livestock Research Institute (ILRI) at Luang Prabang, Lao PDR on October 24-25, 2006. Dr. Chanda Nimbkar gave a presentation on "Options for genetic improvement of goats by smallholders".

17. Ms. P.P. Ghalsasi and Dr. P.M. Ghalsasi attended the XVII National Congress of Veterinary Parasitology and National symposium on "Strengths, Challenges and Opportunities in Veterinary Parasitology" held at Rajiv Gandhi College of Veterinary and Animal Sciences, Kurumbapet, Puducherry from November 15-17, 2006. Ms. P.P. Ghalsasi presented a paper 'Reduced time duration of efficacy of a long acting anthelmintic in sheep and goats'.

18. Dr. Anil K. Rajvanshi was invited as chief guest at the inauguration of National Conference on Role of Engineering Education in Nation Building. The conference was organized by Sinhgad Institute of Technology, Pune from 21-24 November 2006.

19. The Animal Husbandry Division (AHD) participated in the Yashawant Agricultural, Business and Livestock Exhibition held at Karad, Maharashtra, India from November 24-28, 2006. Some *FecB* carrier rams were exhibited by AHD. Mr. K. M. Chavan gave information about the importance of these rams to visitors at the stall. Dr. P.Ghalsasi gave

a powerpoint presentation on 'Use of the *FecB* gene in sheep to increase productivity' on 28 November 2006.

20. Dr. Chanda Nimbkar attended a workshop organized jointly by FAO and BAIF in Pune on "Policies and Strategies for the Development of Animal Genetic Resources" from 28-30 November 2006.

21. Dr. Anil K. Rajvanshi attended the PAN-IIT 2006 conference held in Mumbai from 23-25 December 2006 and delivered an invited talk entitled "Sustainable Energy for Rural Development". Around 40 invited talks were given by various experts to 5000 IITians from all over the world.

22. Dr. Anil K. Rajvanshi gave an invited talk "Social Entrepreneurship", to around 175 undergraduate students at **I.I.T. Kanpur** on 27 December 2006.

23. Mr. K. M. Chavan participated in the guidance workshop for NGOs in Maharashtra organized by Council for Advancement of People's Action and Rural Technology, New Delhi.

24. Dr. P. M. Ghalsasi attended the National Seminar on "Innovations and Recent Advances in Reproduction for Augmenting Small Ruminant Production" organized by the Indian Society for Sheep and Goat Production and Utilization (ISSGPU) held at Central Sheep and Wool Research Institute, Avikanagar, Rajasthan from 28-30 December 2006. He presented a lead paper 'Use of new reproductive technologies in sheep and goats under field conditions'.

25. Mr. J. H. Akade attended the DOR-sponsored training course on 'Hybrid seed production technology for sunflower, castor and safflower' held at Directorate of Oilseeds Research, Hyderabad on 19 January 2007 and delivered a lecture on 'Certified hybrid seed production in safflower'.

26. Dr. Anil K. Rajvanshi, Dr. N. Nimbkar and Dr. V. Singh attended the National Seminar on Changing Global Vegetable Oils Scenario : Issues and Challenges before India held at Acharya N. G. Ranga Agricultural University, Hyderabad from 29-31 January 2007. Dr. Singh gave a poster presentation while Dr. Rajvanshi presented the theme paper for the topic "Vegetable oils and biofuels".

27. Dr. Chanda Nimbkar and Mr. B. V. Nimbkar attended the Scientific Advisory Committee meeting of the Krishi Vigyan Kendra, Sharadanagar, Baramati on 1 February 2007.

28. Dr. P. M. Ghalsasi attended the National Seminar on "Emerging diseases of small ruminants and their containment under WTO regime" organized by ISSGPU held at Central Institute for Research on Goats, Makhdoom, U.P., from 3-5 February 2007. He gave a poster presentation on 'Experiences of assessment and control of bluetongue in Phaltan, Maharashtra'.

29. Two staff members Shri K. M. Chavan and Shri S. Kulkarni attended the workshop on 'Madgyal sheep' organized by Punyashlok Ahilyadevi Maharashtra Sheep and Goat Corporation, Pune on 14 February 2007.

30. Dr. Chanda Nimbkar attended the seminar on "Sustainable Use and Conservation of Deccani Sheep (Meat and Wool)' held at Anthra, Hyderabad from 20-22 February 2007. She presented a paper 'Genetic improvement of Deccani sheep for increased profit'.

31. Mr. K. M. Chavan delivered a lecture on 'Improving goat management in rural areas' in the session on 'Rural employment' organized by Nehru Yuva Pratishthan at village Mhangrevasti, Tal. Khandala, Dist. Satara on 2 February 2007.

32. Five staff members attended a one-day training course in "Goat rearing" held at Krantisinh Nana Patil Veterinary College, Shirval, Tal. Khandala on 1 March 2007.

33. Dr. Anil K. Rajvanshi was invited as chief guest at the valedictory function of National Conference on Renewable Energy organized by Tatyasaheb Kore Institute of Technology, Warnanagar on 3 March 2007.

34. Dr. Anil K. Rajvanshi gave a public lecture in the Globalization series at the prestigious Patel Center for Global Solutions in **University of South Florida (USF),** Tampa, U.S.A. on 21 March 2007. His talk entitled "Energy for Rural Poor – Challenge for Global Community" was very well received by the USF and Tampa Bay Community. Last year Ms. Wangari Maathai-the Nobel Laureate and the acclaimed author Jared Diamond were invited to give lectures in this series.

35. Dr. Anil K. Rajvanshi attended the 11th Annual Meeting of National Collegiate Inventors and Innovators Alliance (NCIIA) held in Tampa, Florida, U.S.A. from 22-24 March 2007 and gave two powerpoint presentations.

36. Dr. Anil K. Rajvanshi gave an invited lecture at **University of Florida (UF), Gainesville,** U.S.A. entitled "Energy for Rural Poor", on 30 March 2007. The lecture was organized jointly by Department of Environmental Engineering and UF Chapter of Engineers without Borders.

V. IMPORTANT VISITORS

1. Dr. U. Krishnamoorthy paid a visit to NARI on 6-7 April 2006 to discuss various aspects of the sweet sorghum project with Dr. Nandini Nimbkar, Dr. Chanda Nimbkar, Dr. D. R. Bapat, Dr. P.Ghalsasi and Dr. Vrijendra Singh.

2. Dr. Banibrata Pandey, Business Head, Project Brahma, Nagarjuna Fertilizers and Chemicals Ltd., Hyderabad visited NARI on 17 June 2006 to hold discussions regarding funding a research project on sweet sorghum breeding at NARI.

3. Dr. Gerard Farias, Executive Director, Institute for Sustainable Enterprise, Silberman College of Business, Fairleigh Dickinson University, Madison, N.J., USA visited NARI on 5 July 2006 and held discussions about possible collaborations.

4. Prof. B. A. Chopade, Head, Department of Microbiology, University of Pune and Director, Institute of Bioinformatics and Biotechnology, University of Pune visited NARI on 10 July 2006 to learn about the various research activities being carried out.

5. Nachiket and Jayoo Patwardhan, architects and film makers from Pune visited NARI on 17 September 2006. They held discussions on the design of the building of the proposed Center for Sustainable Development with Dr. Rajvanshi.

6. Two agricultural extension specialists, Dr. Julian Prior from the University of New England, Australia and Dr. D. V. Rangnekar from Ahmedabad, visited NARI from 18 to 23 September 2006. They helped to prepare a draft survey questionnaire for interviewing the shepherd households where *FecB* carrier rams/semen and/or ewes were introduced. The questionnaire was modified further by NARI researchers, translated into Marathi and administered to 15 shepherds participating in AHD's project.

7. Ms. Charusheela Sohoni, Secretary to the Government of India, Dept of Animal Husbandry, Dairying and Fisheries, Dr. S. K. Bandyopadhyay, Animal Husbandry Commissioner, Government of India, Dept of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, New Delhi and Shri Bijay Kumar, Commissioner, Animal Husbandry, Maharashtra State, Pune visited AHD on 8 October 2006. These officers were shown around the farm, exhibition hall and laboratories in the new AHD building.

8. Dr. U. Krishnamoorthy and Dr. Nadim Fairoze, Associate Professors, Dept of Livestock Production and Management, Veterinary College, Karnataka Veterinary, Animal and Fisheries Science University, Bangalore visited AHD on 4 November 2006. This visit was arranged to discuss the collaborative project proposal to be submitted under funds for research on rural development.

9. Dr. Nilkanth Rath, the noted economist, Indian School of Political Economy, Pune visited NARI on 3 December 2006 and held discussions regarding research activities of the institute with Dr. Anil K. Rajvanshi and Dr. N. Nimbkar.

10. Dr. Idupulapati M. Rao, Plant Nutritionist / Physiologist from Dr. Papalotla's group at the Tropical Soil Biology and Fertility (TSBF) Institute, CIAT - International Center for Tropical Agriculture in South America visited the AHD (NARI), Phaltan on 16 December 2006 to see progress of Mulato grass. A trial of Mulato (Brachiaria hybrid) fodder grass provided by the Papalotla group was taken on the institute's farm this year. He inspected the mulato plots and was satisfied with its growth. For future plans there were discussions between Mr. B.V. Nimbkar, Dr. Nandini Nimbkar, Dr. Chanda Nimbkar, Dr. P.M. Ghalsasi, Mr. Zia Qureshi, Chairman and Managing Director, Nimbkar Seeds Pvt. Ltd., Dr. C.D. Basarkar, General Manager, Nimbkar Seeds Pvt. Ltd. and Dr. C. R. Ramesh, Consultant.

11. Mr. Abhay Vaidya, Chief of Bureau, Times of India and his wife Smt. Gita Nair from Pune visited NARI on 17 December 2006 along with Mr. Jagtap-a handicapped person and held discussions about how the completely motorized trike can be used by the handicapped person.

12. Ms. Varsha Pardeshi of the National Chemical Laboratory, Pune visited on 5 Janurary 2007 to help with *FecB* genotyping of lambs belonging to NARI and shepherds.

13. Mr. P. C. Verma, Retired Chief Commissioner of Income Tax, Pune visited NARI on 7 January 2007 to learn about the research activities being carried out at the institute. He

has been very helpful in guiding us in matters related to exemption under I.T. Act 35 (1)(ii) which we had applied for.

14. Dr. Sudhir Kumar Goyal, Divisional Commissioner, Amravati visited NARI on 8 January 2007 to learn about NARI's latest activities. He has been a well-wisher of the institute and was very helpful to the institute during his tenure in Pune as the agricultural commissioner.

15. Dr. S. N. Deshmukh (Breeder), PDKV, Akola, Mr. D. R. Murumkar (Jr. Plant Pathologist), Mahatma Phule Krishi Vidyapeeth (MPKV), Solapur, Mr. L. Hanumantharaya (Jr. Entomologist), UAS, Dharwad and Mrs. P. Padmavathi (Sr. Scientist, Agronomy), DOR, Hyderabad as members of monitoring team visited on 17 January 2007 to evaluate AICRP (Safflower) programme.

16. Dr. O.P. Dhanda, Asst. Director General (AN & P), Division of Animal Sciences, Indian Council of Agricultural Research (ICAR) visited AHD, NARI on 24 January 2007. Dr. B.R. Ulmek from MPKV, Rahuri accompanied him. He was provided information about the research activities of AHD.

17. Dr. D. M. Hegde, Project Director, DOR, Hyderabad along with Dr. S. K. Shinde, Director, Dr. S. B. Deshmukh (Agronomist) and Dr. V. B. Akashe (Entomologist) from MPKV, Solapur visited the trials of the All India Coordinated Research Project on Safflower on 18 February 2007 and gave their useful suggestions for improvement.

18. Dr. S. G. Narayankhedkar, Associate Dean, Krantisinh Nana Patil Veterinary College, Shirval, Tal. Khandala and some professors and undergraduate students of the college visited AHD on 15 March 2007. They were given information on research activities carried out at AHD. They also visited some shepherds' flocks where fecundity gene introgression work is being carried out by the AHD.

19. Dr. P. G. Adsule, Director, Dr. G. S. Karibasappa, Senior Scientist (Hort.), Dr. J. Sharma, Scientist (Soil Science) and Dr. J. Satisha, Scientist (Hort.) from National Research Centre for Grapes, Pune visited NARI on 29 March 2007. Discussions were carried out regarding possible causes for non-bearing of Crimson seedless variety and suggestions were given regarding cultural practices to be followed in the grape garden during the coming year.

In addition, about 100 farmers, 150 school and college students, 20 workers from NGOs and other people wanting information on safflower and sweet sorghum production, sheep and goat rearing and renewable energy resources visited NARI during the year.

VI. VISITS BY STAFF

1. Dr. P. M. Ghalsasi and Ms. Padmaja Ghalsasi visited Asad Farms at Anantpur, Andhra Pradesh belonging to Mr. Mansoor on 26 May 2006. They inspected the Dorper sheep which were imported as embryos and transferred into local Jodipi sheep.

2. Dr. P. M. Ghalsasi visited the College of Veterinary and Animal Science at Parbhani on 21 June 2006 to get information and see their work on the bluetongue vector Culicoides.

Dr. V. V. Deshmukh, Principal Investigator of ICAR All India Network Program on Bluetongue Disease at the college showed their laboratory and offered to collaborate in joint projects on research and extension.

3. Ram fertility test: A sheep breeder from Andhra Pradesh, Mr. G.S. Mansoor requested AHD to conduct a fertility test of 40 Dorper rams born from imported frozen embryos at his Asad Farms in Anantpur, Andhra Pradesh. Dr. P. M. Ghalsasi and Mr. Rupesh Khanvilkar visited his farm on 27-28 September 2006 and conducted the test. It included ram training, semen collection and semen evaluation.

4. Mr. N. M. Kolekar attended the Plasto-2006 exhibition in Pune on 23 December 2006 to gather information about plastic containers to pack Madhura syrup.

5. Dr. V. Singh and Mr. M. B. Deshpande attended the field day organized at Pargaon Khandala by the Phaltan Taluka Agricultural Officer on 8 February 2007. This field day was attended by all the taluka agricultural officers and agricultural assistants of Satara district in addition to four scientists of the Sugarcane Research Station, Padegaon. In the morning there was a visit to the frontline demonstration of safflower hybrid NARI-NH-1 at Khed followed by a lecture in the afternoon by Dr. V. Singh on safflower production at the Krantisinh Nana Patil Veterinary College, Shirval.

6. Dr. V. Singh and Mr. M. B. Deshpande toured the districts of Satara, Sangli and Kolhapur in Maharashtra and Belgaum in Karnataka from 9-11 February 2007 to collect the seed of land races of rabi sorghum. They made a total of 88 collections during this trip.

7. *FecB* DNA test: Ms. Padmaja Ghalsasi visited the National Chemical Laboratory at Pune eight times and the Vidya Pratishthan School of Biotechnology at Baramati four times to use their facilities to conduct the DNA test to detect the *FecB* mutation in sheep blood samples.

8. Shri B. V. Nimbkar, Dr. Chanda Nimbkar and Dr. P. M. Ghalsasi along with two other staff members visited Krantisinh Nana Patil Veterinary College, Shirval, Tal. Khandala on 7 March 2007. Dr. Ghalsasi gave a presentation to the college staff on the activities of the institute.

VII. HONOURS

1. Marathi article “Importance of colostrum in kid and lamb rearing” (Pillanchya sangopanat chikache mahatwa) written by Dr. Sanjeevani Lad and published in the leading Marathi magazine on agriculture “Baliraja” in March 2005, received the second prize for best writing in Baliraja competition in 2006 in the category of articles on occupations complementary to agriculture.

2. Nimbkar Agricultural Research Institute (NARI) received the prestigious “Vasantrao Naik Award” on 1 July 2006 from the Vasantrao Naik Agricultural Research and Rural Development Trust for NARI’s research and development work in agriculture and animal husbandry. Dr. Nandini Nimbkar and Dr. Chanda Nimbkar attended the ceremony in Mumbai and received the award on behalf of the institute.

3. The poster entitled "Existence of apomixis in safflower" by Dr. V. Singh, J. H. Akade and N. Nimbkar was adjudged the third best poster of the national seminar on "Changing Global Vegetable Oils Scenario : Issues and Challenges Before India" held at Hyderabad from January 29-31, 2007.

VIII. OTHER ACTIVITIES

1. An eight minute film on NARI's electric cycle rickshaw programme was shown on **Doordarshan's National T.V. Channel** in a programme on environmental awareness for children. The programme was broadcast on 26 July 2006 at 9 a.m.

2. Two patent applications-one on ethanol stove and the other on ethanol lantern have been filed in the Patents office, Kolkata in October 2006. Nagarjuna Fertilizers and Chemicals Ltd., Hyderabad has shown an interest in purchasing these patents from NARI.

3. A half-an-hour video interview of Dr. Anil K. Rajvanshi was shot by Cornell University, USA on 22 March, 2007. This interview, on far-ranging subjects including social entrepreneurship, sustainable development, role of NGOs in rural development etc., has been put on Cornell University website as 13 short e-clips for widespread dissemination to educators, students and public at large. A CD of this interview has also been made for distribution.

4. **Parasitological testing** : Faecal samples of sheep from 80 smallholder flocks were tested for worm burden and advice given on anthelmintic use twice (in the middle and at the end of the monsoon). These samples were collected and delivered to NARI by workers of Anthra, an NGO and they also conveyed the results and advice to the flock owners.

5. One FecB carrier ram each were supplied to the following two interested sheep rearers.

   1) Mr. Fattesing Jagtap, Dhakale, Tal. Baramati
   2) Mr. Yogesh Kokare, Pandare, Tal. Baramati

6. Two types of rickshaws for the handicapped have been given to needy persons. The first-a motor-assisted hand-pedal rickshaw (MANHARA™) was given to Mr. P. T. Bhattarai from Nagpur. The second completely motorized type (trike) has been given to Mr. Sandip Jagtap, who is partially paralyzed. This trike was specially designed to take care of his needs. It gave him mobility for the first time in his life and he used it to travel around Pune. Due to this his livelihood was improved as it increased the sales of keychains and other knickknacks from his stall.

7. During the year about 800 kg seeds of various safflower varieties, hybrids and their parents were distributed to farmers and seed companies all over India. Also 20 kg dried safflower flowers were sold as herbal health tea. Attempts are being made to sell the tea in teabags for ease of use, so that it becomes more popular.

8. During the year 800 kg seed of Madhura sweet sorghum hybrid was distributed to various farmers and companies including parties in Mexico, Canada and Republic of Benin. About 40 kg syrup was also sold.

9. About 6000 sticks of the grape variety 'Redglobe' were distributed to interested grape growers in Sangli district.

10. Dr. N. Nimbkar and Dr. V. Singh reviewed many articles for national and international journals.

IX. APPOINTMENTS

(1) Dr. Chanda Nimbkar was nominated as a non-official member of the Institute Management Committee of Project Directorate on Foot and Mouth Disease (PDFMD), Mukteshwar by Union Minister of Agriculture and President, ICAR Society for a period of three years from 26 February 2007.

(2) Dr. Anil K. Rajvanshi was appointed as a member of a four-person team to evaluate projects for funding by National Collegiate Inventors and Innovators Alliance (NCIIA), U.S.A. Five projects with each being given $ 50,000 were chosen for the award. The announcement of these awards was made at a special workshop during the NCIIA meeting in Tampa, Florida in March 2007.

(3) Dr. Chanda Nimbkar was nominated as the member of the Executive Body of the Indian Society for Sheep and Goat Production and Utilization (ISSGPU) for the year 2007-08 and 2008-09 by the President of the Society.

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