भाकृअनुप
ICAR

केकृवाअनुसं
CAFRI

ISO 9001:2015

Annual Report 2021

All India Coordinated Research Project on Agroforestry

ICAR-Central Agroforestry Research Institute

Jhansi 284003, Uttar Pradesh, India

+91-510-2730214

+91-510-2730364

pc.aicrpaf@gmail.com

https://aicrp.icar.gov.in/agroforestry

भाकृअनुप
ICAR

केकृवाअनुसं
CAFRI

ISO 9001:2015

Annual Report 2021

All India Coordinated Research Project on Agroforestry

ICAR-Central Agroforestry Research Institute

Jhansi 284003, Uttar Pradesh, India

Supervision & Guidance
Dr. A. Arunachalam

Compiled by
Dr. A.K. Handa
Mr. Suresh Ramanan S

Published by:
Project Coordinator
All India Coordinated Research Project on Agroforestry
ICAR-Central Agroforestry Research Institute
Jhansi 284003 (Uttar Pradesh), India
Telephone : +91-510-2730214
Fax. : +91-510-2730364
E.mail : pc.aicrpaf@gmail.com
Website : https://aicrp.icar.gov.in/agroforestry

2021

Printed at :
Classic Enterprises, Jhansi
7007122381, 9415113108

Preface

Agroforestry is one of the best practices for diversification of agricultural enterprise and integrate the agricultural enterprises for ensuring better returns and reduced risks associated with variable climate. Currently, it is being practiced by millions of farmers' world over and has traditionally been a way of life and livelihood in India for centuries. But now, with technological interventions, it is contributing significantly to land use and farm income diversification, natural resource management and can be a one of the major factors in economic transformation of farmers. The recent studies by ICAR-Central Agroforestry Research Institute, Jhansi have shown that there is approximately 28 m ha area under agroforestry in 15 agro-climatic zones of the country. While we began agroforestry research and development with a ore basic and strategic research, demonstrating the efficacy and motivating the people and other stakeholders for systematic integration of trees into conventional farming systems, now with the adoption of National Agroforestry Policy and implementation of Sub Mission on Agroforestry, it is more important to access industrial perspectives and quantify the environmental services to call on policy makers to push for concerted efforts on agroforestry.

The All India Coordinated Research Project initiated by ICAR in 1983 has contributed tremendously for providing tree-based land use options. The coordinating centres are conducting recurrent surveys to design new technologies based on the requirements of the stakeholders and evaluating different tree species and their germplasm for higher productivity and adaptability. This annual report summarizes the salient achievements of the coordinating centre and detailed results of each centre.

The guidance received from Dr. Trilochan Mohapatra, Secretary, DARE and DG, ICAR is gratefully acknowledged. The mentorship role of Dr. S.K. Chaudhari, Deputy Director General (NRM), Dr. S. Bhaskar, Assistant Director General (Agronomy, Agroforestry and Climate Change) and suggestions helped in implementing the project activities. I am grateful to all the Vice-Chancellors and Directors of Research of SAU's and Directors of ICAR institutes, participating in this project. Thanks are due to OIC's (Agroforestry) at all coordinating centres for their efforts in executing the project at their respective centres.

I record my thanks to all the Scientific, Technical and Administrative staff of CAFRI, Jhansi for their help in the working of this project. My special thanks are due to scientists of Project Coordinating unit of the Project for their sincere efforts and help in execution of the project and preparation of this report.

(A. Arunachalam)
Director, ICAR-CAFRI &
Project Coordinator, AICRP-Agroforestry

Contents

1. Introduction

The All India Coordinated Research Project (AICRP) on Agroforestry was started in 1983 with 20 centres and it has now expanded to 37 centres – 26 in SAUs, 10 in ICAR Institutes and 1 in ICFRE Institute representing all agro-climatic zones in the country (Figure 1). The Coordinating unit of AICRP-Agroforestry was shifted from ICAR Headquarters to CAFRI, Jhansi w.e.f. 1st April, 1997 with the following specific mandates:

- ✓ Screening and genetic upgrading of selected plant species for their compatibility in different agroforestry systems
- ✓ To optimize tree-intercrop combination for different regions
- ✓ Performance enhancement of the pre-dominant agroforestry systems being already practiced by the farmers
- ✓ To upgrade and refine the existing technologies for higher productivity and sustainability.

Objectives:

- Diagnostic survey and appraisal of existing farming system and agroforestry practices and farmers' preference.
- Collection and evaluation of promising tree species, cultivars of fuel, fodder and small timber for agroforestry interactions.
- Studies on management practices of agroforestry systems such as agri-silviculture, boundary plantation, silvipasture, silvi-horticulture, agri-silvi-horticulture, multistorey, homestead, *etc.*
- To analyze economics of agroforestry systems.
- To explore and attribute the role of agroforestry in environment protection.
- To conduct studies on post-harvest technology, fishery, apiculture, lac, *etc.* in relation to agroforestry systems

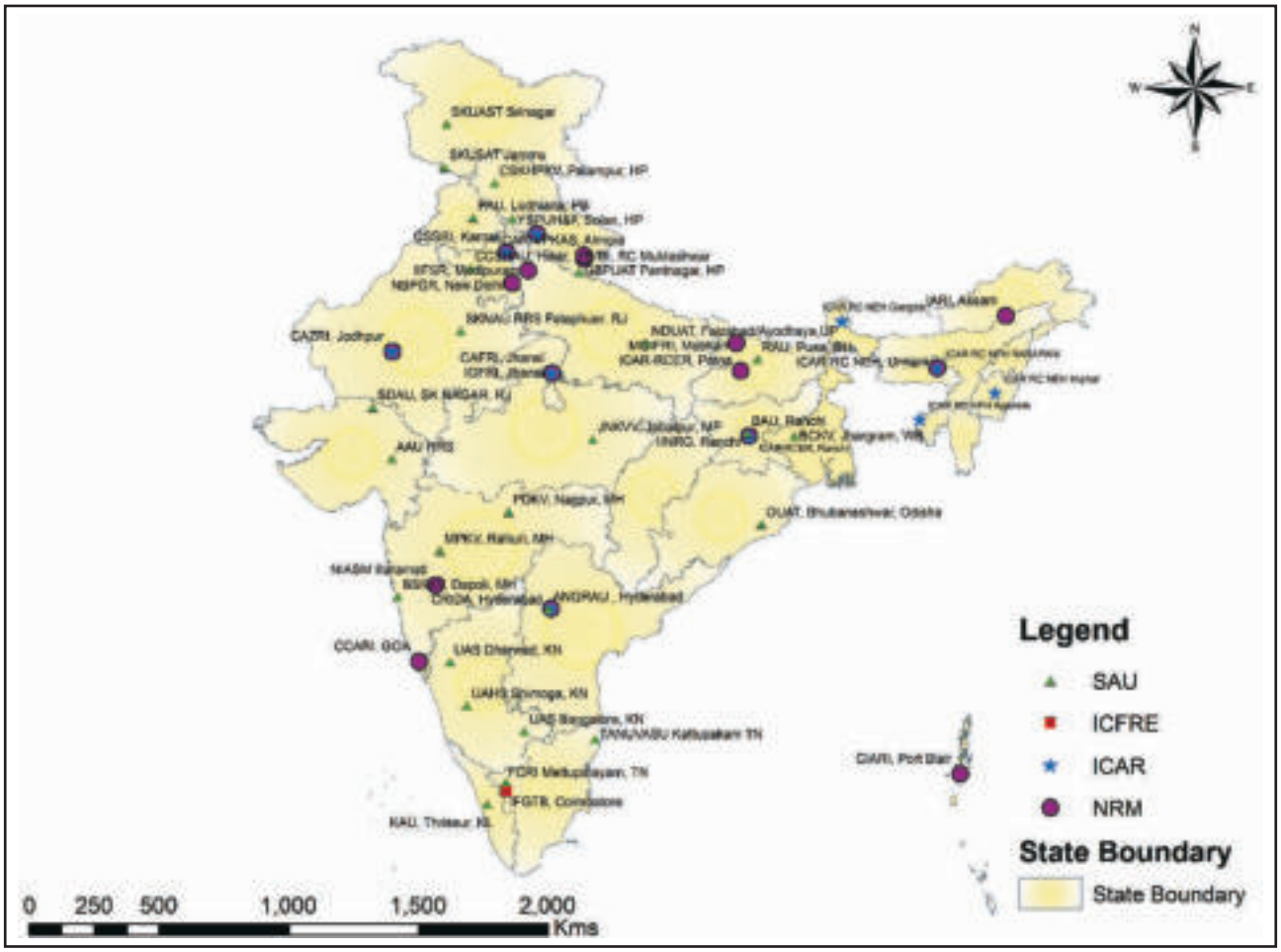

Figure 1. AICRP-Agroforestry Centres across the country

ICAR-Central Agroforestry Research Institute (ICAR-CAFRI), formerly the National Research Centre for Agroforestry, is a multidisciplinary premier research institute of the Indian Council of Agricultural Research (ICAR) with a major focus on integrating trees, crops, and livestock on the same farmland. The Institute is in Jhansi, Uttar Pradesh (25.5o N 78.5o E), India and has a total area of 254.859 acre (214.079 research farm and 40.78 office & residential area). CAFRI is the only dedicated research institute of the country working on key research areas of agroforestry with 31 scientists, 16 technical, 12 administrative and 8 skilled supporting staff as its sanctioned cadre strength. CAFRI has developed robust agroforestry models and package of practices for different agroclimatic conditions covering small and marginal farmers and provides technical backstopping to the States and stakeholders.

2. Salient Achievements

SK UNIVERSITY OF AGRICULTURAL SCIENCE & TECHNOLOGY, SRINAGAR

Tree Germplasm Collection, Evaluation and Improvement

The cuttings of Salix *alba* var. *Caerulea* (Ganderbal-1 source) exhibited maximum height of 2.97 m and collar diameter of 30.10 mm after the completion of fifth growing season. Fifteen clones of salix collected from Solan centre have been introduced for evaluation and were transplanted in the nursery.

System Research

Under Evaluation of Apricot based Agro-forestry system under temperate conditions of Kashmir, after the completion of seventh growing season, the apricot-based agroforestry system at Benhama revealed a good potential for the stake holders, Apricot with maximum height of 4.12m and collar diameter of 66.01 mm was recorded when grown in combination with Orchard grass followed by 3.71 m with Tall fescue and collar diameter 62.13 mm with Lucerne. Number of branches (21.66) and fuelwood production (0.45Kg/tree) were recorded maximum in T_2 (Apricot + Orchard grass). Among the four fodder species *viz*. Timothy, Orchard grass, Lucerne, Tall fescue sown in interspaces and control (natural grass), Orchard grass performed better with green fodder yield of 23.04t /ha followed by tall fescue with yield of 14.98 t/ha. Average fruit production of 2.5 kg per tree was recorded from Apricot trees and average oil content of 40% was recorded.

The evaluation of walnut-based agroforestry system under temperate conditions of Kashmir valley exhibited that at the end of sixth growing seasons the maximum tree height (2.78), Collar diameter (60.11 mm), No. of branches per tree (35.31), plant spread 2.81 m and fodder yield (18.91 t/ha) was observed in T_1 (Walnut + Lucerne). The trees came into bearing and fruits were harvested first time at the age of six years. The CITH-Walnut-1 performed better in terms of fruit weight (29 gm per fruit) followed by CITH-Walnut-3 (20gm per fruit) and minimum fruit weight was recorded in Sulieman (9gm per fruit).

Salix based system under cold arid conditions of Leh revealed that the maximum average height (3.51 m) and diameter (39.01 mm) after third year was recorded in treatment T_1 (Salix + Lucerne) and cabbage performed better as compared to other crops in combination with *Salix* by attaining a yield of 11.0 t/ha, whereas in control the yield of cabbage was 16.01 t/ha. While Lucerne production was maximum 10.71 ton/ha as sole crop compared to 9.5 t/ha in combination with *Salix*.

Under evaluation of horti-silvi-medicinal and horti-silvi-agriculture systems under different apple tree densities under temperate conditions of Kashmir Valley two Apple varieties Red velox and Gala mast were planted at 4 different densities *viz.* T_1 (1.0 m x 3m) T_2 (1. 5 m x 3m), T_3 (2.0 m x 3m), T_4 (2.5 m x 3 m). After completion of one growing season 100% survival was recorded in case of fruit trees planted under all densities. Fruiting was observed in case of variety Gala mast in the same year where average fruit yield of 0.25 kg per tree was recorded in treatment T_2. Beans (40q/ha) and lavender (244 kg of flowers/ha) when intercropped with Apple gave maximum production of with the spacing of 2.5 x 3 m.

SK UNIVERSITY OF AGRICULTURAL SCIENCE & TECHNOLOGY, JAMMU

System Research

The growth and productivity of *Melia composita* planted at a spacing of 6 m × 4 m after two and a half years of planting showed impressive growth performance with an average height of 8 m. The centre-initiated Poplar based agroforestry system in the Sub-tropics of Jammu and Kashmir to study the performance of *Rabi* (Potato, Spinach, Cabbage) and *Kharif* (tomato, Brinjal, Okra) vegetables under Poplar based agroforestry system in the sub-tropics of Jammu.

Under Development of Silvi-pastoral System for north-western Himalayan Region the average tree height of *Terminalia chebula* ranged from 143.06 to 204.98 cm whereas the collar diameter of the trees ranged between 26.71 to 35.01 mm. The maximum height (204.98 cm) and collar diameter (35.01 mm) for *T. chebula* was recorded in control treatment, whereas the minimum height (143.06 cm) and collar diameter (26.71 mm) were recorded in treatment *T. chebula* with *Setaria*.

Dr. YS PARMAR UNIVERSITY OF HORTICULTURE & FORESTRY, NAUNI, SOLAN

Survey, Diagnostic and Design

Study conducted on appraisal of existing agroforestry systems in Seraj valley of District Mandi, H.P. revealed that there were seven different types of agroforestry systems prevalent in the Seraj valley *viz*., Horti-agriculture (HA), Agri-silvi-horticulture (ASH), Horti-pastoral (HP), Agri-horti-silviculture (AHS), Agri-horticulture (AH), pastoral-silviculture (PS), Agri-silviculture (AS). The most predominant agroforestry system in Seraj valley was Horti-agriculture whereas Pastoral-silviculture was the least dominant agroforestry system. Irrespective of all farmer categories, horticulture component seems to play a

significant role in generating higher net returns as compared to other component. In the study area some technical, social, scientific and infrastructural gaps were noticed and suitable solutions to overcome them have been suggested such as public sector jobs, family businesses, and employment as daily wagers in the private or public sector were the major sources of off-farm employment/income. Off-farm employment/ income can be generated through encouraging small-scale agro-based industries at the village, Panchayat, and Block levels.

System Research

Studies on evaluation of performance of black gram (*Vigna mungo* L. Hepper) and wheat (*Triticum aestivum* L.) under fruit tree based agroforestry systems among, different doses of fertilizers, growth and yield parameters of wheat *i.e.* plant height (84.18cm), number of tillers (7.39), spike length (6.33 cm), test weight (40.37 g), economic yield (29.16 q/ha), straw yield (47.78 q/ha) and biological yield (76.94 q/ha) during first year were found maximum when recommended dose of fertilizer was used. Among four systems all growth parameters were recorded higher in open field. Similarly, growth and yield parameters of black gram *i.e.* plant height (45.89 cm), number of primary branches (5.28), number of pods per plant (28.74), number of grain per pod (7.27), dry matter per plant (4.46), test weight (33.82 g), economic yield (5.57 q/ha), straw yield (17.41 q/ha) and biological yield (22.98 q/ha) were found maximum with the application of recommended dose of fertilizer. Soil physico-chemical properties were found to be improved under tree canopy as compared to outside canopy. All organic manures generally improved the physical and chemical properties of soil which in turn enhanced the growth and production of wheat and black gram under different agroforestry system as well as in sole crop. Use of organic manures increased the availability of nutrients to the plant. The maximum net return (19108.06 Rs./ha) was obtained when recommended dose of fertilizer was used under peach tree. The application of recommended dose of fertilizers resulted in higher gross return (Rs./ha 53277) under peach-based agroforestry system. Highest (5.08) B:C ratio was observed under peach tree; where, no manure was applied. However, for black gram the highest cost of cultivation (35236.51 Rs./ha) under pear-based agroforestry system with the application of farmyard manure. Net return for black gram was reported maximum (14218.80 Rs./ha) for the treatment T_4, under peach-based agroforestry system. The highest cost of cultivation (41787 Rs./ha) was recorded in treatment T_1, under pear tree. B:C ratio was recorded maximum (5.05) under peach-based agroforestry system when no manure was applied.

CSK HIMACHAL PRADESH KRISHI VISHWAVIDYALAYA, PALAMPUR

Tree Germplasm Collection, Evaluation and Improvement

The two species allocated to this centre for germplasm evaluation are *Toona ciliata* and *Sapindus mukorossi*. In case of *Toona ciliata*, out of the best 8 superior seed sources under field evaluation since 2012, HPI(c) 22 seed source of Solan attained significantly higher stem height and DBH in comparison to all other seed sources and it was 100.40 and 135.03% higher than HP 4(c) 87, the least performing germplasm source from Kangra. Seed sources from Mandi *i.e.*, HP5 (b) 48 and HP 5(b) 71 were the next two best performing in terms of growth parameters.

In case of *Sapindus mukorossi*, out of best performing 8 seed sources under field evaluation since 2012, AS8 from Mangla, Distt. Chamba was found to be the best performing in terms of growth parameters of height and DBH followed by AS3 from Sihunta and AS5 from Mangla. It had 8.17% and 35.80% higher height and diameter respectively than AS23 a local germplasm source from Rajpur.

Sapindus germplasm under evaluation

A significant difference in the important growth parameters of the two varieties of *Leucaena* was recorded in the field at the time of application of management practices. Preliminary data and observations revealed that in general, K-636 was found to be more robust in foliage growth. The different extraction, clean up and quantification procedures for mimosine from *Leucaena* leaves were validated for reliable and accurate results.

System Research

Under development of *Harar* based silvipastoral system for north-western Himalayan region, different treatments had a significant effect on all the growth parameters. *Terminalia chebula* attained significantly maximum height (168.7 cm) when grown with *Brachiaria* which was

statistically at par when grown with Setaria+clover. Collar diameter and spread was significantly higher when grown with white clover in comparison to all the treatments. Least height and collar diameter were attained when grown with combination of two grasses and clover. Number of fruits per plant ranged from 1 to 35 and there was 76-90% pulp recovery. Green fodder yield of the system was highest in case of Setaria + Clover (99.47 t/ha) followed by Setaria+ Brachiaria+ Clover. However dry matter yield in the latter (25.23 t/ha) was statistically at par with that of Setaria+Clover (23.76 t/ha). The most important aspect is that quality green fodder can be harvested from the system from April –June when the indigenous grass (T7) in the low productive *ghasnis* is still not rejuvenated from severe winter. Significantly maximum number of cattle (14) or sheep (68) can be fed with Setaria+Clover which was at par with Setaria+Brachiaria+clover. Quality of the fodder was enhanced in terms of crude protein (9.35%) when two grasses were combined with clover. Trees contributed maximum (7.70 t/ha) towards total carbon sequestered when grown with Setaria + clover.

ASSAM AGRICULTURAL UNIVERSITY, HRS-KAHIKUCHI

Tree Germplasm Collection, Evaluation and Improvement

Nineteen seed sources of *Gmelina arborea* collected from six different sites *viz.* 4 from Goalpara, 3 from Dudhnoi, 3 from Damara, 4 from Boko, 2 from Byrnihat and 3 from Silchar. The Seed source from Byrnihat (AAU 15 & AAU 16) registered 28.67 & 26.61 m and Silchar (AAU 17 & AAU 18) registered 25.56 & 27.11 m tree height respectively, in 19 yrs old plantation, whereas, AAU 15, AAU 16, AAU 17 & AAU 18 registered dbh of 44.93, 44.57, 49.87and 51.0 cm respectively, in 19 years; The highest timber volume of 2.60 m3/tree, biomass of 1546.14 Mg/ha and above ground C stock of 773.07 Mg/ha was recorded for AAU 18 (Silchar).

System Research

In *Acacia mangium* based system, the maximum plant height (16.23 m), dbh (35.79 cm), timber volume (411.63 m^3/ha), tree biomass (512.55 Mg/ha) and above ground carbon stock (256.27 Mg/ha) was recorded in intercrop plot where tree spaced at 5 m x 4 m. The maximum fodder yield of Hybrid napier (50.65 t/ha) was obtained in sole fodder followed by tree spaced at 5 m x 6 m (46.29 t/ha), 5 m x 5 m (40.56 t/ha) and 5 m x 4 m (39.24 t/ha), respectively. The highest increase in OM%, available N in kg/ha, P_2O_5 in kg/ha & K_2O in kg/ha of 37.76%, 29.10%, 30.35% & 14.71%, respectively over the initial year were recorded in the intercrop plot of tree & fodder where trees spaced at 5 m x 4 m.

In Jackfruit based AF system, the tree height of 8.78 m was recorded in intercrop plot whereas it was 8.44 m in tree without crop. The dbh (30.03 cm) of jackfruit was superior in intercrop plot in comparison to sole tree plot (29.45 cm). Timber volume, tree biomass and above ground C stock for jackfruit was higher in intercrop plots, being 58.65 m^3/ha, 119.34 Mg/ha, and 59.67 Mg/ha, respectively. However, canopy diameter (8.13 m) was higher in sole jackfruit. The fruit yield of jackfruit increased by 2.30% in the 16 years of plantation over the previous year. Under the system increase in OM%, available N in kg/ha, P_2O_5 in kg/ha & K_2O in kg/ha of 43.62%, 24.56%, 22.14% & 10.25%, respectively over the initial year were recorded.

The *Gmelina arborea* based system showed that during the 4th year of plantation maximum tree ht. (6.15 m) collar girth (30.15 cm) was observed in sole tree plot and Cowpea-Toria sequence as intercrop respectively. The maximum canopy diameter (2.00 m) was found in GG-Toria sequence as intercrop and the maximum annual increment for tree height (371%), collar girth (298%) and canopy diameter (257%) recorded in GG-Toria sequence as intercrop. The highest increase in OM%, available N in kg/ha, P_2O_5 in kg/ha & K_2O in kg/ha of 16.42%, 9.21%, 21.51% & 8.52%, respectively over the initial year were recorded in the intercrop plot of tree & GG - Toria sequence.

Muli bamboo attained 11.62 m in height and 1336 cm in girth in 17 years and mean yield of matured bamboo was 30000 no./ha. For *Bambusa balcooa,* the mean plant height (24.89 m), spread (5.10 m), new culm (18.30 nos.), total culms (134.56 nos), canopy diameter (26.92 m), biomass (179.32 Mg/ha) and harvestable yield (1108.3 no./ha) was recorded in 12th year after plantation. The increase in OM%, available N in kg/ha, P_2O_5 in kg/ha & K_2O in kg/ha of 43.36%, 13.80%, 10.80% & 6.35%, respectively over the initial year were recorded. The *Bambusa tulda* recorded mean plant height (20.08 m), spread (3.43 m), new culm (27.45 no.), total culms (96.34 nos.), canopy diameter (11.34 m), biomass (218.45 Mg/ha) and harvestable yield (1972.45 no./ha) during 12th year after

plantation. An increase in OM%, available N in kg/ha, P_2O_5 in kg/ha & K_2O in kg/ha of 39.51%, 14.61%, 11.81% & 5.05%, respectively over the initial year were recorded.

PUNJAB AGRICULTURAL UNIVERSITY, LUDHIANA

Tree Germplasm Collection, Evaluation and Improvement

A multi-locational trial for evaluation of 15 clones of poplar (5 from Pantnagar, 3 from HAU and 7 from PAU) was established at PAU Ludhiana and RRS Bathinda in January 2014. After 7-year growth, the lowest DBH (17.23 cm) was of HAU-S1 and the highest (20.73 cm) of PP9-25, followed by PP9-20 (20.40 cm). The minimum height (17.53 m) was in PP9-29 and the maximum (19.75 m) in FNR-357. A Multi-locational trial of *Melia composita* was established in 2016 to screen 20 progenies at PAU Ludhiana and 14 progenies at Ruldu Singh Wala Bathinda at 4 x 2.5 m spacing in a well-replicated and randomized block. After five years, the height of progeny 20 was maximum (13.19 m) followed by progeny 19 (12.38 m), progeny 15 (12.13 m) and progeny 13 (12.0) and the DBH was maximum that of progeny 19 (20.80 cm) followed by progeny 20 (16.94 cm) and progeny 16 (16.79 cm). The best performing progenies were from TNAU (TNA2 and TNA5) which shows that these progenies maintain their superiority even across regions.

System Research

Under poplar-based system, the average tree height and diameter of 5-year-old poplar (8 x 2.5 m spacing) recorded was 14.2 m and 16.6 cm with a crown spread of 16.7 m^2. Under poplar, the significant increase in seed yield of Indian mustard cultivars was up to 150% RDF:$N_{150}P_{45}$ kg/ha (1595 kg ha^{-1} respectively), whereas, in open conditions, it was up to 125% RDF (1726 kg ha^{-1}). PBR 357 variety recorded significantly higher seed yield under poplar (1293 kg ha^{-1}) and under open conditions (1582) compared to Giriraj and RLC 3 variety. Onion: Six onion varieties (POH-1, PRO-6, PRO-7, PWO-2, PYO-1 and Punjab Naroya) were transplanted at four planting times (mid-December, end-December, mid-January and end-January) under poplar. PRO-7 variety recorded a significantly higher bulb yield (24.4 t/ha) than the rest of the varieties. Planting of onion crop gave better bulb yield in mid-December (23.3 t/ha) than end December (19.1 t/ha) and mid-January planting (16.3 t/ha). The per cent reduction in bulb yield under five-year-old poplar was 36.70. The benefit-cost ratio of the poplar-onion model was higher (2.94) as compared to poplar-wheat (2.74) and sole onion (1.92).

GB PANT UNIVERSITY OF AGRICULTURE & TECHNOLOGY, PANTNAGAR

Survey, Diagnostic and Design

In Udham Singh Nagar district, Kanakpur village, Rudrapur block was randomly selected. Surveyed farmers were in three categories *viz.* small, medium and large, and farmers were well versed with agroforestry systems but were not aware on utility of tree fodder and most of them were not using tree fodder for animals. But farmers showed their inclination for planting of multi-purpose tree species so that tree produce may be used in any emergent situation. It was observed that for poplar farmer prefer agri-silviculture compared to bund/boundary plantation but in case of eucalyptus farmers follow bund/boundary plantation compared to agri-silviculture.

Tree Germplasm Collection, Evaluation and Improvement

Total 94 indigenous and exotic MPTs including 7 species of bamboos have been maintained at Patharchatta (Old) site and total 54 indigenous and exotic MPTs suitable for agroforestry systems together with 14 species of bamboos have been collected at Haldi (New-AFRC) site. At Patharchatta site, *Anthocephlus cadamba, Eucalyptus* sp. *Casuarina equisetifolia, Dalbergia sissoo, Albizzia lebbeck, Terminalia belerica, Terminalia chebula, Toona ciliata, Bombax ceiba, Trewia nudiflora* and *Dendrocalamus strictus* (among bamboos), have shown good establishment and growth. However, the *Populus deltoides* and *Acrocarpus fraxinifolius* were designated as extremely fast growing. At Haldi site maximum height was recorded in *Eucalyptus* followed by *Kadamb, Melia.* The minimum height was recorded in *Diospyros and Muraya*. DBH was found maximum in *Melia followed* by *Paulwonia. Maximum* crown spread was observed in *Delonix regia* followed by *Cassia siamea* and *Albizia lebbeck.*

System Research

The performance of turmeric (*Curcuma longa* L.) under 11 different agroforestry tree species (12 years old) showed that different growth parameters, yield attributes and yield of turmeric were found higher under different agroforestry system as compared to an open system. Among the different agroforestry system, the maximum growth parameters of turmeric were recorded under *Terminalia bellirica* (T_4) and *Pterospermum acerifolium* (T_7), whereas yield attributes and yield were highest under *Dalbergia sissoo* (T_{11}) followed by *Anthocephalus cadamba* (T_{12}).

The comparative soil appraisal of 7-year-old *Dalbergia sisoo* based agroforestry soil with sole crop system showed that the physico-chemical parameters in two ecosystems showed a marked difference. The Organic matter, organic Carbon, available Nitrogen, available phosphorus, available potassium, organic carbon, organic matter content was found to be highest for Shisham based agroforestry ecosystem. Total protein and enzyme (*viz.* protease, urease and amylase) activity in soil was observed in soil of both the ecosystems which were showing a high variation *i.e.* before and after crop harvesting.

ND UNIVERSITY OF AGRICULTURE & TECHNOLOGY, KUMARGANJ, AYODHYA

Tree Germplasm Collection, Evaluation and Improvement

Five shisham clones from GBPUAT, Pantnagar and three from PAU, Ludhiana were planted at Ayodhya Centre in 8.0 m x 2.5 m spacing. Based on plant growth performance, the maximum plant height (2.81 m) and collar diameter (5.14 cm) was noticed in PS-52 and minimum plant height (1.87 m) in PS-38 and minimum collar diameter (2.90 cm) recorded in L-2. The maximum number of branches (25) counted in PS-52, PS-90 (24) and L-1 (24) while minimum (17) noted in PS-20. As far as crown spread is concerned, the maximum crown spread (78.50 cm) was measured in PS-52, followed by PS-20 (69.20 cm) and least in PS-54 (60.9 cm).

System Research

In *Casuarina equsetifolia* and *Psidium guajava* based agri-silvi-horti system, trees were planted on sodic wasteland 10m x 2m spacing and 10m x 6m during the year 2002. After standardization of four fertilizers and FYM treatment combinations were applied (recommended dose of NPK 120:80:80 kg ha^{-1}, 75% NPK+ FYM 5 t ha^{-1}, 50% NPK+FYM 10 t ha^{-1}, 25% NPK+FYM 15t ha^{-1} and FYM 20 t ha^{-1}). Maximum turmeric rhizome yield (7.18 t $ha^{-1}yr^{-1}$) has been obtained due to application of 50% recommended dose of NPK (120:80:80 kg ha^{-1}) + 50% FYM dose (recommended dose 20 t ha^{-1}) as compared to other treatments under agri-silvi-horti system.

Growth and yield of paddy and wheat under *Dalbergia sissoo* based agri-silviculture system the tree height and dbh were found maximum under the treatment pressmud. The wheat (variety NW-2054) yield was also found maximum in treatment FYM (10 t ha^{-1}) (2.21 t/ha and least being in T_3 paddy straw (10t ha^{-1}) (1.88 t/ha). 20.80% higher grain yield was noticed in open area than under the system in FYM 10 t ha^{-1}. Similar trend was also followed in case of wheat straw. Maximum grain yield was recorded under the treatment FYM (10 t/ha) (1.92 t/ha) and minimum noted in T_3-paddy straw 15 t ha^{-1} (1.74 t/ha). 20.90% higher grain yield was noticed in open area than the system in FYM 10 t ha^{-1}.

Dr. RAJENDRA PRASAD CENTRAL AGRICULTURAL UNIVERSITY, PUSA SAMASTIPUR

Tree Germplasm Collection, Evaluation and Improvement

Out of 18 different clones of Poplar (*Populus deltoides* Bartr.), PP-9-OPR-1 and PP-9-J1 were superior in terms of height and DBH at the age of 4 years of plantation. Height and DBH varied from 7.33-7.86 m and 7.75-8.41 cm, respectively.

System Research

In *Bombax ceiba* based agri-silvicultural systems, the growth parameters in terms of height and GBH of 6-year-old *B. ceiba* trees and their mean annual increment were significantly higher under lower density plantations (*i.e.* at the spacing of 5 × 4 m and 5 × 5 m). On the other hand, crown width did not show any marked difference with the density of the plantations and varied between 3.56-4.39 m. Sesamum and lentil yield significantly decreased irrespective of the spacings when compared to the sole cropping. Grain yield reduction of the crops varied from 14.0 to 46.2% and 17.8 to 37.7%, respectively and the yield reductions were in the order of 5 m × 2 m > 5 m × 3 m > 5 m × 4 m > 5 m × 5 m, respectively.

The assessment of soil properties in the thirteen-year-old plantations of Kadamb, Litchi, and Simarouba, the latter was found to have significantly higher soil active carbon, soil respiration, soil protein, and microbial biomass in all four seasons *i.e.* summer (June), autumn (September), winter (December) and spring (March). Soil active carbon, soil respiration and soil protein varied from 121.45-277.09 mg kg^{-1}, 0.324-0.694 mg g^{-1} and 0.67-2.25 mg g^{-1}, respectively. Significantly lower metabolic quotient alongwith significantly higher microbial quotient values were found in agroforestry systems in comparison to control. All the three plantations, Kadamb, Litchi, and Simarouba exhibited a significant increase in wet aggregate stability in comparison to the control, though soil hardness and bulk density were significantly higher in the control plot in comparison to agroforestry. All treatments showed a decrease in wet aggregate stability and an increase in soil hardness and bulk density with an increase in soil depth.

ORISSA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, BHUBANESHWAR

Survey, Diagnostic and Design

Diagnostic and Design survey related to homestead agroforestry was undertaken in four districts (Khurda & Puri) comprising 4 blocks and 8 villages. A total number of 100 farmers were interviewed as per the pre-structured questionnaires. Many heterogeneous species of trees, shrubs, vegetables and herbaceous plants are grown in random arrangements with dense plant population. The home gardens are characterized by high species diversity

and usually 3-4 vertical canopy strata. These consist of an herbaceous layer near ground, a tree layer at the upper level and two intermediate layers. The upper most layer is tree layer which can be divided into two, consisting of the emergent full-grown timber and fruit trees having height more than 20.0 m and medium size trees of 10-20 m. In the upper layer, species like *Samanea saman*, *Bambusa vulgaris*, *Bambusa tulda*, jamun, coconut, arecanut, jack fruit, bael, tamarind, neem, subabul, *etc.* are grown.

Tree Germplasm Collection, Evaluation and Improvement

Seven entries of *Gmelina arborea* collected from three states namely Odisha, West Bengal and Assam and after 66 months of planting, the Durgaprasad (Odisha) entry recorded highest plant height (4.62 m), basal girth (22.5 cm) and crown spread (5.27 m). However, the lowest plant height of (3.06 m), basal girth (17.04 cm) and crown spread (4.01 m) was found with Jhargram, WB collection.

System Research

In silvipastoral system the highest plant growth was observed in *Acacia mangium* with setaria (height 15.6 m, DBH 14.8 cm and crown spread 8.4 m) followed by *A. auriculiformis* (height 12.7 m, DBH 10.7 cm and crown spread 7.8 m) and lowest tree height of 4.6 m, DBH 6.2 cm and crown spread 3.1 m were recorded in *S.saman* with thin napier after 66 months of planting. The highest solar radiation interception was recorded in *S. saman* with guinea. Better moisture storage was evident with *A. mangium* during August, September and October irrespective of intercrops. The maximum green forage yield was obtained from Guinea (17.6 t/ha) from three cuttings and Thin Napier was the next best with a yield of 14.9 t/ha during 2020. Highest yield recovery percentage was recorded with Guinea (62.2%). In gambhar based agri-silvicultural system the highest plant height (6.15 m), basal girth (30.5 cm) and crown spread (5.65 m) was observed when intercropped with green gram-toria. The highest values of soil available N (262.4 kg/ha), K_2O (118.8 kg/ha) and lowest value of available P_2O_5 (43.7) were with green gram-toria. *G. arborea* + cowpea-toria recorded the highest arhar equivalent yield of 1012 kg/ha and the net return of Rs. 25,960/ha and B:C ratio of 1.47. In mango + pineapple agri-horticultural system, the highest mango equivalent yield was observed in the treatments having drip irrigation system *viz.,* STD (100%)+ FYM 5 t/ha (19496 kg/ha). The maximum average net return of Rs. 4,09,880 and BCR of 3.34 & highest field water use efficiency (147.7 kg/ha-cm) recorded with STD (100%)+ FYM 5 t/ha with drip irrigation. The organic treatment recorded lowest fruit yield, net return and BCR irrespective of irrigation method. The B:C ratio was highest in pineapple under *Tectona grandis* having paired row spacing 60-100 x 30 cm^2 as 2.41.

BIDHAN CHANDRA KRISHI VISHWA VIDYALAYA, RRS-JHARGRAM

Survey, Diagnostic and Design

Survey among farmers in different villages of Jhargram, Binpur II of Jhargram district; Salboni of Paschim Medinipore for extension of agroforestry systems in farmers' plots. Based on the findngs of the survey, on-farm Demonstration of gamhar (*Gmelina arborea* Roxb.) - mango (*Mangifera indica* L.) based systems with pigeon pea {*Cajanus cajan* (L.) Millsp.}, boundary plantation with gamhar and lamboo, homestead agroforestry has been done.

Tree Germplasm Collection, Evaluation and Improvement

Evaluated multipurpose trees *Acacia auriculiformis, Neolamarckia cadamba,* and lamboo on height, diameter at breast height (DBH), bole height and volume yield have been recorded to identify superior germplasms in terms of growth habit and timber quality. Evaluated 18 germplasms of *Gmelina arborea* for genetically superior plants and six superior germplasms identified based on their growth parameters. Twenty-nine germplasms of *Acacia auriculiformis* evaluated and eight were identified for better growth.

System Research

The studies on effect of alley cropping and mulching on early growth of gamhar (*Gmelina arborea*) – ber (*Zizyphus mauritiana* Lam) agroforestry system, showed mulching improved growth of both gamhar as reflected in Dbh, height as well as crown spread of gamhar. It has influenced shoot length, girth and fruits yield also. The System return increased from Rs. 29,316/- to Rs. 34335/- with inclusion of arhar as intercrop and mulching further increased system profit Rs. 33576-34335 without arhar and Rs. 36994-37294 with inclusion of alley crop.

In order to identify the appropriate land use system towards enhancing productivity of marginal lands under rain fed conditions, an effort was made to develop agroforestry system integrating the arable crops, fruit trees and silvi components for rainfed upland under red & laterite tract of humid & sub-humid zone. The study was

conducted to evaluate effect of intercropping in *Neolamarckia cadamba*) – mango (*Mangifera indica* L.) - based agroforestry system. The maximum wood volume yield (11.56 m^3/tree) was in sole *Neolamarckia cadamba* and the lowest wood volume was in T4 (*Neolamarckia cadamba* – mango). Alley crop increased wood volume of *Neolamarckia cadamba* when alley crops were grown in silvi-horti agroforestry system (Table 5.3.2.1). Maximum Mango fruit yield (1.65 t/ha) was recorded both in sole mango T6. Inclusion of silvi components and intercropping favoured height of mango plants but reduced fruit yield. Alley crop in agroforestry system improved physico chemical properties of the soil over sole silvi or silvi-horti system or sole alley crops. Analysis of soil after growing of inter crops indicated that arhar grown within the rows of *Neolamarckia cadamba* – mango (T_1) based agroforestry system recorded the highest values of available N (171.7 kg/ha), K (225 kg/ha), and available P (35.5 kg/ha). Organic carbon in this system varied from 2.92 g/kg in T_6 (Sole mango) to 3.77 g/kg in T_1 (*Neolamarckia cadamba* – mango - arhar). The pH range varies from 5.2 in T_5 (sole *Neolamarckia cadamba)* and T_6 (sole mango) to 5.5 in T_1 (*Neolamarckia cadamba* – mango + arhar), T_2 (*Neolamarckia cadamba* - mango + cowpea + toria) and T_3 (*Neolamarckia cadamba* - mango + green gram + toria). Maximum net return (Rs. 28052/ha) and maximum arhar equivalent yield (AEY) (9.67) and BCR of 3.08 was obtained in T_8 (cowpea + toria) among alley crops under different production systems. However overall net return from the agroforestry system was much higher in T_2 (*Neolamarckia cadamba* - mango + cowpea + toria) (Rs. 183426/ha) in comparison to T_4 (*Neolamarckia cadamba* – mango) (Rs. 167951/ha) or sole mango (Rs. 109000/ha) or sole *Neolamarckia cadamba* (Rs. 35531/ha).

BIRSA AGRICULTURAL UNIVERSITY, RANCHI

Tree Germplasm Collection, Evaluation and Improvement

Under evaluation of Multipurpose Tree Species (MPTs) for Adaptability and Growth Performance, after three years of plantation the maximum average height was observed in treatment T_{10} - *Acacia auriculiformis* 6.39 m. followed by treatment T_7 - *Gmelina arborea* 3.38 m. Whereas average maximum dbh (8.04 cm) were observed in treatment T_{10} - *Acacia auriculiformis*, followed by (5.67 cm) in treatment T_7 - *Gmelina arborea.* The maximum height increment (3.15 m) was found in treatment T_{10} - *Acacia auriculiformis.*

System Research

Studies on performance of fodder crops with Bakain (*Melia azedarach*) under silvi-pastoral system revealed, after three years of plantation, significant height increment with different fodder crops with maximum in treatment T_5 –*ie.* Sole Bakain 1.93 m followed by at par performance of height growth increment in treatment T_3 - Bakain with Brachiaria 1.69 m and *treatment* T_1 - Bakain with *Stylosanthus hamata* 1.58 m. The minimum height increment was observed in treatment T_4 - Bakain with Hybrid Napier 0.71 m. Significantly maximum green fodder yield (941.50 q/ha) of forage crops was recorded in treatment T_9 sole Hybrid Napier, followed by in combination treatment T_4 - *Melia azedarach* + Hybrid Napier 807.43 q/ha, whereas the minimum green fodder crops yield (255.17 q/ha) was recorded in of treatment T_2 - *Melia azedarach* + Charabadam (*Arachis glabrata*) combination. The combination of Bakain + Hybrid napier treatment gave maximum net income Rs. 143394 with net benefit cost ratio 7.55. The maximum organic carbon content (0.37%) and available nitrogen content (200.33 kg/ha) was recorded in treatment combination treatment T_1 - Bakain + *Stylosanthes*.

After three years of establishment of Tephrosia hedgerow under Alley cropping based Agrisilviculture system, black gram equivalent yield (q/ha) was calculated for all the four crops *viz*. soybean, Finger millet, green gram and groundnut. Significantly maximum grain yield (10.75 (q/ha) was recorded in treatment combinationT_4 Tephrosia + Black gram, whereas minimum grain yield (4.74 q/ha) was recorded in treatment combination T_5 *i.e.* Tephrosia + Green gram. It was observed that the combination Tephrosia + Ground nut + Lentil recorded maximum net return of Rs. 76576 with Benefit ratio 1.63 followed by net return of Rs. 61968 with benefit cost ratio 1.48 in treatment combination Tephrosia + Finger millet + Field pea.

CHAUDHARY CHARAN SINGH HARYANA AGRICULTURAL UNIVERSITY, HISAR

Tree Germplasm Collection, Evaluation and Improvement

Sixty eight clones of poplar from PAU, Ludhiana; GBPUA&T, Pantnagar and WIMCO has been raised in nursery and 14 clones from University of Horticulture & Forestry, Nauni, Solan have been observed for growth performance in field as multi-location trial. Progenies of 18 CPTs of *Melia composita* exhibited significant variability *w.r.t* growth characters in the field.

System Research

After 4 years of age, poplar planted at 8×3 m attained significantly higher dbh (22.6 cm) than other spacings (7×3, 6×3, 5×3, 4×3 and 3×3 m) and it was about 24 per cent higher than closer spacing (3 × 3 m). The maximum grain yield (4.64 t/ha) was recorded in wheat variety HD-2967 closely followed by WH-711 (4.21 t/ha) in wider spacing (8 ×3m) of poplar. On an average, the reduction in grain yield of different wheat varieties under poplar varied from 1.81 (8×3m) to 23.5 per cent (3 × 3 m) over control (sole wheat). The maximum green fodder yield of berseem (40.0 t/ha) and sorghum (35.4 t/ha) was found under 8×3 m spacing of poplar plantation however,

overall reduction of 16.5% and 25.5% in green fodder yield of berseem and sorghum, respectively under different spacing was recorded over control. In five-years-old poplar planted at 5×3 m spacing, recommended dose of fertilizer + additional dose of N (10, 20 and 30%) significantly increased the grain as well as straw yield over recommended dose of fertilizer in wheat. However, the differences between RDF + 10% additional dose of N, RDF + 20% additional dose of N and RDF + 30% additional dose of N were found non-significant.

In trial of eucalypts planted at 8×2 m spacing, the reduction in yield of cowpea, mustard, moong, wheat and barseem was 27.9, 27.6, 22.6, 19.9 and 15.6 per cent, respectively over control (sole crop). Significantly higher grain and straw yield of wheat was observed in agri-horti system as compared to agri-silvi-horti system. However, grain yield of wheat under agri-silvihorti and agri-horti system reduced up to 78.26 and 74.14 per cent, respectively over control (sole wheat).

Maximum grain and straw yield of wheat was found in the interspaces of Eucalyptus clone-83 followed by C-7. The average reduction in grain and straw yield of wheat under eucalypts (planted in February, 2015 at 7×3 m) was 27.8 and 30.5 per cent, respectively over control (devoid of trees). Five years old poplar and eucalypts planted on field bunds exhibited significant reduction up to 6 m in fodder yield of sorghum and up to 3 m in grain yield of wheat from tree line.

SRI KARAN NARENDRA AGRICULTURE UNIVERSITY, RRS, FATEHPUR SHEKHAWATI

Tree Germplasm Collection, Evaluation and Improvement

Evaluating thirteen provenances of *P. cineraria* (Gujarat), 15 plus tree germplasm of local Sikar district and germplasm of six location source of Rajasthan *viz.,* Bikaner, Jhujhunu, Churu, Sikar, Jaipur, Nagaur and one from Haryana (Hisar) available with the centre. The centre is also evaluating the germplasm of *H. binata* bought from CAFRI, Jhansi and CAZRI, Jodhpur in rainfed arid condition of Rajasthan. Four tree species *viz*., *P. cineraria, A. nilotica, A. tortilis* and *H. binata* were planted at 5 m x 5 m in block plantation. Data revealed that *A. tortilis* registered maximum tree volume 0.92 m^3/tree followed by *P. cineraria* 0.25 m^3/tree and *H. binata* 0.22 m^3/tree after 23 years.

System Research

Experiment on performance of 33-year-old *Hardwickia binata* in agri-silviculture system indicated that the effect of tree spacing on growth performance was found significant. The tree height and dbh was increased up to 5-meter row spacing and received highest volume 0.35 cu m/tree. Thereafter, the growth was less pronounced with spacing. Thus, it is recommended that these trees gave good growth when planting at 5 x 5 m spacing in rainfed condition of arid zone.

Studies on Intercropping of rainfed *kharif* crops varieties in *Prosopis cineraria* based agri-silviculture system revealed that highest yield was recorded in clusterbean RGC-1066 (663 kg/ha) followed by RGC-1033 (637kg/ha), Cowpea RC-101 (601 kg/ha) and Pearl millet MPMH-17 (528 kg/ha). When we compared the data with open field it is concluded that under *P. cineraria* yield was higher in comparison to sole cropping system in all the crops and was highest increased observed in Clusterbean 1033 (22.92%) followed by Pearlmillet (21.97%) and Cowpea (20.52%). Intercropping of rainfed *kharif* crops varieties in *Hardwikia binata* based agri-silviculture system showed that highest yield was recorded in Cowpea RC-101 (471 kg/ha) followed by RGC-1066 (419 kg/ha) and RGC-1033 (407 kg/ha). Upon comparison with open field, it is concluded that under *H. binata* tree (15-18 years old) crops yield was observed low in comparison to sole cropping system in all the crops taken and was highest decreased observed in Pearlmillet (37 to 25%) followed by Clusterbean-1066 (25.97%) and Moth-257 (23.65%) without pruned tree condition.

Studies on effect of different agro-forestry systems on biomass and carbon stock in arid zone of Rajasthan showed that in more than 25 years old agroforestry system, the highest soil organic carbon stock was recorded in Rohida (*Tecomella undulate + Cenchrus ciliaris*) based silvi-pasture system *i.e.* 23.44 t per ha followed by babool-based forestry system *i.e.* 21.06 t/ha, respectively. The Highest Carbon stock recorded in *Cenchrus ciliaris* Nutans-based silvi-pasture system *i.e.* 2.04 ton /ha followed by Rohida (*Tecomella undulate* + *Cenchrus ciliaris*) based agro-forestry system.

SARDARKRUSHINAGAR- DANTIWADA AGRICULTURAL UNIVERSITY, SK NAGAR

Tree Germplasm Collection, Evaluation and Improvement

Ailanthus excelsa germplasm evaluation studies in rainfed

condition revealed that among the thirty germplasm of ardusa Mithivavadi and Soneripura villages seed sources is the best performing in terms of growth parameters *viz.* the highest plant height (10.77m) in Mithivavadi germplasms and the highest collar diameter (27.02 cm) in Soneripura germplasms after tenth years of plantation. Collar diameter of different germplasm ranged from 17.94 to 27.02 cm.

After sixteen years of plantation among the ten elite progenies of neem along with a local check Progeny No 110 gave the highest plant height (8.73 m) and collar diameter (26.65cm) in the multi locational coordinates trial. Among the eleven genotypes of melia along with a local check a significant difference was observed for their growth parameters under arid and semi-arid region of the Gujarat. After twenty-four months of plantation significantly higher plant height (7.38 m) was noted under the genotype SDAUMD-11and the highest collar diameter (11.73 cm) was also recorded in SDAUMD 11 genotype. Significantly the highest Canopy N-S was observed in SDAUMD-7 (2.87 m) and it was followed by SDAUMD-3 (2.84 m) over local check (2.28 m) and in E-W direction it was significantly higher in SDAUMD-7 (2.98 m) and it was followed by SDAUMD-8 (2.94 m) and SDAUMD-3 (2.89 m) than local check (2.46 m).

System Research

In boundary plantation of ardusa + neem, ardusa plantation has maximum plant height (12.12 m) in north side but collar diameter (40.96 cm) in south side. Whereas, in case of neem plantation, maximum plant height (7.44 m) and collar diameter (16.50 cm) was recorded in south direction. Maximum grain yield of moongbean (390 kg ha-1) and mustard (440 kg ha^{-1}) and straw yield (756 kg ha^{-1}) of moongbean in the moongbean- mustard crop sequence were observed in middle part of the plot.

During second year of *Ailanthus*-based medicinal plants agroforestry system significantly the highest plant height was noted under the treatment of kalmegh sole (72.4 cm) and it was followed by ardusa + kalmegh and ardusa + ashwagandha. Significantly the highest isabgol equivalent yield was recorded under the treatment of kalmegh sole (757.20 kg/ha) and it was followed by ardusa + kalmegh, isabgol sole and ardusa + isabgol treatments. The lowest isabgol equivalent yield was obtained from the ardusa + ashwagandha. Significantly the highest phosphorus content at 0-15 cm was noted under isabgol sole treatment over rest of the treatments except ardusa + isabgol treatment but at 15-30 cm soil depth phosphorus content did not differ significantly. Significantly the highest potassium content was noted under the treatment of ardusa + isabgol treatment over rest of the treatments except isabgol sole at 0-15 cm depth and isabgol sole and kalmegh sole at 15-30 cm soil depth.

MAHATAMA PHULE KRISHI VIDYAPEETH, RAHURI

Tree Germplasm Collection, Evaluation and Improvement

Among the 21-tree germplasm under evaluation for various characters, *Khaya grandiflora* recorded highest plant height (24.20 m), collar diameter (57.15 cm), DBH (47.56 cm) and bole height (11.10 m), followed by *Anogeissus latifolia, Acacia tortilis* and *Terminalia bellirica* were also found promising for the growth characters.

System Research

In the experiment on evaluation of agri-horticulutral system of different fruit tree species with inter crop under irrigated condition, treatment T_5 *i.e.* Tamarind in conjugation with aonla, aonla recorded maximum plant height (540) cm, collar diameter (22.6 cm), more branches per plant (7) and the east-west spread (765.52 cm), and north-south spread (504.62 cm) of tree canopy. Tree canopy was more of Anola in treatment T_7 Mango in conjugation with aonla. In *Rabi* season T_9 *i.e.* (Sole chickpea + sole soybean) recorded significantly the highest grain and straw yield of Gram (12.85 and 21.85 q ha^{-1}). Among inter crop treatments, treatment T_8 *i.e.* (Mango + Custard apple recorded the grain and straw yield of chickpea (11.71 and 18.14 q ha^{-1}). In *Kharif* season T_9 *i.e.* (sole chickpea + sole soybean) recorded significantly the highest grain and straw yield of soybean (13.08 and 19.55 q ha^{-1}) which was at par with rest of the treatments under investigation except T_1 & T_5. The highest gross, net monetary returns, and B:C ratio (Rs. 64818, 32818,2.0) respectively was obtained with the treatment T9 *i.e.* sole chickpea. In *kharif* season the highest gross, net monetary returns and B:C ratio, Rs. 52721, 19721, 1.6 ha^{-1} and 1.65), respectively was obtained with the treatment T_9 *i.e.* (Sole soybean). With different fruit tree species, the highest gross/net monetary returns and B:C ratio (Rs. 104026, 198087 ha^{-1}) and 2.2 was obtained in the treatment T_7 i:e Mango + Aonla. In total Agro horti system highest gross, net monetary returns and B:C ratio (Rs, 19887, 109113) and 2.2 respectively was obtained in the treatment T_7 Mango + Aonla (R. Chickpea + K. Soybean).

In the experiment entitled "Effect of planting geometry on productivity of Teak under Agroforestry system in semi-arid condition" the growth parameters *viz.*, plant height, collar diameter, crown spread (East, West) and (North, South) of teak plants. The litter fall ranged from (190 to 290 kg ha^{-1}) maximum plant height, collar diameter, crown spread (east west) and (north south) 523,10.72,245 and157 cm respectively was recorded under T_6 (Teak + cowpea + mulching – fodder. The grain and straw yield were highest in sole treatments of Cowpea and Black gram 10.11 and 8.98 q ha^{-1}. Among intercrop treatments grain and straw yield was recorded more under treatment T_6 (Teak + Cowpea + mulching - Fodder Maize) (9.58 q ha^{-1} and 18.38 q ha^{-1}) respectively. In regards with *Rabi* season the sole crop

fodder maize T_9 (Sole crop black gram - fodder maize) recorded higher fodder yield (387.13) q ha^{-1}. Among intercrop fodder treatments, T_7 Teak + Black gram mulching + fodder maize and T_2 *i.e.* Teak + Cowpea-fodder maize recorded higher maize fodder yield (384.92 q ha^{-1}). Land equivalent ratio for *kharif* pulses was more in treatment T_3 (Teak (Paired row) 8 m x 2 m x 2 m + Cowpea - Fodder Maize (0.95) and for *Rabi* fodder, intercrop treatment T_2 (Teak Paired row 8 m x 2 m x 2 m) + Cowpea - Fodder sorghum (0.99). The Pulses fodder system economics based on cowpea equivalent yield (*kharif* and *rabi*) revealed that the higher system productivity q h^{-1} was obtained in treatment T_8 and T_2 (26.68 & 26.02 q ha^{-1}). Significantly higher GMR was obtained in treatment T_8 (sole crop cowpea + fodder sorghum) Rs. 113620, which was at par with treatment T_2, T_4 and T_9. Whereas regarding NMR (Rs. 43620) and B:C ratio (1.62) was more in T_8 (Sole crop Cowpea + Fodder Sorghum).

Dr. PANJABRAO DESHMUKH KRISHI VIDYAPEETH, COA, NAGPUR

Tree Germplasm Collection, Evaluation and Improvement

Among the evaluation of thirteen plus trees of Teak on the basis of wood volume ha^{-1} it can be concluded that CPT No. CAN/ MHK/1 is best followed by CAN/ MHK/4. The progeny of CPT-1 and CPT-4 were found better in all characters. These CPTs may prove better in future for selection of the superior genotype. Among the different *Melia dubia* clone, maximum height and girth were recorded in PDKV/MTP/5 and PDKV/MTP/4, respectively, whereas maximum tree volume ha^{-1}, above ground biomass, below ground biomass, total standing biomass, above ground carbon, below ground carbon and total carbon sequestration tha^{-1} was recorded in PDKV/MTP/6 followed by PDKV/MTP/4 and PDKV/MTP/5. In a study on effect of fertilizers on growth and yield of *Bamboosa balcooa,* it observed that among the different fertilizer treatment applied to *Babmoosa balcooa*, the application of 100:25:75 gm NPK $plan^{t-1}$ attained maximum height (4.03 m), girth of culm (10.25 cm), clump volume (125.35 m^3 ha^{-1}), aboveground biomass (38.86 t ha^{-1}), belowground biomass (10.10 t ha^{-1}), total standing biomass (48.96 t ha^{-1}), aboveground carbon (19.43 t ha^{-1}), below ground carbon (5.05 t ha^{-1}) and total carbon sequestrated was 24.48 t/ha.

System Research

In a study of agri-horti-silviculture system under citrus based agroforestry system concluded that the yield of intercrops was recorded in order: Sole cropping (5.75 & 10.31 qha^{-1}) > Sole Mandarin (4.28 & 8.51qha^{-1}) >Mandarin + *Eucalyptus tereticornis* (3.22 & 7.93 q ha^{-1}) >Mandarin + *Tectona grandis* (2.51 & 7.45qha^{-1}) >Mandarin + *Ailanthus excelsa* (2.12 & 6.82 qha^{-1}). The collar diameter (5.92 cm) and height of mandarin (2.79 m) was maximum under mandarin in combination with *Tectona grandis*, whereas lowest collar diameter (3.00 cm) and height (1.47 m) of mandarin in absence of trees. *Ailanthus excelsa* recorded maximum tree GBH (64.00 cm) and tree collar girth (82.75 cm) followed by *Eucalyptus teretocornis* and *Tectona grandis*. Maximum tree height was recorded in *Eucalyptus tereticornis* (11.64 cm) followed by *Ailanthus excelsa* and *Tectona grandis*. The total standing biomass in *Eucalyptus tereticornis* was 75.94 and 48.10% higher as compared to *Tectona grandis* and *Ailanthus excelsa*, respectively. The total aboveground, belowground and total standing biomass in experimental agroforestry system was 80.96, 21.03 and 101.99 t ha^{-1}, respectively. The total carbon sequestrated in *Eucalyptus tereticornis* was 48.18 and 79.34% higher as compared to carbon sequestrated in *Ailanthus excelsa* and *Tectona grandis*. The value carbon stock ranged between 14.30 to 12.85 Mg ha^{-1}under different agroforestry systems. Carbon stock was recorded maximum in Mandarin + *Ailanthus excelsa* agroforestry systems (14.30 Mg ha^{-1}) and lowest in Mandarin + *Eucalyptus tereticornis*. The carbon stock in soil under Mandarin + *Ailanthus excelsa* was 0.35, 2.87, 9.37 and 10.14 per cent higher than the stock in soil of sole cropping, sole Mandarin, Mandarin + *Tectona grandis* and Mandarin + *Eucalyptus tereticornis*, respectively. The economics of sole cropping in comparison to different citrus based agroforestry systems show that maximum benefit : cost ratio was recorded under mandarin + *Eucalyptus teriticornis* + intercrop (5.06), whereas minimum value was recorded under (2.94).The percent increase in B:C ratio under T_3Mandarin + *Tectona grandis* + Intercrop (cowpea + Mustard), T_4 Mandarin + *Eucalyptus teritocornis* + Intercrop (cowpea + Mustard), T_5 Mandarin + *Ailanthus excelsa* + Intercrop (cowpea + Mustard) was 40.75, 139.81, 39.336% over the sole cropping (cowpea + Mustard).

The study on different treatment under paired-row teak plantation, the maximum height and collar diameter of teak was recorded in treatment T_3 (Teak (Paired row) 8 x 2 x 2 m + Green gram–Fodder Barseem). Highest grain yield (8.27 q ha^{-1}) and highest straw yield (17.25q ha^{-1}) was recorded in Sole black gram-Fodder Barseem. During *rabi* season highest fodder yield (548.10 q ha^{-1}) with monetary return (Rs. 126063 ha^{-1}) was recorded in sole black gram + Barseem sequence.

In a study on effect of Feeding Bamboo (*Dendrocalamus strictus*) leaves on growth performance of Osmanabadi Goats, it revealed that the bamboo leaves contained 57.90% DM, 12.38%CP, 26.34% CF, 4.17% EE, 18.26% total ash and 38.85% NFE on dry matter basis respectively. Feeding of 60 per cent bamboo leaves with concentrate and roughages improved the growth performance of osmanabadi goat. Digestibility of nutrients and efficiency

of feed utilization was significantly higher in 60 per cent inclusion of bamboo leaves. The leaves had DCP 8.13 per cent and 53.38 per cent TDN showing good source of protein and energy for goat feeding. The feeding bamboo leaves at 60 per cent level is economical in term of body weight gain. It is therefore, suggested that incorporation of 60 per cent bamboo leaves in the diet of osmanabadi goats could meet the requirement of maintenance and growth without any adverse effect on health.

JAWAHARLAL NEHRU KRISHI VISHWA VIDYALAYA, JABALPUR

Tree Germplasm Collection, Evaluation and Improvement

A total of seven provenances of *Dalbergia sissoo* were collected from different places including seedlings of two plus tree from Jhansi (PT_6 and PT_2) and evaluated for their performance with respect to plant height, collar diameter, branches per plant and dbh at an interval of one year. Half-year-old provenances were planted at 5mx3m row to row and plant to plant spacing during 2010 *Kharif* season. Among the different progenies PT_2 (NRC Jhansi) attended the maximum height of 986 cm, collar diameter (192 mm) and dbh of 157 mm closely followed by PT_6 (NRC Jhansi) 932 cm, 190 mm and 153 mm, respectively at an age of 10½ years old. These two provenances proved their superiority over others, taken under study.

System Research

A fruit tree - minor millets- oilseed crop under mango based agri-horticulture practice was evaluated in order to assess the effect of fruit tree orientation on growth and yield of millets subsequently on linseed. Results revealed that growing of Kodo under mango gave grain yield of 686.2 kg ha^{-1} which was superior to other millets. Further, it was also observed that in an intercrop, there were a minimum yield reduction of millet under the system of mango over sole. However, higher net income of Rs. 6694 was received with Kutki under mango though, the net income was reduced by Rs. 3765/ha. The minimum yield reduction of millets under mango may be due to its slow initial growth resulting less shade and competition with crops. The growing of various minor millet crops with mango fruit tree as companion crop showed differential behavior with the vegetative growth of mango fruit tree. The significantly maximum height (147.25 cm) and collar diameter (34.95 mm) of mango was observed under sole closely followed by mango + kutki 138.76 and 32.76 cm for height and collar diameter, respectively. While the lowest height of 131.38 cm and collar diameter (30.48 mm) of mango was observed when kodo was grown with mango. In *rabi* crop, among the varieties of linseed JLS-66 performed well under both the conditions of with mango or without mango (open) with respect to seed and straw yields. The variety JLS-66 recorded 710.60 and 713.46 kg ha^{-1} seed yield and fetched NMR of Rs. 19163 and 23553/ha under shade and open, respectively.

A field study was carried out to select out the suitable herbicidal treatment for enhancing yield potential of crops (Rice and Wheat) under different pruning intensities of *Dalbergia sissoo.* In *Kharif,* the growth and development of paddy under 75% pruning was found superior over no pruning and pruning at 50 and 25%. However, cultivation of paddy under open condition performed well over shade. As regards to herbicidal treatment, application of Pendimethalin @ 1.0 kg ha^{-1} as PE followed by hand weeding at 30 DAS gave 1904 kg ha^{-1} grain yield with NMR of Rs. 52988 ha^{-1} however the NMR of Rs. 55820 ha^{-1} was observed under Pendimethalin @ 1.0 kg ha^{-1} as PE, followed by Bispyriback sodium @25 g ha^{-1} as PoE. In *Rabi* season, the wheat yield of 1834kg ha^{-1} with net return of Rs. 39915 ha^{-1} was recorded under pruning intensity of 75% which was proved superior over other pruning. Similarly, the spray of Pendimethalin followed by metribuzin @ 1.0 kg as PE and 230g ha^{-1} as PoE respectively fetched higher monitory return of Rs. 57823 ha^{-1} and found superior over others.

PROFESSOR JAYASHANKAR TELANGANA STATE AGRICULTURAL UNIVERSITY, HYDERABAD

Tree Germplasm Collection, Evaluation and Improvement

In Neem multi-location trial (MLT), Line-117 recorded higher mean plant height (8.1 m), Line-115 (8.1 m) with mean girth (72.8 cms). The fruiting score was higher in these lines. In Pongamia germplasm, SRJ-39 recorded highest plant height (8.0 m) followed by SRJ-43 (7.6 m), SRJ-45 (7.5 m). In terms of DBH, SRJ-39 recorded highest DBH (70 cms) followed by NGSR-27 (68 cms). The pod yield was 10.5 to 12 kg / plant.

System Research

In custard apple based Horti-pastoral system (6 years old), application of 75% RDN + 25% N Pongamia green leaf manuring (PGLM) produced higher green forage yield (21.5 t /ha), dry forage yield (6.97 t/ha) which was at par with 100% RDF (60-60-40 N P kg ha^{-1}) recorded GFY (19.2 t /ha) followed by 75% RDN + 25% N Poultry manure (19.4 t / ha), 75% RDN + 25% FYM (18.05 t / ha) and significantly higher when compared to other treatments. The seasonal gas emissions of CO_2 and N_2O were not influenced by type of grasses. Whereas, CO_2 emissions was influenced by INM practices and varied from 851 kg ha^{-1} $season^{-1}$. (Control) to 1370 kg ha^{-1} $season^{-1}$ (100% RDF).

Neem green leaf manuring (25% substitution) lowered seasonal CO_2 emission. Whereas, N_2O emissions were lower with 25% substitutions of NGLM (712 g ha^{-1} $season^{-1}$) when compared to 100% RDF. We can conclude that

integration of green manuring along with inorganic is environmentally safe for recommendation as the CO_2 and N_2O gas emissions were low in green manuring treatments as compared to 100% inorganic treatment.

In Mango based Agri-horti system (4 years old), significantly higher maize equivalent yield (MEY) in Maize + Redgram system along with curry leaf filler crop, the system productivity was recorded with 125% RDF (8,398 kg/ha) followed by 100% RDF (8,204 kg/ ha), 75% RDN + 25% Poultry manure (8,065 kg/ha). The net returns and B:C ratio was recorded was significantly higher with 125% RDF (Rs. 1,29,066/ha, 2.04), 100% RDF (Rs. 1,21,816/ha, 1.98) and 75% RDN + Poultry manure (Rs. 1,11,823/ha, 1.61). we can conclude that 75% inorganic + 25% organic is best treatment for recommendation as the yields and net returns were on par for 125% RDF followed by 100% RDF and 75% RDN + 25% Poultry manure.

In studies on performance of different intercrops in *Melia dubia* system, blackgram has produced significantly higher returns when compared to other inter crops (Rs. 12832, 15100 ha^{-1}) during both the years. The net returns from all the sole crops were higher when compared to intercropping. There was less percentage (<20%) reduction of net returns when grown as intercrops. The light intensity and light interception values show that there was partial shading of trees on different inter crops. The mean biomass and carbon stock estimated was higher in clone-II (17.0 t/ha, 7.6 t/ha) during 4^{th} year of cultivation.

Among the intercrops, Cowpea intercropping has produced higher tree parameters like mean biomass (17.6 t/ha) with carbon stock (7.9 t/ha), which was significantly at par with other inter cropping systems. Based on the results, we can recommend either millets or pulses as inter crops in *Melia dubia* system. Farmers can choose either millets or pulses based on the demand and marketability (supporting price) at their locality.

Dr. BALA SAHEB KONKAN KRISHI VIDYAPEETH, DAPOLI

Tree Germplasm Collection, Evaluation and Improvement

After four year of evaluation MTP-2 (Clone) of *Melia dubia* at 5 x 5 m spacing, the average height of *Melia dubia* was observed 13.38 m and CAI of height was 0.45 m, whereas DBH of *Melia dubia* was 20.54 cm also CAI of DBH was 1.51 cm. The performance of growth and development of *Melia dubia* under Konkan condition after four-year evaluation is satisfactory and very fast-growing multipurpose tree. The Screening of varieties of lemon grass *viz.* Chirharita, Nima, CKP-25, Krishna, Praman and Kaveri, among the varieties Krishna variety is best performing for getting highest oil and foliage yield under *Arecanut* based agroforestry system.

System Research

The studies on effect of agroforestry litters on decomposition dynamics and soil properties in Alfisol, the application of *Terminalia tomentosa* residue @5 t ha^{-1} followed by *Gliricidia sepium* residue @5 t ha^{-1} showed significant improvement in available NPKS and DTPA-Zn, Fe, Mn & Cu of soil. The higher CO_2 evolution of soil was recorded *Terminalia tomentosa* residue @5 t ha^{-1} in throughout season may be due to conserve soil moisture. Incorporation of Application of *Terminalia tomentosa* residue @5 t ha^{-1} followed by *Gliricidia sepium* residue @5 t ha^{-1} had significant effect on height of mustard, protein and oil content in mustard grain than other. Overall, it can be concluded that the incorporation of *Terminalia tomentosa* residues @5 t ha^{-1} significantly improved soil fertility and crop productivity mustard grown in Alfisol than other residue applications. In option to incorporation of *Gliricidia sepium* residues @5 t ha^{-1} was observed at par with *Terminalia tomentosa* residues @5 t ha^{-1} and may be also recommended for farmer's use.

TAMIL NADU AGRICULRAL UNIVERSITY, METTUPALAYAM, TAMIL NADU

Tree Germplasm Collection, Evaluation and Improvement

A promising clone (MTPCP 18 – Arachalur) for *Ceiba pentendra* (Kapok) was observed to be drought tolerant coupled with high pod yield (1.2 lakh pods/ha) followed by Paramakudi MTPCP 37 clone (1.03 lakh pods/ha). A new kapok trial was established in farmer's field in Samanaickenpalayam, Coimbatore District. Twenty-three kapok progenies and 2 clonal genetic resources have been assembled for growth and yield evaluation. Early/Juvenile evaluation of the progenies and clones is in progress. Five genetic resources of *Melia dubia* are being evaluated in farmer's field at Therampalayam, Mettupalayam Three released clones *viz.* Melia MTP 1, MTP 2, MTP 3, Pre-release culture MTP 4 and MD 44 are being evaluated. Melia MTP 2 recorded maximum height, girth at breast height, basal diameter, and volume at 6, 9 and 12 months after planting followed by pre-release culture Melia MTP-4

System Research

To evaluate tree fodder to improve livestock productivity through development of quality feed pellets, tree fodder bank established with 20 tree species and significantly higher fodder yield of 238 t/ha was recorded in *Leucaena leucocephala* followed by *Leucaena diversifolia* (231 t/ha) and Preparation of pellets from the tree fodder is in progress. In 10-year-old Melia MTP 1 plantation, 25 medicinal plant species were intercropped for evaluating compatibility, growth and yield and initial growth evaluation studies indicated better compatibility of Adathoda (*Justicia adathoda*) under Melia.

TAMIL NADU VETERINARY AND ANIMAL SCIENCES UNIVERSITY, KATTUPAKKAM

System Research

In hortipasture model of agroforestry, soil application of biogas slurry and 3% foliar spray of Panchagavya significantly (P<0.05) increased the Desmanthus virgatus height and green fodder yield of 126.1 cm and 128.13t/ha/year, respectively. *Desmanthus virgatus* leaf meal harvested and dried from the hortipasture model can be included upto 7.5 per cent in Aseel birds ration without any adverse effects. No significant difference (P>0.05) was observed in the body weight between the treatment groups at the end of 12th week. Thus, Desmanthus virgatus leaf meal can be used in ration of aseel birds and can be enabled to reduce the competition of conventionally used feed ingredients among the livestock species.

Among the two different horti-pastoral systems, Cocos nucifera based horti-pastoral system sequestered the highest carbon (69.55 t/ha) followed by *Psidium guajava* based horti-pastoral system with 38.04 C t/ha. This is due to higher carbon storage by growing intercrops especially perennial fodder crops as compared to mono-cropping system. Among different *in-situ* soil moisture conservation treatments, mulching with coconut husk (T_2) produced significantly higher guava yield (44 kg/ tree) and pasture yield (10 t/ha) in the existing hortipasture system as compared to control.

Psidium guajava + *Cenchrus ciliaris* & *Stylosanthes hamata* 3:1 ratio-based grass-legume intercropping system is the best system for enhanced fodder production under hortipasture based agroforestry system. The total gas production is higher and methane production is lower during monsoon season.

The total biomass of thirteen-year-old *Gliricidia sepium* in silvipasture model in degraded wastelands was calculated as 98.64 t ha^{-1}, and a single tree accounts to about 0.061 t biomass. A total of 45.65 t C ha^{-1} was stored in the thirteen-year-old *Gliricidia sepium*. A total of 94.63% carbon was sequestered in the above ground components whereas only 5.37% carbon was sequestered in the below ground components of the trees. Annual increase in carbon sequestration potential of silvipasture in degraded lands was 2.96 t/ha. *Gliricidia sepium* with the understorey of *Stylosanthes scabra* based silvipastoral system show significant carbon accumulation in living biomass, as well as soil carbon, demonstrating the potential to offer the environmental service of carbon sequestration. Among different *in-situ* soil moisture conservation treatments, Gliricidia leaf mulch (T_3) produced significantly higher tree fodder and pasture yield in the existing silvipasture system as compared to control.

No significant difference was observed in *in vitro* total gas, carbon dioxide and methane produced between conventional concentrate mixture and Gliricidia sepium leaf meal incorporated concentrate mixture at 24 hours of incubation. There is non-significant difference in the milk yield between the conventional concentrate mixture and *Gliricidia sepium* leaf meal incorporated concentrate mixture fed group. Hence *Gliricidia sepium* tree leaf meal can be included upto 30 per cent in the concentrate feed of dairy cattle. Inclusion of *Gliricidia sepium* tree leaf meal upto 30 per cent reduces the concentrate feed cost by Rs. 4.64/-.

UNIVERSITY OF AGRICULTURE SCIENCES, DHARWAD, KARNATAKA

Survey, Diagnostic and Design

In Northern Dry Zone, *Azadirachta indica*, *Hardwickia binata, Prosopis cineraria, Acacia nilotica, Santalum album, Pterocarpus santalinus etc.*, are very common tree species. The other tree/fruit species *viz*., Teak, Malbar neem, Mango, Pomegranate, Papaya, Grapes etc are dominant in irrigated ecosystem. In Transitional Zone, the predominant perennial components are Teak, Mango, Sapota, Guava, Curryleaf, Jack and Jamun *etc.*, However, Teak is planted on the bunds/channels. *Melia dubia* is being cultivated in the recent past on large scales. In Hill Zone, the multi storied agroforestry systems are noticed in farmer's field where Arecanut, *Erithrina indica*, Jack, Cardamom, Jamun *etc*., were common species observed. The paddy is main field crop grown in lowlands. *Casuarina equisetifolia* is mainly grown as wind breaks in these areas.

Tree Germplasm Collection, Evaluation and Improvement

Among the fourteen tamarind collections *viz.,* NTI–5, NTI-14, NTI-15, NTI-19, NTI-31, NTI-32, NTI-77, NTI – 79, NTI-80, NTI-84, SMG-4, SMG-13, TKA-1, PKM-1 evaluated, the growth of NTI-5 (9.85 m) and NTI-80 (9.70 m) were significantly higher than the other collections. The highest fruit yield of tamarind was recorded in NTI-14 (19.47 kg/tree), NTI-19 (19.42 kg/tree) and SMG-13 (19.42 kg/tree) as compared to other clones. Among the ten tamarind clones *viz.*, V-2, TH, H-5, P-11, S-132, U-112, PKM-2, B-1, S-201 and HR-107 evaluated in degraded soil conditions, the maximum height was recorded in V-2 (12.33m) and PKM-2 (11.43 m), whereas the highest fruit yield of tamarind was recorded in the PKM-2 and V-2 when compared to other clones. Among the twenty provenances of the neem species collected, the maximum basal area and volume was recorded in source of Bijapur (0.102 m^2/tree and 0.899 m^3/tree) and Raichur (0.097 m^2/tree and 0.887m^3/tree) provenances respectively when compared to other provenances. However, the highest neem seed yield was registered in Bijapur (6.21 kg/tree) and Raichur provenances (6.10 kg/tree) compared to other provenances.

Among the eleven provenances of *Pongamia pinnata viz.*, RAK-103, RAK-106, RAK-11, RAK-90, RAK-22, RAK-5, RAK-89, MTP-1, MTP-II, MTP-III and DPS-4 evaluated, the maximum height was observed in the MTP-I (8.70 m) and MTP-II (8.18 m) while the highest seed yield was recorded in RAK-22 followed by MTP-II when compared to other provenances. Among the nine provenances of thorn less bamboo with 4 different clones of bamboo species evaluated, *Dendrocalamus stocksii* of Nasik provenance attained maximum height (6.65 m) followed by *Bambusa balcoa* of Chandagad (5.63 m) when compared to other bamboo species. The number of culms were higher in provenance of *Dendrocalamus stocksii* of Sindhudurg (15.58 culms) and *Bambusa vulgaris* of Ponnampet (12.53 culms). Among the seven varieties of *Emblica officinalis viz.*, Kanchan, NA-6, Chakaiya, NA-7, NA-10, Banaras, Dharwad varieties evaluated, the maximum height and collar diameter were recorded in Kanchan (1.66 m and 4.90 cm respectively) followed by Banaras (1.56 m and 3.97 cm respectively) as compared to other clones.

System Research

In an investigation of sapota - timber tree species-based agroforestry models, the height, basal area and volume was significantly higher in the *Pterocarpus marsupium* (14.34 m, 0.113 m^2/tree and 0.894 m^3/tree), whereas the growth of Sapota was significantly higher in association with Sapota + *Lagerstroemia lanceolata* (6.02 m). The fruit yield of sapota was maximum when sapota was grown alone (50.67 kg/tree) followed by Sapota + *Lagerstroemia lanceolata* (20.53 kg/tree) as compared to other tree species. The soil pH has slightly increased in the Sapota + *Tectona grandis* (7.2) while electrical conductivity (EC) of soil was decreased in Sapota + field crop and Sapota + *Pterocarpus marsupium* (0.40 dS/m) and Sapota + *Lagerstroemia lanceolata* (0.40 dS/m) as compared to initial values. The available nutrients *viz.,* nitrogen, phosphorous and potassium content were increased in Sapota + *Tectona grandis* (238.0 kg/ha), Sapota + *Pterocarpus marsupium* (55.2 kg/ha), Sapota + *Pterocarpus marsupium* (233.0 kg/ha) respectively and the organic carbon was increased in Sapota+ *Tectona grandis* (5.4 g/kg) as compared to initial values.

In the experiment on neem-based agroforestry system, the maximum height, DBH and volume of the tree was observed in the Bijapur provenance (8.41 m, 24.23 cm and 0.213 m^3/tree, respectively) when compared to other provenances. The neem seed yield was higher in Bijapur (2.75 kg/tree) and Gulbarga (2.53 kg/tree) provenances. The maximum soil pH was recorded in Bijapur (7.60 pH), while soil electrical conductivity was higher in Dharwad source (0.43 dS/m). The available nitrogen and potassium content were higher in Bijapur source (254.0 kg/ha and 302.0 kg/ha respectively) whereas the available Phosphorous content was higher in Dharwad source (51.3 kg/ha) when compared to other neem sources. The available sulphur, calcium and magnesium content were higher in Bijapur source (16.0 ppm, 35.0 Cmol (p+) / kg and 16.6 Cmol (p+)/kg, respectively when compared to other sources. About economic evaluation (14 years), the net returns, benefit cost ratio and IRR% were higher in Bijapur source (Rs. 25871.0 /ha/yr, 2.46: 1 and 86% respectively) when compared to other neem sources. The total gross income from neem-based agroforestry system was highest in Bijapur source (Rs. 40176.9). Among the four sources of neem evaluated, Bijapur and Gulbarga sources performed well and hence can be grown in agroforestry system. Both the sources can be recommended for bund plantation under wider spacings.

An experiment to estimate the biomass and carbon sequestration of different timber tree species grown with sapota based agroforestry systems indicated that, the total biomass and carbon sequestration was significantly higher in *Eucalyptus tereticornis* (138.77 ton/ha and 69.39 ton/ha respectively) while among the sapota trees, total biomass, carbon stocking and sapota fruit production was higher in sapota grown with *Lagerstroemia lanceolata* (19.22 ton/ha and 9.61 ton/ha, respectively) as compared to other agroforestry systems.

UNIVERSITY OF AGRICULTURE SCIENCES, BANGALORE, KARNATAKA

Tree Germplasm Collection, Evaluation and Improvement

Out of 27 germplasms of tamarind, higher plant height was observed in NFN-6 (640 cm) followed by Hosakote-2 (620 cm), Hosakote-3 (605 cm) and NFN-7 (558 .2 cm). The higher girth at breast height (GBH) was recorded with of NFN- 6 (74.45 cm) followed by NFN-5 (70.25 cm), NFN-8 (69.23 cm) and NFN-9 (65.09 cm). The performance of all fourteen local selections of simarouba, comprising of 7 each in 'Kaali' and 'Gouri' genotypes were found satisfactory even after ten years of planting. The height of all the eight germplasm of pongamia planted during 2017 was found to be on-par with each other, whereas highest height was recorded in RAK-2015-01 2.47 m with GBH of 7.78 cm.

System Research

In *Melia dubia* based system, significantly higher tree height was found in 24 m x 5 m (14.02 m) followed by 20 m x 5 m (13.99 m) and 16 m x 5 m (13.04 m). Same kind of GBH was observed in (125.39, 117.03 and 105.36 m) and canopy spread N-S (8.89, 8.61 & 8.27 m, respectively) and E-W direction (8.35, 8.17 & 7.86 m, respectively). Tree biomass accumulation has significantly varied with different tree spacing in *Melia dubia*, maximum above ground, below ground and total biomass was recorded with a spacing of 12 m x 5 m (72.81 t ha^{-1} 18.93 t ha^{-1} and 91.74 t ha^{-1}, respectively), followed by 8 m x 5 m (64.64 t ha^{-1}, 16.80 t ha^{-1} and 81.44 t ha^{-1}, respectively and 10 m x 5 m (63.37 t ha^{-1}, 16.47 t ha^{-1} and 79.85 t ha^{-1}, respectively). Higher tree carbon sequestered in *Melia dubia* with a spacing of 12 m x 5m (157.81 t ha^{-1}), followed by 8 m x 5 m (140.10 t ha^{-1}) and least carbon sequestered with 16 m x 5 m (124.94 t ha^{-1}). *Melia dubia* sequestered considerable quantity of atmospheric carbon because of more biomass accumulation and vigorous growth.

In fruit crop-based agroforestry system was established having three dry land orchard tree crops such as *Anacardium occidentale, Syzygium cumuni* and *Mangifera indica* with inter & intra row spacing of 10 m. Among these fruit crops, *Syzygium cumuni* recorded higher tree height (7.8 m) and diameter at breast height (20.02 cm). The canopy spread on N-S and E-W direction was also higher in *Anacardium occidentale* (5.76 and 7.24 m, respectively) as compared to other fruit crops. In Mahagony-based agroforestry system, mahogany was planted in 2010 where average height and diameter at breast height is 11.72 m and 12.63 cm respectively and the canopy cover in east-west and north-south direction is 4.5 m and 4.8 m respectively. In Mahagony, highest periodic level of height and collar diameter was recorded in 5 m x 4 m (39.15 cm and 12.74 mm, respectively). In sandal-based agroforestry system among different spacing highest periodic annual increment of height and collar diameter was recorded in 5m x 5m (29 cm and 8.11 mm respectively).

KERALA AGRICULTURAL UNIVERSITY, THRISSUR

Tree Germplasm Collection, Evaluation and Improvement

In the teak provenance evaluation trial, v*arious* provenances showed consistent trend in growth at the 20th year of establishment. Nilambur provenances like Cherupuzha, Nedumkayam-2, Nellikutha-5 and Nedumkayam-1 showed superior growth as compared to provenances from other regions.

System Research

Boundary plantation of fast-growing fodder trees in small holder livestock farms as triple hedgerows can be a cheap and good alternative to expensive concentrates feeds and as a source of quality forage. Preliminary results indicated that trees like Kadamba (*Neolamarckia cadamba*), calliandra (*Calliandra calothyrsus*), gliricidia (*Gliricidia sepium*) and mulberry (*Morus indica*) can be recommended as ideal species for triple hedgerow boundary planting in partially shaded homesteads/small holder farms of humid tropical Kerala. Kadamba and calliandra yielded 2 and 1.6 t ha^{-1} green fodder, respectively in the initial year of planting.

Cereal fodder maize (African Tall) and bajra (Co8) can be economically cultivated under partially shaded young coconut gardens (aged 25 years, light transmission 42%) without much yield reduction and it yields better than hybrid napier especially in the initial phase of planting. The yield under coconut garden followed the trend maize (34.01 t ha^{-1}) > bajra (32.78 t ha^{-1})> hybrid napier (24.51 t ha^{-1})> sorghum (14.2 t ha^{-1}), with yield reduction of 8.46, 6.34, 12.37 and 33.01 per cent, respectively compared to corresponding to yield from open conditions.

In a bamboo-based agroforestry trial at the 4th year of establishment, growth parameters of bamboo *viz.* collar diameter (113.55 mm) and internode characteristics of *Dendrocalamus stocksi* bamboo were superior under wider spacing of 8 x 8 m and 6 x 8 m, when compared to the closely spaced stands (4 m x 8 m). However, plant height showed a levelling trend across various densities with a narrow range of 6.69 to 6.93m. Comparing different medicinal intercrops in bamboo, Kasthuri turmeric performed well under bamboo plantation with a rhizome yield of 14.61 t ha^{-1}, followed by turmeric (11.50 t ha^{-1}). Ginger showed moderate performance with a yield of 5.68 t ha^{-1}, whereas alpinia was found to be a poor yielder under bamboo plantations.

UNIVERSITY OF AGRICULTURAL & HORTICULTURAL SCIENCES, SHIVAMOGGA, KARNATAKA

Survey, Diagnostic and Design

The choice of the species by farmers would vary with farm size and most of the farmers prefer tree species based on the shade, timber production and standard for pepper. More than half of the respondents prefer native tree species for planting.

Tree Germplasm Collection, Evaluation and Improvement

In order to have a collection of different species of bamboos in the form of bambusetum and assessment of between and within species variation in selected bamboo species for further utilization 10 bamboo species of Tissue culture origin were planted at Iruvakki. *Litsea chinensis* is one of the important *jigat* yielding plant and is considered as one of the important tree species for providing raw material to incense stick industry. Efforts were made to develop appropriate vegetative propagation techniques for mass production of the species the species responded very poorly for rooting of cuttings. The propagation through seeds have been initiated and this year we could produce around 500 plants from seeds.

3. Subsidiary Activities

Brainstorming Session on `*Har Med Par Ped*'

ICAR-Central Agroforestry Research Institute, Jhansi and AICRP-Agroforestry organized a Brainstorming Session on `*Har Med Par Ped*' on 26th April, 2021 in virtual mode to discuss the constraints and challenges of growing trees on farm bunds and boundaries. Around 80 participants including leading scientists from Indian Council of Agricultural Research and its constituent Research Institutes, faculty/scientists associated with ICAR's All India Coordinated Research Project on Agroforestry, State Agricultural Universities and ICFRE Institutes, representatives from State Forest Department, Industry and Progressive Farmers attended the session.

Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR warranted choice of species to be grown on bunds and boundaries in different agro-climatic regions of the country. While doing so, we need to keep the productivity attributes, environmental services and the socio-economic imperatives of tree growing on farmlands in mind and suggest remedies to the constraints and challenges in implementing the objectives of National Agroforestry Policy, he added. He stressed upon bridging of existing gap in our lab to land programs and suggested to involve all stakeholders including KVKs and State Departments to upscale the program attributes for enriching the "*Har Med Par Ped*" objectives and devise mechanisms to ensure availability of quality planting materials.

Dr. S.K. Chaudhari (DDG, NRM, ICAR HQ) in his opening remarks, underlined the importance of tree plantations and emphasized on upscaling of success stories in this regard. He also pointed out the crucial role of agroforestry-based farming system in sustaining the rural livelihood in rainfed ecosystem.

Dr. A. Arunachalam, Director, CAFRI highlighted the theme of discussion as one of the seven-point strategies given by our Hon'ble Prime Minister in 2015 for Doubling Farmers' Income by 2022. He further extended the scope of the discussion by narrating that about 17 lakh trees are cut in our country every year against planting of 26 lakh trees, most of them in lands outside forest governance, thereby conforming the scope and role of agroforestry in this endeavour of bund/boundary plantations using tree species. This was followed by presentations by a Panel of Experts who spoke on prospects of bund planting and boundary plantations in different ecological zones such as Himalaya, Indo-Gangetic, North-East, Semi-arid and Coastal regions. In addition, an industry representative and a progressive farmer also shared their field experiences. The glimpses of their discussions are documented below.

The Western Himalayan Region

Dr. Punam, Professor and OIC, AICRP-Agroforestry, CSKHPKVV, Palampur gave a presentation on bund/boundary plantation in the Indian Himalayan region. She highlighted suitable tree species for the region and their preferable characteristics, proper spacing and direction of plantation along with the advantages of tree plantations and their socio-economic and cultural implications. She emphasized that trees with open crown, faster growth, deep tap root system and few shallow lateral roots such as in Toona, Grewia, Bauhinia, Morus, Leucaena *etc*. are the most preferred ones in the region. She also pointed out the tenurial and ownership issues in this regard.

The North-Eastern Hill Region

Dr. B.P. Bhatt, Former Director, ICAR Research Complex for Eastern Region, Patna emphasized that NEH region has lot of potential for boundary plantation to check soil erosion and water runoff. He mentioned about important tree species like *Parkia roxburghii* and bamboo species that are much popular in the region both for ecological and nutritional reasons and detailed their management practices. He further suggested to create awareness on its value addition to help enhance income generation in the region.

The Indo-Gangetic Region

Dr. R.I.S. Gill, Professor, PAU, Ludhiana presented on `Boundary Plantation Management & Key Challenges in the Indo-Gangetic plains'. He stated that fast growing Multipurpose Tree Species (MPTs) with low crown diameter with self-pruning ability and good marketability are the generally chosen for bund and boundary plantations. A few examples included Poplar, Melia, Eucalyptus, Toona, Dalbergia and Acacia. He further added that the legal issues (common farm boundaries), land rent issues, growth of adjoining crops and marketing are the key constraints in the region.

The Semi-Arid Region

Sh. Ram Kumar, APCCF and Agroforestry Mission Director, Gujarat informed about various agroforestry schemes in operation for the benefit of farmers. He stated that Melia and Ailanthus are the important species for the semi-arid region and informed that state forest department is providing quality planting materials of these species to the farmers. He also screened a video film based on the agroforestry and tree planation programs implemented in Gujarat by the State Agroforestry Mission.

The Coastal Region

Dr. T.K. Kunhamu, Professor and Associate Director of Research, KAU, Thrissur presented Boundary/Bund Plantations: Prospects and challenges in humid and coastal regions of the country. He mentioned that homegardens, aquaculture with trees, commercial plantation crop-based agroforestry (coconut/coffee/arecanut/cardamom/ rubber plantations), multipurpose tree-based systems (live fences black pepper, medicinal/spices/kokam *etc*), bamboo-based production systems, social forestry/farm forestry are some of the common agroforestry practices in the humid regions. He indicated that bund and boundary planting is an opportunity in space constrained agricultural landscapes for reaping benefits in terms of food, timber, fruits, fiber, fuelwood, and fodder along with eco-restoration of agricultural lands. He also gave an account of managerial limitations like fragmented farm holdings, heavy pest and disease infestation in humid regions, lack of quality planting material for saline soils, and policy constraints in terms of soft loans and insurance for tree crops and poor market intelligence for tree produce. In research front, Dr. Kunhamu stressed on setting of research priorities for development of replicable models of suitable bund/border planting systems for various agro-ecological zones in humid tropics and socio-economic evaluation of boundary plantation.

Industry Perspective

Dr. Jagdish Tamak, DGM, Plantations, ITC Limited highlighted that the Indian pulp and paper industry has agroforestry roots and strong backward linkages with the farming community, from whom wood, which is a key raw material, is sourced. He articulated that eucalyptus is the most suited tree species for bund plantation due to its economic status, and faster returns. Additionally, he emphasized about the myths regarding eucalyptus and informed that this species is in fact a water efficient fast-growing tree and provides optimum yield even under harsh conditions. Unavailability of ready market for the tree produce and farmers mindset about farm forestry particularly in the context of gestation period of tree, increasing menace of monkeys and shade effect of trees on field crop areas are some notable challenges in adopting tree plantations on bunds.

Farmers' Perspective

Sh. R.P. Ganesan, a progressive farmer in his presentation informed the farmers' perspective on selection of species for boundary plantations, soil suitability, market condition, economic gains, and symbiosis of the trees with other crops. He suggested that creating a separate Division of Agroforestry and establishment of "Timber Development Board" under the Ministry of Agriculture and Farmer's Welfare, Govt. of India are required for timely implementation of government programs to effect `*Har Med Par Ped*'. Sh. Ganesan went on to advocate subsidies for the tree growers as payment for environmental services.

Open discussion followed these zone-wise presentations. After detailed deliberations, the following action points emerged:

- A tree species with faster growth, clear bole, thin canopy, and deeper root system along with lesser water requirements and productive tree-crop interactions are essentially required to suit to the space availability in the bunds and boundaries. Accordingly, the appropriate species are to be identified and prescribed for different agro-ecologies. To this effect, a document on ecologically suitable tree species for promotion under "*Har Med Par Ped*" to be prepared and circulated to the implementing agencies and other stakeholders.
- A pan-India mega campaign to be organized to promote tree culture. 16th July, being the ICAR Foundation Day was identified as the day of operation to this effect.
- Interface with KVKs for agroforestry extension including bund/boundary plantations
- Detailed study on the economics of bund planting and boundary plantations and evaluate their ecological services in an agroforestry system

In addition, the experts opined that an effective institutional arrangement for linking ICAR-CAFRI, AICRP (Agroforestry) Network and the KVKs with state governments for promotion of agroforestry technology and demonstration of "*Har Med Par Ped*" should be put in place by the implementing agency; In this endeavour, cluster development for value addition and market to qualify "*Har Med Par Ped*" can be a profitable proposition for the farmers and other stakeholders. The session ended with thanks to one and all.

Agroforestry Photography Competition, 2021

Agroforestry Photography competition was organized for the coordinating centres of AICRP on Agroforestry during April 2021. The competition was open for all the scientists associated with the Project with a limit of maximum five photographs from one coordinating centre. The guidelines for participation were that photograph must be from agroforestry system in the experimental farm of the centre or demonstration in farmers field with full details of location, tree and crop component and age of tree. Fourteen centres participated in the competition and seventy entries were received. An independent committee evaluated the photographs with the following winners:

First Prize: Dr. Chhavi Sirohi, Assistant Scientist, Department of Forestry, CCSHAU, Hisar

Second Prize: Dr.V.S. Mynavathi, Scientist and Dr. S. Gunasekaran, Senior Scientist Institute of Animal Nutrition, TANUVAS, Kattupakkam

Third Prize: Dr. P. Rajendran Assistant Scientist and Dr. K. Ramah, Assistant Scientist, FCRI, Tamil Nadu Agricultural University, Mettupalaym and

Dr. S.C. Mohapatra, Senior Scientist, Odisha University of Agriculture and Technology, Bhubaneshwar

In addition, Commendation Certificates were conferred for innovative integration in agroforestry to the following individual or group of scientists:

Dr. Ranjita Bezbaruah, Assistant Scientist, HRS, AAU, Kahikuchi

Dr. Megna Rashid, Assistant Scientist, and Dr. G.M. Bhat, Senior Scientist, Faculty of Forestry, SKUAST–K, Srinagar

Dr. R.I.S. Gill, Dr. Navneet Kaur and Dr. Baljit Singh, Department of Forestry and Natural Resources, PAU, Ludhiana

STC and SCSP Component

The Coordinating centres of the project undertook various activities for the welfare of weaker sections of the society belonging to Schedule Tribe and Schedule Cast categories by providing various inputs in form of seedlings, seeds of intercrops, fertilizers, small equipment for ensuring livelihood opportunities and nutritional security. The centres also conducted capacity building programmes for skill upgradation and knowledge enhancement for adopting agroforestry-based land use system. Some of the activities undertaken during the period of report are:

S.No.	Description	Unit	Achievement
1.	Monitoring of demonstration units on farmers' fields	ha	30 ha
2.	Seedlings of MPTS, Fodder and fruit trees	Number	10000
3.	Nursery raising & maintenance of quality planting material	Number	2500
4.	Intercrop seed (Maize, soyabean, bajra, fodder maize, Brinjal, chilli, Tomato, Okra, Cowpea)	Kg	155
5.	Banana suckers	Number	1000
6.	Fertilizer	Kg	1200
7.	Barbed wire	Kg	200
8.	Small farm equipment	Number	580
9.	Germination tray	Number	330
10.	Bio manure Grow Bags	Number	180
11.	Coconut climbing Machine	Number	4
12.	Supply of kit for establishment of tree nursery	Number	18 set
13.	Supply of kit for small ruminants comprising of small ruminant feeder, tree leaf meal-based concentrate feed, mineral mixture and salt lick	Number	15 Kit
14.	Poultry birds	Number	100
15.	Poultry Incubator with eggs of Kadaknath breed	Number	02 Incubator with 300 eggs of Kadaknath breed
16.	Training/ Awareness programme for capacity building for skill developments	Number	15

Awareness Programme on Boundary/Bund Plantation *"Har Med Par Ped"*

Agroforestry is being practiced in various ways like the tree on field bund/ boundary, block plantation; alley cropping, scattered trees in the field, homegardens, *etc*. Among these, bund plantation is a very common practice throughout the country. Bunds on agricultural lands are considered as another potential area for agroforestry. In such conditions, mostly multipurpose tree species are likely to be chosen to plant on field bunds to achieve the

benefits like fruits, fibre, fuelwood, fertilizer, food, and medicine. Similarly, the boundary plantation around individual landholding also acts as a demarcation line that acts as a bio fence, timber source, windbreak, shelterbelts, *etc.* The Central Agroforestry Research Institute, Jhansi and its constituent All India Coordinated Research Project on Agroforestry organize awareness campaigns among the farming community, school children and other stakeholders regarding the importance of trees on farmlands. With the proclamation of `*Har Med Par Ped'* by our Hon'ble Prime Minister, a special focus on growing trees on bunds and boundaries is being emphasized. During the campaigns, the focus has been given to the suitability of tree species on farm bunds and boundaries, and their management has been disseminated for public appraisal. During the period under report each coordinated centre organized one boundary plantation awareness programme as per the following schedule.

S.No.	Month	Name of Centres
1	June	KAU, Thrissur
		UAHS, Shimoga (CoF, Ponnampet)
2	July	PAU, Ludhiana
		MPKV, Rahuri
3	August	OUAT, Bhubaneshwar and UAS, Dharwad
		Dr. YSPUH&F, Solan
4	September	SKNAU-ARS, Fatehpur-Shekhawati and PJTSAU, Hyderabad
		SKUAS&T, Srinagar
5	October	PDKV, Akola (COA, Nagpur) and SKUAS&T, Jammu
6	November	BSKKV, Dapoli and Dr. RPCAU, Pusa Samstipur
7	December	CCSHAU, Hisar, CSKHPKV, Palampur and JNKVV, Jabalpur
8	January	TNAU, Coimbatore (FCRI, Mettupalaym)
		TNV&ASU, Kattaupakkam
9	February	NDUA&T, Ayodhya
		SDAU, SK Nagar
10	March	GBPUA&T, Pantnagar
		BCKVV, Kalayani (HRS, Jhargram)
11	April	AAU, Jorhat (HRS, Kahikuchi)
		UAS, Bangalore
12	May	BAU, Ranchi and CAFRI Jhansi

4. Awards and Recognition

- Dr. Raju L. Chavan, OIC, AICRP on Agroforestry UAS, Dharwad received the Scientist of the Year Award by the Society for Scientific Development in Agriculture and Technology (SSDT), Astha Foundation, Meerut (UP) during the year 2020.
- Dr. S.T. Hundekar Scientist, UAS, Dharwad received Incentive Award from UAS Dharwad on 11th November 2020
- Dr. Sangita Sawant, STA, BSKVV, Dapoli secured Ist Rank for best paper presentation award in *National Conference at Dr. BSKKV, Dapoli, MS on* 13th and 14th February 2021.
- Dr. S.K. Verma OIC, ANDUAT, Ayodhya received Best teacher Award of the University on the occasion of teacher's day 2021.
- Dr. Ranjita Bezbaruah, OIC, AICRP on Agroforestry, HRS, Kahikuchi received second best award for oral paper presentation on success story on "Employment generation through Agri- entreprenureship in Nalbari district of Assam' during National Webinar on Motivation of youth towards Agri-entreprenurship and innovative farming organized by JNKV, Jabalpur on 4-5 July, 2020.
- Dr. S. Gunasekaran OIC, AICRP on Agroforestry, TNV&ASU, Kattaupakkam received second prize in the oral presentation entitled "Assessing the potential of detoxified Jatropha curcas oil cake as animal feed" in the National level e-symposium on "Agroforestry system for augmenting livestock productivity and empowering resource poor rural farmers" Institute of Animal Nutrition Centre for Animal Production Studies Tamil Nadu Veterinary and Animal Sciences University in collaboration with National Bank for Agriculture and Rural Development through online mode during 10-11 March, 2021.
- Dr. V.S. Mynavathi Scientist, TNV&ASU, Kattaupakkam received first prize in the oral presentation entitled

"Integration of vegetable crops in Sesbania grandifiora based agroforestry system for improving the milk yield of milch cows, in the National level e-symposium on "Agroforestry system for augmenting livestock productivity and empowering resource poor rural farmers" Institute of Animal Nutrition Centre for Animal Production Studies Tamil Nadu Veterinary and Animal Sciences University in collaboration with NABARD through online mode during 10-11 March, 2021.

- Dr. Chhavi Sirohi, Assistant Scientist, CCSHAU, Hisar received Young Scientist Award 2020 by The Society for the Science of Climate Change and Sustainable Environment, New Delhi for her exemplary work in the field of Forestry & Environmental Sciences.
- Dr. Chhavi Sirohi, Assistant Scientist, CCSHAU, Hisar received First Prize for Oral Presentation in *National level e-symposium on "Agroforestry system for augmenting livestock productivity and empowering resource poor rural farmers"* organised by Institute of Animal Nutrition Centre for Animal Production Studies Tamil Nadu Veterinary and Animal Sciences University in collaboration with NABARD through online mode during 10-11th March, 2021.
- Dr. Salil Tewari Professor, GBPUA&T, Pantnagar, appointed as Member, Board of Management, FRIDU, Dehradun under distinguished scientist category.
- Dr. P. Rajendran, OIC, AICRP on Agroforestry and Dr. K. Ramah, Associate Scientist FCRI, Mettupalayam were awarded the first prize with certificate and medal for their active involvement in Doubling Farmers Income Scheme of TNAU for the past two years (May 2019 to May 2021) and for contributing technical advisories to beneficiary farmers.
- Dr. K. Ramah, Associate Scientist FCRI, Mettupalayam received Best Paper Award in the 5th National Conference on Agrl. Scientific Tamil, 2020 held on 9th and 10th October, 2020 at TNAU, Coimbatore (under Forestry category.
- Dr. K. Ramah, Associate Scientist FCRI, Mettupalayam, received Best Paper Award in the 6th National Conference on Agrl. Scientific Tamil, 2020 held on 21st and 22nd October, 2020 at TNAU, Coimbatore (under Agronomy category)
- Dr. Hanumanthappa, D.C. Scientist and Mr. Bhaskar, V OIC, AICRP on Agroforestry, UAS, Bangalore received Best Integrated Farming Demonstration Plot from University of Agricultural Sciences, GKVK, Bangalore on 13th November 2020.
- Dr. S. Panda Scientist, HRS, Jhargam was one of the contributors for identifying Twenty-Three Unsolved Problems in Hydrology, an initiative supported by IAHS, EGU, AGU and IAH.
- Dr. B. Biswas OIC, AICRP on Agroforestry, HRS, Jhargram nominated as Expert by Central Silk board, Government of India for evaluation of research projects of Central Sericultural Research & Training Institute, Berhampore, West Bengal, India.
- Dr. B Biswas OIC, AICRP on Agroforestry, HRS, Jhargram acted as Chairman, C-DAP Committee for preparation of comprehensive district agricultural plan of Government of West Bengal under RKVY-RAFTER
- Dr. B. Biswas OIC, AICRP on Agroforestry, HRS, Jhargram acted as Visiting Expert, Pradhan Mantri *Krishi Sinchayee Yojana* -Watershed Development Component under MELD system at Government of West Bengal.

5. Research Publications

UAS, Bangalore

Kiran, A., Sikdar, K., Hanumanthappa, D.C. and Mallesh, T. M. (2020). A drip irrigation modelling to fruit and vegetable crops using queuing theory. *International Journal of Science, Technology, Engineering and Management-A VTU Publication*, 2(4), 25-34.

Veena, J., Sathish, A. and Hanumanthappa, D.C. (2020). Effect of graded levels of incineration ash as a source of manure on growth, yield and nutrient uptake in paddy (*Oryza sativa*). *Mysore Journal of Agricultural Sciences*, 54(2), 37-43.

OUAT, Bhubaneshwar

Mishra, P.J., Behera, B. B. and Behera, S. (2020). Carbon sequestration, soil health improvement and livelihood security through mango-based agroforestry system. *Indian Journal of Horticulture*, 77(2), 376-380.

BSKVV, Dapoli

Gawali1, A.S. and Meshram, N.A. (2020). Potential Underutilized Fruits Tree Species – A Review. *Agriculture Observer,* 1(6), 73.78.

Joke, A., Khobragade, N., Meshram, N.A., Garad, M., Wahane, M., Jondhale, D.J., & Dhopavkar, R.V. (2021). Studies of nutrient content pattern in turmeric at different growth stages as influenced by graded levels of nitrogen under *Acacia mangium* based agroforestry system. *Journal of Pharmacognosy and Phytochemistry*, 10(1), 1100-1102.

Joke, A., Khobragade, N., Meshram, N.A., Wahane, M., Garad, M. and Jondhale, D.J. (2021). Effect of graded levels of nitrogen on growth, yield of turmeric and nutrient status of soil under *Acacia mangium* based agroforestry system in lateritic soils of Konkan. System in lateritic soils of Konkan. *The Pharma Innovation Journal*, 10(1), 423-425.

Meshram, N.A., Dalvi, V.V., Pinjari, S.S., Rathod R.R. and Narkhade, S.S. (2020). Effect of forest trees leaf litter on decomposition dynamics, microbial community and soil fertility under different trees in Alfisol. *Indian Journal of Agricultural Sciences*. 90 (6), 1166–9. 2) N. A.

Meshram, V.V. Dalvi, M.M. Burondkar and A.S. Shigwan (2020). *Mangifera indica* L. : An Agroforestry Tree Species for Humid Subtropical Ecosystem. *Agriculture Observer*, 1 (1): 53-57.

UAS, Dharwad

Chavan, R.L., Hundekar, S.T., Mokashi, M.V., Mutanal, S.M. and Pawar, K.N. (2020). Interaction of Different Spacings on Productivity of *Melia dubia* and Soybean Yield, *Progressive Research an International Journal,* 15(3), 160-163

Kariyappa, I.S. and Chavan, R.L. (2020). Effect of different pre-sowing treatments on *Terminalia alata* seed germination, *Progressive Research- An International Journal*, 15 (3), 193-195.

Pawar, K.N., Chavan, R.L., Mutanal, S.M., and Mokashi, M. V. (2020). Potential of leguminous tree species on morpho-physiological traits on productivity of Safflower, *Progressive Research – An International Journal,* 15(4), 252-255.

Shaziya K. L., Bidari B. I., Hundekar S.T. and Pushalatha, M. (2020). Effect of Cow Urine Foliar Spray on Quality Attributes and Chemical Characteristics of Byadgi chilli (*Capsicum annum* L.) in a Vertisol, *International Journal of Plant & Soil Science*, 32(6),1-8.

Vaudev K.L., Chavan, R.L. and Devagiri G. M. (2020). Effects of Soil types and Age gradations on Growth performance of *Melia dubia* under central dry zone of Karnataka, *International Journal of Chemical studies*.8 (3), 2518-2519.

Vaudev K. L., Chavan, R. L. and Devagiri G. M. (2021). Carbon sequestration potential in total biomass of *Melia dubia* Cav. under semi-arid region of Karnataka, *International Journal of Chemical studies,* 9(2), 898-902.

CCSHAU, Hisar

Kumar, P., Sirohi, C., Dhillon, R.S., Kumari, S., Bhardwaj, K. K., Kumar, M., Chaudhary, K. and Nanda, K. (2021). Effect of bund planted eucalyptus on the yield of agricultural crops and soil properties in semi-arid region of Haryana. *Journal of Plant Development Sciences,* 13 (3), 105-111.

Sirohi, C., Kumar, P., Dhillon, R.S., Handa, A.K., Bhardwaj, K. K., Kumari, S. and Ahlawat, K.S. (2021). Crop productivity of barley and growth performance of eucalyptus clones under agri-silvicultural system in semi-arid ecosystem of Haryana, India. *Indian Journal of Agroforestry*, 23 (1), 18-22.

PJTSAU, Hyderabad

Geetha, K., Chaitanya, T., Padmaja, G. and Krishna, A. (2021). Effect of different land use systems on soil properties - *The Pharma Innovation Journal*, 10(8), 1-6. (NAAS Rating: 5.23)

Ishwarya L., V., Krishna, A., Madhavi L.A. and Parameswari,

Y.S. (2021). Effect of *Melia Dubia* Based Agroforestry System on Chemical Properties of Soil and Physiological Parameters. *Multi logic in science*.,11 (38), 1918 -1921

Ishwarya L.V., Krishna, A., Madhavi L.A. and Parameswari, Y.S. (2021). Evaluation of *Melia Dubia* for its Biomass Production, Carbon Stock, Carbon Sequestration and Economic Returns in Agroforestry System. *International Journal of Plant & Soil Science*, 33(11), 46-54.

Ishwarya L., V., Krishna, A., Madhavi L.A. and Parameswari, Y.S. (2021). Evaluation of pulses and millets in agri-silvi system. *Journal of Pharmacognosy and Phytochemistry,* 9(5), 243-249.

Jhonsonraju, S., Krishna, A., Madhavilata, A and Chaitanya, T. (2021). Growth parameters of perennial fodder species as influenced by integrated nutrient management practices in custard apple based Horti-pastoral system. *The Pharma Innovation Journal,* 10(9), 1700-1706. NAAS Rating: 5.23.

Parameshwari, Y.S., Aariff Khan, M.A and Krishna, A. (2020). Influence of Nutrient management practices on growth and yield of pearl millet in *Melia dubia* based Agri-silvi system. *International Journal of current microbiological applied Sciences*, 7(6), 443-454 NAAS

JNKVV, Jabalpur

Malviya P., Sharma S., Dongre R., Sahu, M.L., Ghode, B.D. and Upadhyaya, S.D. (2019). Variation in growth performance of shisham (*Dalbergia sissoo* Roxb.) provenance in central India. *JNKVV Research Journal,* 53(1-3), 62-66.

Sharma, S., Malviya, P., Upadhyaya, S.D. and Singh Y. (2020). Effect of different pruning intensities of *Dalbergia sissoo* and different levels of fertilizer dose and seed rate of wheat on carbon sequestration of agrisilviculture based agroforestry system". *International Journal of Chemical Studies,* 8(3), 2002-2005. (NAAS Rating 5.31).

Singh Y., Mishra, R.C., Singh, A. and Sharma, S. (2020). "Estimation of Carbon Sequestration Potential and Wheat Productivity under different Silvicultural and Agronomic management practices" *Journal of Tropical Forestry,* 36(3), 44-56. (NAAS Rating 4.16)

HRS, Jhargram, BCKVV

Adhikary, S, Priya, A. and Biswas, B. (2020). Evaluation of Awareness Aspect of Organic Cultivation and Organic Product Certification among Indian Population, In: Rawat, R.K., Tripathi, U.K. (Eds.), Advances in Agronomy. Akinik Publication, New Delhi. 91–104.

Adhikary, S. and Biswas, B. (2020). Adoption of Direct Seeded Rice over Transplanted Rice in Areas Having Water and Labour Scarcity. *Agriculture & Food Newsletter,* 2:247–249.

Adhikary, S., Biswas, B. and Priya, A. (2020). Conservation Agriculture: An Efficient Tool to Overcome the Drawbacks of Conventional Agricultural System towards Sustainable Crop Production. *Int. J. Curr. Microbiol. App. Sci,* 9(7), 1333-1340.

Adhikary, S., Naskar, M.K., & Biswas, B. (2021). Seed priming-one small step for farmer, one giant leap for food security: I application and exploration. *J Pharmacogn Phytochem*, 10(1), 409-412.

Bandyopadhyay, A., Ghosh, D.K., Biswas, B., Parameswarappa, M.H. and Timsina, J. (2020). Fertigation Effects on Nutrient Use Efficiency, Energy Productivity, and Economics of Coconut (*Cocos nucifera* L.) Cultivation in the Eastern Indo-Gangetic Plains of South Asia. *International Journal of Fruit Science,* 20(sup3), S1483-S1494.

Banerjee, S. and Biswas, B. (2020). Assessing Climate Change Impact on Future Reference Evapotranspiration Pattern of West Bengal, India. *Agricultural Sciences,* 11(9), 793-802.

Biswas, B. (2020). Branching Out: Relay Grass Pea (*Lathyrus sativa* L.) Production on Rice Fallows in the Eastern Indo-Gangetic Plains. *Int. J Curr. Microbiol. App. Sci*, *9*(1), 836-838.

Biswas, B., Timsina, J., Garai, S., Mondal, M., Banerjee, H., Adhikary, S. and Kanthal, S. (2020). Weed control in transplanted rice with post-emergence herbicides and their effects on subsequent rapeseed in Eastern India. *International Journal of Pest Management*, 1-13.

HRS, Kahikuchi

Bezbaruah, R. and Borkotoky, B. (2020), Impact of water management on growth and yield of early ahu rice variety through on farm trail in Morigaon district of Assam *J. Soils and Crops,* 30(2), 260-263.

Bezbaruah, R. and Deka, R.S. (2020). Effect of vocational training programme on vermicompost and other organic input production as income generating enterprise. *J. of Comm. Mobi. and Sustain. Development,* 15(1), 235-238.

Bezbaruah, R. and Deka, R.S. (2020). Enhancing Productivity and Profitability of Sesame under Cluster Frontline Demonstration in Morigaon District of Assam, India, *Int. J Curr. Microbiol. App. Sci*, 9(11), 1678-1682.

Bezbaruah, R. and Deka, R.S. (2020). Impact of Cluster Frontline Demonstration on Productivity and Profitability of Greengram in Morigaon District of Assam. *J Krishi Vigyan ,* 9(1), 164-169.

Phukon, R.N., Saikia, S., Borah, P., Das, S., Bagowati, S. and R. Bezbaruah (2020). Vegetable Grafting for Enhancing Yield and Combating Biotic Stress in Bhut Jolokia (*Capsicum chinense*) under Protected Condition. *Int. J Curr. Microbiol. App. Sci*, 9(9), 3051-305.

PAU, Ludhiana

Bhardwaj, A., Kaur, N., Dhat, A.S. and Gill, R.I. (2021). Optimization of onion planting time and variety under *Populus deltoides*-based agroforestry system in North-Western India. *Agroforestry Systems*, 95(3), 533-546.

Kaur, R., Kaur, N., Gill, R.I.S., Sandhu, S.K. and Singh, A. (2021). Optimization of nutrient requirement of Indian mustard (Brassica juncea L.) cultivars under poplar (*Populus deltoides*) based agroforestry system. Indian Journal of Agroforestry, 23(2).

Kaur, R., Singh, B. and Dhaliwal, S.S. (2020). Dynamics of Soil Cationic Micronutrients in a Chronosequence of Poplar (*Populus deltoides* Bartr.)-Based Agroforestry System in India. *Journal of Soil Science and Plant Nutrition,* 20, 2025-2041.

Singh, B., Kaur, N., Gill, R.I.S. and Gosal, S.K. (2021). Effect of biofertilizers and chemical fertilizers on growth of clonal eucalyptus plantations. *Agric Res J.* 58(4), 632-35.

FCRI, Mettupalaym

Parthiban, K.T., Fernandaz, C.C., Sudhagar, R.J., Sekar, I., Kanna, S.U., Rajendran, P. and Kumar, N.K. (2021). Industrial Agroforestry—A Sustainable Value Chain Innovation through a Consortium Approach. *Sustainability*, 13(13), 7126.

Pralhad, B.S., Rajendran, P., Divya, M.P., Rajeswari, R., Thangamani, G. and Ramaha, C. (2020). Assessing the Effect of Different Agroforestry Practices on Soil Physico-chemical Properties and Microbial Activity. *Int. J. Curr. Microbiol. App. Sci.* 9(12), 2802-2816. doi: https://doi.org/10.20546/ijcmas.2020.912.335

CSKHPKVV, Palampur

Bharti, A., Sharma, R.P., Sankhyan, N.K. and Kumar, R. (2021). Productivity and NPK uptake by maize as influenced by conjunctive use of FYM, lime and fertilizers in an acid Alfisol. *Journal of Soil and Water Conservation*, 20(1), 100-106.

Kumar, R. and Seth, M. (2020). Productivity and profitability of legume based cropping systems grown under organic conditions in mid-hills of Himachal Pradesh. *Journal of Crop and Weed,* 16(2), 117-121.

Meghna, P., Kumar, R. and Seth, M. (2020). Effect of soil moisture regimes and sources of nutrients on carbon sequestration potential in rice-wheat cropping system. *Journal of Crop and Weed,* 16(3), 85-90.

Sharma, D., Sharma, K. and Agnihotri, R.K. (2020). In vitro evaluation for acaricidal efficacy of *Melia azedarach* and *Eupatorium adenophorum* against *Rhipicephalus* (Boophilus) *Microplus* ticks of goats. *Indian Journal of Small Ruminants* (The), 26(1), 86-91.

Thakur, A., Sharma, R.P., Sankhyan. N.K. and Kumar R. (2020). Maize grain quality as influenced by 46 years' continuous application of fertilizers, farmyard manure (FYM), and lime in an alfisol of North-western Himalayas. *Communications in Soil Science and Plant Analysis,* 48(18), 2193-2209.

GBPUAT, Pantnagar

Dey, B.J., Verma, A.K., Tewari, S.K. and Dubey, A. (2020). Biochemical and molecular characterization of Bamboo variants. *Journal of non-timber forest products*, 27(1): 50-55.

Dey, B.J., Verma, A.K., Tewari, S.K. and Dubey, A. (2020). Organogenesis optimization in *Dendrocalamus asper*. Journal of non-timber forest products, 27(2), 74-77.

Joshi, A., Dubey, A., Sachan, A. and Joshi, B. (2020). Effect of Pistia stratiotes an aquatic weed on digestive enzymes of Tarai region carps in Uttarakhand. *International Research Journal of Modernization in Engineering Technology and Science*. 2(7), 1215-1221.

Joshi, R., Tewari, S.K. and Kaushal, R. (2020). Evaluation of different bamboo species in Tarai region of Himalyan foothills: Growth, biomass, carbon storage and soil properties. *Journal of non-timber forest products,* 27(1), 56-60.

Kanwal, M.S., Kaushal, R., Tewari, S.K., Banik, R.L. and Yadava, A.K. (2020). Evaluation of different bamboo species in Tarai region of Himalyan foothills: Growth, biomass, carbon storage and soil properties. *Journal of non-timber forest products*, 27(1), 33-38.

Ray, A., Banerjee, A. and Dubey, A. (2020). Characterization of biochars from various agricultural by-products using FTIR spectroscopy, SEM focused with image processing. *International Journal of Agriculture, Environment and Biotechnology*, 13(4), 423-430.

MPKVV, Rahuri

Kolse R.H., Dhonde, A. and Thorat, S. (2020). Effect of irrigation regimes and fertigation on nutrient uptake & soil properties. *Journal of Bio technology & crop sciences,* 9(14), 52-63. Kolse R.H., Dhonde, A. and Thorat, S. (2020). Effect of different irrigation regimes and Fertigation levels on water requirement of Turmeric. *Journal of Bio technology & Crop Sciences*, 8(4), 2252-2253.

Najan, B.R. (2020). Climate change and its impact on insect-pest incidence of dry land crops on the scarcity zone of Maharashtra state, *IJCS*, 8(1), 202-215.

Najan, B.R., Shelar, A.S., and Totre A.S. (2020). Stability analysis of sesame genotypes in *Kharif* season *IJCS*, 9(2), 742-746.

Wankhede D.C. and Najan B.R. (2019). Genotype × Environment Interaction Studies in Mungbean (*Vigna radiata* L. Wilczek). *Int. J. Curr. Microbiol. App. Sci*. 8(10), 2577-2581.

BAU, Ranchi

Dhanyashri, P.V., Malik, M.S., Agarwal, Y.K. and Kumar, S. (2020). Growth and yield of spice crops under bamboo-based agroforestry system in plains of Chota Nagpur plateau of Jharkhand. *Indian Journal of Agroforestry*, 22(2), 105-109.

Kumar, A., Singh, V., Shabnam, S. and Oraon, P.R. (2020). Carbon emission, sequestration, credit and economics of wheat under poplar based agroforestry system. *Carbon Management*, 11(6), 673-679.

Kumari B., Das, B., Oraon, P.R. and Dhakar, M.K. (2020) Growth performance of silvi-horti-agricultural Systems under rainfed plateau conditions of Jharkhand. *International Journal of Chemical S*tudies; 8(1), 2848-2853.

Panda, M.R., Oraon, P.R. and Tirkey, P. (2020). Distribution of woody biomass reserves in tropical dry Sal (*Shorea robusta* roth.) forests of Ranchi. *The Pharma Innovation Journal.* 9(6), 477-482.

Panda, M.R., Oraon, P.R. and Tirkey, P. (2020). Understorey diversity of tropical dry deciduous forest of eastern plateau, India. *International Journal of Chemical Studies.* 8(4), 73-77.

Prakash, J.J. and Oraon, P.R. (2020). Effect of inorganic, organic and Biofertilizers on growth characteristics of *Albizzia lebbeck* (L.) Benth at seedling stage. *Journal of Pharmacognosy and Phytochemistry,* 9(4), 697-701.

Sinku, S.K., Oroan, P.R., Kumar, A. and Singh, B.K. (2021). Plant Composition, Diversity and Richness of Homegardens in Jharkhand, India. *Indian Forester*, 147(3), 267-275.

SDAU, SK Nagar

haudhari, H.D., Jat, J.R., Kumar, S., Malav, J.K. and Pavaya, R.P. (2020). Physical and chemical properties of soils in Banaskantha district under groundnut cultivation. *Journal of Pharmacognosy and Phytochemistry*. 9(3), 382-387.

Chaudhari, H.D., Jat, J.R., Kumar, S., Malav, J.K., Pavaya, R.P. and Patel, J.K. (2020). Distribution of different forms of Sulphur and their relationship with properties of soils of Banaskantha district under groundnut cultivation. *Journal of Pharmacognosy and Phytochemistry*. 9(3), 422-427.

Parmar, Nirav, Jat, J.R., S Kumar, Malav, J.K., Pavaya, R.P. and Patel, J.K. (2020). Effect of different organic and inorganic fertilizers on nutrient content and uptake by summer sesamum (*Sesamum indicum* L.) in loamy sand. *Journal of Pharmacognosy and Phytochemistry*. 9(3), 303-307.

Parmar, Nirav, Jat, J.R., S. Kumar, Malav, J.K., Pavaya, R.P. and Patel, J.K. (2020). Growth, quality, yield and available nutrient status after harvest of summer sesamum (*Sesamum indicum* L.) in loamy sand as influence by integrated nutrient management. *Journal of Pharmacognosy and Phytochemistry*, 9(3), 388-390.

YSPUH&F, Solan

Anand, S., Bhardwaj D.R. and Thakur C.L. (2020). Soil Carbon stock and nutrient study in different agroforestry systems at Kinnaur district Himachal Pradesh. *Plant Archives,* 20 (2), 4251-4260.

Bhardwaj, D.R., Thakur, C.L., Kaushal, R., Sharma, P., Kumar, D. and Kumari, Y. (2021). Bamboo-based agroforestry system effects on soil fertility: Ginger performance in the bamboo subcanopy in the Himalayas (India). *Agronomy Journal*.

Kanwar, A., Bhardwaj, D.R., Panwar, P. and Pal, S. (2021). Allometric models for predicting above-ground biomass and carbon stock of fodder tree species in north-western Himalayas. *Indian Journal of Ecology*, 48(2), 387-392.

Kumar S., Bhardwaj D.R, Mishra V., Rajpoot, B.S. and Warpa P. (2020). Effect of Harvesting time and species on nutritional quality of edible bamboo shoots. *The Phrama Innovation Journal,* 9(9), 111-113.

SKUAS&T, Srinagar

Ahmad, P.I., Puni, L., Pandey, R., Pala, N.A., Rather, M.M., Rashid, M. and Malik, A.R. (2021). Influence of different treatments and techniques on rooting behaviour of *Rhododendron arboreum* Sm. In Indian Himalayas. *Acta Ecologica Sinica*, https://doi.org/10.1016/j.chnaes.2021.01.001

Aslam, M., Sofi, P.A., Masoodi, T.H., Pala, N.A., Rashid, M., Mugloo, J.A. and Dutt, V. (2021). Effect of Spacing and Nitrogen Fertilizer on Survival and Growth of *Betula utilis. Indian Forester*, 147(1), 26-32.

Bhat, G.M., Bhat, R.A., Islam, M.A., Bakshi, M.R., Pala, N.A., Majeed, H. and Fatima, S. (2020). Ethnopharmacology of *Acorus calamus* L. among Indigenous Communities of Ganderbal District in Kashmir. *Journal of Scientific Research and Reports*, 42-48.

Bhat, G.M., Majeed, H., Islam, M.A., Rashid, M., Pala, N.A. and Fatima, S. (2020). Economic Contribution to Household Dependence through *Ocimum basilicum* L. Cultivation: An Important Plant for Health and Livelihood Security in Kashmir Valley (J&K), India. *Current Journal of Applied Science and Technology*, 39(44), 8-14

Bhat, G.M., Majeed, H., Islam, M.A., Rather, T.A., Bakshi, M., Shahkhan, F.A. and Bhat, R.A. (2020). Indigenous medicinal practices of *Ocimum basilicum* L. in rural Kashmir. *Journal of Pharmacognosy and Phytochemistry*, 9(5), 1876-1881.

Islam, M.A., Wani, A.A., Bhat, G.M., Gatoo, A.A., Murtaza, S., Atta, U. and Shah, S.S.G.S. (2020). Economic Contribution and Inequality Mitigation of Wicker Handicraft Entrepreneurship in Rural Kashmir, India. *Current Journal of Applied Science and Technology*, 39(18), 138-149.

Jan, S., Rashid, M., Abd_Allah, E.F., and Ahmad, P. (2020). Biological efficacy of essential oils and plant extracts of cultivated and wild ecotypes of *Origanum vulgare* L. *Bio Med research international*, 1-16.

Mir, J.I., Jan, A., Rashid, M., Singh, D.B., Raja, W.H., Sharma, O. C. and Chand, L. (2020). Genetic variability studies for various morphological and quality traits in apple. *Indian Journal of Horticulture*, 77(2), 227-236.

Rafiq, N., Bhat, G.M., Islam, M.A., Bakshi, M.R., Pala, N.A., Bhat, R.A. and Fatima, S. (2020). Effect of spacing and rhizome diameter on different growth parameters and oil content of *Bergenia ciliata* L. under temperate conditions of Kashmir Valley. *Emergent Life Sciences Research*, 6, 82-89.

Sofi, P.A., Aslam, M., Masoodi, T.H., Pala, N.A., Rashid, M. and Ishtiyak, P. (2020). Influence of seed source and stratification on germination and growth of *Betula utilis* D. Don under temperate conditions in Kashmir Himalaya. *Indian Forester*, 146(6), 532-537.

KAU, Thrissur

Patric, A., Raj, A.K., Kunhamu, T.K., Jamaludheen, V. and Santhoshkumar, A.V. (2020). Productivity of tree fodder banks in a typical homegarden of Central Kerala. *Indian Journal of Agroforestry*, 22(1), 17-23.

Rocha, D., Kunhamu, T.K., Kumar, B.M., Santhoshkumar, A.V. and Jamaludheen, V. (2021). Density manipulation and pruning on fine root production and decomposition dynamics in a mature *Acacia mangium* Willd Stand in Kerala, India. *Agroforestry Systems*, 1-15.

6. Budget (Centre-wise head wise break up)

Name of centres	Pay allow.	TA	Rec. Cont	Eqp NRC	TSP	SCSP Gen.	SCSP Cap.	Total
OUAT, Bhubaneshwar	38.00	0.40	6.00	0.00	2.00	1.25	0.00	47.65
TNAU, FCRI-Mettupalaym	30.00	0.40	7.00	0.00	0.00	1.50	0.75	39.65
BSKKV, Dapoli	34.00	0.40	6.00	0.00	0.00	1.50	0.61	42.51
UAS, Dharwad	60.00	0.40	6.00	0.00	0.00	1.50	0.75	68.65
NDUA&T, Ayodhaya (Faizabad)	16.00	0.40	5.00	0.00	0.00	0.00	0.00	21.40
SKNAU-ARS, Fatehpur-Shekhawati	24.00	0.40	6.00	0.00	0.00	0.00	0.00	30.40
CCSHAU, Hisar	30.00	0.40	6.00	7.63	0.00	0.00	0.00	44.03
PJTSAU, Hyderabad	60.00	0.40	6.00	0.00	0.00	1.25	0.00	67.65
JNKVV, Jabalpur	30.00	0.40	6.00	0.00	0.00	1.25	0.00	37.65
TANUVAS, Kattaupakkam	30.00	0.40	6.00	0.00	0.00	1.50	0.75	38.65
PAU, Ludhiana	33.00	0.40	6.00	0.00	0.00	0.00	0.00	39.40
AAU, HRS-Kahikuchi	40.00	3.00	11.88	0.00	2.00	0.00	0.00	56.88
PDKV-COA, Nagpur	43.00	0.40	6.00	7.13	1.00	1.50	0.00	59.03
GBPUA&T, Pantnagar	40.00	0.40	6.00	0.00	0.00	1.50	0.00	47.90
RAU, Pusa	0.00	0.40	4.00	0.00	0.00	0.00	0.00	4.40
MPKV, Rahuri	29.00	0.40	6.00	0.00	0.00	0.00	0.00	35.40
BAU, Ranchi	25.00	0.40	6.00	0.00	2.00	0.00	0.00	33.40
SDAU, SK Nagar	40.00	0.40	6.00	0.00	0.00	1.50	0.75	48.65
YSPUH&F, Solan	45.00	0.40	6.00	0.00	0.00	0.00	0.00	51.40
SKUAS&T, Srinagar	58.00	0.40	6.00	0.00	2.00	0.00	0.00	66.40
KAU, Thrissur	42.00	0.40	6.00	0.00	0.00	0.00	0.00	48.40
BCKVV, HRS-Jhargram	35.00	0.40	6.00	0.00	1.35	1.50	0.00	44.25
UAS, Bangalore	70.00	0.40	6.00	0.00	2.00	0.66	0.00	79.06
CSKHPKV, Palampur	48.00	0.40	6.00	0.00	2.00	1.50	1.50	59.40
UAHS, CoF-Ponnampet	0.00	0.00	3.50	0.00	0.00	0.50	0.00	4.00
SKUAS&T, Jammu	0.00	0.00	3.50	0.00	2.00	0.00	0.00	5.50
PC Unit	0.00	0.00	5.79	0.00	0.00	0.00	0.00	5.79
Total	900.00	12.20	160.67	14.76	16.35	18.41	5.11	1127.50

7. Staff Strength

Sl.No.	Name of the centre	Scientist (02 at each centre)	Tech.	Supp Staff	Total
1	OUAT, Bhubaneshwar	Dr. S.C. Mohapatra and Mrs. Sasmita Behera	1	2	5
2	TNAU, Coimbatore	Dr. P. Rajendran and Dr. K. Ramah	1	2	5
3	BSKKV, Dapoli	Dr. Suchitra S. Desai and Dr. N.A. Meshram	1	1	4
4	UAS, Dharwad	Dr. Raju L. Chavan and Dr. S.T. Hundekar	1	2	5
5	NDUA&T, Faizabad	Dr. S.K. Verma and Vacant	1	1	4
6	SKNAU, Jobner, (Fatehpur shekhawati)	Dr. Dharmendra Tripathi and Sh. Ramu Meena	1	2	5
7	CCSHAU, Hisar	Dr. Chhavi Sirohi and Dr. Parvinder Kumar	1	1	4
8	ANGRAU, Hyderabad	Dr. A. Krishna and Dr. T. Chaitanya	1	1	4
9	JNKVV, Jabalpur	Dr. B.D. Ghode and Shri Yashpal Singh	1	1	4
10	TNV&ASU, Chennai (IAN, Kattaupakkam)	Dr. S. Gunasekaran and Dr.V.S.Mynavathi	1	1	4
11	PAU, Ludhiana	Dr. R.I.S. Gill and Dr. Navneet Kaur	1	1	4
12	AAU, Jorhat (HRS, Kahikuchi)	Ms. R. Bezbaruah and Ms. Gautami Kataky	1	1	4
13	PDKV, Akola, (COA, Nagpur)	Dr. V.M. Ilorkar and Dr. P.D. Raut	1	1	4
14	GBPUA&T, Pantnagar	Dr. S.K. Lavania and Dr. Ashutosh Dubey	1	2	5
15	MPKV, Rahuri	Dr. B.R. Najan and Dr. R.H. Kolse	1	1	4
16	BAU, Ranchi	Dr. M.S. Malik and Dr. P.R. Oraon	1	1	4
17	SDAU, SK Nagar	Dr. J.R. Jat and Dr. A.G. Patel	1	2	5
18	YSPUH&F, Solan	Dr. D.R. Bhardwaj and Sh. Krishan Chand	1	2	5
19	SKUAS&T, Srinagar	Dr. G.M. Bhat and Dr. Megna Rashid	1	2	5
20	KAU, Thrissur	Dr. V. Jamaludheen and Dr. Asha K. Raj	1	2	5
21	BCKVV, Kalayani (HRS, Jhargram)	Dr. Benukar Biswas and Dr. Subhabrata Panda	1	2	5
22	UAS, Bangalore	Mr. Bhaskar, V. and Dr. Hanumanthappa, D.C.	1	1	4
23	CSKHPKV, Palampur	Dr. Punam and Dr. Rameshwar	1	1	4
	TOTAL	**46**	**23**	**33**	**102**

Volunteer centres in SAU partially funded without any Manpower : 03: SKUAS&T, Jammu and UAHS, Shimoga (CoF, Ponnampet) and Dr. RPCAU, Pusa

Volunteer Centres without any financial commitment: 11 CSWCR&TI, Dehradun (Uttrakhand), ICAR Research Complex for NEH Region, Barapani (Meghalaya), Regional Centre of ICAR-NEH Region, Imphal (Manipur), Regional Centre of ICAR-NEH Region, Gantok (Sikkim), Regional Centre of ICAR-NEH Region, Agartala (Tripura), CSSRI, Karnal (Haryana), ICAR RCER, HARP, Plandu, Ranchi (Jharkhand), CAZRI, Jodhpur (Rajasthan), CRIDA, Hyderabad, CARI, Port Blair (AN), IFGTB (ICFRE), Coimbatore (TN).

8. Directory of Key Personnel

S.No.	Name	AICRP-Agroforestry Secretariat/Centre	Email	Mobile
1.	Dr. A. Arunachalam	Director, ICAR-CAFRI & Project Coordinator, AICRP-Agroforestry	pc.aicrpaf@gmail.com director.cafri@icar.gov.in	09412441230
2.	Dr. A.K. Handa	Nodal Scientist, PC Unit	aicrpagroforestry@gmail.com Arun.Handa@icar.gov.in	09415179658
3.	Mr. Suresh Ramanan S.	Associate Scientist, PC Unit	suresh.s@icar.gov.in	09149587827
4.	Dr. S.B. Agarwal	JNKVV, Jabalpur	sureshagrawal4@rediffmail.com	09425861048
5.	Dr. Ranjita Bezbarua	HRS, AAU, Kahikuchi	ranjitabezbarua@gmail.com	09101093228
6.	Dr. D.R. Bhardwaj	Dr. YSPUH&F, Solan	bhardwajdr_uhf@rediffmail.com	08219327754
7.	Dr. V. Bhaskar	GKVK, UAS, Bengaluru	bhaskaragroforestry@gmail.com	09448985523
8.	Dr. G.M. Bhat	SKUAST-K, Srinagar	bhatm67@gmail.com	09797832690
9.	Dr. Benukar Biswas	HRS, BCKV, Jhargram	kripahi@gmail.com	09434759696
10.	Dr. R.L. Chavan	UAS, Dharwad	aicrpafdwd@uasd.in	08951831964
11.	Dr. D.K. Das	Dr. RPCAU, Pusa	dasdkdlipi@gmail.com	09430046537
12.	Dr. Suchitra Desai	BSKVV, Dapoli	suchitadesai77@gmal.com	09420909308
13.	Dr. Ashutosh Dubey	GBPUAT, Pantnagar	ashutoshdubeyaf@gmail.com	09412381277
14.	Dr. R.I.S. Gill	PAU, Ludhiana	rishigill@pau.edu	08146600670
15.	Dr. Gunasekaran	IAN, TANUVAS, Kattupakkam	gunaj2@gmail.com	09444477155
16.	Dr. Ramakrishna Hegde	CoF, UAHS, Ponnampet, Shimoga	vanasiri03@gmail.com	09448312978
17.	Dr. V.M. Ilorkar	CoA, PDKV, Nagpur	ilorkar@yahoo.co.in	09422831053
18.	Dr. V. Jamaludheen	KAU, Thrissur	jamaludheen.v@kau.in	09447271867
19.	Dr. A. Krishana	PJTSAU, Hyderabad	a.krish62@gmail.com	09553522001
20.	Dr. M.S. Malik	BAU, Ranchi	mohdshujamalik@yahoo.com	09934582241
21.	Dr. S.C. Mohapatra	OUAT, Bhubaneswar	Scmohapatra19765@gmail.com	09437464682
22.	Dr. Bhimaraj Rangnath Najan	MPKVV, Rahuri	Bhimaraj.najan@rediffmail.com	08806282240
23.	Dr. A.G. Patel	SDAU, SK Nagar	rsagroforestry@sdau.edu.in	09429029595
24.	Dr. Punam	CSKHPKVV, Palampur	profpunam@gmail.com	09816366664
25.	Dr. Sandeep Sehgal	SKUAST-J, Jammu	sehgals1@yahoo.com	09419109684
26.	Dr. Chhavi Sirohi	CCSHAU, Hisar	chhavisirohi22dec@gmail.com	09050547849
27.	Dr. Jude Sudhagar	FCRI, TNAU, Mettupalaym	judesudhagar@rediffmail.com	09790293293
28.	Dr. Dharmendra Tripathi	ARS, SKNAU, Fatehpur Shekhawati	dhtrepathi@gmail.com	09680355511
29.	Dr. Sanjay Verma	ANDUAT, Ayodhaya	ver.sanj@gmail.com	07408006003

9. Dignitaries' visit AICRP-Agroforestry Centres

Hon'ble President of India visited Coordinating Centre at Forest College and Research Institute, Mettupalaym on 6th August, 2021 accompanied by Hon'ble Governor of Tamil Nadu

Hon'ble Defence Minister Sh. Rajnath Singh visited Coordinating Centre at FCRI, Mettupalayam on 28th August, 2021

Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR visited Coordinating Centre at TNAU and reviewed the AICRP-Agroforestry Experiments in the Field on 31th October, 2021

Appendix 1

Review of AICRP-Agroforestry by 5th Quinquennial Review Team (QRT)

The Director General, ICAR vide letter of F. No. NRM/16-4/2018-IA-II dated 13th August 2019 (*Annexure V*) constituted the Quinquennial Review Team (QRT) to review the work done by ICAR-Central Agroforestry Research Institute (CAFRI), Jhansi and All India Coordinated Research Project on Agroforestry for the period from 2013 to 2018 under the Chairmanship of Dr. K.R. Dhiman, Former Vice Chancellor, Dr. Yashwant Singh Parmar University of Horticulture and Forestry (YSPUH&F), Solan (Himachal Pradesh). The other members of the team were Dr. A.K. Vashisht, Former ADG (PIM), ICAR, New Delhi; Dr. Rajeshwar Chandel, Executive Director, Natural Farming, Department of Agriculture, Shimla (Himachal Pradesh); Dr. A.K. Mohapatra, Former Professor Agronomy, Odisha University of Agriculture and Technology (OUAT), Bhubaneshwar (Odisha); Dr. S.J. Patil, Ex-Dean, Student Welfare Officer, University of Agricultural Sciences (UAS), Dharwad (Karnataka) and Dr. A.K. Handa, Principal Scientist, CAFRI, Jhansi as Member Secretary. The team reviewed the progress of CAFRI Jhansi and AICRP-Agroforestry based on interaction with the scientists, University administration, farmers, NGOs, wood-based industries and other stake holders. The detailed presentations about research achievements and infra-structure facilities were made before the team by the scientists from all coordinating AICRP centres as given below:

S.No.	Date	Coordinating Centres	Presented by
1.	20-21 January, 2020 at UAS, Bangalore	UAS, Bangalore	Dr. D.C. Hanumanthappa
2.		UAS, Dharwad	Dr. S.M. Mutnal
3.		TNAU-FCRI Mettupalayam	Dr. P. Rajendran
4.		TNVASU, Kattaupakkam	Dr. S. Gunasekaran
5.		KAU, Thrissur	Dr. V. Jamaludheen
6.		UAHS-COF, Ponnampet	Dr. R.K. Hegde
7.	7-8 February, 2020 at OUAT, Bhubaneshwar	OUAT, Bhubaneshwar	Dr. S.C. Mohapatra
8.		BAU, Ranchi	Dr. M.S. Malik
9.		RPCAU, Pusa	Dr. D.K. Das
10.		NDUAT, Faizabad	Dr. S.K. Verma
11.	10-11 February, 2020 at HRS, Kahikuchi	AAU-HRS, Kahikuchi	Dr. J.P. Barua
12.		BCKVV-HRS, Jhargram	Dr. Benukar Biswas
13.	9th and 19th March, 2021 (Virtual Mode)	PAU, Ludhiana	Dr. R.I.S. Gill
14.		SKUAS&T, Jammu	Dr. Sandeep Sehgal
15.		SKUAS&T, Srinagar	Dr. G.M. Bhat
16.		CSKHPKVV, Palampur	Dr. Punam
17.		Dr. YSPUH&F, Solan	Dr. D.R. Bhardwaj
18.		CCSHAU, Hisar	Dr. Chhavi Sirohi
19.		GBPUAT, Pantnagar,	Dr. Ashutosh Dubey
20.		SKNRAU, Fatehpur Shekhawati	Dr. Dharmendra Tripathi
21.		JNKVV, Jabalpur	Shri Yashpal Singh
22.		PDKV, Nagpur	Dr. V.M. Ilorkar
23.		SDAU, SK Nagar	Dr. J.R. Jat
24.		MPKVV, Rahuri	Dr. B.R. Najan
25.		BSKVV, Dapoli	Dr. Suchitra S. Desai
26.		PJTSAU, Hyderabad	Dr. A. Krishna

The final report of the QRT was presented before Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR by Dr. K R Dhiman, Chairman of the QRT in virtual mode on 7th October, 2021 in the presence of Dr. S.K. Chaudhari, Deputy Director General (NRM), Dr. S. Bhaskar, Assistant Director General (Agronomy, Agroforestry and Climate Change), Dr. A. Arunachalam, Director, CAFRI, Jhansi and other members of the team.

Appendix 2

ATR on the Recommendations of the previous Annual Group Meeting of the Project

ATR on the Recommendations of the previous Annual Group Meeting

The proceedings of the previous Annual Group Meeting of the AICRP-Agroforestry are placed as Annexure 1.

S.No.	Recommendation	Action taken
1.	It is strictly recommended that all the centres must adhere to financial guidelines of ICAR communicated to all centres as per instructions from Director (Finance) ICAR F. No. FIN. 22/15/2013 -CDN (A&A) dated 4 September, 2014 and the information related to Utilization Certificate, Audit Utilization Certificate and Second Half Demand must be submitted as per schedule.	Action Complied and all centres following the guidelines
2.	All the expenditure of the project to be booked strictly under PFMS, otherwise no grant will be released to the centre.	Action Complied and all centres following the guidelines and booking expenditure through PFMS
3.	The TSP and SCSP grant to be utilized strictly as per the guidelines and the centres have to submit annual and quarterly report as per the schedule in the prescribed format (Quarterly Report: 7th July for April to June, 7th October for July to September, 7th January for October to December and 7th April for January to March; Annual Report 7th April for April to March).	Action Complied and centres utilizing grant under TSP and SCSP as per guidelines and submitting quarterly report
4.	Centres to compile information on carbon sequestration potential of different tree species from the old experiments.	The carbon sequestration information for promising tree species compiled
5.	The lead centre for the common experiments to submit summary results and status report after compiling information from other centres.	Lead centres complied information and will present in their presentations
6.	Each centre to develop one demonstration of the successful agroforestry technology in the farmer field.	Demonstration of successful agroforestry technologies demonstrated by also involving KVKs.
7.	Quality planting material essential component of agroforestry, each centre to strengthen nursery activities for raising quality planting material of the important agroforestry tree species and initiate nursery experiments for further refinement of propagation techniques of tree species.	Nursery component strengthened at all centres and centres providing quality planting material to farmers and other stake holders.
8.	The centre having large germplasm of agroforestry species and having facilities to give emphasis on tree improvement work, initially centres at Pantnagar, Hisar, Mettupalaym, Solan, Nagpur, Ponnampet to strengthen work on tree improvement / breeding aspects in the tree species available with these centres including biotechnological/molecular aspects.	Information sharing is underway; TNAU Centre has initiated sharing of germplasm to other units for multi-location trials; However, biotechnological/molecular studies have not yet been taken up due to acute financial crunch.
9.	All centres to coordinate with their respective Agroforestry Mission Directors in the State Government and to create awareness among farmers about the National Agroforestry Policy.	All centres providing technical back up to respective State Agroforestry Missions and conducting capacity building programme as and when required.
10.	As per the recommendations of the high-powered committee on AICRPs by ICAR for review of AICRPs, the young scientists working in the AICRPs needs to be encouraged and made PI of the Units.	Young scientists and being encouraged at all centres

11.	Effective collaboration should be established with other departments.	The centres are collaborating with other departments of the University and nearby Institutes. For instance, TNAU Centre got representation in the NITI Ayog Committee on Sandalwood
12.	There should be full administrative and financial powers to the OICs of coordinating centres of the project for smooth functioning of the project as per the guidelines of ICAR.	Being followed at some Universities
13.	The centres to conduct awareness programme on boundary/ bund plantation and one silvipasture system as per the schedule given below and submit the report as per timeline.	All centres are following the schedule and are conducting awareness programme on boundary plantation; the Coordinating Unit also did a major exercise of organising `Har Med Par Ped' on the eve of ICAR Foundation Day in 2021 and enabled plantation of 9.54 lakh seedlings across the country through our AICRP units as well.

Annexure 1

Proceedings of Annual Group Meeting of AICRP on Agroforestry

Proceedings of Annual Group Meeting of All India Coordinated Research Project on Agroforestry held at TNAU-FCRI, Mettupalayam during 18-20 September 2019

The Workshop of All India Coordinated Research Project on Agroforestry was organized at Forest College and Research Institute, Mettupalayam from 18-20 September 2019. Dr. K.T. Parthiban, Professor and Head, Department of Agroforestry, Forest College and Research Institute, Mettupalayam welcomed the gathering. He talked about the consortium and business mode agroforestry systems being followed in Tamil Nadu. Dr. K.K. Suresh, Dean (Forestry) honoured the honourable Vice-chancellor, Director of Research, TNAU, Coimbatore and Director, CAFRI. The Vice-chancellor has honoured Dr. C. Surendran, former Dean (Forestry), Dr. M.G. Dasthagir, former HoD and first OIC of AICRP Mettupalayam centre, former Heads of the Department of Agroforestry and previous OICs of Mettupalayam centre.

Dr. K.K. Suresh, Dean (Forestry), FC&RI, Mettupalayam delivered introductory remarks with the emphasis on bringing farmers, scientists, industries, insurance companies, banking sectors under single umbrella called CIAF and business incubation centre. Dr. Anil Kumar, Project coordinator and Director CAFRI, Jhansi presented the Coordinator's report and stated that agroforestry research needs to be focussed in developing agroforestry models suitable for different agro-climatic zones of country with changing climate scenario. Dr. K.S. Subramanian, Director of Research, TNAU, Coimbatore in his special address emphasised the need for *in-situ* and *ex-situ* conservation of forests with native species to increase the existing forest cover of 21.56%. Honourable Vice-chancellor of Tamil Nadu Agricultural University, Coimbatore Dr. N. Kumar inaugurated the programme and in his presidential address stated that in near future due to the uncertainties in climatic conditions, only agroforestry can withstand rather than relying only on either agriculture or horticulture. In TNAU more focus has been given to develop agroforestry systems by earmarking an area of more than 500 ha exclusively for agroforestry research with a special importance to multifunctional agroforestry system. He emphasised that successful agroforestry models and technologies of AICRP centres must be transferred to the tree growers and stakeholders across the country. The Vice-chancellor released twenty-two publications including books, booklets, and pamphlets of various AICRP centres. Dr. P. Rajendran, OIC AICRP-Agroforestry FCRI, Mettupalayam delivered the Vote of Thanks.

The event got wide coverage in the print and electronic media. The session wise brief report and major recommendations are presented below:

Technical Sessions

The Himalayan Zone

Dr. G.M. Bhat presented the progress of the SKAUST, Srinagar and informed that eight sources of *Ulmus villosa* (Elm) were collected from different regions of Kashmir valley and planted (Boundary plantation) at Shalimar Campus of the University. Elm source from Pulwama exhibited a greater advantage in the leaf fodder to overall yield 17.2 kg/tree. The apricot-based agroforestry system revealed a good potential for the stake holders after the completion of five growing seasons. The apricot trees recorded the maximum plant height (3.33 m), collar diameter (65.84mm), Number of branches (18.33) and fuelwood yield 0.40 kg/ tree in combination with Orchard grass followed by Tall fescue with a height of 2.96 m, collar diameter of 61.58 mm with Lucerne at 2 x 3 m tree spacing. Among the four fodder species *viz.* Timothy, Orchard grass, Lucerne, Tall fescue and natural grasses (control) sown in interspaces; Orchard grass performed better with 22.80 t/ha green fodder yield followed by Tall fescue (14.50 t/ha). Centre raised five thousand seedlings of MPTS and fruit trees for distribution among farmers/tribals of Kangan (Ganderbal district) and Stakna (Leh district). An arboretum of different multiple purpose tree species has been established at Benhama Ganderbal. Till date about 24 different multipurpose tree species were planted in the arboretum for *ex-situ* conservation.

Dr. D.R. Bharwaj presented the report for YSPUH&F, Solan. Eleven clones of *Morus alba* were analyzed for growth and developmental traits by Solan centre. The study revealed that after 18 years of plantation different clones displayed their superiority for various traits. The collar diameter growth was maximum in the clone 7, whereas the plant height growth was maximum in the clone no 5. Maximum leaf (12.03 t ha^{-1}) was displayed by clone no.5. Whereas total biomass (leaf+ branch wood biomass) (45.99 t ha^{-1}) was displayed by the clone no. 6, which was closely followed by clone no.5. All the families of *Grewia optiva* established in the seed orchard at Nauni behaved

differently. No specific trends for different seed traits have been noticed during the year under report. However, family no SO-6 registered superiority for seed length, seed width *etc.* Green leaf biomass (g plant^{-1}) displayed significant variation among different family code. Maximum green leaf biomass (2366 g plant^{-1}) was exhibited by the family code CH-3, which was closely followed by SL-11(2320 g plant^{-1}) and BL-3 (1725 g plant^{-1}). In *Grewia optiva* based AF system, irrespective of lopping intensity maximum plant height (38.74 cm), number of leaves (2.78) of *Allium cepa* (onion) was found in the plant supplied with the Farmyard manure (FYM) on N equivalent ratio of recommended doses of fertilizers. The leaf length (35.16 cm) and the yield (27.90g) was maximum in the plants treated with vermicompost @ on N equivalent ratio of recommended doses of fertilizers. However, maximum bulb weight (27.90 g) in the plots treated with Jeevamrut. The effect of lopping intensity on plant height (cm) and number of onion leaves were non-significant. Leaf length (34.48 cm) was maximum at 75% lopping intensity. Weight per bulb (28.05 g) and total yield (10.80 t ha^{-1}) were maximum at 50% lopping intensity. An experiment was carried out to study the effect of lopping intensities- 75, 50, 25% and no lopping of *Morus alba* (M-5 clone) trees, and organic manures- vermicompost, FYM, Jeevamrut and no manure on the growth and yield behavior of maize (*Zea maize*). It was found that growth- plant height, number of seeds per cob, dry matter production per plant, 100 grain weight per plant-1, stover yield per plant & ha^{-1} enhanced significantly with the increase in lopping intensity. Similarly, all these traits showed their maximum values when the maize plants were supplied with vermicompost on nitrogen equivalent ratio. The level of the OC%, available N, P& K also enhanced significantly with the application of all types of the organic manure than the no application. However, maximum returns (Rs. 70,750) were calculated in the treatment involving lopping at 50% intensity and application of FYM. Under TSP about 2000 apple plants of the different cultivars were planted in the Sangla tehsil of Kinaur district of Himachal Pradesh.

The report of CSKHPKVV, Palampur was presented by Dr. Punam. Palampur centre evaluated 25 germplasm sources of *Toona ciliata* since 2006. Out of these, best 8 superior seed sources have been under field evaluation since 2012. Seed sources from Mandi *i.e.*, HPV(b)71 is coming out to be best performing in the field followed by HPV(b) 48 and HPI(c)22 seed source of Solan in terms of overall height gained, diameter and canopy spread. HP V(b)71 recorded 72.41%, 69.20% and 43.12% higher height, dbh and spread respectively than HPIV(c)87, the least performing germplasm source from Kangra. In case of *Sapindus mukorossi*, out of best performing 8 seed sources under field evaluation since 2012, AS11 from Dhraman, Sihunta Distt. Chamba was found to be the best performing in terms of growth parameters and had 23.8% and 35.29% higher height and diameter respectively than AS23 a local germplasm source from Rajpur, whereas 50.84% higher spread was attained by another seed source from Chamba-Mangla than the local AS23 seed source. AS11 is followed by two other seed sources from Chamba- AS5 and AS3 in their growth performance. *Morus* based silvi-pastoral system has been recommended for reclamation of degraded grass lands and increasing their productivity potential in mid hills of Himachal Himalayas. Introduction of *Morus alba* (3x3m) along with the improved grasses *i.e. Setaria* and *Napier (*50x50 cm*)* recorded 26 and 23 percent respectively more total green fodder yield from the degraded land as compared to their production without tree component. Quality green fodder was obtained from tree (through pollarding at a height of 5´) and grass components, three times in a year in the months of May, July and September. Productivity of the system was enhanced to the tune of 2.83 and 3.33 times respectively as compared to the natural grass treatment. The overall net income per hectare per year of degraded grassland was raised from Rs. 5400/- to Rs. 14130/ha/ year in the initial years. D&D exercise conducted by the centre in Nurpur-Valley sub regions revealed that Agri-horti-silviculture and Horti-agri-silviculture system were the most prevalent agroforestry systems. Fodder, timber & fuelwood trees are mainly concentrated on boundary of the agricultural fields. Fruit trees are either on the bunds or in the centre of the fields. When all the 21 species of trees were classified based on their uses, it was seen that horticulture tree species had the highest share (52%) followed by fodder (22%), timber (13%) and fuelwood (8%) tree species. About 7 ha tribal farmers' land has been developed in district Kangra under Silvipasture and Hortipasture agroforestry systems through peoples' participation approach. Quality planting material of *Morus, Grewia, Poplar, Eucalyptus*, lemon and Galgal along with recommended fast growing grasses like Setaria were also distributed to the beneficiaries for plantation in the demonstration trials. About 0.5 ha has been adopted in village Sichling in district Lahual and Spiti under TSP programme.

Dr. Sandeep Sehgal from SKUAS&T, Jammu informed The Jammu centre-initiated Poplar based agroforestry system in the Sub-tropics of Jammu and Kashmir to study the performance of Rabi (Potato, Spinach, Cabbage) and Kharif (tomato, Brinjal, Okra) vegetables under Poplar based agroforestry system in the sub-tropics of Jammu. Growth and productivity of *Melia composita* planted at a spacing of 6×4 m after two and a half years of planting showed impressive growth performance with an average height of 8 m. Village Nanetar and Palai of Block Sumb in the District Samba adopted for carrying out TSP activities by the

Jammu centre. Seed treatment drum and Knapsack sprayers were distributed in both Nanetar and Palai villages to be used by the people of the respective villages on sharing basis. Encouraging the farmers for treating seeds before sowing. Seed treatment drum uses less time and saving labour cost. Helps to boost up farm income by improving productivity. A training programme on, "Scientific benefits of Tree crop combinations" was conducted with an objective to improve the knowledge of TSP beneficiaries about scientific benefits of Tree crop combinations. It was also aimed at providing options for diversification of existing farming systems for increased productivity by agroforestry adoption.

The Indo-Gangetic Zone

The session had five presentations and each speaker presented the progress of the work during the last year and the salient findings are presented here. Dr. R.I.S. Gill from PAU Ludhiana presented the progress of the work carried out during the last year. Under the tree improvement work, the Centre opined that after five years of planting, the Clone PP9-25 had the highest DBH (16.12 cm) and the Clone HAU-S3 had the maximum height growth (17.33 m) out of the 15 clones tested. Under *Melia composita* tree improvement, total 20 and 24 parent progenies were plated at two locations with 4 m X 4 m spacing. After nine years of planting performance of progeny was highest in height (17.1 m) and DBH (29.4 cm) growth followed by progeny 19. In the experiment on assessment on performance of poplar and intercrops under different spacing, 16 wheat varieties were tried over two trees spacing. After six years of planting two wheat varieties PBW 725 and PBW 677 had significantly better yield.

The experiment on response of potato to potassium revealed that application of K_2O has considerably increase the potato yield. Study on the soil properties under poplar and Melia plantations revealed that soil OC, available N, P and K were maximum under 4 m X 3m spacing under poplar plantation after 7 years of planting, whereas in Melia the values were maximum under 7 m X 3 m spacing. Under the experiment on development of Eucalyptus based AF system after two years of planting, the reduction in the yield of *rabi* and *kharif* crops were observed. In an experiment on application of biofertilizer on growth of Eucalypus the application of consortium had the growth on par with application of recommended inorganic nutrients. In an experiment to assess the effect of sewage sludge on tree growth on tee growth it was found that the highest DBH was notices in treatment with FYM. However, application of sludge (100%) produced an average height of 21.74 m after six years of planting and with FYM it was 21.21 m.

Dr. Ashutosh Dubey from GBPUA&T, Pantnagar presented the centres work. The centre has an arboretum of 96 tree species, and it has good clonal collection of poplar (121 clones), Eucalyptus (24 clones) and *Dalbergia sissoo* (8 clones). It was observed that soil microbial enzyme activity, metagenome bacterial diversity and physicochemical properties under *Dalbergia sissoo* provenances varied significantly for phosphorus solubilizing bacteria. The use of biochar (perlite with pine needles biochar 50:50) and rice husk biochar growing media resulted higher rooting and root growth in Eucalyptus miniclonal experiment. Further, the Centre filed patent for "Development of Antioxidant enriched whey based chalta (*Dillenia indica* L.) beverage and process". The centre generated the revenue to the tune of Rs. 12.00 during the year 2018-19.

Dr. S.K. Verma from NDUAT, Fiazabad presented the activities of the centre. In the experiment on varietal evaluation of different intercrops under *Dalbergia sissoo* and *Casuarina equisetifolia* based agri-silviculture system, it was found that paddy variety sarjoo -52 had the highest yield over other paddy varieties. Further, among the different mustard varieties, variety NDR 8501 produced better yield over other varieties. The plantation of guava with *C. equisetifolia* and aonla with *D. sissoo* based Agri-silvi-horti system has been developed from the centre. Further, the intercropping of turmeric under *D. sissoo* and *C. equisetifolia* has been transferred to farmers.

Dr. Dipty Das from RPCAU Pusa presented that among the different varieties of turmeric under Aonla based agroforestry, it was found that Aonla with turmeric NDH-92 was most profitable based on the LER. Among the eight *D. sissoo* genotypes the best growth performance was recorded in PS -38, PS-90, PS-20 and PS -52. Among the 18 poplar clones, the best growth performance was observed in clones pp9-OPR 1 and PP 9-J1. In experiment on assessment of carbon sequestration potential of *Anthocephalus cadamba* plantation along age series it was revealed that MAI and PAI showed increasing trend upto 10^{th} year and started declining after 10 years. The average volume per tree varied form 4.87 cft (8-year-old) to 8.30 cft (13-year-old). Further it was found that the planting *A cadamba* with 5 m X 4 m spacing could remove 61.8 to 109 $Mgha^{-1}$. The centre recommended *A. cadamba* based AF for Northwest Alluvial plain of Bihar. The use of subsurface irrigation in establishment of bamboo plantation before the onset of monsoon in the riverbed was found to be useful.

The CCSHAU, Hisar centre report was presented by Dr. Chhavi Sirohi. She informed that in multilocation trial on eucalypts with 8 m x 2 m, the cultivation of intercrops (cowpea and moong as *Kharif* crop, wheat, mustard and

barseem as *Rabi* crop) did not affect the grain production after 18 months of planting. In Agri-Silvi- Horticulture system at the age of seven years, a significant increase in the DBH of clone HC-2045 was recorded. Significantly higher grain yield and straw yield in wheat was also observed in agri-horti system compared to agri-silviculture. In an experiment on progeny trial of *Melia composita* the significant variation in growth characters of different progenies were recorded. Among the progenies of 18 CPTs MCB 2 from Haryana highest DBH followed by MCPAU 2 and MCS 6 from Punjab and Himachal Pradesh respectively. In the Coordinated trial of Shisham, the growth performance eight clones of *D. sissoo* were assessed and it was found the clonal variation in height and basal diameter growth was evident in the study.

The Humid and Sub-Humid Zone

The session began with the presentation of Dr. Bisawas, from Jhargram centre. He informed that under evaluation of 18 germplasms of *Gmelina arborea* for genetically superior mother and establishment of seed orchard, 6 nos. of superior germplasms are selected on the basis of their growth parameters. In evaluation of 28 nos. of germplasms of *Acacia auriculiformis* 8 nos. of superior quality are selected. The centre evaluating 12 seed sources of *Gmelina arborea* and the best performance for growth parameters were recorded for Acc. No. 6, Acc. No.11, Acc. No. 12 and Acc. No. 5 at the age of 14 years with 62.6, 56.9, 22.5 and 6.1% higher timber yield, respectively. The highest timber yield (0.119 m^3/tree) of *Gmelina arborea* was in combination with sweet orange + cowpea-toria and that combination yielded maximum sweet orange fruits (994 dozen/ha) also. Arhar equivalent yield of different intercrops studied as alley crops in gamhar – sweet orange plantation, were 19.50 q/ha, 18.00 q/ha and 14.80 q/ha, in cowpea–toria, green gram–toria and arhar, respectively. Cultivation of cowpea-toria sequence as intercrop has also resulted buildup of OC (4.9%), available N (8.8%), available P2O5 (17.1%) and available K_2O (5.7%) along with additional net return of Rs 14140/- from alley crops in the second year. This intercropping sequence as alley crops has also intercepted 2.56% higher light resulting 7.62% extra biomass production and 7.53% carbon sequestration in gamhar and sweet-orange based agroforestry system.

In order to identify the appropriate land use system towards enhancing productivity of marginal lands under rain fed conditions, an effort was made to develop agrofoerstry system integrating the arable crops, fruit trees and silvi components for rainfed upland under red & laterite tract of humid and sub-humid zone. The highest timber yield (0.095 m^3/tree) of *Gmelina arborea* was in combination with sweet orange + cowpea-toria and that combination yielded maximum mango fruit (6.8 t/ha) also. Arhar equivalent yield of different intercrops studied as alley crops in gamhar–mango plantation, were 19.50 q/ha, 18.00 q/ha and 14.83 q/ha, in cowpea–toria, green gram–toria and arhar, respectively. Cultivation of cowpea-toria sequence as intercrop has also resulted build-up of OC (6.78%), available N (3.60%), available P_2O_5 (2.41%) and available K_2O (2.96%) along with additional net return of Rs 14935/- from alley crops in the second year. This intercropping sequence as alley crops has also intercepted 2.41% higher light resulting greater biomass production and carbon sequestration in gamhar and sweet-orange based agroforestry system.

In *Eucalyptus tereticornis* and mango -based agroforestry system, the highest timber yield (0.770 m^3/tree) of *Eucalyptus tereticornis* was in combination with sweet orange + arhar and that combination yielded mango (6.6 t/ha). Arhar equivalent yield of different intercrops studied as alley crops in gamhar – mango plantation, were 19.50 q/ha, 18.00 q/ha and 15.2 q/ha, in cowpea–toria, green gram–toria and arhar, respectively. Cultivation of cowpea-toria sequence as intercrop has also resulted buildup of OC (1.61%), available N (0.57%), available P_2O_5 (2.61%) and available K_2O (3.26%) along with additional net return of Rs 15833/- from alley crops in the second year of the experiment. This intercropping sequence as alley crops has also intercepted 1.18% higher light resulting 38.12% higher biomass production and carbon sequestration in gamhar and sweet-orange based agroforestry system.

Under evaluation of *Gmelina arborea* based Agrisilvicultural System at Ranchi as informed by Dr. M.S. Malik, the average maximum height of *Gmelina arborea* was observed in combination with *G. arobrea* + arhar (*var*. Vishal 120) 130 cm maximum average diameter *35.71 mm in Gmelina arborea* + Green gram in the second year 2019. The average maximum height (173.33 cm) and maximum average collar diameter (*23.92 mm)* of *Melia azedarach* was observed in sole *Melia azedarach* in the second year. Under TSP center distributed and planted *Tectona grandis* (1,500), *Gmelina arborea* (1,500 nos), *Melia azedirach* (1,000 nos), *Mangifera indica* (3,000 nos) and *Psidium guajava* (1,000 nos) in the tribal farmer's field. It has been observed that tribal families have shown interest in intercropping with tree plantations related to agroforestry activities. The farmers have adopted the package of practices of the agricultural crops *viz.*, ginger, onion, pea, tomato, reddish, cabbage, cucumber, bean, mustard and pulse and horticultural crops *viz.* mango, papaya, litchi *etc* and also tree crop like Gamhar, Teak, Bakain.

Dr. S.C. Mohapatra, OIC of the OUAT, Bhubaneshwar presented the progress of the centre and seven entries of

Gmelina arborea were collected at Bhubaneswar from the eastern parts of India for evaluation of growth and biomass production. At 42 months after planting, Durgaprasad (Nayagarh, Odisha) entries recorded highest plant height (2.98 m), basal girth (17.75 cm) and crown spread (1.73 m). However, the performance of Badakameti (Nayagarh, Odisha) was lowest with respect to plant height, basal girth and crown spread among all the seven tested entries. *Acacia mangium* were collected and planted from nine provenances and at 30 months after planting Villigram entries was significantly superior with respect to plant height (12.02 m) DBH (8.48 cm) and crown spread (3.47 m). In guava based agri-horticultural system, the nutritional treatment, (STD (100%) + FYM + Biofertiliser) in guava + arrowroot gave highest guava fruit and fresh arrowroot yield, 2628 kg ha^{-1} and 6568 kg ha^{-1} respectively with the net return of Rs. 64338 and benefit cost ratio 2.19. This higher yield of both crops in the system might be attributed due to balanced nutrition of arrowroot and guava. This system also recorded highest available N (264.5 kg ha^{-1}), P_2O_5 (79.5 kg ha^{-1}) and K_2O (259.7 kg ha^{-1}) in the same treatment (STD (100%) + FYM + Biofertiliser).

Guinea is the most productive and profitable fodder crop irrespective of associated silvi trees in the silvipastoral systems. Maximum fodder yield was obtained from Guinea 20.9 t/ha in association with *A. mangium* with BCR 2.8 and fodder yield recovery percentage over sole was highest in Guinea (79.9) followed by thin Napier (75.2) and Setaria (74.3). Analysis of soil after three cuttings per annum of the fodder crops in silvipasture system indicated highest values of available N in Setaria, available P_2O_5 in thin Napier and available K_2O in guinea. *Gmelina arborea* with intercrops (green gram- toria) at 30 months after plantation recorded highest plant height (2.72m), basal girth (23.2 cm) and crown spread (2.07 m), followed by *G. arborea* with cowpea-toria. In this agri-silvi system, after harvest of intercrops indicated that the highest value of soil available N (229.1 kg/ha) and K2O (105.3 kg/ha) with green gram-toria followed by cowpea–toria. Among the G. arborea based agri-silvicultural systems *G. arborea*+cowpea-toria recorded the arhar equivalent yield of 1146 kg/ha and the net return of Rs 36,700/ha and BCR of 1.66 followed by *G. arborea*+arhar (Net return Rs. 27,400 and BCR 1.78).

Under TSP programme by the centre 35 no of tribal families of Majhisahi village, Dhenkanal Sadar block in Dhenkanal district were benefited. Total 25.0 ha of cropped area in the village were covered under different livelihood and nutritional security practices with seven number of front-line demonstrations, three trainings and one exposure visit. On an average per farmer per year achieved Rs. 25,000-35,000 with an additional engagement of their own family member of 35-100 days. Animal components like poultry and goat with community pisiculture gave them higher profit and more engagement followed by horticultural interventions like vegetable cultivation and orchard management of mango and cashew.

The Arid and Semi-Arid Zone

Dr. Jeevraj Jat highlighted the achievements of SDAU, SK Nagar centre and reported that in *Ailanthus excelsa* germplasm evaluation studies in rainfed condition at SK Nagar revealed that among the thirty germplasm evaluated Mithivavadi and Jagudan villages seed sources is the best performing in terms of growth parameters *viz.* plant height (9.93m) and collar diameter (25.8 cm) after eight years of plantation. Collar diameter of different germplasm ranged from 16.72 to 25.8 cm. Significant difference among the ten elite progenies of neem along with a local check was observed, for their growth parameters in the multi locational trial. After fourteen years of plantation, the Progeny No 110 recorded significantly high plants (8.39 m) and collar diameter (25.73 cm) over rest of the progenies. The *Melia* species evaluation studies revealed that genotype MD 05 performing better in terms of growth parameter i.e. plant height (5.18 m), collar girth (37.36 cm) and collar diameter (11.90 cm) and it was followed by MD 01 Clonal source received from Mettupalaym.

In case of alternate boundary of neem and *Ailanthus*, the highest grain (250 $kgha^{-1}$) and straw yield (600 $kgha^{-1}$) of pearlmillet was observed in middle side and it was followed by north side, west side and the lowest yield was obtained in east side. The grain yield of amaranths maximum 485 $kgha^{-1}$ was recorded in middle side, and it was followed by west side and north side. Alternate boundary plantation of *Ailanthus* and neem shows that the highest plant height (11.62 cm) and collar diameter (40.13 cm) of *Ailanthus* and plant height (7.04 m) and collar diameter (15.86 cm) of neem were observed in south side of the field. The centre produced 7000 plants of different MPTs and Medicinal tree species in the agroforestry for supplying to the farmers. Under Tribal Sub Plan (TSP) tribal farmers adopted different agroforestry systems *viz.* boundary plantation, horti-pastoral systems, vadi project *etc.* and farmers were provided improved seeds of various intercrops (castor, moongbean, clusterbean and oat), fertilizers, castor cake, insecticides (Chlorophyriphos) and fungicide (COC) to the selected farmers of Vagdadi villages.

The Fatehpur-Shekhawati centre report was presented by Dr. Dharmender Tripathi. The centre evaluated 13 provenances, 15 plus trees and 120 CPT's of *P. cineraria* collected from Gujarat and Rajasthan. Under block plantation evaluation, four tree species *viz.*, *P. cineraria, A.*

nilotica, A. tortilis and *H. binata* were planted at 5 m x 5 m in block plantation. Data revealed that *A. tortilis* registered maximum tree volume 0.72 m^3/tree followed by *P. cineraria* 0.25 m^3/tree and *H. binata* 0.22 m^3/tree after 22 years. In rainfed condition experiment under 22-year-old *P. cineraria* based agri-silviculture system highest yield (710 kg/ha) recorded in clusterbean RGC 1066 variety and lowest yield 340 kg/ha recorded in Moth bean variety RMO 435 and significant variation were seen between crop varieties in comparison to control (without tree). The agri-siviculture enrich the soil fertility status in the form of organic carbon and available N, P and K. Organic carbon in the soil, increased from 0.24 to 0.33 percent under this system in rainfed condition of arid climate. Silvipasture systems in dry semi-arid condition maximum green fodder yield of *C. ciliaris* recorded with *P. cineraria* tree 265 q/ha followed by *Tecomella undulate* 2300 q/ha, *A. indica* 165 q/ha and *H. binata* 155q/ha. This year 28 ha demonstrations of Moong based agroforestry system were established under TSP in Banswara district and two trainings were organized. All tribal farmers were provided input such as moong seed, fertilizers (NPK and Urea), fruit plants (Mango, lemon and pomegranate) and insecticides and pesticides.

Dr. V.M. Illorkar presented the report for CoA, PDKV, Nagpur. The Centre collected and evaluating 13 *Ailanthus excelsa* accessions. The best performance for growth was observed in accession No. ACN/MHK/ 4 and ACN/MHK/ 1 were found promising. The wood volume of ACN/MHK/ 4 was observed 30% higher compared to provenance No. ACN/MHK/10. Centre also collected, screened and evaluating six *Tectona grandis* accessions and observed that PDKV/ AF/1 and PDKV/AF/2 were promising. The DBH of PDKV/ AF/2 was observed 33% higher compared to seed raised local teak accession. The centre is having germplasm of twenty bamboo species, out of which *Dendrocalmus stockssi, Bambusa bamboos, Bamboos tulda, Bamboosa balcoa* performing better on biomass basis and identified as promising for cultivation in hot and dry agroclimatic conditions in the Vidarbha region. Centre recommended VANWADI model for paddy growing region. It consists of growing of 300 teak trees/ha on paddy bunds and 30 mango trees/ha under paddy farming. Centre has developed Hi-tech nursery complex for production of quality planting material of medicinally useful trees for afforestation in the region. Fifty thousand saplings were supplied for massive afforestation programme of Maharashtra state. Centre also contributing to the State Agroforestry Mission and planned to raise the Clonal nursery for mandatory species Teak, Ailanthus and Bamboo.

In provenance trial of *Dalbergia sissoo* collected from seven provenances by Jabalpur centre at the age of 8½ years, provenance received from NRC Jhansi (T_7) recorded higher plant height (794 cm) and basal diameter (153 mm) and dbh (124 mm) as reported by Rahul Dongre. Under 20 years old agri-silviculture system (*Dalbergia sissoo* + Paddy-Mustard/Gram/Wheat rotation) where 4 pruning treatments (*viz;* no pruning, 25%, 50% and 75% pruning) and three crop rotation (Early paddy (Danteshwari) + Mustard], [Medium paddy (MTU-1010) + Gram], [Late paddy (Kranti) + Wheat]. Significant maximum grain yield of paddy was recorded under open condition (2241 kg ha^{-1}) at par with 75% pruning (1767 kg ha^{-1}). No pruning recorded significantly lowest grain yield (1198 kg ha^{-1}) at par with 25% pruning (1328 kg ha^{-1}) and 50% pruning (1530 kg ha^{-1}). Managed agroforestry system (*i.e*. pruning treatments) recorded higher monetary return (Rs. 55815 ha^{-1}) as compared to crop alone (Rs. 23092 ha^{-1}) and tree alone (Rs. 41017 ha^{-1}). During *rabi* season crops *viz.*, mustard, gram and wheat were sown after paddy. Significantly higher wheat equivalent yield (9719 kg ha^{-1}) was recorded under open condition and was significantly superior to all the pruning treatments. No pruning recorded significantly lowest yield (3957 kg ha^{-1}). Significantly maximum net monetary return was recorded under *Dalbergia sissoo* + medium paddy (MTU-1010) + Gram (Rs. 71087 ha^{-1}) crop rotation followed by *Dalbergia sissoo* + late paddy (kranti) + wheat (Rs. 60370 ha^{-1}). *Gmelina arborea* based agrisilvicultural system where *Gmelina arborea* + greengram -toria treatment recorded the highest arhar equivalent yield of 1529.3 kg ha^{-1} as compared to sole arhar yield of 772.2 kg ha^{-1}. Among the *Gmelina arborea* based agrisilvicultural system, *G. arborea* + greengram - toria recorded the net return (Rs. 38465 ha^{-1}) and B:C ratio (2.26) as compared to sole arhar in terms of net return (Rs. 26473 ha^{-1}) and B:C ratio (2.04). Studies showed that agrihorticulture system (Aonla + Wheat) was more profitable (Rs. 44520 ha^{-1}) as compared to wheat alone (Rs. 30410 ha^{-1}). The B:C ratio of agri-horticulture system was more (2.23) as compared to growing of crop alone (1.90).

Dr. Najan from Rahuri center informed that eight entries of *Acacia nilotica* var. *indica* were selected from 61 accessions collected from different locations of Maharashtra. The *Acacia nilotica* provenance RHRAN-36 recorded significantly highest plant height (8.97 m) but at par with all the entries studied. The entry RHRAN-57 recorded significantly highest collar diameter (22.30 cm) and DBH (17.27 cm) but at par with all the entries. The entry RHRAN-6 recorded significantly highest bole height (2.76 m) whereas the entry RHRAN-41 recorded highest number of branches (4.95).

Effect of planting geometry on productivity of Teak under agroforestry system in semi-arid condition revealed that the growth parameters *viz.*, plant height, collar diameter, crown spread (East, West) and (North, South) of teak plants ranged from (202 to 248, 3.55 to 5.8, 71.5 to 125.6, 78.4 to135.8 cm) respectively. The litter fall ranged from (109 to 121 kg ha^{-1}) maximum plant height was recorded under (Teak + cowpea + mulching - fodder). Whereas collar diameter, crown spread (East, West) and (North, South) was more under treatment Teak sole – (8 m x 2m x 2 m. Paired row) (5.8, 125.6, 135.8 cm) respectively. In regards of litter fall maximum litter fall was observed under treatment $_{Teak}$ sole – (8 m x 2m x 2 m. Paired row). Among the intercrop treatments maximum plant height (248 cm) collar diameter (5.07cm) and litter fall ha^{-1} 120 kg h^{-1} was recorded in treatment (Teak + cowpea + mulching – fodder maize). The grain and straw yield were highest in sole treatments of Cowpea and Black gram 15.91 and 12.08 (q ha^{-1}). Among intercrop treatments grain and straw yield was recorded more under treatment (Teak + Cowpea + mulching - Fodder Maize) (15.88 qtls and 30.48 qtls) respectively. In regards with *Rabi* season the sole crop fodder maize (Sole crop black gram - fodder maize) recorded higher fodder yield (665.55 q). Among intercrop fodder treatments Teak+Black gram mulching + fodder maize recorded higher maize fodder yield (486.80 qtls). Land equivalent ratio for *kharif* pulses was more in treatment (Teak (Paired row) 8 m x 2m x 2 m + Cowpea + mulching-Fodder Maize (1.0) and for *Rabi* fodder, intercrop treatment (Teak Paired row 8 m x 2m x 2 m) + Cowpea - Fodder sorghum (0.74).

Dr. A. Krishna from PJTSAU, Hyderabad reported that centre evaluating Neem and Pongamia germplasm. There are 49 neem lines and 29 Pongamia lines available at the centre. Among the neem lines since 2002, Line 42 recorded higher growth parameters like height (13 m) girth (75 cm) at the age of 16 years, which is 33% higher in height and 17% higher in girth compared to control. In multi-location trial since 2004, Line 117 recorded mean plant height (7.8 m) followed by Line 115 (7.7 m) followed by girth (78 cm, 68cm) respectively which is 12.8% and 20% more compared to control. In Pongamia germplasm lines since 2004, Line SRJ-39 recorded higher growth parameters like height (7.7 m) girth (66 cm) at the age of 14 years which is 25% higher in height and 28.7% higher in girth compared to control. Two clones from Mettupalayam (Clone-1, Clone-2) along with different inter crops were evaluated. Highest grain yield was recorded with foxtail millet (795 kg/ha) followed by pearl millet (650 kg/ha). The gross and net returns were not influenced by different clones. However, clone-II recorded higher gross (Rs. 10,036 /ha) and net returns (Rs. 5036 /ha). Among the inter crops, black gram (Rs. 20,332/ha, Rs. 12,223/ha), followed by green gram (Rs. 15,750 and 3250 /ha) recorded significantly higher gross and net returns with B:C ratio (1.71), followed by foxtail millet inter cropping (1.39). The carbon stock and CO_2 sequestration values were higher with black gram inter cropping systems (4.64 t/ha, 18.84 t/ha) when compared to only (9.0, 2.7 t/ha) which was at par with application of 100% RDF + 10 t Poultry manure (8.5, 2.5 t/trees.

In nutrient management of Maize-Redgram sequence in Mango based Agri-Horti system, significantly higher maize grain yield (5535 kg/ha) and stover yield (9724 kg ha) was recorded with 125% RDF (275-75-62.5 NPK kg ha), which was at par with application of 75% RDN + 25% N Poultry manure (4596, 8044 kg ha) and sole crop without tree. The higher net returns by entire system with 125% RDF (Rs. 50,355/ ha) with B:C ratio (1.98), which was at par with 100% RDF (Rs. 44,504/ ha) with B:C ratio (1.88) and 75% RDN 25% N poultry manure (Rs. 40,206/ha 1.48). In Custard apple based horti-pastoral system the fruit yield of custard apple was not influenced by type of grasses, or nutrient management practices (1800-2400 kg/ha). Dry and fresh herbage yield was significantly influenced by type of grasses. Significantly higher fresh and dry herbage yield was recorded with *Cenchrus cililaris* (14.3, 4.5 t/ha) followed by *Panicum macimum* (10.1, 3.06 t/ha). Among the nutrient management practices, higher fresh and dry forage yield was obtained with 100% RDF + 10 t FYM/ha ha). Crude protein was higher and crude fibre was lower in Hedge Lucerne (13.2, 19.4%).

The Tropical Zone

Dr. S.M. Mutanal from UAS, Dharwad informed that the centre is evaluating 20 provenances of Neem, the performance of two provinces *viz.* Vijayapura and Raichur were superior to other clones. In tamarind 14 collections were evaluated after 19 years, NTI -80, NTI-14 and SMG-13 recorded higher fruit yield by 25 to 35% as compared to local. The superior clones were propagated for demonstrations purpose in the farmer field.

In Sapota-timber Species based agroforestry system, the height and DBH were significantly higher in the *Pterocarpus marsupium* (12.2 m and 34.25 cm) and lowest in the *Lagerstroemia lanceolata* (9.78 m and 23.25 cm) when compared to other tree species. The height of Sapota was significantly higher in association with Sapota + *Lagerstroemia lanceolata* followed by Sapota + *Pterocarpus marsupium* as compared to sapota with other tree species. Fruit yield of sapota was significantly higher when sapota grown alone (32.98 kg/plant) followed by Sapota + *Pterocarpus marsupium* (20.27 kg/plant) and Sapota + *L. lanceolata* (21.15 kg/plant) followed other tree

specie. Soil chemical properties indicated that, the organic carbon was higher in *Sapota + Tectona grandis + FC* (5.1 g/kg) followed by *Sapota + P. marsupium + FC* (4.9 g/kg) as compared to other agroforestry systems. Among Nitrogen and Potassium had higher in *Sapota + Tectona grandis + FC* (239 and 428 kg/ha respectively) whereas, available Phosphorus had maximum in *Sapota + P. marsupium + FC* (53 kg/ha) agroforestry system as compared to initial status of the soil.

Among the seven fodder tree species evaluated under agroforestry system maximum dbh was recorded in the *Moringa olifera* (8.73 cm) and *Leucaena leucocephala* (7.90 cm). Number of branches was significantly higher in *Leucaena leucocephala* (23.01) followed by *Glyricidia sepium* (20.93) and *Calliandra calophryus* (18.21). The green biomass was significantly higher in *Calliandra calophryus* (1325 kg/ha) and *Leucaena leucocephala* (1225 kg/ha) as compared to other fodder tree species. Maximum Soybean grain yield was higher when soybean grown with *Albizzia lebbeck* (530.70 kg/ha) followed by *Calliandra calophryus* (482.20 kg/ha) when compared to other fodder tree species. Tamarind – Curry leaf-based agroforestry system is recommended by the University for Inclusion of package of practice. Centre has established "Biofuel Park" funded by Karnataka State Bioenergy Development Board in which centre has planted Biofuel seedlings of six species. Centre has also collected and raised germplasm of twenty rare, endangered and threatened (IUCN, RET) species collected from various places of Western Ghats and planted in the same area. During the year, 2000 kg of Neem and 4500 kg Pongamia seeds were procured by the centre. And produced 1176 kg of Neem cake, 2806 kg of Pongamia cake, 500 l of Pongamia oil, 125 l Biodiesel and 20 l of Biphenyl.

The progress report of Thrissur centre was presented by Dr. V. Jamaludheen. The centre is evaluating 10 provenances of *Acacia mangium* collected from their natural ranges in Australia and Papua New Guinea and the best performance for growth parameters were recorded for Papua New Guinea provenances like Kuranda, Arufi Village and Upper Aramia at the age of 17 years, which is 60-70 percent more compared to Australian and Kerala provenances. The centre is also evaluating 30 different teak accessions from South India of which the better ones were from Nilambur region, which is around 80-90 per cent better than other provenances at the age of 17 years.

Studies related to find out suitable silvopastoral system, the integration of protein rich mulberry hedgerows in coconut garden provides an excellent option to enhance quality forage production and carbon sequestration in humid tropics of Kerala. Mulberry fodder banks yielded maximum dry forage (32.85 Mg ha^{-1} coconut garden over three-year period) at the highest tree density of 49,382 plants ha^{-1} and at 12 weeks harvest interval, with proper nutrient management, and has fixed additional carbon of 33 Mg ha^{-1} over three-year period in the plant biomass and in soil up to 40 cm depth, when compared to coconut monoculture systems. The B:C ratio over three-year period was found to be 3.90 with annual net returns of 3 lakhs/ha. A field experiment was conducted at the centre to assess the understorey productivity of four fodder grasses *viz Brachiaria ruziziensis Germain & Everard* (congosignal), *Panicum maximum Jacq.* (guinea), hybrid napier cultivar CO-3 and CO-5 under mature coconut (*Cocos nucifera* L.) and rubber (*Hevea brasiliensis* Muell. Arg,) plantations. The results indicated that the growth and yield attributes of fodder grasses under coconut plantation were almost comparable with open plots. Thus, practice of integrating fodder grasses in coconut plantations can be taken up in a big way in a land crunch state like Kerala, where mature coconut plantations form one of the extensive and prominent land management system.

Dr. V. Dalvi from BSKVV Dapoli reported that the centre collected and conservated germplasm of *Garcina indica*, *Tectona grandis*, *Bamboo species*, *Melia dubia*, *Mellittia pinnata* and *Acacia mangium*. In *Melia dubia* based medicinal agroforestry system, at the age of three years, the average height of *Melia dubia* was observed 11.82 m and CAI of height was 2.00 m, whereas dbh of *Melia dubia* was 17.55 cm and CAI of dbh was 3.02 cm. Among the medicinal plant species, root weight per plant ranged from 4.86 g Adulsa (*Justicia adhatoda*) to 232 g *Gmelinia arborea*. Whereas highest root length (69.8 cm.) and stem weight (880.0 g) was observed in *Gmelinia arborea* per plant. The maximum branches weight per plant was recorded by Chitrak *(Plumbago zeylanica)* (110.17 g) followed by Tetu (*Oroxylum indicum*) (108.75 g). However highest leaves weight (88.25 g) was showed by the treatment Bel (*Aegle marmelos*) and lowest by Dorli (*Solanum khasianum*) (5.0 g). Highest total biomass given by Shivan (*Gmelinia arborea*) (1184.4 g) followed by Agnimonth (*Clerodendrum phlomidis*) (920 g). The centre recommended that *Acacia mangium*, *Gliricidia sepium*, *Pterocarpus marsupium* and *Acacia catechu* are to be planted as a source of nutrients in lateritic soils of Konkan Region under agroforestry system for building up of soil fertility and carbon sequestration.

Dr. S. Gunasekaran presented the progress of Kattupakkam centre. Five species of fodder trees *viz.*, *Sesbania grandiflora, Gliricidia sepium, Leucaena leucocephala, Calliandra calathyrus* and *Moringa olifera* are cultivated in paired row across the slope with a spacing of 0.5 m between trees 0.5 m

between rows in zig zag planting. Among five tree species Studied for leaf meal production, *Sesbania grandiflora* has recorded higher green biomass yield of 3.25 kg tree^{-1} cutting^{-1} followed by *Gliricidia sepium* 3.12 kg tree^{-1} cutting^{-1}. Alley spacing of 5 m were followed. The centre created database of agroforestry models in Western zone of Tamil Nadu and the study revealed that nearly 55.63% of the farmers were having coconut garden with understorey Bajra Napier hybrid grass. Fodder sorghum Co 31 understorey *Cocus nucifera* documented a yield of 22.23 tonnes/harvest/hectare and Fodder cowpea Co(FC) 8 in *Psidium guajava* based pasture system documented a yield of 5.33 tonnes / hectare IN DEGRADED WASTE LANDS. Fodder sorghum Co 31 had a CP, DCP and TDN of 7.9, 5.52 and 69.74% on dry matter basis, and Fodder cowpea Co(FC) 8 had a CP, DCP and TDN of 18.25, 12.76 and 72.20% on dry matter basis. At 48 hours rumen *in vitro degradation,* Fodder sorghum Co 31 revealed *in vitro* true digestibility of dry matter (IVTDDM) of 62.89% and microbial biomass of 10.12% and Fodder cowpea Co(FC) 8 had *in vitro* true digestibility of dry matter (IVTDDM) of 65.16% and microbial biomass of 11.28%. Crop residue-based compost enriched with *Gliricidia sepium* green biomass at 3:1, 3:2 and 3:3 ratios were superior to compost with only crop residue, in terms of Nitrogen, Phosphorus and Potassium.

The UAS, Bangalore centre reported was presented by Dr. Hanumanthappa and he informed that Under Evaluation, Selection and establishment of clonal seed orchard of tamarind by Bangalore centre, among 27 selections after eight years of planting NFN 1, NFN 2, NFN 3, NFN 7, NFN 8, NFN 9, NFN 10, PKM 11, H 2, H 12, SMG 14, GKVK 1, GKVK 2, GKVK 13, OORIGUM 1, DTS 2, Red tamarind and sweet-tamarind germplasms have started bearing. Higher cumulative yield of 24 kg tree^{-1} was recorded with NFN 9. NFN 9 fruits are long (19 cm), lower shell weight (1.94g) and have higher pulp content (18 g). The performance of fourteen local selections, comprising of 7 each in 'Kaali' and 'Gouri' genotypes were found satisfactory under slection of elite trees and establishment of clonal seed orchard of *Simarouba glauca*.

In *Melia dubia* based agroforestry systems, after eight years of planting of *Melia dubia* the tree height was significantly higher in 24 x5 m (13.34 m) followed by 20 x5 m (13.19 m) and 16 x5 m (12.72 m). Similar trend was observed with respect canopy spread in E-W (7.80, 7.53 & 7.19 m respectively) and N-S (8.15, 7.99 and 7.71 m, respectively) direction. The nutrient status showed that, available nitrogen (298 kg ha^{-1}), phosphorus (29 kg ha^{-1}) and potassium (301 kg ha^{-1}) were significantly higher under *Melia dubia* based agroforestry system over fallow land. The Tribal sub-Plan was implemented through participatory approach in Shettalli and Bhudipadaga villages of Mysore district, which covers 326 families. As a part of the programme forestry seedling *viz.,* Melia & silveroak and horticulture seedlings *viz.,* wood apple, custard apple, jack fruit and mango and agricultural implements *viz.*, sickle and gudli were supplied and trainings on improved cultivation practices on agriculture, horticulture and agroforestry system. The agricultural crops such as maize, fingermillet, cotton *etc.*, were cultivated. There was good crop during the year and released an average return of Rs. 25,000 ha^{-1}. It clearly showed that there was better impact of the programme on the improvement of their livelihood. STP famers of Sollepura village Smt. Daasi, Mr. Bhaskar and Mr. Basappa were awarded "Super Star Farmer" and issued Appreciation certificate by one of the lead newspapers of Karnataka Vijaya Karnataka. With the interventions of centre from 2012-13, STP farmers were able to cultivate agricultural and horticultural crops, planting of forest trees along the border. In last season they have taken up cultivation of vegetable crops and harvested an average yield of tomato (23 t ha^{-1}), brinjal (10 t ha^{-1}) and capsicum (5 t ha^{-1}) *etc.* With all these interventions, it was possible to increase the annual income of the tribal farmer.

The UAHS, Ponnampet centre report was presented by Dr. R. K. Hegde. Total 105 candidate trees of silveroak were evaluated their phenotypic superiority and only 10 trees were categorised as Candidate Plus trees by Ponnampet centre. The centre conducted D & D exercise in Kodagu district and found that in the region, coffee plantations are the major agroforestry practices (41%) followed by scattered planting (18%), boundary planting (17%), home gardens (16%) and least was in bund planting (8%). Among the different agroforestry practices, coffee plantations had higher diversity of trees (Shanon diversity index: 2.032) followed by bund planting (0.226) and the least was noticed in boundary planting (0.078). Important tree species preferred for planting were *Acrocarpus fraxinifolius, Dalbergia latifolia, Ficus racemosa, Diospyros ebenum, Mangifera indica, Cinnamomum malabatrum, Artocarpus hirsutus* and *Myristica malabarica.*

Under teak-based mixed agroforestry with suitable agronomic crops in semi-malenad areas, the teak height growth was significantly higher in the treatment having two rows of teak with *A. lebbeck* one row (4.92 m) which was on par with the treatment's teak alone and two rows of teak with *C. junghuniana.* Centre initiated work on package and practices of Litsea species and thirty-month-old *Litsea chinensis* trees were coppiced to get new flushes and softwood cuttings from the coppice shoots were used for rooting of cuttings.

Under the TSP programme tribal communities in the flood affected areas of Madikeri taluk and tribal families in Virajpet taluk were supported. Flood affected tribal families (40) in Madikeri taluk namely three villages (Mukkodlu, Haleri and Monnangeri) were provided with poultry birds to enhance their livelihood and nutritional security. Apart from these based on the preference 38 piglets were distributed tribals (38 families) to have their livelihood. Training programme on bee keeping was organised to seek livelihood option by the flood affected families. Majority of the tribal hamlets were not having electricity and students who were studying in the hamlets were provided solar lamps both in flood affected areas in Madikeri taluk and some places in Virajpet taluk.

Contribution of Volunteer Centres

Three ICAR volunteer centres and two ICFRE centres presented their significant achievements. CSSRI, Karnal was represented by Dr Raj Kumar. He detailed about the agroforestry activities carried out by the institute. Evaluating the salt tolerance of tree species; reclamation of salt soil through tree planation; enhancing biomass production of tree species; developing agroforestry systems for salt affected soil; biodrainage of saline waterlogged soils; saline irrigation for trees and plantation technology for salt affected soils. He informed that Eucalyptus can be successfully grown on the berms of the ponds and will be helpful in keeping the surface soil salinity under check. *Salvadora persica* is very promising species for saline soil where arable farming is not possible directly. CSSRI, Regional Station Bharuch, developed the package of growth, biomass production, seed and oil yield. *Leptochloa* in association with *Prosopis juliflora* produced 46.5 t/ha green fodder in 15 cuttings over a period of 15 months without applying any fertilizer and amendment. *Prosopis juliflora* produced 160 t/ha air dried firewood in 6 years when planted at 2x2m spacing. Improved the soil to greater extent after 6 years. After four years palatable fodder species (*Trifolium resupinatum*, *Trifolium alexandrium* and *Melilotus parviflora*) were grown successfully. Dr. Venkatesh and Dr. Gopinath presented the work of CRIDA, Hyderabad and informed about agroforestry models developed under NICRA. Dr. Jaisankar from CARI, Port Blair presented agroforestry activities of his institute. The IFGTB Coimbatore centre (ICFRE) was represented by Dr. C. Bhuvaneswaran. He informed about casuarina-based agroforestry system and wind break and shelterbelt system for coastal areas developed by the institute. Dr. Adiya from IFP, Ranchi (ICFRE) informed that 45 different clones of poplar from YSPUH&F, Solan and GBOUA&T, Pantnagar were introduced in Bihar. After raising nursery from these clones, field trial has been established at 4 different locations (districts, Purnea at two places, Katihar at one place and Mujaffarpur at one place) in Bihar. 22 clones of salix from YSPUH&F, Solan introduced Two clones *viz*. clone no. 1 and clone no. 19 acclimatized and showed adaptability and selected based on growth performance under adaptation trial.

After the review of progress report, various administrative and financial issues were also discussed. The technical programme of the centres for the year up to 2022 was also finalized under the Chairmanship of ADG (Agronomy, Agroforestry and Climate Change), NRM Division, ICAR.

Annexure 2

Geo-reference of AICRP-Agroforestry Centres

S.No.	AICRP-Agroforestry Centre	Latitude_(N)	Longitude_(E)
1	OUAT, Bhubaneswar	20.265150	85.811684
2	TNAU Coimbatore	11.323766	76.936223
3	BSKKV, Dapoli	17.749701	73.178443
4	UAS, Dharwad	15.488958	74.981328
5	NDUA&T, Faizabad	26.541274	81.832011
6	SKNAU, Jobner, (Fatehpur Shekhawati)	26.965915	75.377555
7	CCSHAU Hisar	29.143798	75.712791
8	ANGRAU, Hyderabad	17.322801	78.417214
9	JNKVV, Jabalpur	23.215662	79.958184
10	TNV&ASU, Chennai (IAN, Kattupakkam)	13.162908	80.243667
11	PAU, Ludhiana	30.901028	75.807112
12	AAU, Johrat (HRS, Kahikuchi)	26.105423	91.612185
13	PDKV, Akola, (COA, Nagpur)	21.144657	79.073815
14	GBPUA&T, Pantnagar	29.022919	79.487865
15	RPCAU, Pusa, Samastipur	25.986368	85.672956
16	MPKV, Rahuri	19.349365	74.646559
17	BAU, Ranchi	23.442346	85.315329
18	SDAU, SK Nagar	24.321776	72.317756
19	YSPUH&F Solan	30.864403	77.169633
20	SKUAST Ganderbal	34.213271	74.809752
21	KAU Thrissur	10.547918	76.279359
22	BCKVV, Kalyani (HRS, Jhargram)	22.456774	87.012040
23	UAS, Bangalore	13.078259	77.579190
24	CSKHPKV Palampur	32.100341	76.546845
25	UAHS,Shivamoga (CoF, Ponnampet)	12.144602	75.938187
26	SKUAST- Chatha, Jammu	32.653089	74.807106
27	CSWCR&TI, Dehradun	30.344669	78.014273
28	ICAR RC NEH Region, Barapani	25.684529	91.912973
29	ICAR RC NEHRegion (Imphal, Manipur)	24.828910	93.926543
30	ICAR RC NEHRegion (Gangtok, Sikkim)	27.319730	88.601934
31	ICAR RC NEHRegion, (Agartala, Tripura)	23.906503	91.313108
32	CSSRI, Karnal	29.708226	76.954191
33	ICAR RC Eastern Region (Ranchi Centre)	23.285277	85.411615
34	CAZRI, Jodhpur	26.262476	72.996741
35	CRIDA, Hyderabad	17.348655	78.501310
36	CARI, Port Blair	11.613934	92.715734
37	ICFRE-IFGTB, Coimbatore	11.017319	76.951150

Notes

Swachh Bharat Abhiyan

एक कदम स्वच्छता की ओर

आज़ादी का अमृत महोत्सव

Agrisearch with a human touch

CENTRAL AGROFORESTRY RESEARCH INSTITUTE

"AGROFORESTRY PATHWAY FOR RESTORATION OF DEGRADED LANDS"

All India Coordinated Research Project on Agroforestry
ICAR-Central Agroforestry Research Institute
Jhansi 284 003, Uttar Pradesh