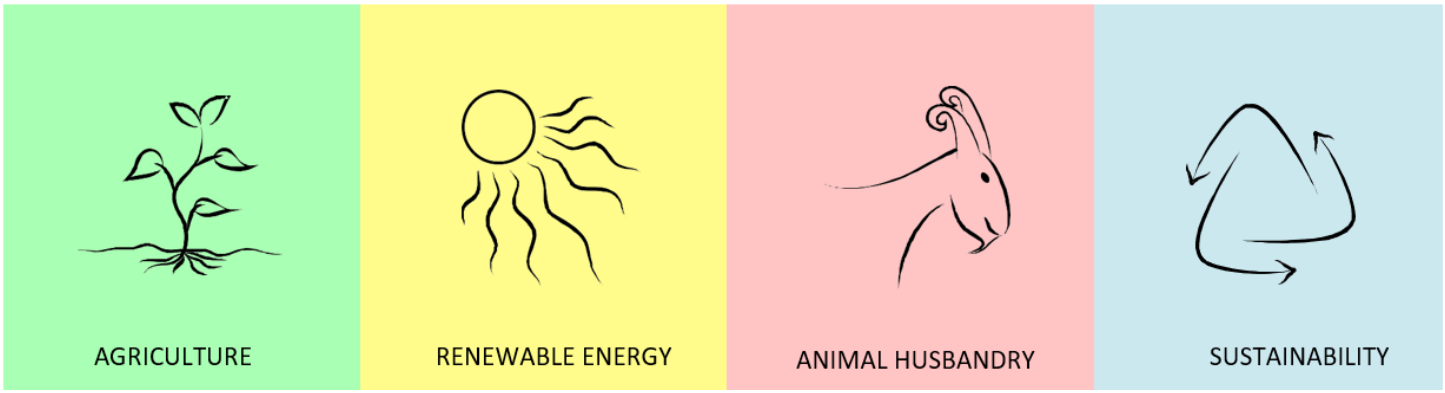
Annual Research Report (2020-21)



Nimbkar Agricultural Research Institute
Lonand Road, Phaltan, Maharashtra

NARI

Report of the President

I have the pleasure of presenting to you the NARI annual research report for 2020-21.

Some significant events of this year were as follows:

Mr. Bon Nimbkar, the founder of NARI and its first president till 1990 i.e., for about 25 years (NARI was functioning for nearly 3 years before it was registered as a trust) passed away on 25 August 2021. Though he was not actively involved in the day-to-day affairs of the institute anymore, his vision guided us and will continue to do so. Personally, for me from coaxing me to go to the US for higher education and then believing in my abilities more than I did, he was the hand behind whatever little I have been able to achieve.

Due to the COVID19 pandemic we had to discourage people from visiting the institute. However, since agricultural work was allowed to continue by the government, the institute did not have to close for a single day even during the lockdown. Therefore, all our activities continued albeit after following the prescribed COVID protocol. We are proud to say that not a single case of transmission of COVID19 has been traced to the institute.

Madhav Ganesh Gogate, IFS passed away at 77 on Sept. 25, 2020, due to COVID19. He was the former principal chief conservator of forests (Wildlife) of Maharashtra and headed the sanctuaries and national parks in the state. In 2016 as wished by Mr. Bon Nimbkar NARI sent him to Israel to study how they augment bee flora using eucalyptus. He helped NARI in this and many other forest and fodder-related projects. We at NARI will greatly miss his sage advice.

The popularity of 'NARI Suwarna' prolific sheep developed by NARI-AHD continues to increase and they disseminated 131 breeding rams and 220 ewes of this breed during 2020-21. Majority of the animals were purchased by the sheep keepers in Karnataka followed by those in Maharashtra.

We have been producing syrup from the juice of sweet sorghum stalks for last nearly 30 years but had concentrated our attention mainly on breeding of better varieties and no systematic work was done on improving the process of syrup production. Dr, Rajvanshi took up the challenge last year and has been able to make considerable progress in the DST-funded project with the help of the scientists and the technical staff. There was a lull in the demand for the syrup during the last year due to the pandemic, but we hope it will pick up soon.

I congratulate Dr. Chanda Nimbkar, Director of NARI A. H. division for having been nominated by the KIRAN Division of the Department of Science and Technology (DST), Government of India, as a member (one of 13 nominated members) of the Subject Expert Committee in the theme area of Agriculture, Food and Environmental Challenges, constituted to evaluate project proposals received under the Women Scientist Scheme-B component and make suitable recommendations to DST.

We are thankful to Bajaj Finserv Ltd. for allowing us to use the remaining funds of their CSR grant and to continue our work by hiring staff to do so.

We are extremely grateful for the generous donations to our corpus from Mr. Sunil Bhonsle (Rs. 36050), Prof. Subhash Chandra Lakhotia (Rs. 25000), Mr. Premendra (Rs. 15000), Mr. Radhakrishna

Singuru and Ravi Kamal Bhargava (Rs. 5000 each). Rs. 3,50,00 each were also donated for research projects by Drs. Nandini Nimbkar and Anil Rajvanshi. These donations make it possible for us to continue our research and development work.

We hope all is well with the readers of this report and the well-wishers of NARI and that the pandemic continues to treat you kindly.

Date

09-10-2021

Dr. Nandini Nimbkar

President

Table of Contents

Agricultural Research

Sweet sorghum

Basic information of sweet sorghum evaluation trials Rabi 2020-21 (Plot-3)

Operation	Date
Sowing	28/10/2020
Irrigation	29/10/2020 10/11/2020 4/12/2020
Spraying (Dimethoate)	7/11/2020 20/11/2020
Thinning	9/11/2020
Weeding	9/11/2020 23/11/2020
Carbofuran application	4/12/2020
Selfing	11/01/2021 22/01/2021
Sampling	22/02/2021 23/02/2021 24/02/2021
Harvesting (Panicles)	1/03/2021
Threshing	13/03/2021 15/03/2021 16/03/2021

Note: Due to the rainfall accompanied with high wind on 18 and 19/2/2021 lodging of the plants occurred. Good seed-filling caused the plants to become top-heavy which probably contributed to the lodging.

The trials were sown in a randomized complete block design with two replications. The plot size was 0.9 X 4.0 m.

a. Evaluation of sweet sorghum germ plasm lines

Thirty germ plasm lines were evaluated along with three checks (Madhura-1, Madhura-2 and Madhura-3). Table 1 shows the 11 germ plasm lines that gave the best overall performance. Out of them NARI-SS-228-2 and NARI-SS-112 were also found to have performed well in Rabi 2019-20. Overall, except for plant height and brix of juice all the germplasm entries performed better in 2020-21 than 2019-20. Among the promising entries Madhura-2 was the only one giving greater plant height, stem diameter, juice weight, panicle weight, seed yield and lower stem borer damage in 2019-

20 compared to 2020-21 despite the much lower plant population (Table 3). The reduced seed yield in 2019-20 was at least partially responsible for the higher brix of juice in that year.

Scientists: Dr. Nandini Nimbkar.

Technical staff: Sharad Choudhari, Sonali Khalate, Anita Gholap and Maruti Shirke.

b. Evaluation of sweet sorghum land races

Eighteen land races were also evaluated in Rabi 2020-21 along with the same three checks. Table 2 shows the 10 land races that gave the best overall performance. Out of them NARI-LC-07-40, NARI-LC-07-46 and NARI-LC-07-38 had also performed well in Rabi 2019-20. Results like those for the germplasm lines were also recorded for the land races with higher panicle weight and seed yield, and lower juice brix, shootfly damage and stem borer damage in 2020-21 compared to 2019-20 (Table 4).

Sweet sorghum plantation for syrup production.

Madhura-3 sweet sorghum seed production.

Scientists: Dr. Nandini Nimbkar.

Technical staff: Sharad Choudhari, Sonali Khalate, Anita Gholap and Maruti Shirke.

c. Evaluation of sweet sorghum cultivars for shootfly (*Atherigona soccata)* and stem borer (*Chilo partellus*) tolerance

A trial was conducted in summer of 2021 to find out which sweet sorghum cultivar among those which are being used for syrup production at NARI are most shootfly and stem borer tolerant.

Among these Madhura-1 (hybrid) and Madhura-2 and Madhura-3 (varieties) have been bred at NARI.

Sugargraze is a single-cut fodder hybrid sold by UPL-Advanta. Despite its seed being supposedly treated with high quality pesticides, it was found to be highly susceptible to shootfly and stem borer.

Honey Pot is a Brown Mid Rib (BMR) multi-cut sweet sorghum fodder variety sold by Foragen seeds. It was also found to be very susceptible to shootfly and stem borer.

Tinopal is a dual-purpose single-cut fodder sorghum variety. However, it is not very sweet, and its juiciness does not last very long after flowering. Therefore, it was not found to be suitable for syrup production.

This trial was planted in a randomized complete block design with three replications. Madhura-1 which is a hybrid had the greatest plant height, number of nodes/plant and number of leaves per plant. Madhura-2 had the greatest stem diameter. Madhura-3 was most tolerant to both shootfly and stem borer (Table 5).

Basic information of trial on evaluation of sweet sorghum cultivars for shootfly and stem borer tolerance Summer 2021 (Plot 16A) is given below.

Plot size	2.7 X 5 = 13.5 sqm
Cultivars	6
Replications	3
Date of sowing	18/1/2021
Dates of irrigation	19/1/2021, 11/3/2021, 14/4/2021
Dates of weeding	6/2/2021
Dates of spraying	19/2/2021, 6/3/2021 (Dimethoate for sucking pest control)
Thinning	2/2/2021
Dates of shootfly count	18/2/2021, 13/2/2021, 23/2/2021, 1/3/2021
Dates of stem borer count	8/3/2021, 15/3/2021, 22/3/2021, 29/3/2021
Date of harvesting	13/5/2021

Table 5: Comparison of sweet sorghum entries for shootfly and stem borer tolerance.

Scientists: Dr. Nandini Nimbkar.

Technical staff: Sharad Choudhari, Sonali Khalate, Anita Gholap and Maruti Shirke.

d. Sweet sorghum syrup project

Department of Science and Technology (DST), Government of India, has sanctioned the sweet sorghum project proposal titled 'Development of a fully mechanized plant to produce syrup from sweet sorghum'. This two-year project commenced on September 1, 2020.

Objectives

1. Designing, modelling and fabrication of a fully mechanized pilot plant to produce syrup from sweet sorghum (SS) juice at NARI.
2. Integration and optimization of all the sub-processes and the respective machinery to produce 150 kg of syrup per day.
3. Standardizing the quality of the syrup produced.
4. Popularizing the syrup produced (and thereby, the SS cultivation) among the farmers through demonstrations/workshops.

Highlights of the work done

For ease of bookkeeping, the complete process of syrup making can be divided into four sections: (a) harvesting and stripping of stalks, (b) crushing of cane and settling of juice, (c) heating of juice, and (d) cooling and storage of syrup. A schematic illustrating the whole process, clearly depicting these four sections, is shown below.

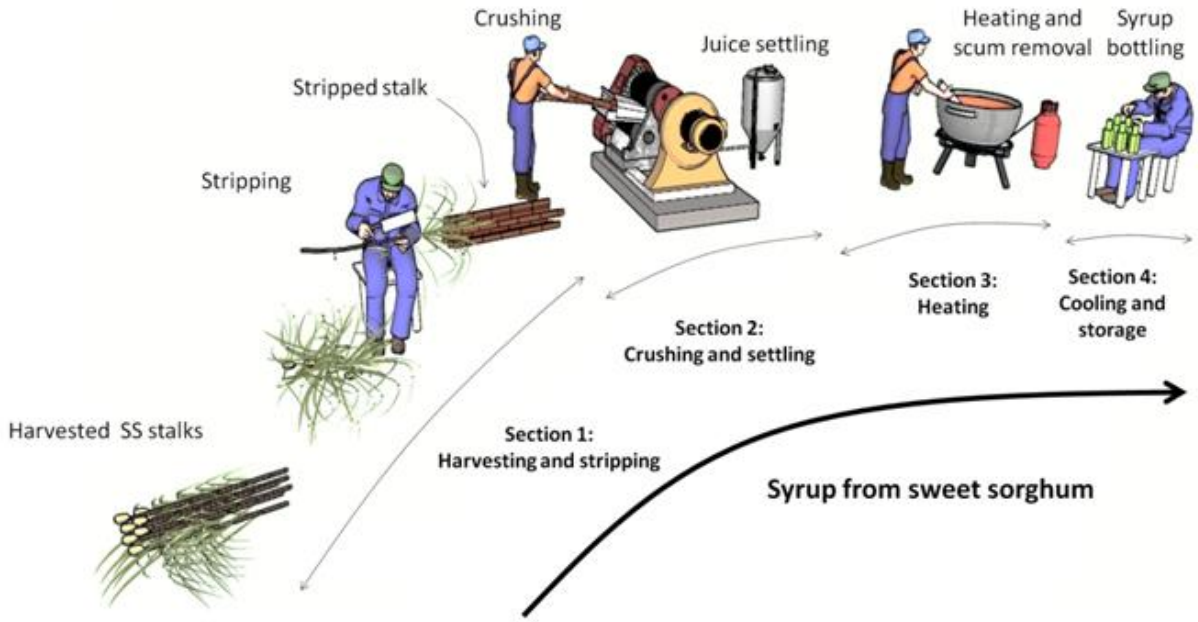


Figure: A schematic of the sweet sorghum syrup production process.

A summary of all the work that has been done in these four sections, and its key impact, is provided in the table below.

Table: Summary of the work done in one year.

Work	Key impact
Section: harvesting and stripping of stalks	
Collected yearlong Brix data	Determination of optimum sowing dates
Adopted contractual stripping	Reduction of time to half of that earlier
Started developing a stripping machine	Work in progress; could reduce time and effort
Section: crushing of cane and settling of juice	
Installed new three-roller crusher	Improvement in crushing efficiency from 30% to 50% and rate by six-fold
Fabricated new juice filtration assembly	Reduction in scum by 40%
Did experiments on effect of settling on syrup quality	Less scum during heating
Installed new settling and storage tanks	Easy juice handling
Installed juice transport system	No juice loss due to manual handling
Section: heating of juice	
Determined okra mucilage preparation strategy	Enhancement in scum formation
Renovated furnace	Lesser loss of flue gases, enhanced efficiency
Determined optimum furnace parameters	Enhancement in furnace efficiency

Performed energy consumption analysis	Help in strategy making
Fabricated capacious stainless steel heating pan	Effective heating and easy handling
Designed pan lifting mechanism	Quick and safe mechanical lifting
Designed a bagasse shredder cum feeder	Convenient and uniform feeding of fuel
Installed digital temperature recorders	Uniformity in syrup quality; prevention of burning/caramelization
Section: cooling and storage of syrup	
Developed a cooling mechanism	Better syrup appearance and flowability
Determined optimum storage conditions	Longer shelf life
Carried out floor and shed work	Sanitary work conditions

Funding Agency: DST and Bajaj Finserv.

Scientists: Dr. Anil Rajvanshi and Dr. Nandini Nimbkar.

Technical staff: Mr. Sharad Choudhari, Mr. Nitin Bhujbal (7.5 months), Mr. Shivam Patange, Mr. Shubham Dhiman (4 months) and Mr. Mihir Narkar (3 months).

Opuntia

Opuntia germplasm was transferred to Plot no. 13 at Tambmal on 22 September 2015 as the land on which the earlier plantation was carried out was given back to the farmer from whom it was leased.

Five plants each of 26 accessions were planted in September 2015. Accession no. 1308 procured from Central Agroforestry Research Institute (CAFRI), Jhansi was planted in May 2016. By harvesting five cladodes from each plant evaluation was carried out in December 2020. Observations of the 12 most promising entries are given in Table 6.

The whole plots containing five plants each were harvested in May 2021 and observations of the eight most promising entries are given in Table 7.

Accession nos. 1292, 1300, 1301 and 1308 were found to have performed well in 2020 and 2021. 1292 is a spiny, fruit type from Mexico. 1300 and 1301 are spineless fruit/fodder types from Mexico and 1308 is a spineless, vegetable type from Mexico. 1292 gave good cladode weight as well as high fruit number. 1300 and 1308 gave the highest number of cladodes. 1301 gave high cladode weight.

Accession 1292

Accession 1300

Accession 1301

Accession 1308

Table 6: Most promising accessions of Opuntia in 2020.

Table 7: Most promising accessions of Opuntia in 2021.

Leucaena

We are promoting two cultivars of *Leucaena* for fodder production. They are

1. **Wondergraze**: This cultivar is derived from the selfed progeny of an interspecific cross between accession K584 and cv. Tarramba bred by University of Hawaii and released in Australia in 2010. Its key attributes are moderate tolerance to the insect pest psyllid (Heteropsylla cubana), good forage yield, branched tree form and excellent seedling vigour. In addition to this it produces copious amounts of seeds very early on in its growth period. Also being bushy in growth habit the seed pod collection is quite easy.

2. **Tarramba**: This cultivar was bred from accession K636 collected from highlands of Mexico and released in Australia in 1997. Its key attributes are erect arboreal habit, excellent biomass and forage production, some cool temperature tolerance, moderate tolerance to the insect pest psyllid and reduced seed production. The latter is a deterrent to popularizing it among farmers as its seed production occurs in small amount and starts only after two years of growth.

From 1 April 2019 to 30 September 2021 about 325 persons bought seeds of leucaena variety Wondergraze from NARI. The quantity varied from 100 g to 10 kg per person. A KVK in Karnataka took 50 kg for distribution to farmers. This good response was mainly due to the extension work carried out by the NARI A. H. Division. They have been recommending leucaena as an excellent nutritious fodder for the ruminant animals.

In the follow-up which we carried out, most farmers were satisfied with the germination and growth of Wondergraze. A few of the farmers faced problems with germination, but the majority said that they got 80-100% germination. The fodder is mostly being fed to sheep with a few farmers also feeding it to their goats and cows.

A few of the farmers complained about poor growth or mortality of seedlings which appeared to be due to either cold temperatures in winter, lack of water for irrigation or psyllid attack, being often a combination of these factors.

The area planted varied from 0.5 are to 1 acre with many of the farmers planting on the field bunds or the borders of their fields or farm ponds.

Leucaena Wondergraze + *Cenchrus.*

Leucaena Wondergraze plantation.

Scientists: Dr. Nandini Nimbkar.

Technical staff: Sharad Choudhari, Sonali Khalate, Anita Gholap and Maruti Shirke.

Indoor agriculture

(Funded by Bajaj Finserv CSR)

Introduction

Hydroponics is the technique of growing plants without soil and without the limitations of space and climate. In the traditional farming system, plants obtain all the nutrients needed for their growth from soil. In contrast, a hydroponic garden provides all these nutrients without involving sunlight and soil. Setting up a hydroponic plant may be expensive and unfeasible for farmers. Our aim at NARI is to develop strategies for setting up a hydroponic system with cheaper environment control. Once this aim is achieved, we plan on training farmers and leasing the developed technology to them so that they can benefit from it.

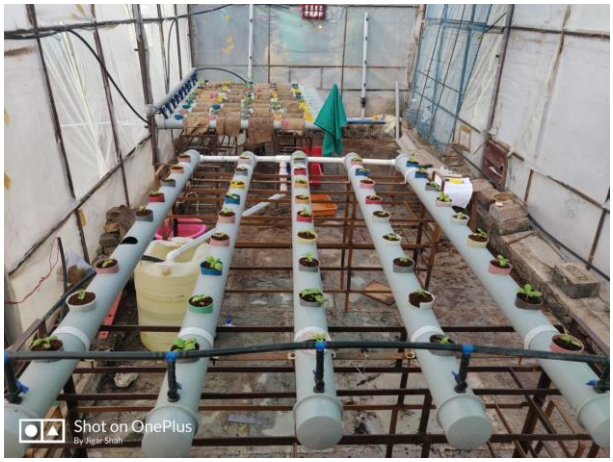
Objectives

1. To develop an efficient and low-cost indoor agriculture technology to produce green fodder and vegetables year-round.
2. Disseminate the developed technology to the local farmers by leasing them some of the developed indoor agriculture units.

Highlights of the work done

Setting up of three hydroponic units

Three hydroponic setups were designed and fabricated at NARI. Plants are being grown using the Nutrient Film Technique (NFT).



Hydroponic plant for basil.

Spinach (*Spinacea oleracea*) cultivation

Spinach is a highly nutritious leafy green. Initially, the growth of spinach was slow, and its leaves were yellow and discoloured, since the nutrient solution used lacked some micronutrients. To ameliorate this, we added chelated micronutrients to the nutrient solution. The effect of the micronutrients was seen within a week. The leaves started to grow and regained their green colour. The leaves were picked as and when they attained maturity. A total of five pickings were carried out before the spinach plants started to bolt due to increasing temperatures. A fresh leaf yield of 20 g/plant was obtained from the spinach plants before they bolted. The expected yield was around 100 g/plant. Unfavourable

environmental factors such as light, temperature and relative humidity apart from the nutrient deficiency led to this decrease in the overall yield.

Spinach yield (g/plant) at NARI.

Expected	Obtained
100	20.3

Lettuce (*Lactuca sativa*) cultivation

Lettuce is another leafy green that is widely used in salads. The iceberg lettuce seeds were germinated using coco peat as the inert medium. The cups were transferred to the hydroponic setup and the lettuce was harvested after 37 days as it started to bolt. The ideal temperature required for growing lettuce is in the range of 18 – 23°C, while the average maximum and minimum temperatures in the greenhouse were around 32.5 and 24°C which were much higher than desired. A yield of 42.25 g/plant was obtained, while the expected yield was around 280 g/plant.

Lettuce yield (g/plant) at NARI.

Expected	Obtained
280	42.25

Basil (*Ocimum basilicum*) cultivation

Basil plants were also grown in the greenhouse. A yield of 22.8 g/plant was obtained from the first crop cycle when the expected yield was around 98 g/plant. Another batch of basil was transplanted in the hydroponic setup and the first harvest was done for the same after around 30 days from transplanting. A yield of around 8 g/plant was obtained after the first harvest. The expected yield from the first harvest was 24.4 g/ plant.

Basil yield (g/plant) at NARI.

Expected	Yield
98	22.8

Basil growth one month after transplanting.

Improvement of hydroponic units

The less than expected yields were mostly due to environmental factors such as unfavourable temperature, relative humidity, and light penetration. To prevent these environmental factors from adversely affecting the plants, different materials such as mosquito net, 50 % shade net and polythene sheet for covering the greenhouse were tried. Their effect was measured by studying the difference in the various parameters inside and outside the greenhouse. Polythene sheet was selected as it resulted in values of environmental parameters close to the desired ones for growing plants like lettuce, basil and spinach. Foggers and evaporative coolers were also installed to further control the environment inside the polyhouse. They brought about a temperature reduction of about 8.5 ^{0}C inside the polyhouse them.

Polyhouse

Shade-net house

Polyhouse

Effect of different materials used for the hydroponic shed on environmental factors.

Hydroponic shed	Temperature difference (°C)	Humidity difference (%)	Light penetration (%)
Shade net	2	2	64
Polythene + shade net	4	12	27
Polythene	8.5	40	77

Economic and efficient environmental control has now been achieved in the polyhouse. We now plan on testing the environmental control methods by growing plants and comparing the yield achieved in the polyhouse to the ideal yield.

More details of this project could be found here.

Funding Agency: Bajaj Finserv.

Scientists: Dr. Anil Rajvanshi and Dr. Nandini Nimbkar.

Technical staff: Mr. Joel Paul (3.5 months), Mr. Jigar Shah (3 months) and Mr. Sharad Choudhari.

Renewable Energy Research

Drinking water technology

(Partially funded by Bajaj Finserv CSR)

Objectives

To develop low-cost drinking water technology (DWT) for rural areas.

Highlights of the work done

In the year 2019-20, a complete low-cost drinking water technology was developed, and a prototype was installed at the NARI campus. Our aim in the year 2020-21 was to install our DWT set-up in the near-by schools. Unfortunately, schools remained shut throughout the year due to Covid-19 pandemic and we could not go through with our intended programme.

Summary sheet of weather data. 2020-21 (April 2020 to March 2021)

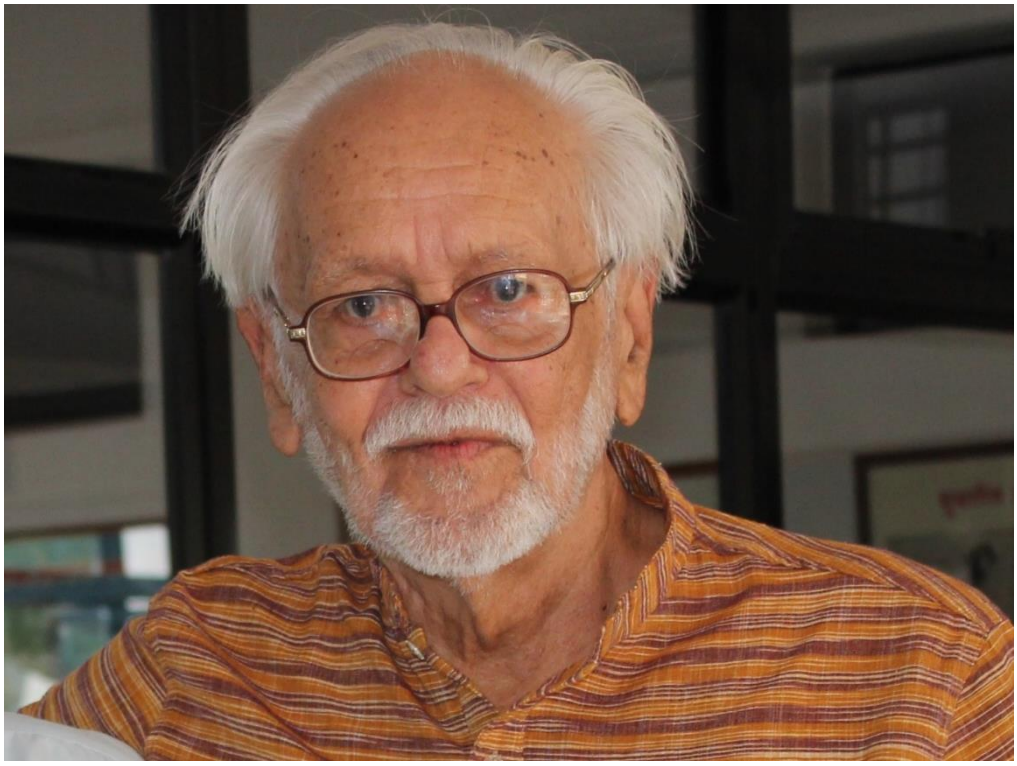
Nimbkar Agricultural Research Institute (NARI) PHALTAN-415523

Month	Air Temperature^{0}C		Rainfall (mm)	Rainy days	Pan evaporation mm/day	Wind direction	Relative humidity (%)		Relative humidity (%)		Nature of sky Octa grade (0-8)	
	Max	Min					Max	Min	8 a.m.	2 p.m.	Morning	Evening
April 2020	40.53	22.27	2.75	1	7.56	NW	84.11	24.80	80.29	27.17	0.13	0.93
May	41.82	23.74	29.1	5	8.18	NW	89.19	28.71	82.10	32.13	0.90	1.58
June	34.32	22.85	165.9	18	3.70	NW	99.50	58.27	98.57	64.50	4.03	5.23
July	31.82	22.81	111.42	17	2.83	NW	99.94	70.76	99.94	76.53	4.00	4.84
August	30.44	22.44	92.55	18	2.18	NW	99.68	77.68	99.68	81.74	5.71	6.58
September	32.53	22.50	190.85	9	2.65	NW	99.33	61.77	99.23	65.53	4.30	4.90
October	32.24	21.55	249.25	9	2.63	NW	100.00	60.26	100.00	61.74	3.19	4.65
November	31.73	17.67	0	0	2.02	NW	98.93	44.80	98.90	45.50	1.30	1.73
December	30.34	15.24	0	0	1.82	SE	97.94	42.58	97.71	43.84	1.48	1.26
January 2021	31.34	17.19	8.45	3	1.97	SE	97.68	45.81	96.71	47.58	1.61	1.94
February	33.02	14.66	4.85	2	3.27	SE	90.68	32.64	89.46	34.61	0.25	0.64
March	38.06	18.84	0	0	5.50	SE	75.13	29.19	73.58	31.23	0.23	0.71
Mean	**34.02**	**20.15**	**855.12**	**82.00**	**3.69**	**NW**	**94.34**	**48.11**	**93.01**	**51.01**	**2.26**	**2.92**

Note: During this year, the highest maximum temperature of 44^{0}C was recorded on 23 and 25 May 2020. The lowest minimum temperature of 9^{0}C was recorded on 22 and 23 December. The highest one-day rainfall of 84.6 mm was recorded on 15 October 2020.

Animal Husbandry Research

Passing away of Mr. B. V. Nimbkar



B.V. Nimbkar (awarded Padmashri in 2006)
1931-2021

The passing away of Shri B.V. Nimbkar, the founder of NARI and of the A. H. Division on 25 August 2021 is a major blow for us. We wish to thank all our friends, colleagues, associates, and well-wishers who offered their condolences and sympathies and gave us the strength to carry on the great legacy he leaves. We will continue to draw inspiration from the ideals for which he established NARI and to work tirelessly for the good of farmers and livestock owners, just like he did.

Some of the thoughts expressed by people who themselves did seminal work in their fields:

- He made a huge impact on Indian agriculture and his contribution to agricultural research in India will be remembered for years to come. The global community of agricultural researchers hold great respect and admiration for him. His life is

an inspiration to us all. (Dr. Bob Clements, Former Director, Australian Centre for International Agricultural Research)

- He was an outstanding person and scientist with drive not equalled by many and with great compassion for doing good for others. He was a man of profound knowledge on many subjects and incredible insight on the world at large combined with his intense interest in what seemed like everything. (Dr. Gerald Wiener, world-renowned livestock geneticist and former Deputy Head, Animal Breeding Research Organization, Edinburgh, Scotland, U.K.)

- He had an uncanny ability to place whatever he saw in a larger context and construct an imaginative vision of possibilities. His amazing imaginative energy and delight in networking with people at all levels of society enabled him to accomplish what he did. (Dr. Maxine Berntsen, Educationist and linguist, Hyderabad, India)

Highlights of the work done

The whole of 2020-21 was under the dark shadow of Covid19. We kept all the livestock farms operating. The farm supervisors and labourers all kept coming to work throughout the lockdowns and containment zone declarations and gave us excellent cooperation. We were thus able to care for the livestock as usual. They also followed the Covid protocol strictly and no farm staff members got infected with Covid19 although close relatives of some of them were infected. We kept the office closed for 11 days during the first lockdown period between 24 March and 11 April 2020. Thereafter, we were able to obtain Phaltan municipality passes for all office staff members and kept the office operating. The office staff gave us full cooperation. This was a difficult time but all staff members showed great strength of mind and resilience. Our extension personnel under the ICAR-AICRP Goat Improvement, Osmanabadi Goat Field Unit were very brave in visiting the villages whenever Covid19 cases reduced and carrying out all the work such as vaccination, deworming, treating sick goats, weighing, and maintaining records. They had to face hardships due to non-availability of food and accommodation, but they found ingenious solutions to these problems, such as sleeping in empty poultry sheds a couple of times.

No training courses, meetings or workshops could be held. Instead, online training was given by Drs. Chanda Nimbkar and Pradip Ghalsasi through training courses organized by different agencies. No visitors were allowed during the lockdown periods. There were a few visitors in-between the lockdown periods. Drs. Nimbkar and Ghalsasi could not travel throughout the year and attended national and international meetings and conferences online.

Highlights of the work done in the year 2020-21 are as follows.

- Dr. Chanda Nimbkar was nominated on 16 October 2020 by the KIRAN Division of the Department of Science and Technology (DST), Government of India, as a member (one of 13 nominated members) of the Subject Expert Committee in the theme area of Agriculture, Food and Environmental Challenges, constituted to evaluate project proposals received under the Women Scientist Scheme-B component and make suitable recommendations to DST. This scheme is meant to encourage women scientists and technologists to carry out applied research in science and engineering leading to S&T based solutions of societal issues and challenges for social benefits. The appointment is for three years.
- **Dr. Chanda Nimbkar was interviewed on 21 May 2020** (i.e., during the first lockdown period) by Shri Pramod Chunchuwar of The Free Press Journal, Mumbai on the Rs.15,000 cr. package announced by the Prime Minister for infrastructure in the animal husbandry sector. The interview was published in the newspaper with the headline "Liquor is served at the doorstep, but sale of mutton is not allowed." Dr. Nimbkar explained that the PM package had ignored the pastoralist community and sheep-goat farmers and was going to be spent on dairy development and value addition of dairy products alone. Eating and selling of mutton was being portrayed as a bad thing when, mutton is a nutritious, high protein food item that boosts immunity. Moreover, farmers needed direct cash transfers, but the package was offering them loans. She gave the example of the Meat and Livestock Commission in Australia which supports livestock owners and said that the expectation from the State and Central governments was that they would also support livestock keepers here.

  Website link: https://www.freepressjournal.in/mumbai/liquor-is-served-at-the-doorstep-but-mutton-is-not-allowed-for-sale

  E-paper link- https://epaper.freepressjournal.in/m5/2681232/Free-Press-Mumbai-Edition/21-May-2020#page/3/1
- This year there was again excellent response from Karnataka to purchase NARI Suwarna sheep. Some of the buyers informed us that due to the Covid19 pandemic, they lost their jobs in the IT field and as they owned land, they wanted to invest in sheep farming. They also said that they wanted the best breed for their farm, which was 'NARI Suwarna'. The NARI Suwarna sheep developed by the NARI-AHD are being selected and improved continually and are very popular. This year, two Krishi Vigyan Kendras (KVK) from Karnataka – ICAR-Taralabalu KVK, Davangere and ICAR-K.H.Patil KVK, Hulkoti, Dist. Gadag purchased NARI Suwarna breeding males and pregnant ewes. The Taralabalu KVK had visited NARI-AHD in 2012 to purchase two NARI Suwarna Rams for their NICRA Project village. A farmer from the Davangere area had purchased four NARI Suwarna female lambs and one male lamb at that time. They informed us that these NARI Suwarna ewes and the progeny of

the ewes and rams performed very well in those villages. The farmers were therefore asking for the NARI Suwarna breed again.

- During 2020-21, we decided to downsize the NARI Suwarna *FecB* carrier sheep nucleus flock due to continuing severe labour shortage. Hence, we sold about 40% of the adult ewes (56 pregnant ewes). The response was tremendous, and they were sold within a day or two of our decision and were transported safely to their respective destinations in Karnataka. The ewes were *FecB* carrier, and they were pregnant with the semen of *FecB* carrier rams so the progeny will be *FecB* carrier, thus giving added benefits to the buyers. Most of the pregnant ewes that were sold, gave twin lambs and some had triplets. During the year, AHD disseminated total **131 rams and 220 ewes.**

NARI *Suwarna* pregnant ewes start on their journey to Karnataka

- On 9 Jan 2021 Shri Sharanu B Tallikeri, Chairman, and Dr. P. Srinivasan, Managing Director, Karnataka Sheep and Wool Development Corporation Limited (KSWDCL) Hebbal, Bangalore visited NARI-AHD to see NARI Suwarna sheep, to find out about improved sheep and goat management techniques and to see how artificial insemination is carried out in sheep and goats. Dr. Chanda Nimbkar and Dr. Pradip Ghalsasi accompanied them to all the farms and laboratories and had discussions with them about the NARI-AHD activities for the welfare of sheep and goat keepers. They were highly impressed with the set up and research and development work going on at AHD. Mr. Tallikeri said in his remarks in the Visitors' Register that NARI AHD 'looks like University of Sheep and Goat'. Dr. Srinivasan wrote in the register that the AHD is a great help to farmers and officers to learn more about sheep and goats. In August 2020, the KSWDCL Kalaburagi branch in Karnataka purchased 24 NARI Suwarna BB rams from AHD for dissemination to sheep owners. Since 2014, KSWDCL have purchased more than 100 NARI Suwarna rams from NARI-AHD and have thus been instrumental in spreading the NARI Suwarna breed in Karnataka as all these rams were given to shepherds at a subsidy.

KSWDCL team visited field AI lab and appreciated weights of twin-born lambs.

The AHD supervisors at Lundy farm, Shri Vikram Shedge and Shri Dilip Dhaigude were given cash prizes at the hands of Shri Tallikeri to honour the hard work done by them in good management of NARI Suwarna ewes and lambs during the year.

- On 16 March 2021, Shri. S.P. Singh, IAS, Commissioner, Animal Husbandry, Maharashtra, Dr. Parkale, Additional Commissioner, Animal Husbandry, Maharashtra, Dr. Parihar, District Deputy Commissioner, Animal Husbandry, Maharashtra visited AHD together with other officers. Dr. P.M Ghalsasi showed them the frozen semen lab and the steps in the standardized buck semen freezing protocol. Shri Singh was impressed to see the excellent progressive motility of the sperms in the buck frozen semen sample he saw under the microscope. The visitors discussed with Drs. Chanda Nimbkar and Ghalsasi how the technologies developed

by the NARI AHD and the knowledgebase at NARI-AHD could be useful to Maharashtra government-initiated projects.

Dr. Chanda Nimbkar and Dr. Ghalsasi giving information to Officers of Animal Husbandry, Maharashtra and Visit to Frozen Semen Lab.

- The ICAR-National Institute of Animal Nutrition and Physiology (NIANP), Bengaluru, Karnataka has introduced **'Milk Replacer', a special nutrition supplement for lambs before weaning**. This will be very helpful for farmers rearing NARI Suwarna sheep. The breed, developed by NARI-AHD, is gaining popularity in Southern states and is in high demand by the farmers. This development of a milk replacer by an ICAR institute in response to NARI Suwarna sheep rearers' demand is a testimony to the profitability and popularity of the breed.
  ICAR-NIANP carried out a field trial of the milk replacer with the progressive farmers rearing NARI Suwarna identified in the Sira Taluk of Tumkur District with the help of the State Animal Husbandry Department, Government of Karnataka. Young lambs of two-to-three weeks were selected for the trial. The supplement when fed during first 60 days of life leads to better health of lambs, reduced mortality, and faster weight gain. As per their report, the economics of supplementation revealed that for every kg of Milk Replacer supplemented (costing Rs.150), lambs gained 1.5 to 2.0 kg live weight (priced at Rs.300 per kg). The farmers expressed their willingness to adopt the product.
  For more details, (https://icar.gov.in/content/icar-nianp-introduces-milk-replacer-supplementation-economic-meat-production-lambs).

Osmanabadi goat field unit of the ICAR - all India coordinated research project on goat improvement

Salient achievements

i. **Development of a FAMACHA chart for Osmanabadi goats**: About 300 inner eyelid colour pictures of Osmanabadi goats under field conditions were taken and using selected photos for different FAMACHA scores, a standard FAMACHA chart for Osmanabadi goats has been developed. Goat keepers can use this chart for detection of anaemia and therefore blood-sucking worm (*Haemonchus contortus*) load in their goats. If the score is found to be above 3, rapid action can be taken to prevent further adverse consequences.

ii. **Performance recording of more than 7,000 Osmanabadi goat does and their progeny over the last ten years** has led to selection of fast-growing twin- or triplet-born males produced by high milk-yielding does with superior reproductive performance. **Breeding values of bucks for 6 to 9-month weights are now estimated**, based on weights of 15 to 40 progeny per buck. High breeding value males are used for breeding in project villages and frozen semen of high breeding value progeny-tested bucks is disseminated in areas outside the project through a network of AI technicians. The **Osmanabadi Field Unit has thus established an effective model of genetic improvement** and its dissemination which can be considered the first in the country.

iii. After seeing the results of the project such as excellent, fast growing kids and drastic reduction in mortality and morbidity, some **goat keepers** earlier opposed to ear tags, have enthusiastically embraced ear tags, and are **taking interest in the recording and weights of their kids**. A few goat keepers have started keeping records in notebooks or on a calendar in their house. This helps them to check predicted kidding dates and weight gain in kids.

iv. Local butchers mention that **meat quality of kids born to NARI's superior bucks is better and consumers prefer this meat**. This could be due to higher live weight and higher proportion of meat compared to bones.

v. NARI's **continuous public awareness creation for feeding nutritious fodder to goats** has resulted in plantation by goat keepers, of improved fodder crops like Subabhul (*Leucaena leucocephala*), Dashrath (*Desmanthus virgatus*), Marvel (*Dichanthium annulatum*), Stylo (*Stylosanthes seabrana*) and fodder maize (*Zea mays*). 53% of participatory goat keepers have reserved an area of 5-to-20-acre plots for cultivation of fodder crops. A few goat keepers have planted fodder trees like Moringa, Subabhul and Mulberry for feeding high-protein tree leaves to their goats.

vi. **The proportion of Osmanabadi true-to-type goats in the Project villages has increased to 95% now**. Goat keepers have retained for breeding the good does sired by the improved bucks in the project. Goat keepers have stopped using Sirohi

or other local bucks for breeding their goats. They have thus started contributing to the genetic improvement of Osmanabadi goats, which is the main objective of the AICRP on Goat Improvement.

vii. There is **substantial improvement in the incomes of goat keepers** due to reduced mortality, better health of goats and kids and consequently less expenditure on health care and knowledge of kid weights which enables calculation of the expected sale price.

Using the FAMACHA chart prepared by NARI-AHD to assess worm burden.

Superior Osmanabadi breeding buck supplied by NARI-AHD.

For more details, see this report.

Funding Agency: Indian Council of Agricultural Research (ICAR), Government of India, New Delhi, administered by the Central Institute for Research on Goats, Makhdoom, Via Mathura, U.P.

Scientists: Dr. Chanda Nimbkar and Dr. Pradip Ghalsasi.

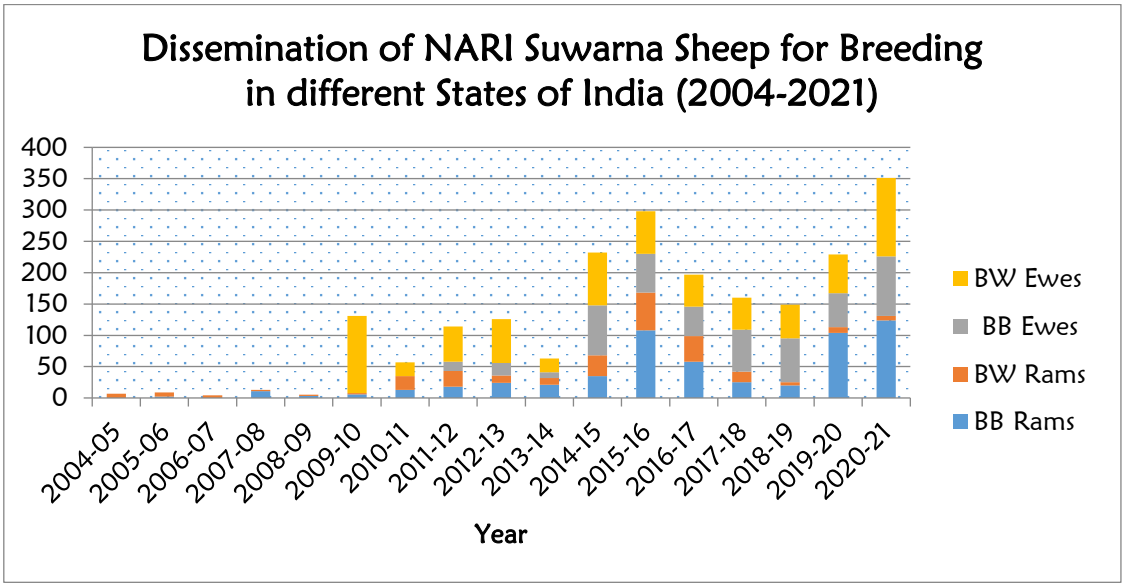
Technical staff: Mr. Kanhaiya Chavan, Ms. Karishma Shaikh (from 2 November 2020), Mr. Navnath Patange, Mr. Rupsing Khanvilkar (until 7 December 2020), Mr. Dilip Dhaigude, Ms. Minakshi Ghorpade (in Dhakale, Tal. Baramati, Dist. Pune), Mr. Mithu Garje (Sakat and Gandhanwadi, Tal. Jamkhed and Patoda, Dist. A'Nagar and Beed respectively).

Increasing profitability of sheep production by genetic improvement using the *FecB* (Booroola) mutation and improved management in conjunction with the project for dissemination of *FecB* carrier sheep to Karnataka.

This successful breeding programme has continued to be self-sustaining since 2012, by generating income mainly from the sale of breeding rams and ewes and secondarily from the sale of surplus lambs and cull sheep.

Breeding programme

A new strain of Deccani sheep has been developed, called 'NARI Suwarna', that gives about 40-50% higher lamb production due to a 50% higher litter size compared to local Deccani sheep. The growth rate, mothering ability and conformation of the new breed were improved by the introduction of the Madgyal and Awassi breeds, and continuous selection is being carried out to improve these traits further. The breed has been disseminated to shepherds in Maharashtra, Karnataka and Andhra Pradesh and they are profiting from its use. Total **838** breeding rams and **1307** breeding ewes have been supplied. Out of these, **131** rams and **220** ewes including **60 pregnant ewes** were supplied during 2020-21. Majority of the rams and ewes were purchased by sheep keepers from Karnataka, followed by those from Maharashtra.



All ewes are bred by artificial insemination (AI) in order to use a large number of breeding rams to maintain diversity and control inbreeding and maintain accurate pedigree records. Each of the three AI programmes in **2020-21** went on for one month, roughly covering two oestrus cycles. Ewes were inseminated in natural oestrus detected by vasectomised teaser rams. All ewes were inseminated cervically once, about 5-6 hours after oestrus detection. Ewes were inseminated with fresh, diluted semen of the

allotted rams. The overall conception rate of 82% indicates the high standard of practices used for the AI programme and the good condition of ewes and rams. Genetic analysis was used to estimate breeding values.

Table 8: Results of four AI programs carried out at NARI's Lundy farm, Rajale in December 2019, March, June, and September 2020.

The conception rate to artificial insemination of 82% was slightly lower than last year. **The table shows that the average litter size of *FecB* carrier ewes was about 41% higher than that of non-carrier ewes but this advantage declined to 26% because of the higher proportion of abortions and stillbirths among *FecB* carrier ewes. There was, however, an increase in the number of live lambs born per ewe conceived from 1.23 to 1.31 this year. We are making improvements in the management of pregnant ewes to reduce abortions and embryonic mortality. The advantage of twin-bearing ewes over single-bearing ewes can, however, be clearly seen as the range of weight of lambs weaned by twin-bearing ewes (when both lambs survived to weaning age) was 32.2 to 43.5 kg at 4 months age compared to 18.5 to 26 kg for single-bearing ewes.**

There is evidence that our selection strategy is also working. We now have ewes that give birth to triplets and rear all three lambs with some support of cross-fostering and supplementary feeding of lambs.

NARI Suwarna flock and a NARI Suwarna ewe with twins at AHD's sheep farm at Rajale.

Genotyping of sheep DNA at the *FecB* locus

The *FecB* genotyping protocol is now **fine-tuned and cost-effective** and **100%** results were obtained at the first go in all the genotyping tests conducted this year also. This year the Hot Start Taq enzyme was replaced by a new Taq called 'Dream Taq Hot Start' because the production of the earlier Taq was stopped by the company. The

composition of the new Taq Buffer is different hence the genotyping test had to be standardized. This was successfully done by Ms. Padmaja Ghalsasi, our Technical Officer under the guidance of Ms. Sheetal Ranade, our consultant.

Table 9: *FecB* genotypes of NARI Suwarna sheep tested at AHD during 2020-21.

Table 10: *FecB* genotypes of blood samples received from outside NARI.

Scientists: Dr. Chanda Nimbkar and Dr. Pradip Ghalsasi.

Technical staff: Mr. Rupsing Khanvilkar (until 7 December 2020), Mr. Vikram Shedge, Mr. Dilip Dhaigude, Mr. Kanhaiya Chavan, Mr. Anil Chavan, Mr. Dattatray Mulik, Ms. Padmaja Ghalsasi and Ms. Karishma Shaikh (from 2 November 2020).

Setting up a state-of-the-art A.I. centre for sheep and goats under the national livestock mission scheme under the component 'interventions towards productivity enhancement'

(This project was originally sanctioned under the Central Sector Scheme – Integrated Development of Small Ruminants and Rabbits).

The project was submitted to the Government of India, Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries under Central Sector Scheme – Integrated Development of Small Ruminants and Rabbits on 21 August 2010 through Commissioner, Animal Husbandry Maharashtra State. The proposal was approved for 100% Central Government assistance by the Government of India, Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries vide their administrative approval letter No. 48-51/2010-TS/Sheep dated 24 November 2010.

The total project amount was received in five installments from October 2011 to August 2016. An audited utilization certificate of the last installment was submitted to the Deputy Commissioner, Animal Husbandry, Satara District, Maharashtra on 28 April 2017.

1. **Date of commissioning of the semen freezing lab**: 2 January 2012

2. **Production and utilization of buck frozen semen doses during the period January 2012 to March 2021**

   We established a standard protocol for freezing of buck semen and started producing frozen semen straws in June 2012. These straws are regularly supplied to State Governments and private customers and excellent conception rates of average 50% are being achieved.

   Table 11: Number of buck frozen semen straws produced and used from June 2012 to 31 March 2021.

- 500 frozen semen straws of Osmanabadi bucks were given for breed conservation to the National Bureau of Animal Genetic Resources (NBAGR), Karnal, Haryana under the technical programme of the Osmanabadi field unit at NARI-AHD under the ICAR-All India Coordinated Research Project on Goat Improvement.
- 2608 goats belonging to farmers from surrounding villages and 3,602 goats of the Institute have so far been artificially inseminated using these frozen semen straws.

Goat keepers from nearby villages bring their goats in oestrus to NARI farm for cervical AI. AI technicians who used to carry out AI of only cows and buffaloes belonging to farmers, have started to take buck frozen semen from NARI and carry out AI of does at the farmers' door. During the year 2020-21, (April to September 2020) 50 goat does belonging to local goat keepers were inseminated, out of which 43 could be followed

up and 29 kidded. Thus, the conception rate to A.I. was 67.4%. This is an all-time high and reflects the high semen quality as well as the skill of our farm supervisors/inseminators.

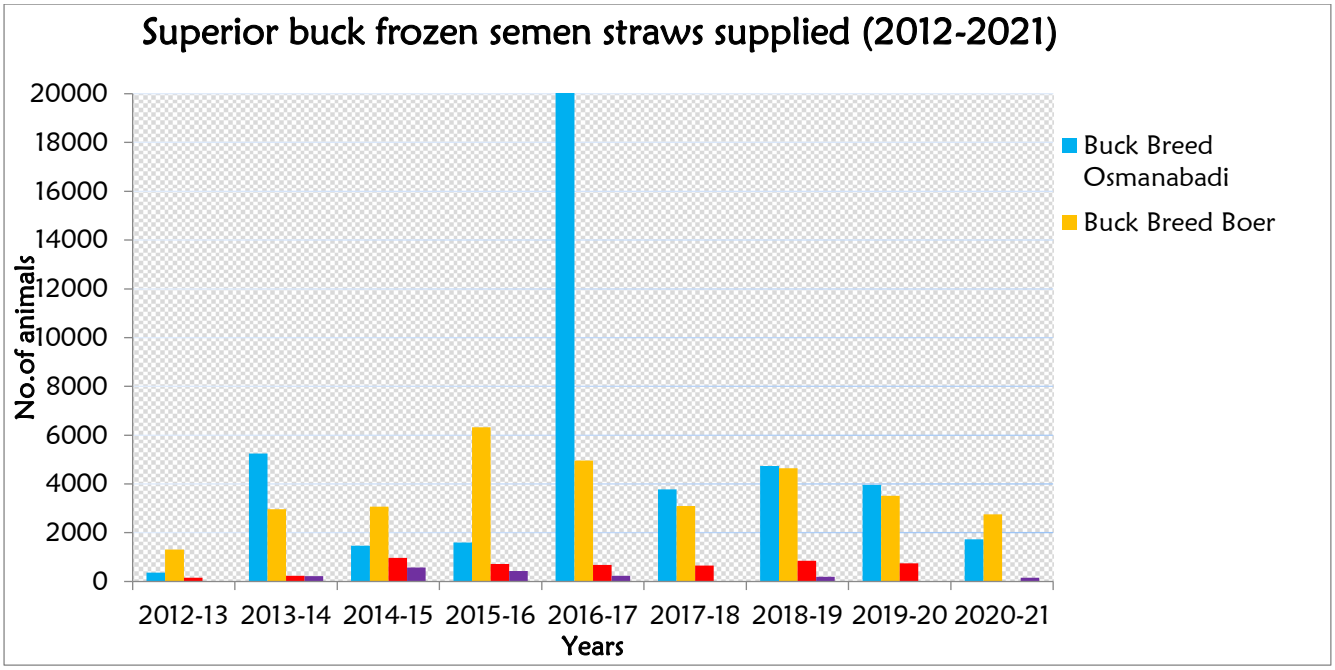
Table 12: Results of AI of farmers' goats from June 2012 to 30 September 2020 using frozen buck semen on NARI farms and by private AI technicians in Maharashtra.

Artificial insemination of local goat keeper's goat at AHD farm, Wadjal.

Training courses

During 2020-21 **no training courses** could be organized due to the **Covid19 pandemic**. The details of training courses conducted between 2007 and 2020 are given in Table 13.

Table 13: Training courses conducted and number and classification of participants (2007-2020).



1. 2016-17: 20,000 Osmanabadi semen straws supplied to Government of Karnataka.
2. 2020-21: straw sale reduced due to the Covid19 pandemic.

Scientists: Dr. Chanda Nimbkar and Dr. Pradip Ghalsasi.

Technical staff: Mr. Rupsing Khanvilkar (until 7 December 2020), Mr. Vikram Shedge, Mr. Dilip Dhaigude, Mr. Kanhaiya Chavan, Mr. Anil Chavan, Mr. Dattatray Mulik, Ms. Padmaja Ghalsasi and Ms. Karishma Shaikh (from 2 November 2020).

Research in veterinary parasitology with special reference to sheep and goats

We monitored faecal worm egg counts (FEC) and FAMACHA scores of our sheep and goat flocks to assess the gastro-intestinal nematode (GIN) worm burden under natural infection. However, we could not monitor samples of goat flocks of goat keepers participating in the Osmanabadi Goat Field Unit under the ICAR-AICRP Goat Improvement project as the field visits were limited due to the Covid19 pandemic. We have been studying internal parasite burdens and parasite epidemiology in sheep and goats for more than 20 years. During the last 10 years, we have also included FAMACHA score monitoring as a part of our sustainable GIN control strategy. FAMACHA chart is an anaemia guide which indicates whether an animal is infected with blood sucking parasites and whether it should be drenched. It can be effectively used especially when laboratory facilities are not available. Anaemia in sheep and goats is mainly caused by the parasite *Haemonchus contortus* which is the predominant species in our area.

Rainfall

During 2020-21, Phaltan region received heavy rain. There was heavy rainfall in fewer days mostly between June and October 2020. This led to water stagnation in all plots and other areas of the farms for at least a week at a time.

Farm name	Total rainfall (mm)	Number of rainy days	Days with maximum rainfall
Lundy farm, Rajale	926	51	September: 301 mm in 9 days.
Dhuldeo farm	707	31	October: 260 mm in 6 days.
Wadjal farm	802	42	October: 292 mm in 10 days.

The rainfall had major impact on prevalence of internal and external parasites. Worm infection was found to be heavy during the monsoon.
AHD maintains sheep and goats on three farms - Wadjal, Dhuldeo and Lundy farm (Rajale). The details of these farms can be found out here.

Major findings

- **Good nutrition** is very important to help sheep and goat handle internal parasites better.
- This year too we managed and monitored the nutrition and feeding of all the animals at all the farms. The concentrate was increased by 100-200 g/day/animal depending on the physiological status (lambed/kidded), growth stage and stress on the animals such as shearing. Chaffed green fodder fed to animals was also

increased by about 1 kg/animal and loppings of Leucaena (NARI *Nirbeeja* or Wondergraze) were always made available in every pen. When the sheep were sent out for grazing at Lundy farm and Dhuldeo farm it was ensured that there were quality crop residues and enough pasture for the number of animals grazing. Silage was prepared on all farms using CO Fodder Sorghum and fodder maize. This was used during scarcity of fresh forage. To ensure that the feeding is going on correctly, all the animals were **weighed every fortnight** instead of monthly. When there was weight loss, the feeding was altered. The management announced incentives for the workers of those farms where animals in all the groups gained weight during a particular month.

- We check the FAMACHA scores of ewes every month and those lambed and pregnant ewes whose FAMACHA score is more than 2.5 to 3 as well as those who have high FEC are then drenched individually and given an iron injection.
- Post drench test FEC are always performed 10-14 days after drenching with anthelmintics such as Ivermectin (Hitek) oral, Closantel (oral) and Inj. Levamisole. These were found to be effective.
- The immediate and sustained activity of Closantel which is long-acting, and narrow spectrum was tested at day 14, 28 and 50 post-drench. The larval species differentiation confirmed the absence of *Haemonchus* larvae, and the drug was found effective for 50 days. We concluded that it is the best drug for use during the monsoon for grazing and lambed animals.
- A heavy infection of Coccidia was found in 2-3 months old kids and 1 month old lambs which was associated with Diarrhoea. Sporulation of the oocysts was conducted and mixed infection of *Eimeria* species was seen, and they were identified as *E. hirci*, *E. alijevi*, *E. granulosa* and *E. parva.* The kids and lambs were effectively treated with Nitrofurazone and Sulphonamide. Other preventive measures were also undertaken such as cleaning of pens, spraying Sodium Hypochlorite solution in the pens, feeders, and water troughs.
- Ecto-parasite infection was observed in sheep and goats during and after rainy season. Amitraz was used to treat this.
- Larval culture: The overall predominant larval species (almost 80%) in all the sheep and goat flocks identified from pooled faecal samples was *Haemonchus contortus* followed by *Trichostrongylus* species (17%) and *Oesophagostomum* species (3%).

Funding agency: Internally funded

Scientists: Dr. Chanda Nimbkar and Dr. Pradip Ghalsasi.

Technical staff: Mrs. Padmaja Ghalsasi, Ms. Karishma Shaikh, Ms. Sanyogita Kumbhar, Mr. Kanhaiya Chavan, Mr. Dattatray Mulik, Mr. Vikram Shedge, Mr. Dilip Dhaigude and Mr. Anil Chavan.

To assess the forage yield of the Australian *Leucaena* variety Wondergraze

Cutting trial of Wondergraze in Nov 2020 at Dhuldeo farm.

Introduction

In 2016, Shri B.V. Nimbkar, the founder President of NARI, imported seed of two improved varieties of *Leucaena*, Tarramba and Wondergraze from Australia. Both these are reported to have good seedling vigour, forage yield and psyllid tolerance. In 2017 over 28,000 seedlings were planted at all farms of NARI and about 2000 seedlings were sold to farmers. A trial is being conducted at NARI to see the performance of this variety.

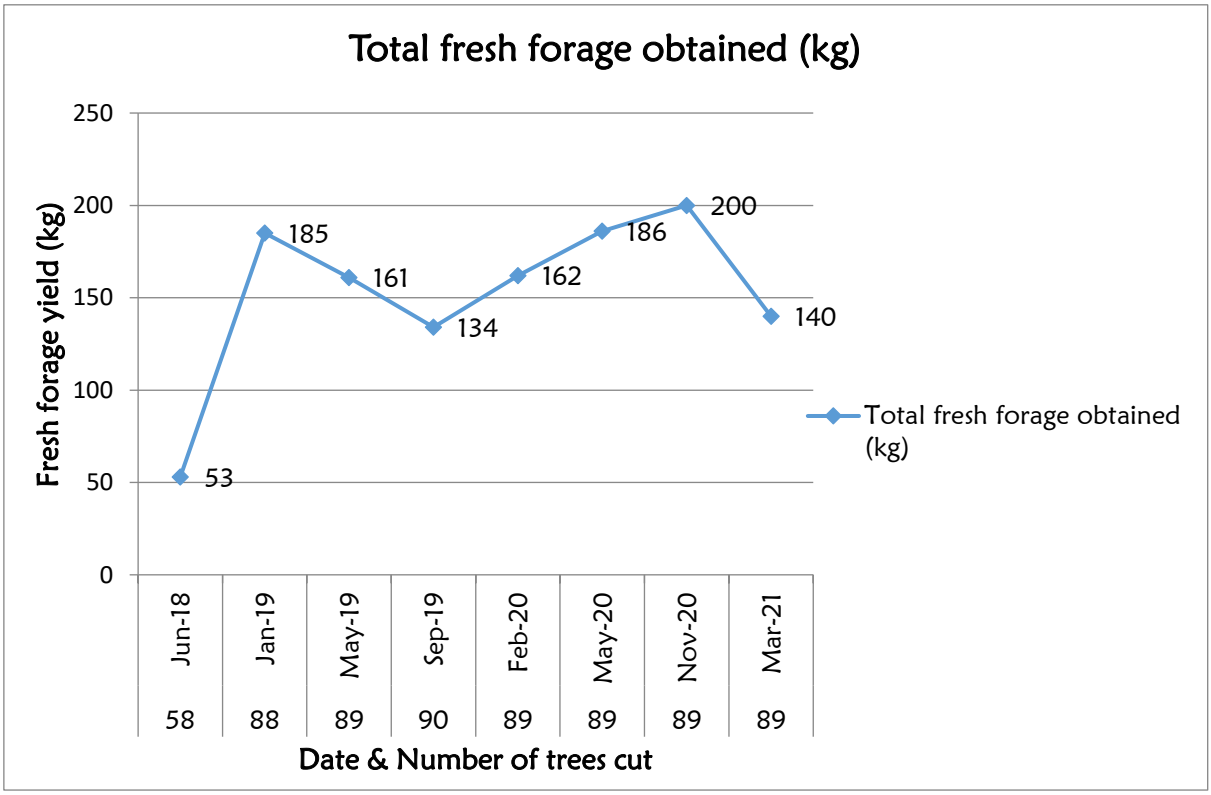
Characteristics of Wondergraze

'Wondergraze' has basal branching with an approximate height of 5 to 6 metres. It has lower seed production (lower weed risk) compared to the prevalent variety K8. It can recover quickly from a psyllid attack and continue to grow. It can sustain droughts. This variety is highly nutritious and palatable, has 35-38% dry matter content and is suitable for cows, buffaloes, goats, and sheep. Its nutrient content is reported to be protein 25%, fibre 24%, carbohydrates 40%, minerals 9%. If sheep and goats weighing 25 to 30 kg are fed 1 to 1.5 kg wilted *Leucaena* leaves daily, they need not be given any other concentrate mixture. *Leucaena* trees can yield fodder for many years. Besides good forage, Wondergraze trees also yield good quantity of fuelwood for cooking or heating bath water.

Materials and methods

- At Dhuldeo farm, Wondergraze trees were planted in rows (on both sides of the furrow) 6 m apart, at 1 m between trees in February 2017 and gaps were filled in July 2017. Sheep manure was applied at the time of planting. There were 154 trees in each row in total five rows.
- For the trial, 90 adjacent trees in row numbers 2, 3 and 4 were selected. Border trees were excluded. The trees were cut at a height of 1 m from the ground.

Results



During three years of yield trial of Wondergraze trees total eight cuttings were carried out at the interval of 110 to 136 days. The average yield per tree per cutting was 2.1 kg. As seen in the graph above, the yield dropped due to water stress in September 2019 and due to severe cold and a psyllid attack in March 2021.

Conclusion

A fully grown Wondergraze tree will yield consistently 1.6 to 2.1 kg fresh forage every 130 days where seasonal irrigation is available for about 9 months from June/July to February/March.

Funding agency: Self-funded

Scientists: Shri B.V. Nimbkar, Dr. Chanda Nimbkar and Dr. Nandini Nimbkar.

Technical staff: Mrs. Padmaja Ghalsasi, Ms. Karishma Shaikh, Mr. Kanhaiya Chavan, Mr. Anil Chavan, and Ms. Sanyogita Kumbhar.

Annual Fact Sheet

Publications

- 6 publications in refereed/non-refereed journals
- 19 magazine/newspaper articles
- 10 essays on Covid-19
- 3 videos
- 1 report

Total sales

- 3980 buck semen straws supplied in bulk
- 351 NARI Suwarna sheep disseminated for breeding
- 1013 kg food products (Sweet sorghum syrup/Jaggery/Safflower oil/Safflower petal herbal tea) sold
- 593 kg seeds of different varieties of sweet sorghum, safflower, leucaena and stylo sold

Visitors to NARI

- 7 dignitaries from national organizations

Visits by NARI staff

- 9 invited lectures/talks/seminars attended (in virtual mode)
- 5 meetings attended

Governing Council (2020-2023)

Nandini Nimbkar, Ph.D., Permanent President, NARI

Chanda Nimbkar, Ph.D., Director, Animal Husbandry Division, NARI

Anil K. Rajvanshi, Ph.D., Director and Hon. Secretary, NARI

Noorie Rajvanshi, Ph.D., Staff Scientist, Siemens, USA

Madhura Rajvanshi, MA, Trustee, Pragat Shikshan Sanstha, Phaltan

S. K. Jha, I.R.S., Retired Chief Commissioner of Income Tax (CCIT), Pune

Niraj Chandra, BA, Industrialist, Satara