
Nimbkar Agricultural Research Institute
Lonand Road, Phaltan, Maharashtra

AGRICULTURE  RENEWABLE ENERGY  ANIMAL HUSBANDRY  SUSTAINABILITY
Report of the President

I have the pleasure of presenting to you the NARI annual research report for 2018-19.

Some significant events of this year were as follows:

An innovative proposal given by Dr. Chanda Nimbkar, the Director of NARI-AHD to the Aga Khan Foundation, New Delhi for establishing a community-based goat breeding program in Project Mesha being implemented by them in Muzaffarpur district of Bihar for the benefit of 50,000 women goat keepers was accepted. This is an important achievement for NARI-AHD, towards consolidation of the work it started 30 years ago for goat genetic improvement. A 5-day training course was held at NARI-AHD on ‘Goat genetic improvement concepts and methods’ for 18 staff members of Project Mesha. This was the first time such an ambitious training course was held by NARI-AHD.

Dr. Chanda Nimbkar was honoured as a Fellow of the Indian Society for Sheep and Goat Production and Utilization (ISSGPU) for the noteworthy research contribution in sheep and goat production. She was also appointed for her second three-year term till November 2021 as a member of the board of trustees of the International Livestock Research Institute (ILRI).

The proposal for ‘mechanized sweet sorghum syrup plant’ submitted by Dr. Anil K. Rajvanshi, Director, NARI to Department of Science and Technology (DST) has been approved and we expect to get the sanction letter soon. We hope this will lead to the culmination of three decades of NARI research into popularizing this crop among farmers for syrup production.
Dr. Anil Rajvanshi was the chief guest of the Foundation day function at Savitribai Phule Pune University on 10 February 2019 and also gave the Jeevansadhana Gaurav Puraskar to five luminaries on the occasion.

We gratefully acknowledge the generous donation to the corpus from Dr. Subhash Chandra Lakhotia, Distinguished Professor (life-long) of Banaras Hindu University (BHU) and for research from Mr. Amarjit Sahay, New Delhi and Mr. Stephen Arthur Lazars, Pune.

We are very grateful to the Bajaj Group and thank them for continuing to fund Bajaj Fellows at our Institute. This has greatly helped in running the Institute and have helped us to write proposals for DST and get them funded.

September 18, 2019

Dr. Nandini Nimbkar
President
Agricultural Research
  Safflower  5
  Sweet Sorghum  7
  Pasture and Trees  9

Renewable Energy Research
  Proposed DST Projects  14
  Studies  15

Animal Husbandry Research
  Highlights  19
  Osmanabadi Goat Field Unit  21
  ‘FecB’ gene in sheep  22
  A. I. centre  23
  Veterinary Parasitology  24
  Leucaena  25

Annual Fact Sheet  26

Trustees and Governing Council  27
SAFFLOWER

All India Coordinated Research Project (AICRP) on Oilseeds (Safflower)

Funding Agency: Indian Council of Agricultural Research, New Delhi (till October 2017)
Scientist: V. Singh (Ph.D)
Technical staff: V. Singh, Ph.D; M. B. Deshpande, M.Sc.; P. R. Salgude, M.Sc.; S. V. Choudhari, B.Sc;

This center which was operational for last 38 years was closed on 1 October 2017 due to the following:

1. Due to many different circumstances have caused the area under safflower to steadily decline over last 8-10 years.

2. After the sixth pay commission recommendations were implemented by the Government of India the salaries of project personnel went through the roof. This resulted in 90-92% of the project funds being allotted to pay and allowances and only 8-10% being given for actual research expenditure. It became more and more difficult to carry out such a large field-based research project in such meagre funds and therefore we requested ICAR to terminate the NARI center.

During Rabi 2018-19 seed production program of safflower varieties and hybrids developed at NARI was undertaken. Since 380 Kg seed of NARI-57 from previous seasons was available, no seed production program was taken up for this variety. Seed production of all other varieties and parents of hybrids was carried out under nylon net enclosures to maintain purity of seed. The quantity of seed produced is given in Table 1.

Crop rotation trial

Objective: To evaluate the performance of safflower planted after different kharif season crops

Material and methods: Safflower variety NARI-6 was sown in rabi 2018-19 after harvesting of crops Maize (Zea mays), Sorghum (Sorghum bicolor), Green gram (Vigna radiata), Black gram (Vigna mungo), Sunnhemp (Crotalaria juncea), Niger (Guizotia abyssinica), Cowpea (Vigna unguiculata), Pearl millet (Pennisetum glaucum), Dhaincha (Sesbania aculeata) and Soybean (Glycine max).
Results and Discussion: Significantly highest seed yield of safflower was obtained when it followed niger, pearl millet, sunnhemp or sorghum. There was no statistically significant difference in initial and final plant stand, number of primary branches per plant, capitulum diameter and days to maturity. Height of safflower plants was significantly reduced when it followed either black gram or soybean. Highest number of capitula were recorded on safflower plants when it followed either cowpea or green gram.

Effect of soil solarization and previous crop on safflower performance

Objective: To evaluate the performance of safflower with or without soil solarization and following a fallow or sorghum in kharif season.

Material and methods: Soil solarization was carried out by covering each plot by a transparent polythene sheet (thickness: 200 microns) from end of April to end of May (one month).

Results and discussion: Highest safflower seed yield was obtained when soil was solarized during summer and the plot was kept fallow in kharif season. However, higher initial and final plant stand, total plant height, capitulum diameter and number of branches per plant were found in plots without solarization. This may have been due to the fact that solarization kills not only the pathogens and weed seeds, but also the beneficial microorganisms in the soil.

The previous kharif sweet sorghum crop (variety Madhura-3) was also harvested and syrup made from it. The data collected showed that as compared to that in plots without solarization the crop planted in solarized plots flowered five days earlier and produced higher weight of biomass, stripped stalks and leaves. It also showed less damage by stem borer (Chilo partellus) and had higher stripping and juice extraction percentages. Syrup recovery was also higher in the solarized plots. Height of plants in the solarized plots was more but the stem diameter was less as compared to the plants from the plots without solarization. Overall, the practice of solarization appears to benefit both sweet sorghum and safflower crops.

The temperatures of the soil at the surface and 5 cm below the surface were recorded every day at 11:30 A.M. and 2:30 P.M. The average temperatures are given in Table 2.
SWEET SORGHUM

Evaluation of station germ plasm

In Rabi 2018-19 207 entries of station germ plasm were evaluated in an unreplicated trial. The date of sowing was November 13, 2018. Each entry was planted in two 5 m long rows (plot size : 0.9 X 5 m = 4.5 m²). Table 3 shows 50 best entries giving high values of different characteristics such as stalk and seed yields, juice brix, stem height and diameter and days to 50% flowering and maturity. The five highest values for each characteristic are shown in bold.

These 50 entries will again be evaluated in Kharif 2019. After identifying the entries with best performance in either Kharif, Rabi or both the seasons, multiplication will be carried out in Rabi 2019-20 for producing larger amounts of seed for assessing the suitability of these entries for syrup production. The entries will also be screened for tolerance to stem borer (*Chilo partellus*).

In Rabi 2018-19 the following five entries were found to be the most promising.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Entry</th>
<th>Promising characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>NARI-SS-57-4</td>
<td>High stem diameter, stripped stalk weight and juice extraction</td>
</tr>
<tr>
<td>2.</td>
<td>NARI-SS-150</td>
<td>High seed yield</td>
</tr>
<tr>
<td>3.</td>
<td>NARI-SS-180</td>
<td>High biomass yield</td>
</tr>
<tr>
<td>4.</td>
<td>NARI-SS-235</td>
<td>High stripped stalk weight, stripping % and juice weight</td>
</tr>
<tr>
<td>5.</td>
<td>NARI-SS-112</td>
<td>High biomass yield, seed yield and juice weight</td>
</tr>
</tbody>
</table>

Evaluation of land races

In Rabi 2018-19 87 land races were evaluated in an unreplicated trial with Madhura-3 as a control. The date of sowing was November 13, 2018. Each entry was planted in two 5 m long rows (plot size : 0.9 X 5 m = 4.5 m²). Table 4 shows the 21 best entries giving high values of different characteristics such as stalk and seed yields, juice brix, stem height and diameter and days to 50% flowering and maturity (earliness). The two highest values for each characteristic are shown in bold.

These 21 entries will again be evaluated in Kharif 2019. After identifying the entries with the best performance in either Kharif, Rabi or both the seasons, multiplication will be carried out in Rabi 2019-20 for producing larger amounts of seed for assessing the suitability of these entries for syrup production.
In Rabi 2018-19 the following five entries were found to be the most promising:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Entry</th>
<th>Promising characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>NARI-LC-07-9-1</td>
<td>High plant stand</td>
</tr>
<tr>
<td>2.</td>
<td>NARI-LC-07-23</td>
<td>High biomass and seed yield</td>
</tr>
<tr>
<td>3.</td>
<td>NARI-LC-07-33</td>
<td>Tall plants and high juice weight</td>
</tr>
<tr>
<td>4.</td>
<td>NARI-LC-07-10</td>
<td>High stem diameter, stripped stalk weight, panicle weight and juice weight</td>
</tr>
<tr>
<td>5.</td>
<td>NARI-LC-07-40</td>
<td>High stripping % and juice brix</td>
</tr>
</tbody>
</table>

Syrup production from sweet sorghum

We have been preparing syrup from sweet sorghum hybrid Madhura-1 and varieties Madhura-2 and Madhura-3 regularly for last 4-5 years. For this we have been carrying out sowing in every month of the year.

Table 5 shows the months of sowing when the best performance of the three cultivars for different parameters was observed. We were not able to designate any specific sowing months as most suitable for getting highest yield of good quality syrup. This was due to the year-to-year variability observed which was probably mainly due to the variation in weather conditions. Also due to shortage of seeds especially of hybrid Madhura-1, its sowing could not be carried out on many of the dates resulting in relatively fewer data being collected for it. Madhura-3 appears to be the most consistent in its performance when planted on different dates throughout the year.
LEUCAENA
Comparative evaluation of three Eucalyptus and four Leucaena accessions for biomass production

This trial was planted on December 20, 2017 and all the details are given in Annual Report 2017-18. Saplings of Leucaena leucocephala cv. NARI Nirbeeja (KX2) were not available at the time of planting the trial and so were planted later on February 6, 2018. Except for L. leucocephala K-8, seedlings of all other species were planted. K-8 seed was directly sown in the field.

Three months after planting significantly higher mortality was noted in all the leucaenas and in Eucalyptus pellita. In the fourth month significantly higher mortality (15%) was noted only in L. leucocephala cv. K-8.

Three months after planting, significantly highest stem diameter was recorded for E. urophylla, E. camaldulensis and L. leucocephala cv. Tarramba on each of the 12 monthly observation dates. However, from the fourth month onwards leucaena hybrid NARI Nirbeeja (KX2) gave the significantly highest stem diameter followed by L. leucocephala cv. Tarramba on each of the 12 monthly observation dates (Table 6). Similar were the results for plant height measurements with Leucaena hybrid NARI Nirbeeja being significantly superior. We stopped recording the height of Leucaena cultivars from February 2019 onwards as they became too tall to measure.

Observations of Tarramba Leucaena plants

Twelve seedlings of L. leucocephala cv. Tarramba were planted in the garden of Mr. B. V. Nimbkar’s house. They were planted in a row, with spacing between them varying from 45-105 cm. Observations were recorded on plant height, stem diameter (1 m from ground) and number of tillers. The trees were cut to record the fresh weight of leaves and wood. The first cutting was carried out on 14 May 2018 and the second after 7.5 months on 31 December 2018. The mean observations of 12 plants are given in Table 7.

Leucaena leaf meal production

All the sowings of L. leucocephala cvs. ‘Wondergraze’ and ‘Tarramba’ on our farm at Tambmal have been carried out to form hedges and so we continuously cut them back every 3-4 months at 1 m from the ground level. The cut trees are allowed to fall in place and fertilize the soil. We attempted to dry the leaves so that they could be stored for a longer time and then used as animal feed at a later date. Harvesting was carried out on 12 December 2018. In 5 days we could dry the leaves to 7% moisture in sun and 10% moisture in the shade. The maximum air temperature during this period ranged from 28-31°C and minimum from 11-17.5°C. From 1 hectare area it will be possible to
get about 57 T fresh foliage (7 T dried leaves) and 18 T wood every 3-4 months. Taking into consideration only the cost of labour and petrol for cutting with a chain saw as well as supervision, the minimum price for which the dried leaves can be sold will be Rs. 20 per kg. This can be lower if wood can also be marketed. Cost of establishment of plantation was not taken into account.

**Eucalyptus**

On plot 12 at Tambmal few seedlings of nectariferous (melliferous) eucalyptus species supplied by J. K. Paper Mills Ltd. (Songadh, Gujarat) were planted on 6 September 2018. They were as follows:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Species</th>
<th>No. of seedlings planted</th>
<th>No. of seedlings surviving</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>Eucalyptus leucoxylon</em></td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td><em>E. melliodora</em></td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td><em>E. microcarpa</em></td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td><em>E. lansdowneana</em></td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>5.</td>
<td><em>E. erythrocorys</em> No. 2</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>6.</td>
<td><em>E. erythrocorys</em> No. 1</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td><em>E. pellita</em></td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>8.</td>
<td><em>Corymbia spp.</em></td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>

The reasons for high mortality were the very small size of the seedlings and the two-month closure of canal during summer. The latter prevented us from providing adequate irrigation during the unusually hot summer.
Preliminary assessment of rearing male buffalo calves on *Leucaena leucocephala*-buffel grass pasture in Maharashtra State, India

NANDINI NIMBkar, SHARAD CHoudhari and BON NIMBkar

*Nimbkar Agricultural Research Institute, Phaltan, Maharashtra, India. narihaltan.org*

**Keywords:** Animal growth rates, *Bubalus bubalis*, pasture, tree legumes.

**Introduction**

India’s US$4 billion buffalo meat export industry relies mainly on the slaughter and processing of females that have stopped lactating. The potential for fattening of male buffalo calves (MBCs) for quality meat production was identified in 1995 in a report of the National Dairy Research Institute: “Underfed MBCs after weaning are either starved to death or pushed to the slaughterhouse. Such malnourished calves, weighing 60 to 80 kg, yield only 30 to 35 kg carcasses of inferior quality. These calves, if reared on high energy diets up to a live body weight of 350 kg, may yield 180 kg carcasses of good quality”. The rearing of MBCs could augment meat exports and provide raw material for the domestic leather industry, thereby developing a new avenue for rural employment.

*Leucaena leucocephala* is high quality forage, which is highly regarded in seasonally dry environments in Eastern Indonesia, due to its excellent ability to produce year-round fodder if properly managed and regularly pruned. In previous research in India, no ill-effects on the general health of MBCs fed 70% of their dry matter requirements as *L. leucocephala* were observed, although daily bodyweight gains were less than 50% of those of the control group given 3.5 kg concentrates and 3.5 kg wheat straw daily. This may have been due to reduced dry matter intake, lower levels of serum triiodothyronine (T3) and thyroxin (T4) and increased aspartate transaminase (AST) and alanine transaminase (ALT) activities in plasma as reported by Gupta in 1995. ALT and AST are serum biochemical variables whose activities are considered as biomarkers for liver function, and synthesis of protein, albumin and globulin largely depends on the liver function status. T4 and T3 levels are considered valuable indicators of thyroid function in animals.

Given the contrasting results from previous experiments in India, the objective of this study was to conduct a preliminary assessment of rearing MBCs on leucaena-buffel grass pasture in a semi-arid part of the state of Maharashtra in India.

**Materials and Methods**

The study consisted of 2 experiments:

- Experiment 1: 1 December 2015–27 February 2016 (2 MBCs)
- Experiment 2: 5 January 2017–1 August 2018 (4 MBCs)
A pasture of *L. leucocephala* cv. Wondergraze + *Cenchrus ciliaris* cv. Laredo (buffel grass) was established on a 4,000 m² area at ‘Tambmal’ farm of the Nimbkar Agricultural Research Institute (NARI) by sowing 1 kg leucaena seed on 13 July 2015. Twin rows of leucaena were planted with inter-row spacing of 4.5 m. This was followed by sowing of 1 kg buffel grass seed on 13 August 2015 in the inter-row space (between the leucaena twin rows).

Another pasture was established on 8,000 m² at ‘Madhura’ farm at Jadhavwadi village near Phaltan, where buffel grass cv. Laredo was planted with slips in 2013. About 1,300 seedlings of leucaena cv. Tarramba were planted in this pasture at a spacing of 4 × 1 m in October 2016. Both pastures were located near Phaltan town (17.98°N, 74.43°E; 568 masl) on medium black basaltic soils.

In the first experiment, the 2 MBCs (about 7–8 months old and 79 and 89 kg of weight) were allowed to graze in the leucaena-buffel grass pasture for 3 months. The 2 MBCs were weighed weekly. After they showed satisfactory growth, they were sold and 4 additional MBCs (about 3–4 months old and 37–51 kg) were acquired on 5 January 2017 for Experiment 2. No measures were undertaken for internal or external parasite control in these 4 MBCs. They were shifted between the 2 farms (buffel or leucaena + buffel pastures at Madhura and Tambmal farms, respectively), depending on the availability of fodder, and were housed at night.

### Results and Discussion

In Experiment 1, weights of the 2 MBCs increased to 125 and 137 kg, respectively, after 88 days in the leucaena-buffel grass pasture, giving growth rates of 466 and 716 g/d, respectively.

For Experiment 2, final weights of the 4 MBCs after 574 days ranged from 218 to 305 kg. Average daily gains ranged from 304 to 452 g/d, with the highest daily gains (582–970 g/d) during the trial occurring in the last 98 days when leucaena was fed.

Overall, growth rates were much higher when animals grazed leucaena-buffel grass pasture than on buffel grass alone. Feeding leucaena forage on the buffel pasture increased weight gains but daily weight gains on leucaena-buffel grass pasture were 2.8 times greater than on buffel grass pasture.

No overt signs of mimosine toxicity were observed but hair was lost from the bodies of the MBCs by the end of the first year and there was no need to shave them as is the normal practice.

The cost of establishing the buffel grass-leucaena pasture on the 4,000 m² area was about INR 25,000 with 50% being spent on manual weed control. The cost of putting up a barbed wire fence around this pasture was INR 40,000. The 3–4 month old MBCs cost about INR...
5,000 each. This makes the total cost of the operation INR 85,000. The price realized for 250–300 kg MBCs is INR 25,000–40,000 each. Even with the lower figure of INR 100,000 for 4 MBCs, about INR 15,000 net income can be expected from them in 1.5–2 years. This is expected to increase to about INR 75,000 from the next 4 MBCs kept on this pasture.

Conclusions

The study has demonstrated that the use of leucaena as a source of high-quality protein feed can result in high levels of liveweight gain in MBCs compared with being fed grass alone and this can be highly profitable. Local farmers should be encouraged to take up the planting of leucaena to feed their buffalo male calves and possibly other ruminants as well.

This paper can be read in detail here.

Leucaena Trials

In 2017 over 28,000 seedlings of improved varieties of *Leucaena*, Tarramba and Wondergraze from Australia 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.

The trees grew well initially as they were irrigated once a month for four months and there was 858 mm rainfall between June and October 2017. Irrigation was given in September and December 2017 and on 25 April 2018. After the first cutting on 26 June 2018 when the trees were 1 to 1.3 years old, there was not much rain in July or August and irrigation could not be given either, so the trees did not grow so well. Consequently, the foliage growth was low after 3 months. The next cutting was therefore postponed for another 3 months. All trees, however, survived the dry spell.

The average yield of forage per tree was 914 g at the first cutting and 2.1 kg at the second cutting. KX2 (NARI Nirbeeja) trees that are 1 to 1.5 years old, give an almost 3-fold higher yield of 6-7 kg of fresh forage per cutting at an interval of 12 weeks. More details on forage and wood yield can be found here.
RENEWABLE ENERGY RESEARCH
PROPOSED DST PROJECTS

DST Proposal for a low cost Indoor Agriculture Unit

A proposal titled ‘Development and extension of economically viable indoor agriculture units’ has been written and sent to the SEED division of the DST, Govt. of India. This project is planned for 2 years. The aim of the project is to design and set up a small modular indoor farm for production of common Indian green leafy vegetables and animal fodder at NARI. Then reduce the initial and operational expenditure of indoor production by developing innovative and cheap alternatives for the major contributors to the cost, making it viable for a small scale farmer to pursue indoor agriculture.

DST Proposal for Mechanized Sweet Sorghum Syrup Plant

NARI has been making and selling the sweet sorghum syrup for the past 3 decades. The whole process of syrup production starting from stripping of the leaves (leaf laminae and sheaths) to finally bottling of the syrup is currently done manually. Hence, in addition to being labour-intensive, the quality of the syrup varies in every batch due to human errors. To address the problem, NARI has planned to set up a small mechanized plant for producing syrup. NARI envisages that if similar plants are set up by groups of small farmers, they can get excellent remuneration by selling the syrup themselves.

A proposal titled ‘Development of a Fully Mechanized Plant for the Production of Syrup from Sweet Sorghum’ has been written and sent to the Technology Development Programme (TDP) of the Department of Science and Technology (DST), Govt. of India. The project is planned for 2 years. The project includes: improvement in the current process of syrup production through experimentation; design, fabrication and assembly of the machinery for the plant; testing the plant for possible faults and failures; establishment of market channels to sell syrup on large scale; and conduction of workshops to popularize the plant among the local farmers.
STUDIES

Development and extension of economically viable indoor agriculture units

Objective:

1) To develop a low-cost indoor agriculture unit.
2) To optimize the parameters inside the unit for maximum yield of common fodder crops and Indian green leafy vegetables.
3) To develop a reliable open source dataset of optimal conditions for growth of aforementioned crops.

Work Done:

An experimental indoor unit has been set up at NARI. The unit has two sections: one covered with high density polythene and shade net (section A) and the other covered with only shade net (section B). Currently two stands for growing fodder and an NFT (Nutrient Film technique) setup for growing leafy vegetables has been installed inside the section A.
Three test batches of maize fodder were grown. All of the batches showed high fungal growth, the reasons of which might be presence of fungal spores inside the seeds, insufficient ventilation and poor drainage. The grown batches were fed to buffaloes, cows and goats belonging to a nearby farmer and the responses of all three were different. The buffaloes consumed the whole patch without any hesitation whereas the cows smelled the grass and went away possibly due to the presence of fungus. The goats ate the leaves on the top and left the seeds (fungus affected) at the bottom.

**Future Work** :-

Experiments will be conducted :-
1) To identify the reasons for the fungal growth in the hydroponic maize fodder and thereby minimize it
2) To optimize the conditions to obtain maximum yield of maize and other fodder crops like wheat and barley
3) To optimize the conditions to maximize the yield of commonly grown Indian green leafy vegetables like spinach, methi, shepu etc. using the NFT technique
Study on Lanstove (Lantern cum stove)

Objective :-

1) To improve the existing design of the lanstove making it suitable for mass production.
2) To utilize the heat from the lanstove to charge electronic devices using a thermo-electric module.

Work Done :-

Optimization of pre-heater of the lanstove – Experiments were conducted on the lanstove where various pre-heaters were designed, fabricated and tested to reduce starting time of the lanstove. Results for different designs of pre-heaters were compared and one which had the fastest starting time was selected and installed on all other lanstoves.

Thermoelectric device for lanstove to charge low-power devices - Experiments were conducted on utilization of waste heat emanating from lanstove surfaces for charging low-power devices such as phones. Thermoelectric modules were used as these modules directly convert thermal heat into electricity. Module performance (power, voltage) depends on temperature difference between hot side and cold side. As lanstove gives excellent hot side temperature, the challenge was to develop a cold side. Different materials, various cooling mechanisms, series-parallel combination of modules: all were tested to get the phone charged. It was found that charging rate was very slow primarily due to low power output from the module. Also, these modules were very inefficient and expensive in comparison to the regular electric chargers.

Future Work :-

Further experiments will be conducted to improve the design of lanstove and also for making provision for charging electronic devices.
Studies on sweet sorghum syrup preparation

Objective :-

1) Study and improve upon the existing syrup manufacturing process
2) Set up a mechanized plant for the production of syrup

Work Done :-

Analysis of Variation in Brix from top to bottom of sweet sorghum plant - A study was conducted to find out how the Brix of juice varied from top to bottom of a plant from a batch and to find out how brix varied every day in a batch, to find the optimum time for harvesting. About 5 plants were taken daily of sweet sorghum plantation each for a given planting date was cut at every node and the brix of juice of all the pieces was measured. Graphs were plotted to find out how brix varied from top to bottom of a plant.

Analysis of Damaged plant percentage in sweet sorghum - A study was conducted to find the amount of plant loss due to stem borer damage. Also, syrup was prepared from juice of plants exhibiting different amount of and organoleptic tests were conducted with these syrup samples.

Analysis of Scum removal rate while preparing the syrup - A study was conducted to optimize the scum removal process while making syrup. Different scum removing agents like mucilage form Opuntia, okhra in different proportions (with water) were tested to improve flocculating process.

Scientist : Dr. Anil K. Rajvanshi

Staff : Rahul Pisharody, Shivam Patange, Harishankar Thkkepat
An innovative proposal given by Dr. Chanda Nimbkar of the AHD to the Aga Khan Foundation, New Delhi for establishing a community based goat breeding program in Project Mesha being implemented by them in Muzaffarpur district of Bihar for the benefit of 50,000 women goat keepers, was accepted. Project Mesha aims to ‘Transform the lives of women self-help group members through productivity improvements in small ruminants’. Dr. Nimbkar succeeded in obtaining the collaboration of Dr. Peter Amer of AbacusBio Ltd., New Zealand for this initiative. Thus, for the first time in India, under the guidance of Drs. Nimbkar and Amer, a village based pilot goat breeding program based on individual identification of kidded goats and their kids and selection of male kids for use as breeding bucks, based on criteria decided together with goat owners, was started in 2018-19. This is an important achievement for NARI-AHD, towards consolidation of the work it started 30 years ago for goat genetic improvement.

Two related stories can be read on these links.
https://hail.to/abacusbio/publication/xpdxVDM/article/KB3L834
https://hail.to/abacusbio/publication/xpdxVDM/article/GA9dXSA

On 6-10 August 2018, a training course was held at NARI-AHD on ‘Goat Genetic Improvement Concepts and Methods’ for 18 staff members of “Project Mesha – Transforming the lives of women self-help group members through productivity improvements in small ruminants”, being implemented in Muzaffarpur district of Bihar by the Aga Khan Foundation, New Delhi. Project Mesha aims to enhance the productivity of the goats owned by village women through improvements in the goats’ 1) Genetics 2) Nutrition 3) Health 4) Housing 5) Marketing and 6) Supporting Institutions. Dr. Chanda Nimbkar, Director of NARI-AHD and Dr. Peter Amer of AbacusBio Limited, New Zealand have undertaken a one-year consultancy to help Project Mesha establish a genetic improvement program. In this connection, the training course was held at a specific request from Ms. Tinni Sawhney, CEO of the Aga Khan Foundation. **This was the first time such an ambitious training course was held by NARI-AHD.**
On 25-28 December 2018 another important training course was held at NARI-AHD under the aegis of the Maharashtra Goat and Sheep Research and Development Institute on ‘Buck Semen Freezing Technology’ for 5 staff members of the National Livestock Breeding Centre, Nepal. The participants were senior livestock development officers and livestock service technicians of the Government of Nepal.

The following theory topics were covered in the training course.

- Training and management of bucks for semen collection
- Methods of buck semen collection, evaluation and buck semen freezing protocol
- Equipment necessary for semen freezing and its washing and sterilization
- Method of thawing frozen semen and assessing sperm concentration
- Laboratory hygiene
- Semen storage and types of liquid nitrogen containers

Another highlight of the year was Dr. Chanda Nimbkar being honoured as a Fellow of the Indian Society for Sheep and Goat Production and Utilization (ISSGPU) for her noteworthy research contribution in sheep and goat production. The honour was conferred on her in absentia in the 42nd National seminar held on 14-16 Feb. 2019 at the Bihar Animal Sciences University, Patna. She is the 33rd Fellow and first woman fellow of ISSGPU which has more than 1,000 life members.

NARI AHD’s poster ‘Daily Earning of Goat Keepers from Rearing Osmanabadi Goats’ received the first prize as the Best Poster in the technical session on ‘Socio-economics, Marketing and Financing’ in the Asian Regional Conference on Goats (ARCG-2018) held on 22 to 26 October 2018 at the Amity University, Jaipur in collaboration with the International Goat Association. AHD’s Ms. Padmaja Ghalsasi attended the conference and presented the poster.

Detailed AHD highlight can be found here.
Osmanabadi goat field unit

This year the unit adopted one new cluster - Malshiras taluka in Solapur district. The number of adult does recorded is 538 (120 in Ahmednagar, 31 in Beed, 202 in Pune, 46 in Satara and 139 in Solapur districts respectively). These belong to 169 goat keepers, indicating that about 3.18 goats are reared per household on average. Detailed periodic recording has been done of their body weight, milk yield, reproduction, kid weights, mortality, morbidity, cost incurred for goat rearing and income earned.

The unit has established the least squares mean 90-day milk yield of Osmanabadi does to be 102.4 kg with 1506 records. This was measured using the weigh-suckle-weigh method. This establishes the Osmanabadi breed to be among the top five dairy goat breeds in India.

During 2018-19, total 4,702 Osmanabadi buck straws were supplied to A.I. technicians, farmers and entrepreneurs for breeding Osmanabadi goats.

Performance recording of more than 6000 Osmanabadi goats and their progeny over the last nine years has led to selection of superior twin- or triplet-born males born to high-milk-yielding goats with high reproductive performance. Six Osmanabadi bucks were purchased during the year (making the total number 77). A subset of these males are used for breeding in project villages and frozen semen of another subset is disseminated in areas outside the project through a network of A.I. technicians. 31 selected Osmanabadi breeding bucks have been supplied to villages under the unit during the year. 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.

We have published 14 information booklets/leaflets in Marathi language to give information to goat keepers on better goat management practices. Regular preventive
health care of 5271 goats from within and outside project villages was carried out including vaccinations, deworming and spraying against ecto-parasites.

The unit has started conducting livestock market surveys of Phaltan and Lonand markets once a month. Valuable information has been obtained on trends in numbers of goats and sheep brought to the markets and their prices.

NARI was approached by the World Bank-funded ‘State of Maharashtra Agricultural Transformation (SMART)’ project to prepare a concept note about how to implement goat genetic improvement under the project. The unit has established linkages with 20 organizations for accelerated goat development.

134 goat keepers were trained (10 training courses) in preventive health care of goats and first-aid treatment. 20 lady link workers from the Manndeshi Foundation were trained in goat health care and artificial insemination.

Detailed report of this project can be found here

Funding agency : ICAR, administered by the Central Institute for Research on Goats

Scientists : Dr. Chanda Nimbkar, Dr. Pradip Ghalsasi

Technical staff : Mr. Kanhaiya Chavan, Mr. Navnath Patange, Mr. Rupasing Khanvilkar, Ms. Bharati Pawar (Until 1 December 2018), Mr. Dilip Dhaigude, Ms. Surekha Murumkar (in Sakat, Dist. Ahmednagar), Mr. Shivaji Varat (in Gandhanwadi, Dist. Beed), Mr. Kunal Kadam (in Gosaviwadi, Dist. Satara).

‘FecB’ gene in sheep

So far, about 675 breeding rams and 1023 breeding ewes have been supplied. Out of these, 25 rams and 123 ewes were supplied during 2018-19. Majority of the rams and ewes were purchased by sheep keepers from Karnataka, followed by sheep keepers from Telangana and Maharashtra.
Each of the three AI programmes in 2018-19 went on for one month, roughly covering two oestrus cycles. The overall conception rate was 77%.

This year, the number of live lambs born per FecB carrier ewe conceived, increased by 10 to 13% \( \text{(Details can be found here)} \). Many pairs of twins attained the total weight of around 40 kg at the age of 5 months.

The \textit{FecB} genotyping protocol is now fine-tuned in the new PCR machine and this year 100% results were obtained at the first go in all the genotyping tests conducted. \textit{More details regarding \textit{FecB} genotyping done, can be found here.}

We have now made the test more cost-effective on the advice of our consultant Ms. Sheetal Ghalsasi by introducing two changes. First, amplification of PCR products is tested by gel electrophoresis before subjecting the products to RFLP digestion. Second, we have replaced the High Resolution Blend Nusieve Agarose that we were using earlier, with regular Agarose of Superior Molecular grade which has reduced the cost by 50%. We have found ordinary Agarose gives better quality gels than Nusieve Agarose.

\textit{Scientists} : Dr. Chanda Nimbkar, Dr. Pradip Ghalsasi

\textit{Technical staff} : Mr. Rupsing Khanvilkar, Mr. Vikram Shedge, Mr. Dilip Dhaigude, Mr. Kanhaiyya Chavan, Mr. Anil Chavan, Mr. Dattatray Mulik, Ms. Padmaja Ghalsasi

\textbf{A.I. CENTRE}

76,669 straws of Boer, Osmanabadi, Damascus cross and Beetal bucks were frozen until 31 March 2019.

2,379 goats belonging to farmers from surrounding villages and 3,542 goats of the Institute were artificially inseminated using these frozen semen straws. The overall conception rate achieved was 47%. \( \text{(More details can be found here)} \)
This year, 101 goats belonging to local goat keepers were inseminated. The conception rate was 46% for first A.I. and 58% for second A.I. **Conception rate results for the last six years can be found here.**

During the year two courses were conducted for Pashu-sakhis of Manndeshi Foundation. A total of 21 participants were given 3 days’ intensive training (including theory and practicals) on ‘First aid in goats and artificial insemination’.

**Funding Agency**-Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Govt. of India

**VETERINARY PARASITOLOGY**

NARI-AHD regularly monitor our sheep and goat flocks and goat flocks of goat keepers participating in the Osmanabadi Goat Field Unit under the ICAR-AICRP-Goat Improvement to assess the gastro-intestinal nematode worm burden (GIN) under natural infection. Faecal worm egg counts (FEC) and FAMACHA scores of all sheep and goats are recorded.

In a flock about 25-30% of the animals have high FEC while the remaining are below the threshold level. **More details regarding FEC can be found here.**

Lambed ewes had higher worm infection. This is peri-parturient relaxation of immunity (PPRI) or increase in worm infection due to lambing and lactation stress. In April with a hot, dry climate, only 6 out of 88 ewes had FEC >5000 epg while in August, 30 out of 86 sheep had FEC >5000 epg.

During the year, Out of 312 NARI Suwarna adult ewes, 293 ewes (93%) were drenched twice (mainly after lambing); 66 ewes (21%) were drenched 3 times and 10 ewes (3%) were drenched 4 times. Thus majority of the NARI Suwarna ewes were ‘reasonably resilient’.

**Funding agency**: internally funded

**Scientists**: Dr. Chanda Nimbkar, Dr. Pradip Ghalsasi

**Technical staff**: Ms. Padmaja Ghalsasi, Ms. Sanyogita Kumbhar, Mr. Kanhaiya Chavan, Mr. Rupsing Khanvilkar, Mr. Vikram Shedge, Mr. Dattatraya Mulik, Mr. Anil Chavan and Mr. Dilip Dhaigude
## ANNUAL FACT SHEET

(Click on Main headings for more details)

### Publications
- 29 magazine/newspaper articles
- 8 newspaper reports about NARI
- 3 non-refereed articles
- 3 Annual progress reports
- 1 refereed article

### Total sales
- 9459 buck semen straws supplied in bulk
- 7034 fodder crop seedlings/cactus pads supplied
- 1718 kg of food products (syrup/herbal tea/oil) sold
- 357 kg seeds of different crops sold
- 148 ‘NARI Suwarna’ ewes/rams supplied

### Visitors to NARI
- 1434 students/farmers/sheep and goat holders/trainees
- 55 dignitaries from national/international organizations
- 56 participants in 2 training courses conducted by AHD

### Visits by NARI staff
- 14 conferences/seminars/meetings/workshops attended
- 7 invited lectures/talks attended
NARI Trustees

Smt. Jai Nimbkar, Author, Phaltan
Dr. Nandini Nimbkar, Ph.D., Permanent President, NARI
Dr. Chanda Nimbkar, Ph.D., Director, Animal Husbandry Division, NARI
Dr. Anil K. Rajvanshi, Ph.D., Director and Hon. Secretary, NARI
Dr. Noorie Rajvanshi, Ph.D., Staff Engineer, Siemens Healthineers, USA
Ms. Madhura Rajvanshi, MA, Trustee, Pragat Shikshan Sanstha, Phaltan
Dr. Priyadarshini Karve, Ph. D., Director, Samuchit Enviro Tech, Pune

NARI Governing Council

Dr. Nandini Nimbkar, Ph.D., Permanent President, NARI
Dr. Chanda Nimbkar, Ph.D., Director, Animal Husbandry Division, NARI
Dr. Noorie Rajvanshi, Ph.D., Staff Engineer, Siemens Healthineers, USA
Ms. Madhura Rajvanshi, MA, Trustee, Pragat Shikshan Sanstha, Phaltan
Mr. S. K. Jha, I.R.S., Retired Chief Commissioner of Income Tax (CCIT), Pune
Mr. Niraj Chandra, BA, Industrialist, Satara
Dr. Anil K. Rajvanshi, Ph.D., Director and Hon. Secretary, NARI
Mr. B. V. Nimbkar, Founder and Emeritus President, NARI (Special Invitee)