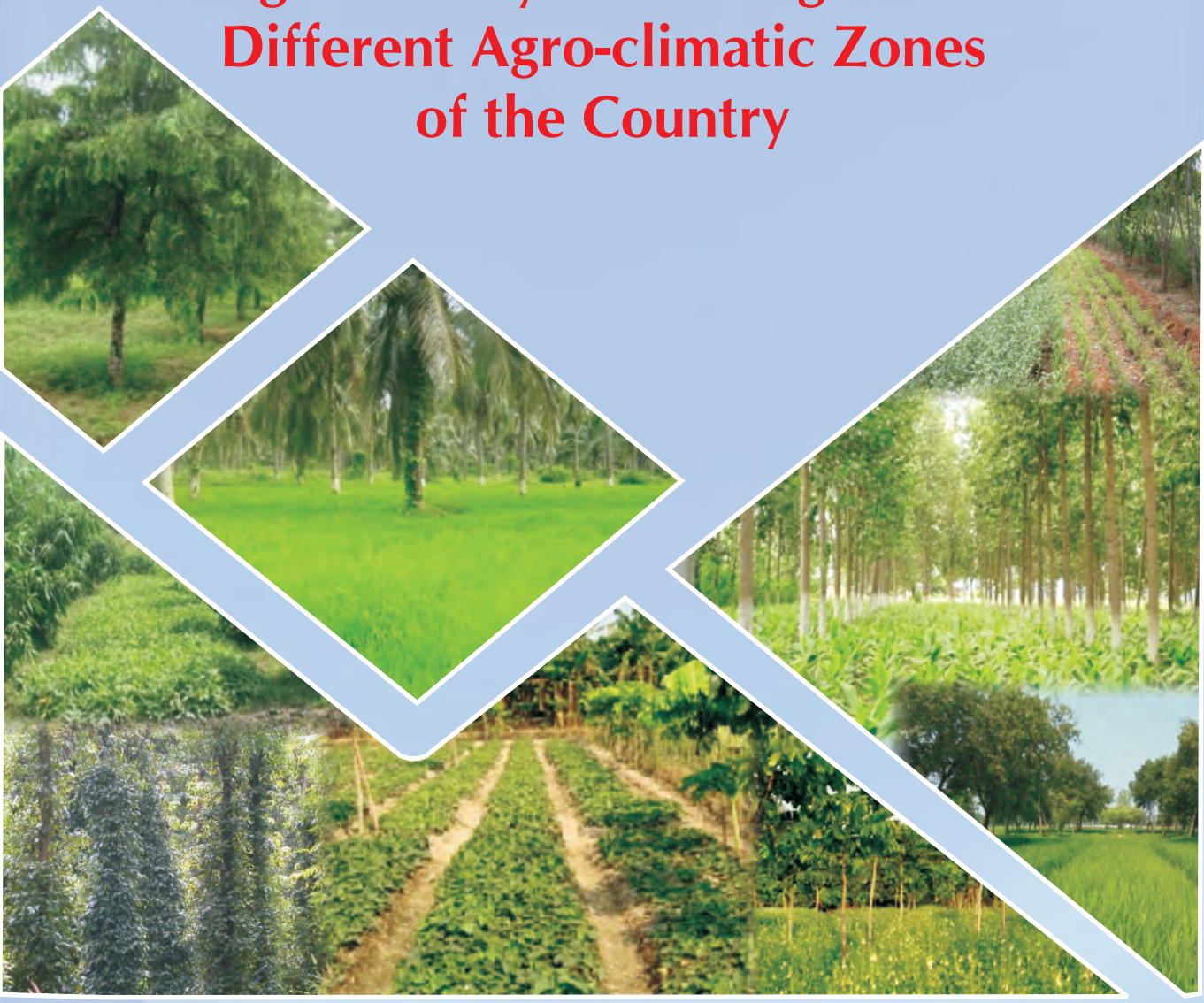
भाकृअनुप
ICAR

Agroforestry Technologies for Different Agro-climatic Zones of the Country



Compiled and Edited by
O.P. Chaturvedi, A.K. Sikka, A.K. Handa and C.K. Bajpai

केकृवाअनुसं
CAFRI

All India Coordinated Research Project on Agroforestry
ICAR-Central Agroforestry Research Institute,
Jhansi - 284 003 (UP)

Agroforestry Technologies for Different Agro-climatic Zones of the Country

All India Coordinated Research Project on Agroforestry

2016

Compiled and Edited by
O.P. Chaturvedi, A.K. Sikka, A.K. Handa and C.K. Bajpai

All India Coordinated Research Project on Agroforestry
ICAR-Central Agroforestry Research Institute,
Jhansi - 284 003 (UP)

PROF M S SWAMINATHAN
Founder Chairman and Chief Mentor
UNESCO Chair in Ecotechnology
M S Swaminathan Research Foundation
Third Cross Street, Taramani Institutional Area
Chennai - 600 113

Preface

Agroforestry combines the benefits of agriculture and forestry in the areas of ecological, food and livelihood security. Agroforestry systems have made very important contributions to local level food security as well as to soil health enhancement and conservation. The present publication is based on agroforestry systems and technologies generated under the All India Coordinated Research Projects in agroforestry of ICAR. This project initiated in 1983 currently has 37 coordinating centres across the country.

India is the first country in the world to have developed and announced a National Agroforestry Policy. Agroforestry is the pathway to sustainable agriculture and food security. I am therefore happy that the present bulletin on agroforestry technologies for different climatic zones of India prepared by Dr O. P. Chaturvedi and his colleagues has brought together a summary of the work done under the coordinated project on agroforestry. We owe a deep debt of gratitude to the authors for their labour of love for the science and practice of agroforestry.

M. S. SWAMINATHAN

Preamble

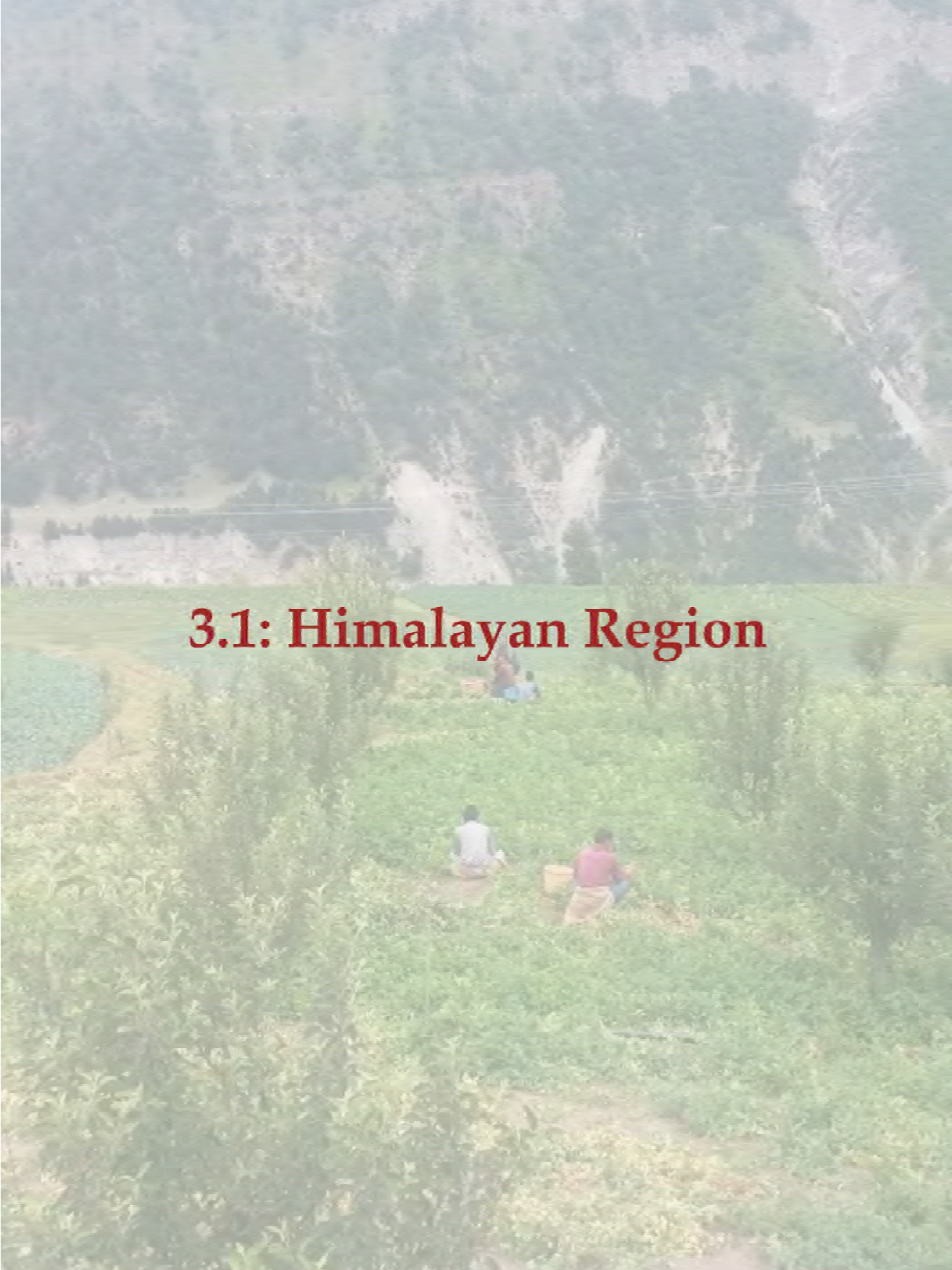
The All India Coordinated Research Project on Agroforestry (AICRP on AF) initiated by ICAR in 1983 is one of the largest network projects under NARS. Over the period of time project completed diagnostic and design survey of existing agroforestry systems and farmers preferences; evaluation of MPTS and development of agroforestry systems for different agroclimatic regions and initiated work on biofuel and bioenergy. Keeping in view the present day challenges, the project is now focusing on role of agroforestry in meeting the environmental challenges, value addition for creating livelihood opportunities and application of modern tools and technologies in agroforestry research. A number of agroforestry systems and technologies have been developed over the period of time by the coordinating centers of the Project. The present bulletin is an attempt to compile the information on agroforestry technologies which can be taken up by farmers and other stake holders for increasing overall productivity and return and ensuring natural resource conservation.

We gracefully acknowledge the valuable guidance and financial support received from Indian Council of Agricultural Research, New Delhi for the implementation of the project. The input provided by the scientists from coordinating centres of the Project for this bulletin is duly acknowledged.

We hope that this bulletin will be of great value to all concerned and will help particularly the small and marginal farmers in adoption of agroforestry in a big way.

O. P. Chaturvedi
A. K. Sikka
A. K. Handa
C. K. Bajpai

Contents



3.1: Himalayan Region

3.1.1: Dr. YSPUH & F, Solan (Himachal Pradesh)

3.1.1.1: Vegetable based Agri-silviculture system in sub temperate rainfed region of Himachal Pradesh

Sl. No.	Item	Details
1	Specifications and salient technical features	An Agri-silviculture system integrating *Melia composita* + Vegetable crops *viz.*, cauliflower (variety PSB-1), pea (variety Azad P-1), tomato (variety Rupali) and capsicum (variety Bharath (F_1)) was developed for rainfed conditions of Himachal Pradesh in order to increase the farm income of a small and marginal farmers of the state. This system can improve the socio-economic status of the farmers by providing multiple products. *Melia composita* was planted in rows East-West direction at two different spacing (i) 8m X 5m, (ii) 8m X 4m and vegetable crops were introduced between rows and fertilized with different doses of organic manure as per package and practices of vegetable crops.
2	Performance results	Vegetable based agri-silviculture system produced cauliflower 12.8 t ha^{-1}, pea 6.8 t ha^{-1}, tomato 12.8 t ha^{-1} and capsicum 9.1 t ha^{-1}. Although the low yield of vegetable crop was recorded in the system as compared to open condition but reduction in yield is compensated by tree component.
3	Likely cost	The total cost of cultivation of different vegetable crops lying in the order of: cauliflower (Rs. 98,669/-), pea (Rs. 97,033/-), tomato (Rs. 1,08,610/-) and capsicum (Rs.1,05,608/-) ha^{-1} respectively whereas net return obtained from the system is in the tune of Rs. 1,94,101/-, Rs. 1,79,563/-, Rs. 79,605/- and Rs. 94,909/- for vegetable crops grown in the system respectively.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net return ha^{-1} from the system is high and ultimately improves the socio-economic status of the small and marginal farmers of the state under rainfed conditions.

5	Social/environmental/other benefits	Presence of *Melia composita* moderates the temperature. Melia canopy and vegetable crops check the intensity of the rain drops thus protects soil erosion and improves the infiltration, leaf litter and residue of vegetable crops also improves different physicochemical properties of soil.
6	Status of commercialization/IP rights etc.	This technology is highly appreciated by the members of 4th Dean Committee, Conl. Dhani Ram Shandil, Social Justice & Empowerment Minister (Govt. of HP) and members of Watershed Development Committee and this technology can also be popularized through training of officers from different Departments like Agriculture, Horticulture, Forestry, Animal husbandry and NGO etc.
7	Efforts for technology dissemination	Yet trials to be conducted on farmers field.
8	Special requirement for its successful realization; any other standards etc.	-
9	Indicative photographs	 ***Melia composita* + *Brassica oleracea* Var. botrytis**  ***Melia composita* + *Pisum sativum***
10	Contact details of person from whom technology and further details can be obtained	Dr K. S. Pant and Dr B. Gupta Department of Silviculture and Agroforestry College of Forestry Dr Y. S. Parmar University of Horticulture and Forestry Nauni, Solan (HP)-173230 Ph-01792-252270
11	Source of availability of technology/expertise	Department of Silviculture and Agroforestry College of Forestry Dr Y. S. Parmar University of Horticulture and Forestry Nauni, Solan (HP)-173230 Ph: 01792-252270 Fax: 01792-252354
Name of Contributors : Dr K. S. Pant, Dr. K. S. Verma, Dr. Rohit Vashist, Dr. C. L. Thakur and Dr. B. Gupta		

3.1.2: SKUAS&T, Srinagar (Jammu & Kashmir)

3.1.2.1: Alley cropping system integrating Elm (*Ulmus wallichiana*) with *kharif* and *rabi* crops in Kashmir valley

Sl. No.	Item	Details
1.	Specifications and salient technical features	In the Kashmir region of Jammu and Kashmir huge tracts are barren and un-cultivated and these areas can be targeted for agroforestry systems. The technology has been devised for sloppy lands under rainfed conditions with up to 30% of slope. Elm trees were planted at different widths of 1, 1.5 and 2 m for evaluation. The trees were regularly pruned at a height of 3 m for fodder and fuel wood.
2.	Performance results	With the increase in alley width from 1 and 2 m there was an increase in the yield of annual crops as well as that of the bio-economic productivity. The 2 m spacing resulted in maximum yield of *kharif* (tomato+potato) and *rabi* (garlic+peas) crops respectively. Yield of fodder and fuel wood from trees was more in 1m spacing recorded a yield of 1.26 and 5.10 t ha^{-1} respectively. Cultivated grasses in buffer zone (*Festuca pretense, Festuca rubra and Trifolium pretense)* recorded yield of 7.87 t ha^{-1}.
3.	Likely cost	Cost of cultivation in the 10th year for the elm + *kharif* (tomato+potato) and *rabi* (garlic+peas) + grasses buffer zone (*Festuca pretense, Festuca rubra and Trifolium pretense)* is about Rs. 1,26,010/- ha^{-1}. Output in terms of net profit per unit area is Rs. 52,642/- ha^{-1} yr^{-1} at 2m alley spacing on sloppy land.
4.	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ knowhow in terms of savings in cost of production, inputs, and time lines: and other pertinent information.	The overall net income ha^{-1} yr^{-1} with elm + *kharif* (tomato+potato) and *rabi* (garlic+peas) + grasses buffer zone (*Festuca pretense, Festuca rubra and Trifolium pretense)* was Rs. 52,642/- ha^{-1} yr^{-1} 2m alley spacing on sloppy land and under rain fed conditions.

5.	Social/ environmental/ other benefits	Alley cropping system with different crop combinations and tree spacings reduce the soil erosion due to rains and at the same times improves water infiltration and water holding capacity. Over all physical characteristics of soil is improved due to addition of leaf litter. The system yield diversified output like pulses, vegetables, fuel wood, tree fodder and grass fodder, therefore, improving livelihood security of farmers.
6.	Status commercialization/ IP rights etc.	Technology has been popularized through training to farmers in Kashmir valley. Besides electronic media has also been utilized for the purpose.
7.	Efforts for technology dissemination	Technology has been transferred through training to farmers in Kashmir valley. Tribals living in the areas close to the forests have also been provided training and demonstrations of the technology.
8.	Special requirement for its successful realization; any other standards etc.	As technology is based on utilization of degraded/sloppy lands by elm based alley cropping system which includes the use of suitable intercrops like tomato, potato, garlic and peas besides grasses like *Festuca pretense, Festuca rubra and Trifolium pretense*, so the availability of quality planting material of elm suitable for the region and improved released varieties of agricultural crops need to be made available to the farmers.
9.	Indicative photographs	
10.	Contact details of person from whom technology and further details can be obtained	OIC-Agroforestry, Faculty of Forestry, Benhama, Ganderbal, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir-191201 Phone: 9419011205 Email: ahmughal1@gmail.com
11.	Source of availability of technology/ expertise	Dean, Faculty of Forestry, Benhama, Ganderbal, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir-191201 Phone: 01942147200 Email: navedmoon66@gmail.com
Name of Contributors: Dr. A. H. Mughal, Dr. K. N. Qaiser, and Dr. P. A. Khan		

3.1.2.2: Apple based Horti-agri-pasture system under temperate conditions of Kashmir valley

Sl. No.	Item	Details
1.	Specifications and salient technical features	Kashmir is home to a large variety of fruits and nuts. Fruit production has a major share in the economy of the state of Jammu and Kashmir. Apple is the principle fruit crop of Jammu and Kashmir and accounts for 51 percent of total area of 2.72 lakh ha. under orchards. The annual apple production in the state is about 14 lakh M tones. The interspaces at the ground level in orchards can be effectively utilized for raising of different fodder and agricultural crops so as to tide over the food and fodder scarcity in the state and at the same time increase per unit production. Different agricultural and fodder crops combinations were incorporated in apple based agroforestry where apple trees were planted at 4.5 x 4.5 m tree spacing.
2.	Performance results	Two agriculture crops (beans and peas) and different grasses species like *Trifolium repense, Dactylis glomerata, Trifolium alexandrium, Medicago sativa* and aromatic crop *Artemesia absinthium* were intercropped under apple. The yield of apple was recorded maximum 12.40 t ha^{-1} in combination with lucerne (*Medicago sativa)* followed by 11.69 t ha^{-1} in combination with artemisia. Apple + orchard grass recorded maximum yield of green fodder 23.0 t ha^{-1} followed by lucerne (*Medicago sativa)* 21.0 t ha^{-1}.
3.	Likely cost	Cost of cultivation is Rs.73,600/- ha^{-1} yr^{-1} while as income averaged at Rs 1,28,900/- ha^{-1} yr^{-1}.
4.	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ knowhow in terms of savings in cost of production, inputs, timelines: and other pertinent information.	The overall net income ha^{-1} yr^{-1} with apple + lucerne and apple + orchard grass is Rs 1,34,400/- and Rs. 1,23,400/- ha^{-1} yr^{-1} respectively.

5.	Social/ environmental/ other benefits	The technology has helped in increasing the farmer's income by getting additional benefits from grasses and medicinal plants, which were grown in the interspaces. The technology also helps in improving the soil physical characteristics and conservation of moisture.
6.	Status commercialization/ IP rights etc.	Technology has been popularized through extension activities in Kashmir valley. Electronic media has also been used for popularization of the technology.
7.	Efforts for technology dissemination	The technology has been demonstrated to the farmers of the valley. Tribal areas have also been targeted for the technology.
8.	Special requirement for its successful realization; any other standards etc.	The availability of quality plant material of apple suitable for the region and improved released varieties of grasses must be ensured besides training programme for the target groups.
9.	Indicative photographs	 
10.	Contact details of person from whom technology and further details can be obtained	OIC-Agroforestry, Faculty of Forestry, Benhama, Ganderbal, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir-191201 Phone: 9419011205 Email: ahmughal1@gmail.com
11.	Source of availability of technology/ expertise	Dean, Faculty of Forestry, Benhama, Ganderbal, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir-191201 Phone: 01942147200 Email: navedmoon66@gmail.com
Name of contributors: Dr. K. N. Qaiser, Dr.Vaishnu Dutt, Dr. A. H. Mughal and Dr. J. A. Mugloo		

3.1.3: HRS, AAU, Kahikuchi (Assam)

3.1.3.1: Coconut based Horti - Agri system in Eastern Himalayas (a)

Sl. No.	Item	Details
1	Specifications and salient technical features	Coconut is considered as non-traditional nut crop in the region but considering its easy adaptability and higher economic return, the crop is gaining popularity in the high humid eastern part of the country. Recently the area under coconut cultivation has increased considerably. Farmers of this region hardly integrate coconut cultivation with other agricultural crops in their farm land with agricultural cops. Orchard or scattered plantation of coconut is generally done on medium high land adjacent to dwelling house. There is ample scope to utilize the large interspaces by agricultural crops, thereby maximizing family income through effective utilization of family labour. Rice nursery- fodder crops rotation was followed in coconut plantation. This system helps to utilize the land for optimum utilization of the land, provide nutritional feed for livestock, helps to build up soil nutrients and prevent soil erosion
2	Performance results	Coconut based horti-agri system produced 90, 08,000 no. of rice seedlings ha^{-1}, 27.84 t ha^{-1} of fodder maize and 9,513 no. of nuts ha^{-1} resulting in higher net profit. Besides total soil N status improved by 0.03 %, available P_2O_5 by 2.06 kg ha^{-1} and available K_2O by 13.25 kg ha^{-1}.
3	Likely cost	The total cost of cultivation for coconut-rice seedlings maize (as fodder) rotation was Rs. 21,176/- resulting in net profit of Rs. 53,988/- ha^{-1}.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income ha^{-1} yr^{-1} with coconut-rice seedlings fodder maize was Rs. 53,988/- as compared to Rs. 29,260/- in coconut as sole crop. Covering of land surface by rice seedlings and fodder reduces the splash impact of rain drops and therefore protects the land from erosion. Besides, organic residues added by fodders improve the physical condition of soil health by delivering bulk density. Nutrient status of the soil was improved due to the intercultural operations taken for intercrops.

5	Social/environmental/other benefits	Rice seedling and fodder maize as intercrop help maintain the soil physical and chemical properties.
6	Status of commercialization/IP rights etc.	Technology has been popularized through trainings and demonstration of the farms in contact farmers.
7	Efforts for technology dissesmination	Technology has been transferred to farmers field in Sualikuchi and Hajo area of Kamrup district.
8	Special requirement for its successful realization; any other standards etc.	The inputs such as planting material/seed of intercrops, fertilizer etc. should be made accessible to the farmers in time by the state department. Besides, the state department should intervene to promote horizontal expansion & management of coconut in homestead.
9	Indicative photographs	 **Rice seedling in coconut garden**
10	Contact details of person from whom technology and further details can be obtained	Dr Ayub Ali Ahmed Horticultural Research Station (AAU), Kahikuchi Guwahati, Assam 781017 Phone: 0361-2840232 Fax: 0361-2841621 Mobile No. : 09435347310
11	Source of availability of technology/expertise	OIC, AICRP on AF, HRS, AAU, Kahikuchi Guwahati, Assam 781017
Name of Contributors : Dr. A.A. Ali, Dr. J.P. Barua and Dr. S. Gogoi		

3.1.3.2: Coconut-based Horti - Agrisystem in Eastern Himalayas (b)

Sl. No.	Item	Details
1	Specifications and salient technical features	Coconut is considered as non-traditional nut crop in the region but considering its easy adaptability and higher economic return the crop is gaining popularity in the high humid eastern part of the country. Recently the area under coconut cultivation has increased considerably. Farmers of this region hardly integrate coconut cultivation in their farm land (with other agricultural crops). Orchard or scattered plantation of coconut is generally done on medium high land adjacent to dwelling house. There is ample scope to utilize the large interspaces by agricultural crops, thereby maximizing family income through effective utilization of family labour. Turmeric, vegetable, pineapple & fodder was cultivated in interspaces. This system helps to optimize utilization of land, maximize income, countering the soil/nutrients lose and provide nutrition to human and animals.
2	Performance results	Cultivation of turmeric in interspaces of coconut produce 25.061 t ha^{-1} and 808 nos. of nuts resulting in higher net profit. Besides, the crop residues helped to raise the available N by 3.10% over initial. On the other hand, cultivation of vegetables produced 6.20 t ha^{-1} of french bean, 6.86 t ha^{-1} okra and 3.46 t ha^{-1} of cowpea along with 7,477 no. of coconuts. Besides the inter crop residues helped to raise available N by 7.39%, available P_2O_5 by 13.59% and available K_2O by 9.18% over initial.
3	Likely cost	The total cost of cultivation for coconut + turmeric was about Rs. 82,571/- and for coconut + vegetable was about Rs. 1,34,625/- ha^{-1} yr^{-1}. Output in terms of net profit is Rs. 3,98,397/- for coconut + turmeric and Rs. 2,92,996/- for coconut + vegetables as compared to Rs. 61,144/- only from sole coconut planting.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income ha^{-1} yr^{-1} in the coconut + turmeric (Rs. 3,98,397/-) and coconut + vegetables (Rs. 2,98,996/-) is much higher in comparison to sole coconut planting (Rs. 61,144/-) as usually done by the coconut farmers.

5	Social/environmental/other benefits	Turmeric and vegetables reduces the splash effect of raindrops on soil by covering land surface and thereby protects and from soil erosion/nutrient removed. Organic residues added by the intercrops added by turmeric and vegetables improved the soil physical condition by decreasing bulk density.
6	Status of commercialization/IP rights etc.	Technology has been popularized through farmers' trainings and demonstration in the farms of contact farmers.
7	Efforts for technology dissemination	Technology has been transferred to farmers field in Sualikuchi and Hajo area of Kamrup district.
8	Special requirement for its successful realization; any other standards etc.	The inputs such as planting material/seed of intercrops, fertilizer etc. should be made accessible to the farmers in time by the state department. Besides, the state department should intervene to promote horizontal expansion & management of coconut in homestead.
9	Indicative photographs	 **Standing stage of fodder between two rows of coconut**  **Standing stage of turmeric between two rows of coconut.**
10	Contact details of person from whom technology and further details can be obtained	Dr Ayub Ali Ahmed Horticultural Research Station (AAU), Kahikuchi Guwahati, Assam 781017 Phone: 0361-2840232 Fax: 0361-2841621 Mobile No. : 09435347310
11	Source of availability of technology/expertise	OIC, AICRP on AF, HRS, AAU, Kahikuchi Guwahati, Assam 781017
Name of Contributors : Dr. A.A. Ali, Dr. J.P. Barua and Dr. S. Gogoi		

3.1.3.3: *Gmelina arborea* based agroforestry system

Sl. No.	Item	Details
1	Specifications and salient technical features	*Gmelina arborea* is most preferable species for timber in north eastern Himalayan zone besides Indo-Gangetic region of India. It is very fast growing species in north eastern region and economic yield could be expected in 10-12 years. Intercropping of several species especially turmeric in *Gmelina arborea* is popular system of farming among farmers of this region.
2	Performance results	Turmeric yield as intercrop in *Gmelina arborea* was 16.252 t ha^{-1} yield of turmeric reduced progressively and from 4th year onwards no economic production was recorded due to tree canopy and root spread of tree space at 4 m X 4 m
3	Likely cost	Total cost of cultivation in 12 years for *Gmelina arborea* + turmeric is about Rs. 2,19,520/-. Total return in terms of net profit per unit area is Rs. 1,05,520/-$ha^{-1}yr^{-1}$.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Total estimated net income ha^{-1} $year^{-1}$ in *Gmelina arborea* + turmeric system raised upto Rs. 1,15,520/- on inclusion of estimated benefit of timber accumulation of *Gmelina arborea* under rainfed conditions.
5	Social/environmental/other benefits	Reduce impact of rain drop and there by protect soil from erosion and improves infiltration. Besides, the residue of intercrop improved soil health through decrease in bulk density.
6	Status of commercialization/IP rights etc.	Technology has been popularized through farmers training in Kamrup, Goalpara, Dhubri and Morigaon district.
7	Efforts for technology dissesmination	Dhupdhora, Dhdnoi, Silchar, Barnihat area under social forestry intervention.
8	Special requirement for its successful realization; any other standards etc.	------

9	Indicative photographs	 **Standing stage of *Gmelina arborea***
10	Contact details of person from whom technology and further details can be obtained	Dr Ayub Ali Ahmed Horticultural Research Station (AAU), Kahikuchi Guwahati, Assam 781017 Phone: 0361-2840232 Fax: 0361-2841621 Mobile No. : 09435347310
11	Source of availability of technology/expertise	OIC, AICRP on AF, HRS, AAU, Kahikuchi Guwahati, Assam 781017
Name of Contributors : Dr. A.A. Ali, Dr. J.P. Barua and Dr. S. Gogoi		

3.1.3.4: Jackfruit based agroforestry system

Sl. No.	Item	Details
1	Specifications and salient technical features	Jackfruit is a multi-purpose fruit free for fodder, fruit and timber is well adopted to warm humid climate of north eastern states. Considering its usefulness it is being suited to Agro-forestry system.
2	Performance results	Yield of sesame- rapeseed intercrop rotation in agri-horti system was recorded as 0.468 t ha^{-1} and 0.600 t ha^{-1}, respectively. Yield reduction of 9.18% and 25.21% in sesamum was observed in 8 and 9 year old tree. On the other hand, yield reduction in rapeseed was observed at 1% and 20 % in 8 and 9 years old jackfruit tree. Fruit yield of jackfruit was 36.874 t ha^{-1} yr^{-1} in 9 year old plantation and progressive increase in fruit yield was observed with plant age. Besides, crop residue of Sesamum and rapeseed and leaf fall of jackfruit added 62.2 kg available N ha^{-1}, 11.8 kg available P_2O_5 ha^{-1} and 15.0 kg available K_2O kg ha^{-1}. Microbial count such as total Bacteria, Azotobacter and PSB increased in intercrop plot.

3	Likely cost	Total cost of cultivation of sesamum-rapeseed rotation in agri-horti system in jackfruit based agro forestry system in twelve years is Rs. 1,93,210/- ha^{-1}. Output in terms of net profit per unit area is Rs. 1,00,618/- ha^{-1} yr^{-1} as compared to farmers practice as sole crop. The major income was attributed by fruit yield of jackfruit.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Total estimated net income per ha per year is Rs. 31,120/- in 6 years old plantation, the net increase progressively with time was found Rs. 1,40,619/- in 10 year old jackfruit.
5	Social/environmental/other benefits	Leaf decomposition and crop residue of sesamum-rapeseed crop increased the organic matter accumulation of soil there by improving the soil physical conditions of crop field.
6	Status of commercialization/IP rights etc.	Technology has been popularized through training of farmers under technology mission in Goalpara and Kamrup district.
7	Efforts for technology dissemination	Dhupdhora area of Goalpara and Morigaon district and homestead garden all throughout Assam with special focus on Barak Valley of Assam.
8	Special requirement for its successful realization; any other standards etc.	Quality planting material and quality seeds for intercrops, other inputs must be made available through different schemes taken up by state govt.
9	Indicative photographs	 **Standing stage of rapeseed between two rows of jackfruit.**  **Fruit bearing jackfruit tree.**

10	Contact details of person from whom technology and further details can be obtained	Dr Ayub Ali Ahmed Horticultural Research Station (AAU), Kahikuchi Guwahati, Assam 781017 Phone: 0361-2840232 Fax: 0361-2841621 Mobile No. : 09435347310
11	Source of availability of technology/expertise	OIC, AICRP on AF, HRS, AAU, Kahikuchi Guwahati, Assam 781017
Name of Contributors : Dr. A.A. Ali, Dr. J.P. Barua and Dr. S. Gogoi		

3.1.3.5: Tree crops interaction studies in *Acacia mangium* based agri silvicultural system in Assam

Sl. No.	Item	Details
1	Specifications and salient technical features	*Acacia mangium* a quick growing leguminous nitrogen fixing tree is newly introduced to Eastern Himalayan Region for its suitability in agro forestry system in the high humid area of Assam.
2	Performance results	*Acacia mangium* based agri silvicultural system produce 0.475 t of sesamum and 0.401 t niger in tree spacing of 5 m X 4 m 0.489 t sesamum and 0.421 t niger in 5m X 5m and 0.502 t sesamum and 0.428 t niger in 5 m X 6 m in second year. Reduction in yield from intercrop was 19 -30 % in third year and 50 -80 % in four year old plantation. These two field crops could not be grown from fifth year onwards owing to increase canopy. Alternate crop studied was hybrid napier and seteria which yielded 32 t and 28 t ha^{-1} $year^{-1}$ respectively. Besides, the crop residue of sesamum and niger added 45 kg, 7.82 kg, 9.37 kg NPK ha^{-1}
3	Likely cost	Total cost of cultivation in ten years for *Acacia mangium* + sesamum-niger rotation is about Rs. 1,20,530/-. Output in terms of net profit per unit area is Rs. 31,747/- ha^{-1} $year^{-1}$ as compared to farmers practice as sole crop.

4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Total estimated net income per ha per year with *Acacia mangium* + sesamum – niger rotation raised up to Rs. 35,850/- including estimated benefit from timber accumulation of *Acacia mangium* under rainfed condition.
5	Social/environmental/other benefits	Leaf fall of *Acacia mangium* and crop residue of sesamum and niger increased the organic matter accumulation in soil. Thereby improving the soil physical condition of crop field.
6	Status of commercialization/IP rights etc.	Technology has been popularized through training of farmers and personnel of oil refinery, Guwahati.
7	Efforts for technology dissesmination	Noonmati, Guwahati and Char area development activities.
8	Special requirement for its successful realization; any other standards etc.	The inputs such as planting material, seeds of intercrop in *Acacia mangium* based systems, fertilizers etc. be accessible to farmers must be ensure in time by the concerned state departments.
9	Indicative photographs	 **Standing stage of fodder, hybrid napier between two rows of *Acacia mangium* .**
10	Contact details of person from whom technology and further details can be obtained	Dr Ayub Ali Ahmed Horticultural Research Station (AAU), Kahikuchi Guwahati, Assam 781017 Phone: 0361-2840232 Fax: 0361-2841621 Mobile No. : 09435347310
11	Source of availability of technology/expertise	OIC, AICRP on AF, HRS, AAU, Kahikuchi Guwahati, Assam 781017
Name of Contributors : Dr. A.A. Ali, Dr. J.P. Barua and Dr. S. Gogoi		

3.1.4: CSKHPKV, Palampur (Himachal Pradesh)

3.1.4.1: Morus based silvi-pastoral system in mid-hills of North Western Himalaya

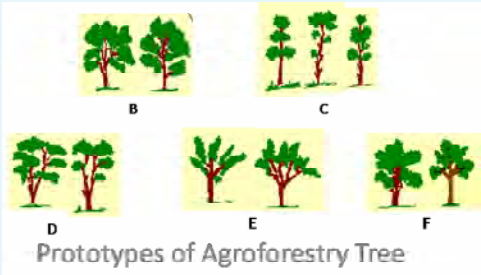
Sl. No.	Item	Details
1	Specifications and salient technical features	Land degradation is a serious problem in mid-hills of North Western Himalayas because of increased grazing pressure on the natural grasslands and poor management by the farmers. This is leading to increased soil erosion resulting in low productivity of the areas. These degraded / waste lands can be reclaimed economically and ecologically by the development of suitable silvi-pastoral agroforestry system. This system being cut & carry system helps in protection of natural grasslands from grazing animals, conserves soil and nutrients and also provides quality fodder on a sustainable basis. *Morus alba* was introduced in a degraded land area. The system was established by planting morus saplings. Improved quality fodder grass napier hybrid-37 was introduced in 2 rows in between tree rows at a spacing of 50cm. Morus was pollarded at a height of three ft. after its initial establishment period of one year.
2	Performance results	Introduction of fodder tree of morus and fast growing, improved grass napier bajra hybrid NB-37 resulted in the production of 8.0 t ha^{-1} green tree fodder and 24.0 t ha^{-1} green grass fodder in comparison to only 6.0 t ha^{-1} green fodder yield from the degraded grassland.
3	Likely cost	The total cost of intervention in five years for the morus + napier grass silvi-pastoral system was about Rs. 47,000/-. Output in terms of net profit per unit area was Rs. 14,130/- ha^{-1} $year^{-1}$ as compared to degraded grassland which gives on an average output to the tune of Rs. 5400/- ha^{-1} $year^{-1}$.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies / know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information.	The overall net income ha^{-1} $year^{-1}$of degraded grassland was raised from Rs. 5,400/- to Rs. 14,130/- ha^{-1} $year^{-1}$ through the development of morus + napier hybrid grass silvi-pastoral system. From morus based silvi-pastoral system, farmer can take three cuts of quality tree as well as green grass fodder which is available to the farmer during lean period also. Availability of quality fodder also boosts

		the livestock based economy of the farmers in the region. Poor management of the grasslands by the farmers lead to weed infestation and low productivity and only one cut of dry fodder is available for harvesting which is not only poor in quantity but also in quality in terms of nutrient status.
5	Social/environmental/other benefits	Intervention of silvi-pastoral system protects the grasslands from degradation and sustains the natural grass cover. Tree cover helps in recycling of nutrients and improving the soil health. Availability of quality green fodder throughout the year encourages the farmer to raise quality milch animals – ensured food security.
6	Status of commercialization/IP rights etc.	Technology has been popularized through trainings of farmers conducted under Technology transfer programme of Operational research projects of DoLR, GOI and AICRP.
7	Efforts for technology dissemination	Technology has been transferred to farmers' field under different Operational Research Projects of Ministry of Rural Development, Govt. of India executed in the earlier Deptt. of Agroforestry & Environment of the university and presently in TSP of AICRP.
8	Special requirement for its successful realization; any other standards etc.	As technology is based on reclamation of degraded lands through Morus + Napier based silvi-pastoral system, so the availability of required inputs (tree saplings and rootslips of improved grass etc.) has to be ensured.
9	Indicative photo graphs	
10	Contact details of person from whom technology and further details can be obtained	Dr. Punam, Principal Scientist (Agroforestry) & PI AICRP on Agroforestry, Deptt. of Biology & Environmental Sciences, CSKHPKV, Palampur-176062, Email: profpunam@gmail.com, 09816366664 (M)
11	Source of availability of technology/expertise	Department of Biology & Environmental Sciences Deptt. of Biology & Environmental Sciences, CSKHPKV, Palampur-176062
Name of Contributors: Dr. Atul, Dr. Rameshwar, Dr. Punam and Dr. Rajesh Uppal		

3.1.4.2: Participatory mapping technique to analyze farmers' perception in adoption of an agroforestry tree.

Sl. No.	Item	Details
1	Specifications and salient technical features	About two-thirds of the rural people in Himachal Himalayas follow diversified farming including animal husbandry, agriculture and fruit farming as major components. As a result of agricultural innovations concentrating heavily on developing high-yielding crop varieties, role of trees in meeting subsistence needs and providing conservation and protective functions as well as traditional management practices and technologies followed by the farmers have been overlooked. This has resulted in the disappearance of some species traditionally used and maintained by farmers. Understanding local tree-use practices, then, is necessary for formulating adoptable agroforestry systems. Through participatory mapping technique carried out in different zones of district Kangra and Mandi of Himachal Himalayas, ideas of the farmers about the management of agroforestry trees on their fields were represented and reflected through sketch drawings which were refined to develop tree protoptypes. Keeping in view the indigenous knowledge of the architectural shape of the tree in which farmer manages a particular type of species, various tree prototype models were developed and tested.
2	Performance results	This participatory sketching of tree prototypes helped in gathering information on farmers' perceptions, preferred location and liked characteristics of the trees, farmers' tree-management objectives and how these objectives differed depending on a tree's ecological niche and the agroforestry production system e.g., in case of *Grewia optiva*, irrespective of the order of preference and variation in the hill zone, the tree was managed in a specific prototype i.e., F and B in which only side branches were partially lopped to meet the fodder and fuelwood requirement and to restrict the height of the plant to a medium level with a single or double forked bole structure. On the other hand the multipurpose tree species (nitrogen fixing, source of fodder and fuel wood etc.) like *Bauhinia variegata* was managed under different prototypes (A to F), shapes indicating their relationship with their multi functional roles.

3	Likely cost	Cost of intervention for tree management varies with tree prototype e.g. in case of *Grewia* which exists only in tree prototypes F and B, it will range from Rs. 2,700/- ha^{-1} (low hills) to Rs. 4,500/- ha^{-1} in mid hills. In case of *Bauhinia variegata*, existing in tree prototypes A to F, cost of tree management varies from Rs. 4,500 to Rs 7,500/- ha^{-1} in mid hills.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies / know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information.	Through this technique, scientists can learn about farmers indigenous knowledge of traditional agroforestry systems as the shape or kind of prototype of an agroforestry tree is a direct function of its role in the system as well as the tree management practice adopted by the farmer to meet his purpose. By transforming these findings into operational intervention programs, traditional agroforestry systems can be made ecologically and economically viable and thus accepted by all farmers particularly the small holders for sustainable Himalayan development
5	Social/environmental/other benefits	Management practices followed by the farmers enhance the regeneration potential of the trees. Tree cover maintained on the farm in traditional Agroforestry Systems checks soil erosion on sloppy lands, enriches the organic matter in the soil and helps in recycling of nutrients in addition to their productive role.
6	Status of commercialization/IP rights etc.	Technology has been popularized through trainings and awareness programmes conducted for the rural stake holders of the region under different technology transfer programmes of DoLR, GOI and AICRP.
7	Efforts for technology dissemination	Technique has been disseminated among farmers for better management and adoptability of Agroforestry systems under different Operational Research Projects of Ministry of Rural Development, Govt. of India executed in the earlier Deptt. of Agroforestry & Environment of the university and presently in TSP of AICRP.
8	Special requirement for its successful realization; any other standards etc.	Awareness, demonstrations and trainings.

9	Indicative photo graphs	
10	Contact details of person from whom technology and further details can be obtained	Dr. Punam Principal Scientist (Agroforestry) & PI, AICRP on AF Deptt. of Biology & Environmental Sciences, CSKHPKV, Palampur-176062 Email: profpunam@gmail.com 09816366664 (M)
11	Source of availability of technology/expertise	Department of Biology & Environmental Sciences Deptt. of Biology & Environmental Sciences, CSKHPKV, Palampur-176062
Name of Contributors: Dr. Atul, Dr. Rameshwar and Dr. Punam		

3.2 Indo-Gangetic Region

3.2.1: PAU, Ludhiana (Punjab)

3.2.1.1: Poplar based agroforestry system (poplar + summer and winter intercrops)

Sl. No.	Item	Details
1	Specifications and salient technical features	Diversification from rice wheat rotation is the need of the hour in Punjab and the state government has decided to bring about 2.0 lakh ha under agroforestry as per the state's crop diversification plan. Poplar (*Populus deltoides*) based agroforestry system has been adopted by the farmers especially along the river bed sites. The crops are cultivated in between the rows of trees. Trees are grown at a spacing of 8 m x 2.5 m or 5 m x 4 m accommodating about 500 trees per hectare. They get an annual income from the sale of intercrops while at the same time maintain trees for 6-7 years. All the *rabi* (winter) and *kharif* (summer) crops can be grown successfully under poplar plantations during the first two years except paddy. Different *rabi* crops like wheat, mustard, potato, barley, and berseem can be successfully grown with poplar throughout its rotation age. However, in *kharif* season shade of trees reduces the crop yield. Therefore, crops in *kharif* should only be grown during first 3-4 years of tree age. The yield of various *kharif* and *rabi* crops and net returns during different years of poplar age indicate that poplar intercropped with turmeric has the highest benefits followed by poplar intercropped with pearlmillet-wheat rotation. Higher productivity of poplar plantations can be achieved by adopting suitable cultural and management practices such as inter-cultivation, irrigation application in channels during wheat growing season, following proper year wise fertilizer schedule for poplar, correcting deficiency of zinc and control of insects and diseases throughout its growth years.
2	Performance results	Growing of pearl millet-wheat rotation in poplar plantation for 6 years produced 143 t ha^{-1} of pearl millet and 21.5 t ha^{-1} of wheat. Growing turmeric (annual crop) in poplar plantation for 6 years produced 37.41 t ha^{-1} of turmeric resulting into higher net profit.
3	Likely cost	The total cost of cultivation in six years for poplar with pearl millet-wheat rotation is about Rs. 2,17,500/- ha^{-1} and for poplar with turmeric is 1,87,500/- ha^{-1}. Output in terms of net profit per unit area is Rs.14,76,471/- ha^{-1} (Rs.2,46,078/- ha^{-1} $year^{-1}$) in case of poplar with pearl millet-wheat rotation and Rs. 15,88,200/- ha^{-1} (Rs. 2,64,700/- ha^{-1} $year^{-1}$) in case of poplar with turmeric. The income from poplar wood has been calculated at rates of Rs. 8000/- t^{-1}.

4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income ha^{-1} $year^{-1}$ with poplar plantations intercropped with turmeric was higher (Rs. 2,64,700/-) as compared to plantations intercropped with fodder-wheat rotation (Rs. 2,46,078/-).
5	Social/environmental/other benefits	Poplar based agroforestry systems add organic matter through leaf litter, thus help to maintain soil health. It has been observed that poplar plantation added about 20.1 t ha^{-1} litter fall throughout its rotation of 6 years which returned about 176, 21.7, 133 and 368 kg ha^{-1} N, P, K and Ca, respectively in the plantation.
6	Status of commercialization/ IP rights etc.	Technology has been popularized through training of development officers of Departments of Agriculture, Horticulture, Forests and Soil Conservation in the state. In addition, the training programmes of the farmers are conducted and Kisan Melas in various regions of the state are organized to promote different technologies.
7	Efforts for technology dissemination	Technology has been transferred to many farmers' fields in central and northern districts of the state, especially on areas along rivers and on coarse textured soils of Punjab.
8	Special requirement for its successful realization; any other standards etc.	The success of any technology depends on the good returns from the final produce. The fluctuation in wood prices sometimes decreases the returns. The state government should ensure some minimum support price of the poplar wood so that the farmers are encouraged for adoption of such technologies. State government has proposed 4 wood markets in state over a period of time to minimize exploitation by middle men in the sale of wood.
9	Indicative photographs	  **Poplar intercropped with wheat** **A well-managed poplar plantation**
10	Contact details of person from whom technology and further details can be obtained	Dr. R.I.S. Gill, OIC, AICRP on Agroforestry, Department of Forestry and N.R., PAU Ludhiana – 141 004 Phone:0161-2401960-380 (Email: rishigill@pau.edu)
11	Source of availability of technology/expertise	Head, Department of Forestry and N.R., PAU Ludhiana – 141 004 Phone:0161-2401960-380 (Email: hodfnr@pau.edu)
Name of Contributors: Dr R I S Gill, Dr Baljeet Singh and Dr Navneet Kaur		

3.2.1.2: Raising clonal eucalyptus plantations for higher productivity

Sl. No.	Item	Details
1	Specifications and salient technical features	The prevalence of rice-wheat rotation for the last many years in Punjab has lead to many problems such as deterioration of soil health, lowering of water table, emergence of insect pests and nutrient deficiencies. Diversification from this rotation is the need of the hour and the state government has decided to bring about 2.0 lakh ha under agroforestry as per the state's crop diversification plan. Eucalyptus is one of the fast growing tree species being adopted by Punjab farmers on their agricultural fields. In addition to regular tree growers, it is being preferred by absentee landlords as it requires less management than other fast growing tree species. Earlier, its plantations were grown from seedlings raised from seeds. The growth of plants in plantations raised from seedlings is highly variable. However, during the last few years it is being propagated vegetatively (clonal plants). It has been observed from the experiments and surveys of farmers' fields that the clonal plantations have uniform growth of all the trees and their productivity is more than double as compared to the plantations raised from seeds after 6-7 years of growth. It is grown as block plantation at a spacing of 4 m x 2 m or 3 m x 3 m, thus accommodating about 1250 plants per hectare. It is harvested after 3-4 years of age for poles and 6-7 years for timber. The crops such as fodders in summers and wheat in winters can be grown with it during first two years of age. More productivity of clonal eucalyptus plantations can be achieved by adopting suitable and improved clones, better cultural and management practices such as irrigation application, following proper year wise fertilizer schedule, control of insects and diseases throughout its growth years, etc.
2	Performance results	Clonal eucalyptus plantations produced 230 t ha^{-1} of wood after 6 years of age. Besides this, the addition of litter fall in the plantations would improve the organic carbon and soil health of the system.
3	Likely cost	The total cost of cultivation in six years for clonal eucalyptus plantations is about Rs. 80,775/- ha^{-1}. Output in terms of net profit per unit area is Rs. 11,84,228/- ha^{-1} (Rs. 1,97,371/- ha^{-1} $year^{-1}$) at the rates of wood prices equal to Rs. 5500/- t^{-1}.

4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income ha^{-1} $year^{-1}$ with clonal plantations increased from Rs. 1,00,162/- in seedling raised plantations to Rs. 1,97,371/- under irrigated and well managed clonal plantations.
5	Social / environmental / other benefits	Due to the continuity of rice-wheat system in Punjab, many problems related to soil health and water table have emerged. Therefore, diversification is the need of the hour as per state government policies and agroforestry is one of the options of diversification. In addition to increasing the area under trees, eucalyptus based system provides sufficient income to farmers. The organic matter added through litter fall improves the physical conditions of soil and adds organic carbon and nutrients through decomposition of litter fall.
6	Status of commercialization / IP rights etc.	Technology has been popularized through training of development officers of Departments of Agriculture, Horticulture, Forests and Soil Conservation in the state. In addition, the training programmes of the farmers are conducted and Kisan Melas in various regions of the state are organized to promote different technologies.
7	Efforts for technology dissemination	Technology has been transferred to many farmers' fields in the state.
8	Special requirement for its successful realization; any other standards etc.	The success of any technology depends on the good returns from the final produce. The fluctuation in wood prices sometimes decreases the returns. The state government should ensure some minimum support price of the eucalyptus wood so that the farmers are encouraged for adoption of such technologies.
9	Indicative photographs	 **Young plantation of clonal eucalyptus having wheat as the intercrop**  **A mature plantation of clonal eucalyptus**
10	Contact details of person from whom technology and further details can be obtained (information on the postal address, email, telephone, fax etc.)	Dr. R.I.S. Gill, OIC, AICRP on Agroforestry, Department of Forestry and N.R., PAU Ludhiana – 141 004, Phone: 0161-2401960-380 Email: rishigill@pau.edu
11	Source of availability of technology/expertise	Head, Department of Forestry and N.R., PAU Ludhiana – 141 004, Phone: 0161-2401960-380 Email: hodfrn@pau.edu
Name of Contributors: Dr R I S Gill, Dr Baljeet Singh and Dr Navneet Kaur		

3.2.2: GBPUA&T, Pantnagar (Uttarakhand)

3.2.2.1: Bamboo based agri-silvicultural system for *tarai* and N-W Himalaya region of Uttarakhand

Sl. No.	Item	Details
1	Specifications and salient technical features	In *tarai* region of Uttarakhand, suitability of land and climate, large holding size, huge market for bamboo wood, fast returns than other tree species, regular income after four years, and easy cultivation favors large scale cultivation of bamboo from the land where other crops fail to perform. High yielding genotypes of bamboo species viz., *Bambusa balcooa, B. tulda, B nutan, D. asper* in tarai region and *Dendrocalamus hamiltoni* in low and mid hills under block plantation of 5m x 5m and on boundary at the spacing of 5m or 3m were introduced. Intercrops like wheat, soybean, rapeseed, bean, mustard are grown successfully for first two years.
2	Performance results	High yielding superior genotypes of bamboo species viz., *Bambusa balcooa, B. tulda, , B. nutan, D. asper* in tarai region and *Dendrocalamus hamiltoni* in low and mid hills region produced average wheat yield levels 2.3-3.0 t ha^{-1}, soybean 1.7-2.0 t ha^{-1} and bamboo 50 t ha^{-1} yr^{-1} resulting higher net profit. In hills bamboo act as check to control soil erosion and supplier of income and material in emergent conditions.
3	Likely cost	The total cost of cultivation in bamboo based system is about Rs. 1,10,000/-. Output in terms of net profit per unit area is Rs. 1,80,000/- to 2,00,000/- ha^{-1} yr^{-1} after four years of age.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income per hectare per year with bamboo based system raised from Rs. 95,000/- to Rs. 2,00,000/- ha^{-1} yr^{-1} after four year under irrigated condition.
5	Social/environmental/other benefits	Bamboo based plantation helps farmers to get high and higher and regular returns on their investment. Industries have fast access to raw material. It is also useful in their daily and agricultural pursuits. It also protects soil from erosion therefore highly preferred in river command areas.

6	Status of commercialization/IP rights etc.	Technology has been popularized through training of farmers, staff of agricultural department, SHGs both on and off campus, kisan mela, gosthis etc. Demonstration experiments are also conducted on farmer's field. Technology is popularized through wide distribution of quality planting material and technical knowhow to stakeholders.
7	Efforts for technology dissemination	Bamboo plantation is coming up in last three year as major measure of soil erosion control particularly on river banks and low lying areas. Few farmers under TOT: Sh. Jaideep Singh Barar, Bilaspur Sh. Atis Khan, Rampur
8	Special requirement for its successful realization; any other standards etc.	Superior clonal planting material of promising species.
9	Indicative photographs	  **Block Bamboo plantation (5m x 5m) with mustard and soybean as intercrop**
10	Contact details of person from whom technology and further details can be obtained	Dr. Salil Tewari, Programmne Coordinator, AICRP-Agroforestry, GBPUA&T, Pantnagar, U S Nagar, Uttarakhnad Phone: 05944-234631 Mobile : +917500241465 Fax: 05944-233473 / 234631 E-mail: saliltewari@gmail.com
11	Source of availability of technology/expertise	Joint Director, Agroforestry Research Centre GBPUA&T, Pantnagar, U S Nagar, Uttarakhnad Phone: 05944-234631 Mobile : +917500241465 Fax: 05944-233473 / 234631 E-mail: saliltewari@gmail.com
Name of Contributors : Salil Tewari, Sumit Chaturvedi, R. Kaushal, V K Sah, S K Lavania and Ashutosh Dubey		

3.2.2.2: Poplar based agrisilviculture system in Uttarakhand

Sl. No.	Item	Details
1	Specifications and salient technical features	Rice–wheat system is major cropping system of the region facing challenges of monoculture, plateauing productivity levels, decreasing income and issues of diversification and environment security. The inter-cropping with poplar is found to be beneficial as it has added more and stable income to the farmer besides improving soil productivity; enhancing biodiversity and it also supply major industrial raw materials. Clonal poplar under block (5mx4m and new 7mx2.75m) and boundary (2.5m) plantation with rotation cycle of six years was introduced. Intercrops like sugarcane was taken for first two years followed by soybean in *kharif* and wheat in *rabi* in 3rd and 4th year. During 5th and 6th year turmeric was grown.
2	Performance results	Poplar based agri-silvi system produced sugarcane 60-65 t ha^{-1}, wheat 3.8 t ha^{-1}, soybean 2.3 t ha^{-1}, turmeric 15-18 t ha^{-1} and poplar 100-125 t ha^{-1} resulting higher net profit. Besides this, litter fall residues of poplar added 68.0, 6.77 and 29.28 kg NPK ha^{-1}yr^{-1}.
3	Likely cost	The total cost of cultivation for six years in poplar based system is about Rs. 2,52,443/-. Output in terms of net profit per unit area is Rs. 9,23,957/- ha^{-1} with B:C ratio 3.66.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income per hectare per year with poplar based system raised from Rs. 95,000/- to Rs. 1,53,993/- under irrigated condition.
5	Social/environmental/other benefits	• Poplar based system moderates the climate thereby increasing crop resilience to adverse weather situations. • Organic residues added by poplar improve the physical conditions of soil health by increasing OM and bulk density. • Pruned branches are also utilized as fuel wood.
6	Status of commercialization/IP rights etc.	Technology has been popularized through training of farmers, staff of agricultural department, SHGs both on and off campus, kisan mela, gosthis etc. Demonstration experiments are also conducted on farmer's field. Technology is popularized through wide distribution of quality planting material and technical knowhow to stakeholders.

7	Efforts for technology dissemination	Technology has been transferred to farmers' field under different agrisilvicultural systems like block and boundary plantation with 42.5% farmers following block plantation and 17.4% under boundary plantation in U S Nagar district of Uttarakhand. Few distinguished farmers under TOT: • Sh. Atis Khan, Rampur • Sh. Harpal Singh, Bajpur • Sh. Gagan Pant, Kichha • Sh. Jaideep Sing, Munda Pande, Moradabad
8	Special requirement for its successful realization; any other standards etc.	1. Quality planting material of promising clones of poplar (PP-5, L-34, PH-6, G-48...). 2. Assured price and market for poplar wood for industries 3. Selection of suitable varieties of under-storey crops which can perform better under poplar.
9	Indicative photographs	  **Block poplar plantation (5m x 4 m) with intercrops**
10	Contact details of person from whom technology and further details can be obtained	Dr. Salil Tewari, Programmne Coordinator, AICRP-Agroforestry, GBPUA&T, Pantnagar, U S Nagar, Uttarakhnad Phone: 05944-234631 Mobile : +917500241465 Fax: 05944-233473 / 234631 E-mail: saliltewari@gmail.com
11	Source of availability of technology/expertise	Joint Director, Agroforestry Research Centre GBPUA&T, Pantnagar, U S Nagar, Uttarakhnad Phone: 05944-234631 Mobile : +917500241465 Fax: 05944-233473 / 234631 E-mail: saliltewari@gmail.com
Name of Contributors : Salil Tewari, Sumit Chaturvedi, R. Kaushal, V K Sah, S K Lavania and Ashutosh Dubey		

3.2.2.3: *Eucalyptus* based agrisilviculture system in Uttarakhand

Sl. No.	Item	Details
1	Specifications and salient technical features	Sowing of wheat during *rabi* season in rice–wheat system is delayed due to high water table coupled with low percolation rate mostly in *tarai* region, which poses problems of low productivity levels and cropping intensity thereby decreasing income of the farmers. The inter-cropping with eucalyptus in boundary as well as block planting is found to be beneficial as it has increased the possibility of timely sowing more crops during *rabi* season thereby increasing and stabilizing income of the farmer. It diversifies and stabilizes the production system and also provides industrial raw materials. Clonal eucalyptus under boundary and block plantation with rotation cycle of five years was introduced. Intercrops like wheat, rice, soybean, rapeseed, mustard, veg pea are grown. Under block plantation at the spacing of 5m x 2m crops can be grown during first three years, however under boundary plantation at 2.0 m spacing any crop can be grown upto the rotation age of eucalyptus.
2	Performance results	Eucalyptus based agri-silvi system produced wheat 3.0 t ha^{-1}, soybean 2.0 t ha^{-1} and eucalyptus 125 t ha^{-1} resulting higher net profit. Besides this, litter fall residues of eucalyptus added 27.1, 2.0 and 7.0 kg NPK $ha^{-1}yr^{-1}$, respectively.
3	Likely cost	The total cost of cultivation for five years in eucalyptus based agroforestry system is about Rs. 1,90,964/-. Output in terms of net profit per unit area is Rs. 6,30,361/- ha^{-1} with B:C ratio 3.3.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income per hectare per year with eucalyptus based system raised from Rs. 95,000 to Rs. 1,26,072/- under irrigated condition.
5	Social/environmental/other benefits	Eucalyptus based system reduces water table thereby increasing choice of crops to be sown as intercrop. It also permits timely sowing of the crops during *rabi* season.

6	Status of commercialization/IP rights etc.	Technology has been popularized through training of farmers, staff of agricultural department, SHGs both on and off campus, kisan mela, gosthis etc. Demonstration experiments are also conducted on farmer's field. Technology is popularized through wide distribution of quality planting material and technical knowhow to stakeholders.
7	Efforts for technology dissemination	Technology has been transferred to farmers' field under different agrisilvicultural systems like boundary and block plantation with 12.8% farmers following block plantation and 27.1% under boundary plantation in U S Nagar district of Uttarakhand. Few farmers under TOT: • Sh. Harpal Singh, Bajpur • Sh. Jaideep Singh, Munda Pande, Moradabad
8	Special requirement for its successful realization; any other standards etc.	1. Quality planting material of promising clones of eucalyptus (K-25, K-28, PES-1..). 2. Assured price and market for eucalyptus wood 3. Selection of suitable varieties of under-storey crops which can perform better under eucalyptus.
9	Indicative photographs	 **Block eucalyptus plantation (5m x 2m) with wheat as intercrop**  **Boundary plantation of eucalyptus (2.0m)**
10	Contact details of person from whom technology and further details can be obtained	Dr. Salil Tewari, Programmne Coordinator, AICRP-Agroforestry, GBPUA&T, Pantnagar, U S Nagar, Uttarakhnad Phone: 05944-234631 Mobile : +917500241465 Fax: 05944-233473 / 234631 E-mail: saliltewari@gmail.com
11	Source of availability of technology/expertise	Joint Director, Agroforestry Research Centre GBPUA&T, Pantnagar, U S Nagar, Uttarakhnad Phone: 05944-234631 Mobile : +917500241465 Fax: 05944-233473 / 234631 E-mail: saliltewari@gmail.com
Name of Contributors : Salil Tewari, Sumit Chaturvedi, R. Kaushal, V K Sah, S K Lavania and Ashutosh Dubey		

3.2.2.4: High density short rotation plantation of poplar and eucalyptus for N-W plain Zone

Sl. No.	Item	Details
1	Specifications and salient technical features	Increasing demand of wood and declining availability of wood supplies has prompted a renewed interest in growing short rotation woody crops (SRWC) under agroforestry systems. Fast growing tree species *viz.*, poplar and eucalyptus are now emerging as a major source of raw materials for wood based industries. Further, low crop yields under tree in later part of rotation cycle have also favoured high density orcharding. Clonal poplar and eucalyptus under block plantation with rotation cycle of 4 years were introduced. Intercrops like wheat, soybean, rapeseed, mustard are grown. Under block plantation at the spacing of 3m x 2m crops can be successfully grown during first two years.
2	Performance results	High density short rotation system produced average wheat yield levels 2.3-3.0 t ha^{-1}, soybean 1.7-2.0 t ha^{-1} and eucalyptus 155 t ha^{-1} and poplar 140 t ha^{-1} resulting higher net profit.
3	Likely cost	The total cost of cultivation for four years in eucalyptus and poplar based high density system is about Rs. 1,50,000/-. Output in terms of net profit per unit area is Rs. 5,60,000-6,20,000/- ha^{-1}.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income per hectare per year with high density short rotation based system raised from Rs. 95,000/- to Rs. 1,40,000-1,55,000/- under irrigated condition.
5	Social/environmental/other benefits	High density short rotation plantation of poplar and eucalyptus helps farmers to get high and early returns on their investment. Ply board/ particle board, hard board Industries have fast access to raw material. Short rotation involves less risk due to uncertain market prices.

6	Status of commercialization/IP rights etc.	Technology has been popularized through training of farmers, staff of agricultural department, SHGs both on and off campus, kisan mela, gosthis etc. Demonstration experiments are also conducted on farmer's field. Technology is popularized through wide distribution of quality planting material and technical knowhow to stakeholders.
7	Efforts for technology dissemination	High density in short rotation plantation is a newer system being adapted by progressive farmers but seen as promising system to be followed in coming times. Farmers under TOT: • Sh. J.S. Bakshi, Bilaspur • Sh. Jaideep Singh, Munda Pande, Moradabad • Sh. Shiv Shyam, Anvaria, Bilaspur
8	Special requirement for its successful realization; any other standards etc.	1. Quality planting material of promising clones.
9	Indicative photographs	 **Block eucalyptus plantation (3m x 2m) with wheat as intercrop**  **Block poplar plantation (3m x 2m) with wheat as inter crop**
10	Contact details of person from whom technology and further details can be obtained	Dr. Salil Tewari, Programmne Coordinator, AICRP-Agroforestry, GBPUA&T, Pantnagar, U S Nagar, Uttarakhnad Phone: 05944-234631 Mobile : +917500241465 Fax: 05944-233473 / 234631 E-mail: saliltewari@gmail.com
11	Source of availability of technology/expertise	Joint Director, Agroforestry Research Centre GBPUA&T, Pantnagar, U S Nagar, Uttarakhnad Phone: 05944-234631 Mobile : +917500241465 Fax: 05944-233473 / 234631 E-mail: saliltewari@gmail.com
Name of Contributors : Salil Tewari, Sumit Chaturvedi, R. Kaushal, V K Sah, S K Lavania and Ashutosh Dubey		

3.2.3: RAU, Pusa Samastipur (Bihar)

3.2.3.1: Poplar (*Populus deltoides*) based agri-silvicultural system in North Western alluvial plain of Bihar

Sl. No.	Item	Details
1	Specifications and salient technical features	Thinly crowned poplars have the larger acceptability among farmers due to its fast growth, multiple uses of wood, less competition with the associated crops and tolerant to flooding for a short time during the rainy season. Besides, plantations receiving various silvicultural treatments of pruning, irrigation, fertilization and inter-cultivation have better growth and timber production than sole trees or poorly managed plantations. Tree Planting: Plant one-year-old entire transplant of poplar G3 in pits of size 60cm x 60cm x 60cm filled with 8-10 kg FYM + 50 g DAP having the spacing 5 m x 4 m. Irrigate regularly at weekly interval up to 60 days when the plant establishes and thereafter as per the need. Intercropping: Cropping pattern I: Grow maize cv. 'Suwan' (in rainy), followed by wheat cv.'HUW 234' (in winter) until the 4th year and after that, the shade-loving crop turmeric cv. 'Rajendra Sonia' from 5th to 9th year. Cropping pattern II: Grow pegionpea cv. 'Bahar' up to 5th year and turmeric cv. 'Rajendra Sonia' from 6th to 9th year Apply normal recommended doses of fertilizers, irrigations and other cultural practices for both the cropping patterns. Change in crop sequences with time is due to drastic reduction in yields and thus replacement with shade loving turmeric crop.
2	Performance results	• Yield of intercrops: Maize grain yield: 0.78-2.05 t ha^{-1}. Wheat grain yield: 1.62-2.60 t ha^{-1}. Turmeric yield: 11.00-24.00 t ha^{-1}. • Poplars provide standing biomass of 90.6 t ha^{-1}at a short rotation of 9 years.
3	Likely cost	The total cost of cultivation in ten years for the cropping pattern I based agri-silvicultural system is about Rs. 1,13,652/- and output in terms of net profit per unit area is Rs. 4,91,106/- ha^{-1}. On the other hand, the total cost of cultivation in ten years for the cropping pattern II based agri-silvicultural system is about Rs. 89,292/- and output in terms of net profit per unit area is Rs. 4,79,146/- ha^{-1}.

4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Economics: At the end of 9th year the cumulative benefit : cost ratio under : *Cropping pattern – I* : 5.32 *Cropping pattern – II* : 6.37 Thus, both the cropping patterns under poplar plantations are profitable in all respect.
5	Social/environmental/other benefits	Disappearance of litter to the tune of 3.71 to 4.13 (3-year-old, young) and 10.55 to 10.74 t ha^{-1} (9-year-old, mature) results in annual transfer of litter nutrient 37.3 to 146.2 N, 5.6 to 17.9 P and 25.0 to 66.3 K kg ha^{-1} $year^{-1}$ to the soil Thus, the system protects the soil health from further deterioration and maintains sustainability.
6	Status of commercialization/IP rights etc.	Technology has been popularized through training of progressive farmers / Agricultural Coordinators / Extension Officers of Bihar and Jharkhand.
7	Efforts for technology dissesmination	Through KVK, Forest Department, NGOs etc.
8	Special requirement for its successful realization; any other standards etc.	Proper irrigation and timely application of fertilizers to intercrops.
9	Indicative photographs	 ***Populus deltoides* + Wheat**
10	Contact details of person from whom technology and further details can be obtained	D.K. Das, OIC (Agroforestry), Department of Forestry, Rajendra Agricultural University, Bihar, Pusa (Samastipur) - 848 125 Email: diptydaspusa@yahoo.co.in Mob: 9430046537 Fax: 06274-240255
11	Source of availability of technology/expertise	Head, Forestry, Rajendra Agricultural University, Bihar, Pusa (Samastipur) - 848 125 Mob: 9308501688 Fax: 06274-240255 University website: www.pusavarsity.org.in
Name of Contributors : Dr D K Das, Dr O P Chaturvedi, Dr R K Jha, Dr M S Ali and Dr Rajeev Kumar		

3.2.3.2: Aonla (*Emblica officinalis*) based agri-horticultural system in North Western alluvial plain of Bihar

Sl. No.	Item	Details
1	Specifications and salient technical features	Aonla based agri-horticultural system has immense potential to utilize and conserve rainfed area for betterment of poor farmers. Aonla being a deep rooted and deciduous tree has a wide range of adaptability to grow in any type of soil and is considered a high tolerant potential fruit species suited to grow under salt-affected and wasteland/ravine lands with the little investments and higher economic return. Tree Planting: Establish an aonla orchard of *cv*. NA-7 at 6m x 6m spacing in 1 m^3 pits filled with 20 kg well rotten FYM, 100 g N, 50 g P_2O_5, and 75 g K_2O. Provide life saving basin irrigation during summer months only at 15-20 days interval for first two years after planting and no irrigation from 3rd year. Intercropping and cultural practices: Shade tolerant crops such as turmeric (*Curcuma domestica*, var. Rajendra Sonia), ginger (*Zingiber officinale*, var. Nadia) and colocasia (*Colocasia esculenta*, var. Sahasramukhi) can be intercropped one meter away from the trunk leaving an area of 3 m^2 around each tree. Well rotten compost @ 20 t ha^{-1} should be applied to the plots 15 days before sowing the intercrops. N, P and K should be applied as basal doses @ 120 : 50 : 100 kg ha^{-1} for turmeric, 60 : 50 : 80 kg ha^{-1} for ginger and 80 : 40 : 80 kg ha^{-1} for colocassia. The recommended spacings should be adopted for different crops, like turmeric and ginger, 30 cm x 20 cm and colocassia, 45 cm x 30 cm. Other cultural practices are as per recommendation of the crops.
2	Performance results	Intercropping of 6 to 8-year-old aonla orchard increases the production of fruits significantly: Aonla in association with turmeric: 11.6-15.7 t ha^{-1}. Aonla in association with colocasia: 10.2-14.0 t ha^{-1}. Aonla in association with ginger: 9.2-13.0 t ha^{-1}. • Yield of intercrops: Turmeric yield: 22.71-26.04 t ha^{-1}. Ginger yield: 9.23-11.05 t ha^{-1}. Colocasia yield: 8.87-10.76 t ha^{-1}
3	Likely cost	The total cost of cultivation in eight years: • Aonla associated with turmeric is about Rs. 73,735/- and output in terms of net profit per unit area is Rs. 4,63,665/- ha^{-1}.

		• Aonla associated with colocasia is about Rs. 52,479/- and output in terms of net profit per unit area is Rs. 1,67,721/- ha^{-1}. • Aonla associated with ginger is about Rs. 96,927/- and output in terms of net profit per unit area is Rs. 3,33,993/- ha^{-1}.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies / know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Economics: At the end of 8th year the benefit : cost ratio under : *Aonla+turmeric* : 6.29 *Aonla+ginger* : 3.45 *Aonla+colocassia* : 3.20 Thus, aonla based agrihorticultural systems with the above intercrops are profitable in all respect.
5	Social/environmental/other benefits	Intercrops do not exert adverse effect on the growth and productivity of aonla. Intercropping in aonla is effective in bringing improvement in the soil fertility, leading to a sustainable production system. These crops can be successfully cultivated in the interspaces to generate substantial additional income (Rs. 1,03,089/- - 3,99,033/- even at the 6th to 8th year of the orchard.
6	Status of commercialization/IP rights etc.	Technology has been popularized through training of progressive farmers / Agricultural Coordinators / Extension Officers of Bihar and Jharkhand.
7	Efforts for technology dissemination	KVK, Forest Department, NGOs etc.
8	Special requirement for its successful realization; any other standards etc.	Proper irrigation and timely application of fertilizers to intercrops.
9	Indicative photographs	 **Aonla + colocassia**  **Aonla + turmeric**
10	Contact details of person from whom technology and further details can be obtained	D.K. Das, OIC (Agroforestry), Department of Forestry, Rajendra Agricultural University, Bihar, Pusa (Samastipur)-848 125 Email: diptydaspusa@yahoo.co.in Mob: 9430046537 Fax: 06274-240255
11	Source of availability of technology/expertise	Head, Forestry, Rajendra Agricultural University, Bihar, Pusa (Samastipur)-848 125 Mob: 9308501688 Fax: 06274-240255 University website: www.pusavarsity.org.in
Name of Contributors : Dr D K Das, Dr O P Chaturvedi, Dr R K Jha, Dr M S Ali and Dr Rajeev Kumar		

3.2.3.3: Litchi (*Litchi chinensis*) based agri-horticultural system in North Western alluvial plain of Bihar

Sl. No.	Item	Details
1	Specifications and salient technical features	Litchi trees are grown in an area of 25300 ha in north Bihar which is 47% of the total acreage under litchi in the country and its contribution to the total litchi production in the country is nearly 74 per cent. Hence, Bihar offers the most salubrious climate to grow this luscious fruit. Tree Planting: Establish a litchi orchard of *cv*. China at 7 m × 7 m spacing in 90 cm × 90 cm × 90 cm pits filled with 20 kg of well rotten FYM, 220 g urea, 185 g superphosphate, and 100 g muriate of potash and 20 g thimet 10G. Before planting is taken up, the pits should receive a couple of good showers of rain. Otherwise, water should be applied so that the soil settled down properly. The best time of planting is July- August. Intercropping and cultural practices: Shade tolerant crops such as turmeric (*Curcuma domestica*, var. Rajendra Sonia), ginger (*Zingiber officinale*, var. Nadia), colocasia (*Colocasia esculenta*, var. Sahasramukhi), and elephant foot yam (*Amorphophallus campanulatus*, var. Gajendra), can be intercropped one meter away from the trunk leaving an area of 3 m^2 around each tree. Well rotten compost @ 20 t ha^{-1} should be applied to the plots 15 days before sowing the intercrops. N, P and K should be applied as basal doses @ 120 : 50 : 100 kg ha^{-1} for turmeric, 60 : 50 : 80 kg ha^{-1} for ginger, 80 : 40 : 80 kg ha^{-1} for colocassia and 80 : 60 : 80 kg ha^{-1} for elephant foot yam. The recommended spacing and other cultural practices should be adopted for different crops.
2	Performance results	Intercropping of 5 to 10-year old litchi orchard increases the production of fruits significantly: Litchi in association with turmeric: 5.3-7.0 t ha^{-1}. Litchi in association with colocasia: 4.4-5.3 t ha^{-1}. Litchi in association with ginger: 4.7-6.1 t ha^{-1}. Litchi in association with yam: 4.0-5.0 t ha^{-1}. • Yield of intercrops: Turmeric yield: 19.84-29.58 t ha^{-1}. Ginger yield: 8.56-11.93 t ha^{-1}. Colocasia yield: 9.08-13.26 t ha^{-1} Yam yield: 7.52-9.42 t ha^{-1}

3	Likely cost	The total cost of cultivation after ten years: • Litchi associated with turmeric is about Rs. 3,82,228/- and output in terms of net profit per unit area is Rs. 12,47,311/- ha^{-1}. • Litchi associated with colocasia is about Rs. 2,61,798/- and output in terms of net profit per unit area is Rs. 279441/- ha^{-1}. • Litchi associated with ginger is about Rs.6,31,027/- and output in terms of net profit per unit area is Rs. 10,74,493/- ha^{-1}. • Litchi associated with yam is about Rs. 2,44,126/- and output in terms of net profit per unit area is Rs. 2,77,313/- ha^{-1}.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies / know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Economics: At the end of 10th year the economic analysis of the systems in terms of B:C ratio revealed that litchi + turmeric gave a higher value (4.26) followed by litchi + ginger (2.70), litchi + elephant foot yam (2.14) and litchi + colocassia (2.07). Thus, litchi based agrihorticultural systems with the above intercrops are profitable in all respect.
5	Social/environmental/other benefits	These inercrops can be successfully grown in the interspaces of Litchi orchard even at the age of ten years with 6.5 – 23.6 % reduction in yield for turmeric, 12.4 – 38.2 % for ginger, 9.8 – 30.2 % for colocasia and 22.5 – 40.5 % for elephant foot yam. These reductions can be compensated by the additional yield of litchi showing approximately 35 % more yield as compared to the pure orchard. Intercrops do not exert adverse effect on the growth and productivity of litchi. Intercropping in litchi is effective in bringing improvement in the soil fertility, leading to a sustainable production system.
6	Status of commercialization/IP rights etc.	Technology has been popularized through training of progressive farmers / Agricultural Coordinators / Extension Officers of Bihar and Jharkhand.
7	Efforts for technology dissemination	KVK, Forest Department, NGOs etc.
8	Special requirement for its successful realization; any other standards etc.	Proper irrigation and timely application of fertilizers to intercrops.

9	Indicative photographs with proper lighting	 **Litchi + turmeric**
10	Contact details of person from whom technology and further details can be obtained	D.K. Das, OIC (Agroforestry), Department of Forestry, Rajendra Agricultural University, Bihar, Pusa (Samastipur)-848 125 Email: diptydaspusa@yahoo.co.in Mob. 9430046537 Fax: 06274-240255
11	Source of availability of technology/expertise	Head, Forestry, Rajendra Agricultural University, Bihar, Pusa (Samastipur)-848 125 Mob: 9308501688 Fax: 06274-240255 University website: www.pusavarsity.org.in
Name of Contributors : Dr D K Das, Dr O P Chaturvedi, Dr R K Jha, Dr M S Ali and Dr Rajeev Kumar		

3.2.4: NDUA&T, Faizabad (Uttar Pradesh)

3.2.4.1: Agri silvihorticulture system for sodic land

S. No.	Item	Details
1	Specifications and salient technical features	The eastern parts of Uttar Pradesh is faced with problem of soil sodicity. Generally, soil as such is considered unfit for agriculture production. Good market for casuarina wood, fast returns than other tree species particularly under sodic soil conditions because plant growth is better as well as reclaimed sodic soil. High growth of genotypes/provenances of *Casuarina equisetifolia viz.*, Methupalayam, Akma Unit-1 and Varanasi under 10m x 2m plantation in sodicity affected eastern parts of U.P. Intercrops like *Psidium guajava* and turmeric (*Curcuma longa*) are grown successfully for six years.
2	Performance results	High growth of genotypes/provenances of *Casuarina equisetifolia viz.*, Methupalayam, Akma Unit-1 and Varanasi in eastern parts of U.P. under sodic soil conditions, produced average guava fruit yield 9.0 t ha^{-1} yr^{-1} and turmeric rhizome yield 4.0 t $ha^{-1}yr^{-1}$, which yielded higher net profit. In sodicity affected eastern part of U.P., *Casuarina equisetifolia* act as a reclament to improve sodic soil condition, also check soil erosion and enhancement of income through turmeric, guava and casuarina.
3	Likely cost	The total cost of cultivation is about Rs. 48,975/- for Casuarina + Guava + Turmeric. Output in terms of net profit per unit area is about Rs. 2,72,984/- after 12 years age of plantation.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of saving in cost of production, inputs, timeliness and other pertinent information.	The overall net income $ha^{-1}yr^{-1}$ with *C. equisetifolia* + Guava+Turmeric based agri-silvi-horti system raised from Rs.75,000/- to Rs.2,72,984/- after 12 years age plantation under irrigated conditions.

5	Social/environmental/other benefits.	Casuarina based plantation helps farmers to get high and higher and regular returns on their investment. Industries have fast access to raw materials. Guava fruits having nutritional properties and turmeric attached medicinal significance in day to day life. Casuarina plantation improves soil sodicity as well as soil fertility. It also checks soil erosion. High caloric value of charcoal from casuarina wood found.
6	Status of commercialization/IP rights etc.	Technology has been disseminated through training of farmers, kisan mela, kisan gosthies etc. Demonstration of experiments are also conducted on farmers' field to aware about technology. Technology also popularized through distribution of quality planting materials and technical know-how to various stakeholders.
7	Efforts for technology dissemination	Casuarina plantation is coming up in last 4-5 years as major measure of improving soil fertility particularly under wasteland condition and also enhancing income. Some farmers are given under adoption of agroforestry system. 1. Sh. Onkar Singh, Vill. & P.O.- Atwara, Distt. Amethi 2. Sh. Suddhu Ram Chaurasia, Vill. & P.O.-Malethua Bujurg, (Block-Haringtonganj) Distt.-Faizabad. 3. Sh. Ramesh Singh, Vill. Haliyapur, Distt. Sultanpur.
8	Special requirement for its successful realization; any other standards etc.	Suprior clonal planting material of promising species/ provenances.
9	Indicative photographs	
10	Contact details of person from whom technology and further details can be obtained	OIC (Agroforestry), Department of Forestry, NDUAT, Kumarganj, Faizabad, U.P. 224229 Email: arunksp2011@gmail.com
11	Source of availability of technology/expertise	OIC (Agroforestry), Department of Forestry, NDUAT, Kumarganj, Faizabad, U.P. 224229
Name of Contributors : Dr A K S Parihar and Dr A K Saxena		

3.2.4.2: *Casuarina equisetifolia* and *D. sissoo* based agri-silviculture system

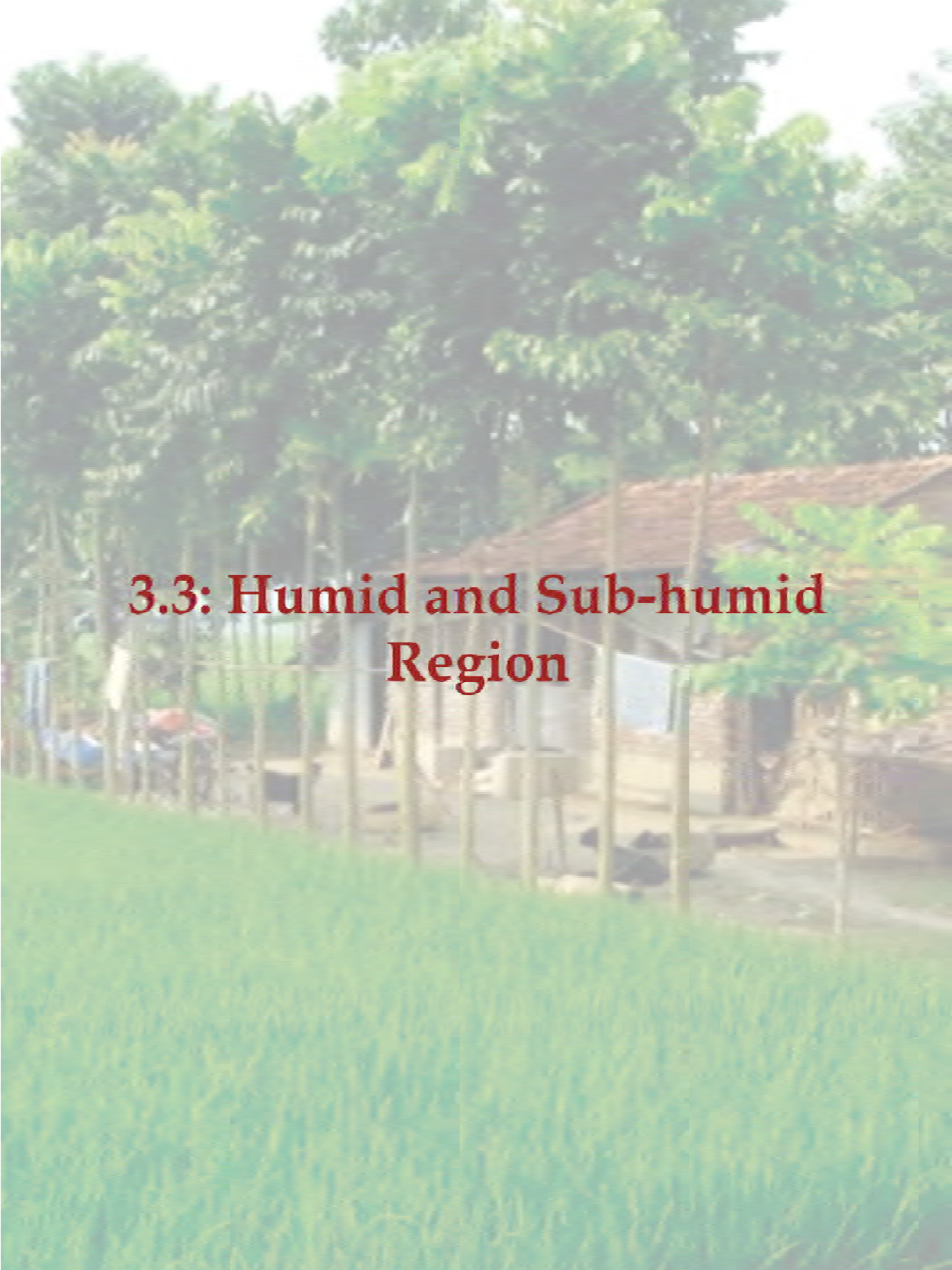
Sl. No.	Item	Details
1	Specifications and salient technical features	High growth of genotypes/provenances of *Casuarina equisetifolia* viz., Methupalayam, Akma Unit-1 and Varanasi under 10m x 2m plantation and *Dalbergia sissoo* viz., Bahraich, Sultanpur and Pantnagar under 6m x 4m plantation in sodicity affected eastern parts of U.P. Intercrops like *Oryza sativa and Triticum aestivum* are grown successfully for seven years.
2	Performance results	High growth of genotypes/provenances of *Casuarina equisetifolia* viz., Methupalayam, Akma Unit-1 and Varanasi and *Dalbergia sissoo* viz., Bahraich, Sultanpur and Pantnagar in eastern parts of U.P. under sodic soil conditions, produced average paddy variety Sarjoo-52 (*Kharif*) yield 2.48 t ha^{-1} obtained due to application of FYM 10 t ha^{-1} and wheat variety NW-2036 (Rabi) yield 1.87 t ha^{-1} due to pressmud 10 t ha^{-1} which yielded higher net profit. In sodicity affected eastern part of U.P., *Casuarina equisetifolia* and *Dalbergia* sissoo act as a reclamant to improve sodic soil condition and improved soil fertility, respectively. Also check soil erosion and enhancement of income through paddy, wheat, casuarina and shisham.
3	Likely cost	The total cost of cultivation is about Rs. 40,335/- for casuarina + paddy + wheat and Rs. 40,425/- for shisham + paddy + wheat. Output in terms of net profit per unit area is about for Casuarina (Rs. 11,710/-) and Shisham (Rs.11,000/-) after 7 years age of plantation.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of saving in cost of production, inputs, timeliness and other pertinent information.	The overall net income $ha^{-1}yr^{-1}$ with *C. equisetifolia* + paddy + wheat based agri-silvi culture system raised from Rs. 8,000/- to Rs. 11,710/- and shsisham + paddy + wheat based agri-silvi culture system raised from Rs.7500/- to Rs.11,000/- after 7 years age plantation under irrigated conditions.

5	Social/environmental/other benefits.	Casuarina and shisham based plantation helps farmer's to get high and higher and regular returns on their investment. Industries have fast access to raw materials. Paddy and wheat having nutritional properties. Casuarina and shisham plantation improves soil sodicity as well as soil fertility. These also check soil erosion. Food requirement available to most of people.
6	Status of commercialization/IP rights etc.	Technology has been disseminated through training of farmers, kisan mela, kisan gosthies etc. Demonstrations of experiments are also conducted on farmers' field to aware about technology. Technology also popularized through distribution of quality planting materials and technical know-how to various stakeholders.
7	Efforts for technology dissemination	Casuarina and shisham plantation is coming up in last 5-6 years as major measure of improving soil fertility particularly under wasteland condition and also enhancing income. Some farmers are given under adoption of agroforestry system. 1. Sh. Ranbahadur Singh, Vill. & P.O.-Pithla, Faizabad 2. Sh. Kamlesh Singh, Vill. Haliyapur, Distt. Sultanpur.
8	Any special requirement for its successful realization; any other standards etc.	Superior clonal planting material of promising species/provenances and high yielding varieties of paddy and wheat.
9	Indicative photographs	
10	Contact details of person from whom technology and further details can be obtained	OIC (Agroforestry), Department of Forestry, NDUAT, Kumarganj, Faizabad, U.P. 224229 Email: arunksp2011@gmail.com
11	Source of availability of technology/expertise	OIC (Agroforestry), Department of Forestry, NDUAT, Kumarganj, Faizabad, U.P. 224229
Name of Contributors : Dr A K S Parihar and Dr A K Saxena		

3.2.4.3: *Dalbergia sissoo* based silvi-pastoral system on sodic land

Sl. No.	Item	Details
1	Specifications and salient technical features	The eastern parts of Uttar Pradesh is faced with problem of soil sodicity. Generally, soil as such is considered unfit for agriculture production. Good market for *D. sissoo* wood-timber, fast returns than other tree species particularly under sodic soil conditions because plant growth is better as well as improved fertility status of soil. High growth of genotypes/provenances of *Dalbergia sissoo* viz., Bahraich, Sultanpur and Pantnagar under 6m x 4m plantation in sodicity affected eastern parts of U.P. Intercrops like *Pennisetum purpurium*, *Brachiara mutica* and *Panicum maximum* have been grown successfully for 11 years.
2	Performance results	High growth of genotypes/provenances of *Dalbergia sissoo* viz., Bahraich, Sultanpur and Pantnagar in eastern parts of U.P. under sodic soil conditions, recorded maximum tree diameter growth increment in the treatment *Pennisetum purpurium* with *D. sissoo* trees. The minimum tree diameter increment was observed in the treatment *Panicum maximum* in *D. sissoo* based combinations. The maximum grass herbage yield (48.76 t ha^{-1}) has been found for *Pennisetum purpurium* grass and minimum (28.35 t ha^{-1}) being in *Panicum maximum* grass. Similar trend was found for dry grasses. Under this system, plant and soil respiration of present study, maximum total (from root, litter and soil) soil respiration observed in the month July followed by June and minimum observed in the month of January.
3	Likely cost	The total cost of cultivation is about Rs. 39,865/- for *D. sissoo* + nappier grass. Output in terms of net profit per unit area is about for shisham (Rs. 50,000/-) after 11 years age of plantation.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of saving in cost of production, inputs, timeliness and other pertinent information.	The overall net income ha^{-1} yr^{-1} with shsisham + nappier based silvi-pastoral system raised from Rs. 35,000/- to Rs. 50,000/- after 11 years age of plantation under irrigated conditions.

5	Social/environmental/other benefits.	Shisham based plantation helps farmers to get high and higher and regular returns on their investment. Industries have fast access to raw materials. Shisham plantation improves soil sodicity as well as soil fertility. It also check soil erosion. Grass requirement available to most of the farmers of the region.
6	Status of commercialization/IP rights etc.	Technology has been disseminated through training of farmers, kisan mela, kisan gosthies etc. Demonstrations of experiments are also conducted on farmers' field to aware about technology. Technology also popularized through distribution of quality planting materials and technical know-how to various stakeholders.
7	Efforts for technology dissemination	Shisham plantation is coming up in last 11 years as major measure of improving soil fertility particularly under wasteland condition and also enhancing income. Some farmers are given under adoption of agroforestry system. 1. Sh. Sahabdeen Maurya, Vill.- Tindauli, Distt.- Faizabad 2. Sh. Narendra Singh, Vill.- Dobhiyara, Distt.- Sultanpur.
8	Any special requirement for its successful realization; any other standards etc.	Superior clonal planting material of promising species/provenances of *D. sissoo* and different perennial grasses of *Pennisetum purpurium*, *Brachiara mutica* and *Panicum maximum* are performing better under sodic soil condition.
9	Indicative photographs	
10	Contact details of person from whom technology and further details can be obtained	OIC (Agroforestry), Department of Forestry, NDUAT, Kumarganj, Faizabad, U.P. 224229 Email: arunksp2011@gmail.com
11	Source of availability of technology/expertise	OIC (Agroforestry), Department of Forestry, NDUAT, Kumarganj, Faizabad, U.P. 224229
Name of Contributors : Dr A K S Parihar and Dr A K Saxena		



3.3: Humid and Sub-humid Region

3.3.1: BCKVV, Jhargram, (West Bengal)

3.3.1.1: Mango + Eucalyptus (*E.tereticornis*) based agri-horti-silvi system in Red and Laterite zone of West Bengal

Sl. No.	Items	Detail
1	Specifications and salient technical features	Red and lateritic soils are one of the most important soil groups of India occupying 107 million ha, approximately one third of the cultivated area of the country. Aberrant monsoon behavior under rainfed condition in Red and Laterite zone of West Bengal results in poor crop yields and makes crop production unstable and sometimes uneconomic. Red and Lateritic soils are low in organic matter and poor in their N, P and K contents; characterized by low water holding capacity and are prone to erosion, such lands have shallow soil depth and gravels/pebbles/stones. Poor management of marginal lands on the topmost tier of the undulating topography of these soils also results in land degradation. Nearly 50 % lands in the western part of West Bengal are estimated to be under rainfed cultivation and face some kind of land degradation. For profitable cultivation some alternate land use systems are needed to be developed for these lands. Fruit-based agroforestry that integrates cultivation of arable crops, fruit trees and silviculture component could be an alternative land use system for these lands. Legume crops in *kharif* followed by mustard crop rotation were in mango (cv. Amrapali) orchard. This system helps in conservation of vegetation, soil and nutrients and provides fruits and food grains on a sustainable basis. Mango (cv. Amrapali) was introduced in Red and Laterite Zone under subhumid climate which was established with suitable pit filling mixtures (5.0 kg FYM + recommended NPK)/pit on degraded lands for sustainable productivity supported with soil moisture conservation measure for initial 2 years.
2	Performance results	Fruit based agri-horti system produced pigeon pea 0.60– 0.80 t ha^{-1}, mustard 0.40 t ha^{-1} and mango fruit 5.0 t ha^{-1} at 4th year resulting higher net profit. Besides this, crop residues of legume crops added OM and NPK after improving soil health vegetables were grown with higher net profit.
3	Likely cost	The total cost of cultivation in four years for the mango+ legume crops/vegetables crops- oil seed crops rotation is about Rs. 1,35,000/-. Output in terms of net

		profit per unit area is Rs. 22,450/- and 35,000/- ha^{-1} at 3rd and 4th year as compared to farmers' practice from degraded land which is presently out of cultivation.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income ha^{-1} $year^{-1}$with mango + eucalyptus - legume/vegetable crops - mustard raised from Rs. 15,500/- to Rs. 3,52,500/- under rainfed condition for under moisture stress situation on erosion prone lands.
5	Social/environmental/other benefits	Mango and cover crops reduces impact of raindrop covers land surface entirely which make water to crawl over the surface instead of running of water and thereby protects from soil erosion and improve infiltration. Organic residues added by leaves litter and mango improve the physical conditions of soil health by decreasing bulk density.
6	Status of commercialization/IP rights etc.	Technology has been popularized through training of farmers and established demonstration plots at different districts of West Bengal.
7	Efforts for technology dissemination	Technology has been transferred to farmers' field under various watershed programs and Transfer of Technology (TOT) nearby Research Station.
8	Special requirement for its successful realization; any other standards etc.,	As technology is based on utilization of degraded land by mango based agri-horti-silvi system which includes the use of suitable intercrops for mango/guava/ber
9	Indicative photographs	 
10	Contact details of person from whom technology and further details can be obtained	Prof. P.K.Dhara, Officer-in-Charge AICRP on Agroforestry, BCKV, Jhargram, Paschim Medinipur, Pin-721507. Phone (M): 09433890079 E-mail : drpratapbckv@gmail.com
11	Source of availability of technology/expertise	Prof. P.K.Dhara, Officer-in-Charge AICRP on Agroforestry, BCKV, Jhargram, Paschim Medinipur, Pin-721507. Phone (M): 09433890079 E-mail : drpratapbckv@gmail.com
Name of Contributors : Dr P K Dhara		

3.3.1.2: Mango + Gamhar (*Gmelina arborea*) based agri-horti-silvi system in Red and Laterite zone of West Bengal

Sl. No.	Items	Detail
1	Specifications and salient technical features	For profitable cultivation some alternate land use systems are needed to be developed for fruit-based agroforestry that integrates cultivation of arable crops, fruit trees and silviculture component could be an alternative land use system for these lands. Legume crops/maize in *kharif* fallowed by mustard crop rotation were in mango (cv. Amrapali) orchard. This system helps in conservation of vegetation, soil and nutrients and provides fruits and food grains on a sustainable basis. Mango (cv. Amrapali) was introduced in Red and Laterite Zone under subhumid climate which was established with suitable pit filling mixtures (5.0 kg FYM + rec NPK)/pit on degraded lands for sustainable productivity supported with soil moisture conservation measure for initial 2 years.
2	Performance results	Fruit based agri-horti system produced maize 8.8 – 9.2 t ha^{-1}, mustard 0.45 t ha^{-1} and mango fruit 5.0 t ha^{-1} at 4th year resulting higher net profit. Besides this, crop residues of legume crops added OM and NPK after improving soil health vegetables were grown with higher net profit.
3	Likely cost	The total cost of cultivation in four years for the mango+ legume crops/maize/vegetables crops- oil seed crops rotation is about Rs. 1,40,000/-. Output in terms of net profit per unit area is Rs. 25,450/- and 36,000/- ha^{-1} at 3rd and 4th year as compared to farmers' practice from degraded land which is presently out of cultivation.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income ha^{-1} $year^{-1}$ with mango+ gamhar - legume/maize/vegetable crops - mustard raised from Rs. 15,500/- to Rs. 3,52,500/- under rainfed condition for under moisture stress situation on erosion prone lands.

5	Social/environmental/other benefits	Mango and cover crops reduces impact of raindrop covers land surface entirely which make water to crawl over the surface instead of running of water and thereby protects from soil erosion and improve infiltration. Organic residues added by leaves litter and mango improve the physical conditions of soil health by decreasing bulk density.
6	Status of commercialization/IP rights etc.	Technology has been popularized through training of farmers and established demonstration plots at different districts of West Bengal.
7	Efforts for technology dissemination	Technology has been transferred to farmers' field under various watershed programs and Transfer of Technology (TOT) nearby Research Station.
8	Special requirement for its successful realization; any other standards etc.,	As technology is based on utilization of degraded land by mango based agri-horti-silvi system which includes the use of suitable intercrops for mango/guava/ber
9	Indicative photographs	
10	Contact details of person from whom technology and further details can be obtained	Prof. P.K.Dhara, Officer-in-Charge AICRP on Agroforestry, BCKV, Jhargram, Paschim Medinipur, West Bengal, Pin-721507. Phone (M): 09433890079 E-mail : drpratapbckv@gmail.com
11	Source of availability of technology/expertise	Prof. P.K.Dhara, Officer-in-Charge AICRP on Agroforestry, BCKV, Jhargram, Paschim Medinipur, West Bengal, Pin-721507. Phone (M): 09433890079 E-mail : drpratapbckv@gmail.com
Name of Contributors : Dr P K Dhara		

3.3.1.3: Mango + *Dysoxylum binectariferum* as boundary plantation based agri-horti-silvi system in new Alluvial zone of West Bengal

Sl. No.	Items	Detail
1	Specifications and salient technical features	Fruit based agroforestry is a proven land use system for vertically enhancing productivity and risk coverage against unstable weather conditions. Monocropping neither provides gainful employment opportunities nor generates sufficient income to meet the family expenses. Effective utilization of available space, both horizontally and vertically, is the concept of modern cropping system i,e. fruit based agroforestry. This system research aims at increasing production and farmers' income in a sustainable manner making use of available technology and physical and socio-economic resources of the farmers. Selection of intercrops, fruit trees and silvi species depends on agro-climatic and farms' choice. Such type modern cropping systems generate higher biomass, yield more produce, provide high and steady income and create gainful on farm employment, in addition to meeting the requirements of food, vegetables and fuel for the family. Best efforts made in last few years by educating, facilitating and creating water resources which were cited as major bottlenecks in agroforestry adoption. Amongst the agroforestry systems demonstrated in the new alluvial region [mango, guava, ber and lambo (*Dysoxylum binectariferum*) and kadam (*Anthocephalus cadamba*) based], guava, ber and mango based agri-horticultural system started fruit production after two /three years of plantation thereby giving source of addition income. Assured availability of water and protection emerged as major determinants of agroforestry land use. Similarly, increased area under vegetables during winters and summers is proving a big boost for fruit based agroforestry adoption. Mango (cv. Amrapali/ Himsagar) was grown in New Alluvial Zone under humid climate which was established with suitable pit filling mixtures (4.0kg FYM + recommended NPK) / pit on lands for sustainable productivity supported with soil moisture conservation measure/irrigation for initial 2 years.

2	Performance results	Fruit based agri-horti system produced rice 5.0 – 5.2 t ha^{-1} in *kharif* cabbage/cauliflower/ pointed gourd *rabi* and summer and mango fruit 5.0 t ha^{-1} at 4th year resulting higher net profit. Besides this, crop residues of legume crops added OM and NPK after improving soil health vegetables were grown with higher net profit.
3	Likely cost	The total cost of cultivation in four years for the mango + paddy-vegetables crops- oil seed crops rotation is about Rs. 1,40,000/-. Output in terms of net profit per unit area is Rs. 75,000/- and 1,25,000/- ha^{-1} at 3rd and 4th year as compared to farmers' practice from monocropping.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income ha^{-1} $year^{-1}$ with Mango+ *Dysoxylum binectariferum* + Paddy - vegetable crops - mustard raised from Rs. 75,000 to Rs. 1,25,000/- under irrigated condition.
5	Social/environmental/other benefits	Mango and cover crops reduces impact of raindrop covers land surface entirely which make water to crawl over the surface instead of running of water and thereby protects from soil erosion and improve infiltration for ground water recharge. Organic residues added by leaves litter and mango improve the physical conditions of soil health by decreasing bulk density.
6	Status of commercialization/IP rights etc.	Technology has been popularized through training of farmers and established demonstration plots at different districts of West Bengal.
7	Efforts for technology dissemination	Technology has been transferred to farmers' field under various watershed programs and Transfer of Technology (TOT) nearby Research Station.
8	Special requirement for its successful realization; any other standards etc.,	As technology is based on utilization of degraded land by mango based agri-horti-silvi system which includes the use of suitable intercrops for mango/guava/ber.

9	Indicative photographs	   
10	Contact details of person from whom technology and further details can be obtained	Prof. P.K.Dhara, Officer-in-Charge AICRP on Agroforestry, BCKV, Jhargram, Paschim Medinipur, West Bengal, Pin-721507. Phone (M): 09433890079 E-mail : drpratapbckv@gmail.com
11	Source of availability of technology/expertise	Prof. P.K.Dhara, Officer-in-Charge AICRP on Agroforestry, BCKV, Jhargram, Paschim Medinipur, West Bengal, Pin-721507. Phone (M): 09433890079 E-mail : drpratapbckv@gmail.com
Name of Contributors : Dr P K Dhara		

3.3.1.4: Guava based agri-horti system in new Alluvial zone of West Bengal

Sl. No.	Items	Detail
1	Specifications and salient technical features	Guava was grown in New Alluvial Zone under humid climate which was established with suitable pit filling mixtures (3.5kg FYM + recommended NPK) / pit on lands for sustainable productivity supported with soil moisture conservation measure/irrigation for first year
2	Performance results	Fruit based agri-horti system produced rice 4.8 – 5.2 t ha^{-1} in *kharif* cabbage/cauliflower/ pointed gourd *rabi* and summer and guava fruit 9.0 t ha^{-1} at 4th year resulting higher net profit. Besides this, Crop residues of legume crops added OM and NPK after improving soil health vegetables were grown with higher net profit
3	Likely cost	The total cost of cultivation in four years for the guava + paddy-vegetables crops- oil seed crops rotation is about Rs. 1,40,000/-. Output in terms of net profit per unit area is Rs. 65,000/- and 1,25,000/- ha^{-1} at 3rd and 4th year as compared to farmers' practice from monocropping.

4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income ha^{-1} $year^{-1}$ with Guava + Paddy - vegetable crops - mustard raised from Rs. 65,000/- to Rs. 1,25,000/- under irrigated condition.
5	Social/environmental/other benefits	Guava and inter crops reduces impact of raindrop covers land surface entirely which make water to crawl over the surface instead of running of water and thereby protects from soil erosion and improve infiltration for ground water recharge. Organic residues added by leaves litter and mango improve the physical conditions of soil health by decreasing bulk density.
6	Status of commercialization/IP rights etc.	Technology has been popularized through training of farmers and established demonstration plots at different districts of West Bengal.
7	Efforts for technology dissemination	Technology has been transferred to farmers' field under various watershed programs and Transfer of Technology (TOT) nearby Research Station.
8	Special requirement for its successful realization; any other standards etc.	As technology is based on utilization of degraded land by mango based agri-horti-silvi system which includes the use of suitable intercrops for mango/guava/ber.
9	Indicative photographs	
10	Contact details of person from whom technology and further details can be obtained (information on the postal address, email, telephone, fax etc.)	Prof. P.K. Dhara, Officer-in-Charge AICRP on Agroforestry, BCKV, Jhargram, Paschim Medinipur, West Bengal, Pin-721507. Phone (M): 09433890079 E-mail : drpratapbckv@gmail.com
11	Source of availability of technology/expertise	Prof. P.K. Dhara, Officer-in-Charge AICRP on Agroforestry, BCKV, Jhargram, Paschim Medinipur, West Bengal, Pin-721507. Phone (M): 09433890079 E-mail : drpratapbckv@gmail.com
Name of Contributors : Dr P K Dhara		

3.3.1.5: Ber based agri-horti system in new Alluvial zone of West Bengal

Sl. No.	Items	Detail
1	Specifications and salient technical features	Ber was grown in New Alluvial Zone under humid climate which was established with suitable pit filling mixtures (3.5kg FYM + recommended NPK) /pit on lands for sustainable productivity supported with soil moisture conservation measure/irrigation for first year.
2	Performance results	Fruit based agri-horti system produced rice 4.8 – 5.2 t ha^{-1} in *kharif* pointed gourd *rabi* and summer and Ber fruit 4.0 t ha^{-1} at 4th year resulting higher net profit. Besides this, crop residues of legume crops added OM and NPK after improving soil health vegetables were grown with higher net profit.
3	Likely cost	The total cost of cultivation in four years for the ber + paddy-vegetables crops- oil seed crops rotation is about Rs. 1,30,000/-. Output in terms of net profit per unit area is Rs. 65,000/- and 1,15,000/- ha^{-1} at 3rd and 4th year as compared to farmers' practice from mono-cropping.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income ha^{-1} $year^{-1}$ with Ber + Paddy - vegetable crops - mustard raised from Rs. 68,000/- to Rs. 1,11,000/- under irrigated condition.
5	Social/environmental/other benefits	Ber and inter crops reduces impact of raindrop covers land surface entirely which make water to crawl over the surface instead of running of water and thereby protects from soil erosion and improve infiltration for ground water recharge. Organic residues added by leaves litter and mango improve the physical conditions of soil health by decreasing bulk density.
6	Status of commercialization/IP rights etc.	Technology has been popularized through training of farmers and established demonstration plots at different districts of West Bengal.

7	Efforts for technology dissemination	Technology has been transferred to farmers' field under various watershed programs and Transfer of Technology (TOT) nearby Research Station.
8	Special requirement for its successful realization; any other standards etc.,	As technology is based on utilization of degraded land by mango based agri-horti-silvi system which includes the use of suitable intercrops for mango/guava/ber
9	Indicative photographs	 
10	Contact details of person from whom technology and further details can be obtained	Prof. P.K. Dhara, Officer-in-Charge AICRP on Agroforestry, BCKV, Jhargram, Paschim Medinipur, West Bengal, Pin-721507. Phone (M): 09433890079 E-mail : drpratapbckv@gmail.com
11	Source of availability of technology/expertise	Prof. P.K. Dhara, Officer-in-Charge AICRP on Agroforestry, BCKV, Jhargram, Paschim Medinipur, West Bengal, Pin-721507. Phone (M): 09433890079 E-mail : drpratapbckv@gmail.com
Name of Contributors : Dr P K Dhara		

3.3.1.6: Agrisilviculture system for new Alluvial zone of West Bengal

Sl. No.	Items	Detail
1	Specifications and salient technical features	Agrisilviculture system is a proven land use system for vertically enhancing productivity and risk coverage against unstable weather conditions. Mono-cropping neither provides gainful employment opportunities nor generates sufficient income to meet the family expenses. Effective utilization of available space, both horizontally and vertically, is the concept of modern cropping system. This system research aims at increasing production and farmers' income in a sustainable manner making use of available technology and physical and socio-economic resources of the farmers. Selection of intercrops and silvi species depends on agro-climatic and farms' choice. Such type modern cropping systems generate higher biomass, yield more produce, provide high and steady income and create gainful on farm employment, in addition to meeting the requirements of food, vegetables and fuel for the family. Best efforts made in last few years by educating, facilitating and creating water resources which were cited as major bottlenecks in agroforestry adoption.
2	Performance results	Fruit based agri-horti system produced rice 4.8 – 5.2 t ha^{-1} in *kharif* mustard in *rabi* and seseam in summer Besides this, crop residues of legume crops added OM and NPK after improving soil health vegetables were grown with higher net profit.
3	Likely cost	The total cost of cultivation in four years for the kadam + paddy- oil seed crops rotation is about Rs.60,000/-. Output in terms of net profit per unit area is Rs. 55,000/- and 1,00,000/- ha^{-1} at 3rd and 4th year as compared to farmers' practice from mono-cropping.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income per hectare per year kadam + Paddy - vegetable crops - mustard raised from Rs. 55,000/- to Rs. 1,00,000/- under irrigated condition.

5	Social/environmental/other benefits	Silvi species and inter crops reduces impact of raindrop covers land surface entirely which make water to crawl over the surface instead of running of water and thereby protects from soil erosion and improve infiltration for ground water recharge. Organic residues added by leaves litter and mango improve the physical conditions of soil health by decreasing bulk density.
6	Status of commercialization/IP rights etc.	Technology has been popularized through training of farmers and established demonstration plots at different districts of West Bengal.
7	Efforts for technology dissemination	Technology has been transferred to farmers' field under various watershed programs and Transfer of Technology (TOT) nearby Research Station.
8	Special requirement for its successful realization; any other standards etc.,	As technology is based on utilization of degraded land by mango based agri-horti-silvi system which includes the use of suitable intercrops for mango/guava/ber.
9	Indicative photographs	   
10	Contact details of person from whom technology and further details can be obtained	Prof. P.K. Dhara, Officer-in-Charge AICRP on Agroforestry, BCKV, Jhargram, Paschim Medinipur, West Bengal, Pin-721507. Phone (M): 09433890079 E-mail : drpratapbckv@gmail.com
11	Source of availability of technology/expertise	Prof. P.K. Dhara, Officer-in-Charge AICRP on Agroforestry, BCKV, Jhargram, Paschim Medinipur, West Bengal, Pin-721507. Phone (M): 09433890079 E-mail : drpratapbckv@gmail.com
Name of Contributors : Dr P K Dhara		

3.3.1.7: Homestead Agroforestry in West Bengal

Sl. No.	Items	Detail
1	Specifications and salient technical features	Growing trees around their home provide farmers with timbers. They do not need to cut down trees in the forest for timber and fuel wood. Woodlots provide much more than fuel and trees planted around the home are providing firewood. Many rural households feed their animals the leaves and branches of trees. Trees also provide shade and shelter for livestock. Heat-stressed animals become sick more easily, put on weight more slowly and do not produce as much milk.
2	Performance results	----------
3	Likely cost	---------
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	----------
5	Social/environmental/other benefits	Silvi species and inter crops reduces impact of raindrop covers land surface entirely which make water to crawl over the surface instead of running of water and thereby protects from soil erosion and improve infiltration for ground water recharge.
6	Status of commercialization/IP rights etc.	Technology has been popularized through training of farmers and established demonstration plots at different districts of West Bengal.
7	Efforts for technology dissemination	Technology has been transferred to farmers' field under various watershed programs and Transfer of Technology (TOT) nearby Research Station.
8	Special requirement for its successful realization; any other standards etc.,	As technology is based on utilization of land around their house by fruit trees/ trees with kitchen garden.
9	Indicative photographs	

10	Contact details of person from whom technology and further details can be obtained	Prof. P.K. Dhara, Officer-in-Charge AICRP on Agroforestry, BCKV, Jhargram, Paschim Medinipur, West Bengal, Pin-721507. Phone (M): 09433890079 E-mail : drpratapbckv@gmail.com
11	Source of availability of technology/expertise	Prof. P.K. Dhara, Officer-in-Charge AICRP on Agroforestry, BCKV, Jhargram, Paschim Medinipur, West Bengal, Pin-721507. Phone (M): 09433890079 E-mail : drpratapbckv@gmail.com
Name of Contributors : Dr P K Dhara		

3.3.2: OUAT, Bhubaneswar (Odisha)

3.3.2.1: *Acacia mangium* based agri-silvicultural system

Sl. No.	Item	Details
1	Specifications and salient technical features	The total cultivated land of the state is 61.80 lakh ha out of which 29.14 lakh ha (47%) is high land 17.55 lakh ha (28%) medium land and 15.11 lakh ha (25%) low land and only about 35% of cultivated land is irrigated. In rainfed uplands crop failure is common phenomenon due to frequent droughts. The soil of those areas is very poor with low organic carbon and available nutrients and about 85 - 95% area are acidic. Lands have sand (78%), silt (10%) and clay (12%), poor water holding capacity, poor fertility status and lack of site specific technologies. Thus, poor soil fertility, low water holding capacity which make these lands low production and support only agroforestry systems. However, these areas can be utilized profitably by introduction of agri-silvicultural systems. Along with *Acacia mangium* in the alleys sesame can be grown up to 5th year, arrowroot from 6th to 8th year and pineapple from 9th to 12th year. This system helps in conservation and build up of soil nutrients and increases overall productivity and profitability of the land. *Acacia mangium* was planted at a spacing of 8m x 2m in a site under sub-humid climate which was established with suitable pit filling mixtures (70% top soil + 25kg FYM + recommended NPK for sustainable productivity supported with life saving irrigation.
2	Performance results	At 1-5 years of planting of *Acacia mangium*, sesame produced 0.71 t. ha^{-1} seed yield with B:C ratio 2.37, at 6-8 years of planting arrowroot produced 5.66 t ha^{-1} with B:C ratio 2.83 and at 9-12 years of planting pineapple produced 7.65 t ha^{-1} with B:C ratio 4.54 resulting higher net profit. At the end of 12 years the system produced 4238 cft. ha^{-1} of timber and 30 t. ha^{-1} of firewood.
3	Likely cost	The total cost of cultivation ha^{-1} in twelve years of *Acacia mangium* with sesame, arrowroot and pineapple Rs. 9,90,200/-, gross return Rs. 33,07,440/- and net return Rs. 23,17,240/- with B:C ratio 3.34 (as per 2015 price).

4	How the new technology will impact the income of the farmers and its benefits over conventional technologies / know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The average cost of cultivation ha^{-1} $year^{-1}$ of *Acacia mangium* with sesame, arrowroot and pineapple Rs. 82,517/-, gross return Rs. 2,75,620/- and net return Rs. 1,93,103/- with B:C ratio 3.34 (as per 2015 price).
5	Social/environmental/other benefits	Provides food, fuel wood and timber from same piece of land, generate additional employment and income, conserve soil and moisture, build organic carbon and higher profit.
6	Status of commercialization / IP rights etc.	Technology has been popularized through training of tribal farmers, Vana Suraksha Samiti members, watershed committee members, plantation growers and on-farm demonstrations through KVKs and TSP programmes.
7	Efforts for technology dissemination	Technology has been transferred to farmers' field in Nayagarh and Khurdha districts of Odisha.
8	Special requirement for its successful realization; other standards etc.	As technology is based on utilization of land by agri-silvi system which includes the use of suitable intercrops with silvi trees, so the availability of arrowroot rhizomes and pineapple suckers to the users must be ensured.
9	Indicative photographs	 **Standing crop of sesame between two rows of *Acacia mangium* during 1-5 years in rainfed upland**
10	Contact details of person from whom technology and further details can be obtained	Senior Scientist & Officer in Charge, AICRP on Agroforestry, OUAT, Bhubaneswar Odisha- 751003 E-mail: ouataf@gmail.com Directorate of Research, OUAT, Bhubaneswar-3 E-mail: deanresearch_03@hotmail.com Tel: 0674-2397692
11	Source of availability of technology/expertise	AICRP on Agroforestry, Bhubaneswar centre / Directorate of Research, OUAT, Bhubaneswar-3
Name of Contributors : Dr P. J. Mishra, Mr B. B. Behera, Dr A. K. Patra, Dr A. K. Mohapatra, Prof. D. Mishra, Dr. S. Mohanty, Dr D. Swain		

3.3.3: BAU, Ranchi (Jharkhand)

3.3.3.1: Gmelina based agroforestry system

Sl. No.	Item	Details
1	Specification and salient technical features	Jharkhand has an approximate geographical area of 80 lakh ha. Out of which 24 lakh ha. is suitable for agroforestry systems. Average land use pattern in the of Jharkhand is agriculture 55%, fallow land 17%, home garden 13% and agroforestry 15%. The region is characterized by humid and sub humid tropical climate. In uplands, soil is sandy loam to gravelly loam in texture with average 3-5% slope, slightly eroded and shallow soil. Average pH is 5.5 in uplands and neutral to slight alkaline in lowlands. The soils of uplands are usually of reddish colour, low in base saturation, CEC (5-10me/100g) and low organic content having low fertility status. The region mainly comprises of soils developed on granite-gneiss (32.6%) and granite schists (14.2%). The Gmelina and groundnut based system helps in improving the soil nutrient and provides the food grains and also enhances the income of farmers.
2	Performance results	The cultivation of groundnut in initial age of gamhar (*Gmelina arborea*) is successful upto three years. It can be taken further with marginal economy upto fifth year. The yield of gamhar produces 11.32 cu. M. ha^{-1}. In gamhar based Agri-silvicultural system groundnut gives yield 0.99 t ha^{-1}. Besides this, residues of legumes crop of groundnut added 0.11% organic carbon, 37.5 kg Nitrogen, 4.62 kg phosphorus and 15.63 kg of Potash ha^{-1} therefore fertility of soil is enhanced.
3	Likely cost	The cost of cultivation of groundnut in ha^{-1} yr^{-1} is about Rs. 29,781/-. Output in terms of net profit per unit area is Rs. 9,979/- ha^{-1} yr^{-1} from degraded land. Besides this predicted income from 15 years old standing tree is approx. 16.5 lakhs ha^{-1} i.e. Rs. 1.1 lakhs yr^{-1} ha^{-1} from agrisilviculture system.

4	How to the new technology will impact the income of the farmers and its benefits over conventional technology/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income $ha^{-1}yr^{-1}$ with gamhar + groundnut system is approx. Rs.1.2 lakh from degraded land .
5	Social/environment/ other benefits	Organic residues added by groundnut and gamhar improve the soil health and check the soil erosion and improve infiltration of rain water.
6	Status of commercialization/IP rights etc.	Technology has been popularised and transfer the technology to the farmers through extension activities.
7	Efforts for technology dissemination	The technology has been transferred to farmers field through KVKs.
8	Special requirement for its successful realization; any other standards etc.	As technology is based on utilization of fallow and uplands by gamhar (*Gmelina arborea*) with leguminous intercrops of groundnut and improves the growth of trees also through nutrient sharing mechanism.
9	Indicative Photographs	
10	Contact details of person from technology and further details can be obtained	Dr. M. S. Malik, Chairman, Deptt. of Silviculture and Agroforestry, Faculty of Forestry, Birsa Agricultural University, Kanke Ranchi, Jharkhand - 834006
11	Source of availability of technology/expertise	Dr. M. S. Malik, Chairman, Deptt. of Silviculture and Agroforestry, Faculty of Forestry, Birsa Agricultural University, Kanke Ranchi, Jharkhand - 834006
Name of contributors: Dr M S Malik, Dr R N Singh and Dr Prabhat Ranjan Oraon		

3.3.3.2: *Cassia siamia* based agrisilvicultural system

Sl. No.	Item	Details
1	Specification and salient technical features	The *Cassia siamia* based agroforestry is very useful for fuelwood and small timber based system. The interspace between trees is utilized for growing groundnut under irrigated conditions.
2	Performance results	The cultivation of groundnut in initial age of chakundi (*Cassia siamia)* upto three years is successful. It can be taken up further with marginal economy upto fifth year. The biomass yield of chakundi produces 125.0 t ha^{-1}. In chakundi (*Cassia siamia*) based agroforestry system groundnut gives yield 1.11 t ha^{-1}. Besides this, residues of legumes crop of groundnut added 0.23% organic carbon, 46.3kg Nitrogen, 5.27kg phosphorus and 23.49 kg of Potash ha^{-1} therefore fertility of soil is enhanced.
3	Likely cost	The cost of cultivation of groundnut in ha^{-1} yr^{-1} is about Rs. 30,213/-. Output in terms of net profit per unit area is Rs. 17,216/- ha^{-1} yr^{-1} from degraded land. Besides this, predicted income from 8 years old standing tree is approx. Rs. 7.50 lakhs ha^{-1} i.e. Rs. 0.94 lakhs ha^{-1} yr^{-1} from chakundi based agrisilvicultural system.
4	How to the new technology will impact the income of the farmers and its benefits over conventional technology/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income ha^{-1} yr^{-1} with chakundi + groundnut system is approx. Rs. 1.11 lakh from degraded land.
5	Social/environment/ other benefits	Organic residues added by groundnut and chakundi improve the soil health and check the soil erosion and improve infiltration of rain water.
6	Status of commercialization/IP rights etc.	Technology has been popularised and transfer the technology to the farmers through extension activities.
7	Efforts for technology dissemination	The technology has been transferred to farmers field through KVKs.
8	Special requirement for its successful realization; any other standards etc.	As technology is based on utilization of fallow and uplands by chakundi (*Cassia siamea*) with leguminous intercrops of groundnut and improves the growth of trees also through nutrient sharing mechanism.

9	Indicative Photographs	
10	Contact details of person from technology and further details can be obtained	Dr. M. S. Malik Chairman, Deptt. of Silviculture and Agroforestry, Faculty of Forestry, Birsa Agricultural University, Kanke Ranchi, Jharkhand-834006
11	Source of availability of technology/expertise	Dr. M. S. Malik Chairman, Deptt. of Silviculture and Agroforestry, Faculty of Forestry, Birsa Agricultural University, Kanke Ranchi, Jharkhand-834006
Name of Contributors: Dr M S Malik, Dr R N Singh and Dr Prabhat Ranjan Oraon		

3.3.3.3: Subabool based agrisilvicultural system

Sl. No.	Item	Details
1	Specification and salient technical features	Subabool based agroforestry system is very useful for the improvement of degraded and wastelands and involves plantation of subabool for fodder, fuelwood and increasing soil fertility due to its ability for nitrogen fixation. The intercrops such as colocassia can be grown successfully.
2	Performance results	Cultivation of shade loving crops *colocasia* with 3 old subabool tree was done successfully. The yield of intercrops of *colocacea* was 1.55 t ha^{-1}. Besides this, fertility of soil is enhanced. The biomass yield of subabool produces 150.0 t ha^{-1}. In subabool (*Leucaena leucocephala*) based cropping system gives yield 1.55 t ha^{-1}. Besides this, residues of crop of *colocasia* added 0.21% organic carbon, 51.3kg Nitrogen, 4.78kg phosphorus and 21.64 kg of Potash ha^{-1} therefore fertility of soil is enhanced.
3	Likely cost	The cost of cultivation of *Colocacea* in ha^{-1} yr^{-1} is about Rs.42, 789. Output in terms of net profit per unit area is Rs.30,111/- $ha^{-1}yr^{-1}$ from degraded land. Besides this, predicted income from 7 years old standing tree is approx. Rs. 8.40 lakhs ha^{-1} i.e., 1.20 lakh $ha^{-1}yr^{-1}$ from Agri siliviculture system.

4	How to the new technology will impact the income of the farmers and its benefits over conventional technology/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income ha^{-1} yr^{-1} with *Colocacea* with subabool system is approx.1.5 lakh from degraded land
5	Social/environment/ other benefits	Organic residues added by *Colocacea* and subabool improve the soil health and check the soil erosion and improve infiltration of rain water. Leaves of the subabul was used as fodder for the goat/sheep and also used as green manuring.
6	Status of commercialization/IP rights etc.	Technology has been popularized and transfer the technology to the farmers through extension activities.
7	Efforts for technology dissemination	The technology has been transferred to farmers field through KVKs.
8	Special requirement for its successful realization; any other standards etc.	As technology is based on utilization of fallow and uplands by leguminous tree subabool (*Leucaena leucocephala*) with intercrops of *Colocacea* and improves the soil fertility also through green manuring and atmospheric nitrogen fixation by subabul.
9	Indicative Photographs with proper lighting	--------
10	Contact details of person from technology and further details can be obtained	Dr. M. S. Malik Chairman, Deptt. of Silviculture and Agroforestry, Faculty of Forestry, Birsa Agricultural University, Kanke Ranchi, Jharkhand-834006
11	Source of availability of technology/expertise	Dr. M. S. Malik Chairman, Deptt. of Silviculture and Agroforestry, Faculty of Forestry, Birsa Agricultural University, Kanke Ranchi, Jharkhand-834006
Name of Contributors: Dr M S Malik, Dr R N Singh and Dr Prabhat Ranjan Oraon		

3.3.3.4: Bamboo based agroforestry system

Sl. No.	Item	Details
1	Specification and salient technical features	Bamboos are integral component in most of the agroforestry systems in the Jharkhand and plantation of bamboo species on farm or pond boundaries is very remunerative. The integration of bamboo in agroforestry systems offer significant opportunity for livelihood improvement through nutritional and economic security particularly for the tribal farming community of the state. The integration of intercrops crops such as ginger and turmeric is beneficial under bamboo based agroforestry system.
2	Performance results	Cultivation of intercrops under bamboo (*Bambusa nutans)* upto 3 year was done successfully. The net income from intercrops of turmeric was Rs. 0.65 lakh ha^{-1}. Besides this, fertility of soil is enhanced. The number of matured culms 2400 ha^{-1} of bamboo plantation. In bamboo based cropping system gives income from intercrops of turmeric of Rs 0.65 lakh. Besides this, residues of crop of turmeric added 0.26% organic carbon, 67 kg Nitrogen, 5.36 kg phosphorus and 65 kg of Potash ha^{-1} therefore fertility of soil is enhanced.
3	Likely cost	The cost of cultivation of turmeric in ha^{-1} yr^{-1} is about Rs. 37,200/-. Output in terms of net profit ha^{-1} yr^{-1} from bamboo based agroforestry is Rs.1.45 ha^{-1} yr^{-1} from degraded land.
4	How to the new technology will impact the income of the farmers and its benefits over conventional technology/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income ha^{-1} yr^{-1} with turmeric based agrisilviculture system is approx. Rs.1.45 lakh from degraded land.
5	Social/environment/ other benefits	Organic residues added by Turmeric and Bamboo improve the soil health and check the soil erosion and improve infiltration of rain water.
6	Status of commercialization/IP rights etc.	Technology has been popularized and transfer the technology to the farmers through extension activities.

7	Efforts for technology dissemination	The technology has been transferred to farmers field through KVKs.
8	Special requirement for its successful realization; any other standards etc.	As technology is based on utilization of fallow and uplands by Bamboo with intercrops of turmeric improves the growth of trees also through nutrient sharing mechanism.
9	Indicative Photographs	
10	Contact details of person from technology and further details can be obtained	Dr. M. S. Malik Chairman, Deptt. of Silviculture and Agroforestry, Faculty of Forestry, Birsa Agricultural University, Kanke Ranchi, Jharkhand-834006
11	Source of availability of technology/expertise	Dr. M. S. Malik Chairman, Deptt. of Silviculture and Agroforestry, Faculty of Forestry, Birsa Agricultural University, Kanke Ranchi, Jharkhand-834006
Name of Contributors: Dr M S Malik, Dr R N Singh and Dr Prabhat Ranjan Oraon		

3.4: Arid and Semi-arid Region

3.4.1: SDAU, Sardarkrushinagar (Gujarat)

3.4.1.1: *Ailanthus excelsa* based agrisilviculture system under rainfed conditions of North Gujarat

Sl. No.	Item	Details
1	Specifications and salient technical features	The climate of North Gujarat is semi-arid and arid type where the average annual rainfall is 550 mm. The inadequate as well as erratic rainfall, sandy nature of the soil having low moisture retention capacity possesses problems of low and unstable crop production and soil degradation due to soil erosion. Therefore, there is a need of tree resources in such areas for supply of fodder, fuel, timber and cash and as soil cover to check, soil degradation. Among MPTs, ardusa *(Ailanthus excelsa)* offers many possibilities in supplementing a part of nitrogen requirement of the associated crop through enrichment of site, providing fuel wood, high quality leaf fodder and small timber to cater to the basic needs of rural people for their sustenance in dry land. Therefore, the experiment was planned to study the potential role of *ardu* in agroforestry.
2	Performance results	In ardusa based agrisilviculture system, seed yield of intercrops (Green gram, Cluster bean, Cowpea and Til) was lower than the sole crops. The average return from the sole arable crop and sole ardusa were Rs. 14,290/- $ha^{-1,}$ Rs. 75,324/- ha^{-1} respectively. whereas mean return from ardusa based agrisilviculture system was Rs. 88,335/- ha^{-1} on completion of 7th year. The returns from ardusa based agrisilvi system was highest (Rs.1,00,524/- ha^{-1}) when ardusa was intercropped with green gram crop.
3	Likely cost	The net return from ardusa intercropped with green gram was highest (Rs. 76024/- ha^{-1}) over other sole and agrisilvi system.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of saving in cost of production, inputs, timeliness; and other pertinent information.	The income from sole ardusa system was obtained at the end of 7th year, while the agrisilvi system gave the income every year from the arable crops. Hence ardusa + green gram system is far better than sole ardusa crop.

5	Social/ environmental / other benefits	The chemical characteristics of soil under different land used system exhibited higher organic carbon and available N, P_2O_5 and K_2O ha^{-1} under agrisilvi system of agroforestry, which decreased under sole crop with no ardusa tree cover. The physical properties of soil indicated a significant decrease in bulk density and increase in water holding capacity and porosity in soil under ardusa based agrisilvi system. Hence the system protects and enriches underneath soil. Ardusa provides fuel, light industrial wood and nutritious leaf fodder for domestic animals during scarcity period.
6	Status of commercialization/ IP rights etc.	The technology has been popularized through the extension line through training of farmers. The farmers under rainfed areas have been highly adopted the recommendation under North Gujarat.
7	Efforts for technology dissemination	The farmer of North Gujarat from rainfed areas have adopted the technology through TOT through on campus and off campus training programme. Ardusa is a promising MPTs for agroforestry under rainfed conditions of North Gujarat. Ardusa provides fuel, light industrial wood and nutritious leaf fodder for domestic animals during scarcity period. Farmers therefore advised to adopt ardusa based agrisilvi system of agroforestry since the system gives more economic return per unit area. The returns are highest when ardusa is intercropped with green gram.
8	Special requirement for its successful realization; any other standards etc.	The technology is adopted under rainfed conditions where green gram crop is intercropped with ardusa. If the inter crop might be taken without any inputs, the system will supply organic product without any chemical application.
9	Indicative photographs	 **Ardusa tree with green gram inter crop on loamy sand**  **Ardusa trees on farmers field**
10	Contact details of person from whom technology and further details can be obtained	R. R. Shakhela, Research Scientist, AICRP on Agroforestry, Agroforestry Research Station, SDAU, Saradarkrushinagar-385 506, Phone: 02748-278465 Fax: 02748-278436 E-mail: rsagroforestry@gmail.com
11	Source of availability of technology/ expertise	Director of Extension Education, S.D. Agricultural University, Saradarkrushinagar-385 506 Phone: 02748-278436 Fax: 02748-278436 E-mail: dee@dau.edu.in
Name of Contributors : S. N. Jaimini, R. R. Shakhela, J. A. Patel and J. M. Patel		

3.4.1.2: Aonla based agroforestry (rainfed green gram-cluster bean in rotation) system with moisture conservation technique

Sl. No.	Item	Details
1	Specifications and salient technical features	In North Gujarat conditions where soil are loamy sand, deep ploughing, soil stirring, mulching and tree cover help in moisture conservation and checking soil degradation due to erosion of top soil through rain water runoff. The investigation was proposed to evaluate different soil covers effective in conserving soil moisture and minimizing water runoff.
2	Performance results	The inter crop yield (green gram-cluster bean in rotation) under each moisture conservation treatment was converted into aonla fruit yield and cumulative aonla yield that is aonla equivalent yield obtained was recorded each year. Maximum yield of rainfed green gram and cluster bean in rotation was recorded under organic mulch treatment i.e. equal quantity of castor cell and mustard cell under aonla canopy area. Similarly the significantly higher fruit yield of aonla was obtained under the organic mulch treatment after 8th years The growth parameters of aonla tree was not performed due to rainfed intercrops as well as by the different moisture conservation techniques. Maximum plant height (8.09 m), collar dia (29.3 cm), plant canopy (N-S: 7.92 m and E-W: 8.50 m) were obtained with the deep tillage at 30 cm soil depth treatment.
3	Likely cost	The highest gross realization (Rs. 37,140/- ha^{-1} year^{-1}) was obtained under the moisture conservation treatment of organic mulch. The net return (Rs. 18,520/- ha^{-1} year^{-1}) and B:C ratio (1:99) obtained with the organic mulch treatment.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of saving in cost of production, inputs, timeliness; and other pertinent information.	The organic mulch treatment of equal quantity of castor cell and mustard cell under canopy area of aonla tree on the onset of monsoon was found effective to get higher aonla equivalent yield, improving soil moisture and soil organic carbon and more profit under aonla based green gram- cluster been rotation in agroforestry systems.

5	Social / environmental / other benefits	There was not any adverse effect of intercrop and moisture conservation technique on the growth of aonla tree. Maximum soil organic carbon at 0-15 cm (0.39%) and 15-30 cm (0.36%) depth was recorded under the organic mulch treatment.
6	Status of commercialization / IP rights etc.	Organic mulch (castor shell and mustard shell) in adult aonla tree is advisable under aonla based greengram/custerbean agri-horti system in rainfed conditions.
7	Efforts for technology dissemination	--------
8	Special requirement for its successful realization; any other standards etc.	In the organic mulch treatment, the castor and mustard shell will be required in bulk from farm as farm by-product.
9	Indicative photographs	 **Aonla with Green gram**  **Aonla with Green gram**
10	Contact details of person from whom technology and further details can be obtained	R. R. Shakhela, Research Scientist, AICRP on Agroforestry, Agroforestry Research Station, SDAU, Saradarkrushinagar-385 506 Phone: 02748- 278465 Fax: 02748- 278436 E-mail: rsagroforestry@gmail.com
11	Source of availability of technology/ expertise	Director of Extension Education S. D. Agricultural University Saradarkrushinagar-385 506 Phone: 02748- 278436 Fax: 02748- 278436 E-mail: dee@dau.edu.in
Name of Contributors : S. N. Jaimini, R. R. Shakhela, J. A. Patel and J. M. Patel		

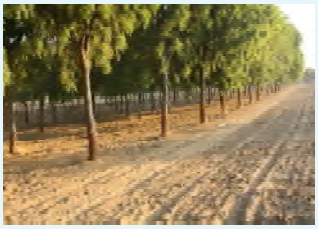
3.4.1.3: *Acacia senegal* as a bio-fence under arid / semi arid conditions

Sl. No.	Item	Details
1	Specifications and salient technical features	Sardarkrushinagar falls under the typical location in the scarcity zone. The inadequate as well as erratic rainfall, sandy loam, marginal soil with low water holding capacity followed by soil erosion have posed problem of low and unstable crop production which resulted in a fodder deficiency for domestic as well as stray cattle and wild animals *viz*., blue bulls. The fodder scarcity has forced the cattle and other animals to graze standing field crops and browse the tree plantation made on farmers field, road side and in forests. Under the situation to protect field crops and the plantation at low cost an investigation on evaluation of thorny shrubs for their suitability as live fence was initiated.
2	Performance results	Seven thorny shrub *viz*. bougainvillea, kumat, ber, ketki, gorasambali, karmada and thor were planted on border as live fence. The survival percentage and height indicated cent percent survival in bougainvillea. The remaining species had survival ranging from 54 to 90 %. Ber followed by bougainvillea and kumat recorded highest gain in height. Kumat had done foliage of 190 cm.
3	Likely cost	The shrub kumat (*Acacia senegal*) which had dense foliage from bottom to top and nutritious green fodder on pruning even during hot summer was considered to be promising bio fence under rainfed conditions of North Gujarat.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of saving in cost of production, inputs, timeliness; and other pertinent information.	The bio fence of kumat will protect the field crops against wild animals and will increase the income of farmers.
5	Social/ environmental / other benefits	*Acacia senegal* has dense foliage from bottom to top, hook shaped thorns which are effective in controlling blue bulls. It also provides nutritious green fodder on pruning.

6	Status of commercialization/ IP rights etc.	The technology is popularized through training of tribal people
7	Efforts for technology dissemination	The technology is mainly based on live fence and transferred to farmers field through TOT through extension department.
8	Special requirement for its successful realization; any other standards etc.	Kumat (*Acacia senegal)* is recommended as a most effective biofence under arid / semiarid rainfed conditions. Kumat biofence not only provides protection to crop against stray /wild animals like blue bulls. It also provides nutritious green fodder on pruning for sheep, goats and camels during scarcity.
9	Indicative photographs	----------
10	Contact details of person from whom technology and further details can be obtained	R. R. Shakhela, Research Scientist, AICRP on Agroforestry, Agroforestry Research Station, SDAU, Saradarkrushinagar-385 506 Phone: 02748- 278465 Fax: 02748- 278436 E-mail: rsagroforestry@gmail.com
11	Source of availability of technology/ expertise	Director of Extension Education S.D. Agricultural University Saradarkrushinagar-385 506 Phone: 02748- 278436 Fax: 02748- 278436 E-mail: dee@dau.edu.in
Name of Contributors : S. N. Jaimini, R. R. Shakhela, J. A. Patel and J. M. Patel		

3.4.1.4: Promising MPTs Neem under rainfed conditions

Sl. No.	Item	Details
1	Specifications and salient technical features	Sardarkrushinagar, the main campus of Sardarkrushinagar Dantiwada Agricultural University is a typical location in the scarcity zone where average rainfall is about 550 mm. The inadequate as well as erratic rainfall, sandy soil having low moisture retention capacity pose problems of low and unstable crop production and degradation due to soil erosion. Under the situation inclusion of suitable multipurpose tree species (MPTs) in farming system will not only provide fodder, fuel, timber and cash to the farmers, it will also improve soil fertility through addition of organic matter in the soil and controlling soil erosion. Different 15 MPTs of the region were included for evaluation for their suitability under agroforestry system. Neem (*Azadirachta indica*), Ardu (*Ailanthus excelsa*) is the most potential MPTs for the region. It provides fuel, light industrial wood and nutritious leaves for domestic animals and enriching underneath soil.
2	Performance results	The survival in all the species except baken neem, drumstick, babul and albida was satisfactory. Neem had the highest survival of 92.7 % which was followed by rohido (62.5%), Israel babool (62.0%), kumat (56.30%) and khejdi (54.10%). At the end of sixteen years of planting eucalyptus attained maximum height of 13.1 m. which was followed by israel babool (11.6 m.). The collar diameter of trunk (27.7cm.) and dbh (23.6 cm) was maximum in kasid whereas eucalyptus recorded maximum cbl (5.15 m.). The maximum above ground biomass (143.9 kg tree^{-1}), total biomass (165 kg tree^{-1}) was recorded with *P. juliflora*.
3	Likely cost	There is no additional expenditure for neem plantation under rainfed conditions. the cost of neem seedling will be around Rs 5-10 per seedling.

4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of saving in cost of production, inputs, timeliness; and other pertinent information.	Among different MPTs, neem recorded maximum income (Rs. 2,92,726/- ha^{-1}), after sixteen years of plantation. The main economic return from neem was due to income from fodder and fuel wood on lopping and neem fruits (nimboli) obtained each year of its life span and fuel wood & small timber on completion of cycle.
5	Social/ environmental / other benefits	Neem considered to be promising among all tree provided maximum return ha^{-1} from nimboli, fodder and fuel wood during its life span and timber on completion of cycle. Neem also improved soil fertility through litter fall.
6	Status of commercialization/ IP rights etc.	Neem (*Azadirachra indica*) is recommended as promising MPTs for agroforestry under rainfed and semi arid condition of North Gujarat. It not only provides maximum economic returns from timber and fuel wood on felling, also provides nimboli and nutritious fodder for goats, sheep etc. on lopping during its life span. It also improves soil fertility beneath its canopy.
7	Efforts for technology dissemination	The technology has been transferred to farmers field through transfer of technology.
8	Special requirement for its successful realization; any other standards etc.	Neem plantation can be done on waste lands without any special requirement.
9	Indicative photographs	
10	Contact details of person from whom technology and further details can be obtained	R. R. Shakhela, Research Scientist, AICRP on Agroforestry, Agroforestry Research Station, SDAU, Saradarkrushinagar-385 506 Phone: 02748-278465 Fax: 02748-278436 E-mail: rsagroforestry@gmail.com
11	Source of availability of technology/ expertise	Director of Extension Education S.D. Agricultural University Saradarkrushinagar-385 506 Phone: 02748-278436 Fax: 02748-278436 E-mail: dee@dau.edu.in
Name of Contributors : R. R. Shakhela, J. A. Patel and A. G. Patel		

3.4.2: ARS, SKNAU, Fatehpur-Shekhawati (Rajasthan)

3.4.2.1: *Dichrostachys cinerea* (Nutans) based silvipasture model for degraded wasteland or pasture land

Sl. No.	Item	Details
1	Specifications and salient technical features	In Rajasthan, total 10 per cent area is covered under forest and 8 lac hectares land is suffering from salt affected problem or poor soil fertility. The climate of the zone IIa ranges from arid to semi arid with an average rainfall of about 300-350 mm, which is mainly received in the month of July and August. The temperature goes as high as 50 ^{o}C in summers and as low as -2.5 ^{o}C in winters. Because of insufficient and uneven distribution of rains, frequent failure of crops is common, consequently resulting into famine. Shortage of fuel, timber and fodder is the common phenomena of the area. Forest and pasture occupy only 3.08 and 5.52 per cent area, respectively of the total cropped area (3.7 m ha) in the zone. Animals are the important source of income of rural folk and extensively support the rural economy. However, the zone frequently encountered with acute shortage of fodder, leading to the problem of migration of cattle herds and sheep to the other parts of country. On the other hand, soil degradation is also a serious problem and mainly associated with soil erosion and shifting of sand dunes is common when green cover is absent or destroyed completely. Rectification of situation calls for steps to improve the green cover. To meet the requirement of the area nutan based silvipasture model introduces for arid and semi-arid condition. In which *D. cinerea* saplings were planted at 5m x 1 m spacing and *Cenchrus ciliaris* grass was planted between the *nutans* row to work out the total biomass production per unit area. *Nutans* is cut through coppicing every year in the month of November.
2	Performance results	Nutan based silvi-pastoral system provide total bimass yield of 3.34 t ha^{-1} in comparison to sole grass system. There was a significant improvement in organic carbon, available N and P_2O_5 in silvipastoral system, compared with open field.
3	Likely cost	In the establishment year system total cost is Rs. 10,000/- ha^{-1} which is at par on benefit, however, form 2nd year on ward a net benefit of Rs 10,000/- ha^{-1} received from system.

4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The System is for degraded waste land from where agriculture crops were not taken. The technology helps farmers to fulfil their fodder requirement during scarcity or famine.
5	Social/environmental/other benefits	This system has high potential to control soil erosion, soil improvement creating congenial and conductive micro-climate for tree and under storey vegetation and reduction in the accumulation of green house gases in the atmosphere. The system also check soil erosion in watershed and provide green cover to degraded waste land.
6	Status of commercialization/IP rights etc.	Technology were popularized through farmers fare, Kisans gosthi and different stack holder farmers trainings organized at KVK and ARS.
7	Efforts for technology dissemination	It has been transferred to Fatehpur watershed for demonstration to farmers and other stakeholders.
8	Any special requirement for its successful realization; any other standards etc.	The tree sapling of *D. Nutan* and grass seed of *C. ciliaris* must be ensure before planting.
9	Indicative photographs	 ***Dichrostachys cinerea* (*nutans*) and *C. ciliaris***
10	Contact details of person from whom technology and further details can be obtained	Dr. Dharmendra Tripathi, Officer Incharge AICRP on Agroforestry, Agricultural Research Station Fatehpur-Shekhawati-332301, District Sikar, Rajasthan Phone: 01571- 297445
11	Source of availability of technology/expertise	Zonal Director Research, Agricultural Research Station Fatehpur-Shekhawati-332301, District Sikar, Rajasthan Phone: 01571- 297445 E-mail : zdr.fatehpur@sknau.ac.in
Name of contibutors: Dr D Tripathi, Dr Man Singh, Dr Mahendra Singh		

3.4.2.2: Aonla based agri-horti model

Sl. No.	Item	Details
1	Specifications and salient technical features	The climate of the zone IIa ranges from arid to semi arid with an average rainfall of about 300-350 mm, which is mainly received in the month of July and August. The temperature goes as high as 50 ^{o}C in summers and as low as -2.5 ^{o}C in winters. Because of insufficient and uneven distribution of rains, frequent failure of crops is common, consequently resulting into famine. To ensure the benefit of farmers in low rainfall year aonla based agri-horti model developed. Farmer's are adopting the model to increasing their income per unit area of land. Experiment on aonla based agri-horticulture system was conducted at farmer's field (Sh. Dana Ram) at Dudwa village (Laxamangarh). Tree component (aonla, variety NA-7) was planted at 9 m x 9 m distance in the year of 1998 and barley intercrop taken. The aonla based agri-horti model provide assure benefit over sole cropping system.
2	Performance results	Average productivity of barley in aonla based agri-horticulture system was 3.407 t ha^{-1} and yield reduction was 4.250-3.407= 0.834 t ha^{-1}. This reduction resulted in reduction of Rs. 10,842/- ha^{-1} (Price of barley was @1,300/q). On the cost of yield reduction of barley, the fruit yield of aonla was received 4.4 t ha^{-1} having the cost of Rs.22,000/-ha^{-1} (@ Rs 5/kg). Thus the returns recorded with open field was Rs. 55,250/- ha^{-1} whereas, the returns recorded with agri-horticulture was Rs. 66,291/- ha^{-1} and net profit was increased by Rs.11,032/- ha^{-1} in horti agriculture system.
3	Likely cost	Aonla based agri-horti model provide total return of Rs. 66,291/- ha^{-1}, however in sole cropping system provide return of Rs. 55,250/- ha^{-1}. A net profit of Rs. 11,032/- ha^{-1} increased in agri-horti model. There was a significant improvement in organic carbon as well in agri-horti model, compared with open field.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	In conventional agriculture system only gross return of Rs. 55,250/- received by farmers, however with aonla based agri-hoti model provide a net profit of Rs. 11,032/- ha^{-1}.

5	Social/environmental/other benefits	Agri-horti model check the soil erosion on high speed wind during summer and conserve the soil moisture in the soil. The soil microbial activity was also higher than the sole cropping system.
6	Status of commercialization/IP rights etc.	Technology was popularized through farmers fare, Kisans gosthi and different stack holder farmers trainings organized at KVK and ARS and farmers field visit.
7	Efforts for technology dissemination	It has been transferred to the field of Shri Dana Ram, Village Dudwa, Laxmangarh, Sikar, Rajasthan
8	Any special requirement for its successful realization; any other standards etc.	The sapling of Aonla variety NA-7 must be ensure before planting.
9	Indicative photographs	 **Aonla based Agri-horti model**
10	Contact details of person from whom technology and further details can be obtained	Dr. Dharmendra Tripathi, Officer Incharge AICRP on Agroforestry, Agricultural Research Station Fatehpur-Shekhawati-332301, District Sikar, Rajasthan Phone: 01571- 297445
11	Source of availability of technology/expertise	Zonal Director Research, Agricultural Research Station Fatehpur-Shekhawati-332301, District Sikar, Rajasthan Phone: 01571- 297445 E-mail : zdr.fatehpur@sknau.ac.in
Name of Contributors: Dr D Tripathi, Dr Man Singh and Dr Mahendra Singh		

3.4.3: CCSHAU, Hisar (Haryana)

3.4.3.1: Poplar based agroforestry system in Haryana

Sl. No.	Item	Details
1	Specifications and salient technical features	Agroforestry as alternative land management system addresses many of the global challenges, including deforestation, unsustainable cropping practices, loss of biodiversity, increased risk of climate change, as well as rising hunger, poverty and malnutrition. Intercropping with high density short rotation tree species is the best option to meet increasing food and industrial raw material requirement through sustainable utilization of natural resources. Agroforestry systems are believed to arrest land degradation and sustain soil productivity and can re-establish some of the forests ecological goods and services like timber production, potentially improves agricultural productivity, soil fertility improvement, carbon sequestration and enhances biodiversity. Trees under agroforestry besides providing the tree products, improves soil productivity through ecological and physico-chemical changes. In India, fast growing exotic tree species have been introduced on-farm in order to obtain maximum monetary gains from a given land unit in a short period of time. Poplar (*Populus deltoides* Bartr.), a winter deciduous tree, has proved itself to be the most promising tree in irrigated Agro ecosystems of Haryana and of adjoining states of the country and is being raised either as block plantation or along field boundaries/windbreaks. Poplar based agroforestry system is one of the viable alternate land use systems to prevent further degradation, obtain biological production on sustainable basis and ameliorate the environment. The past three decades have witnessed the rapid increase in poplar based agroforestry as an alternate land use practice throughout the irrigated agro-ecosystem in Haryana and adjoining states. It is a general practice to combine agricultural crops with poplar plantations.

2	Performance results	Poplar based agri-silvi system (5m x 4m, 10m x 2m and 18m x 2m x 2m spacing) produced average annual yield of wheat as 3.0, 3.4 and 3.7 t ha^{-1} under 5m x 4m, 10m x 2m and 18m x 2m x 2m spacing, respectively. However, mean annual yield of cowpea and berseem (green fodder) varied from 13.3 to 18.2 t ha^{-1} and 32.1 to 38.5 t ha^{-1} under different spacings of poplar based silvi-pastoral system. Overall, the yield of agricultural crops was recorded higher in 18m x 2mx 2m (paired row spacing) as compared to other two spacings however, girth (GBH) was observed highest in 5m x 4m spacing followed by 10m x 2m spacing. The mean rate of carbon storage in poplar based agroforestry has been found to be 113 per cent higher than sole agriculture. The rate of carbon storage was found to be 25.2 t $ha^{-1}year^{-1}$ in poplar based agroforestry system and 11.8 t ha^{-1} $year^{-1}$ in sole agriculture.
3	Likely cost	Total cost of cultivation in eight years poplar based agroforestry (500 trees ha^{-1} of poplar + agricultural crops) is about Rs. 1,73,910/-. Output in terms of profit per unit area is Rs. 93,202/- (5m x 4m), 1,03,017/- (10m x 2m) and 96,382/- (18m x 2m x 2m) ha^{-1} $year^{-1}$ in poplar based agroforestry as compared to Rs. 34,268/- under paddy-wheat rotation (sole agriculture).
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The overall net income per hectare per year from poplar based agroforestry raised from Rs. 34,268/- (sole agriculture) to Rs. 97,534/- (mean income from different spacings of poplar based agroforestry), which is very much beneficial for small to large land holding farmers of India under irrigated conditions.
5	Social/environmental/other benefits	The poplar based agroforestry system improves aggregation of soil through huge quantity of organic matter in the form of leaf biomass. The extent of improvement may be affected by the age of the poplar trees. The soil under poplar based agroforestry system showed 39.7 per cent more organic carbon than sole crop. The soils under poplar based agroforestry had 2.9–4.4 Mg ha^{-1} higher soil organic carbon than in sole crop. The mean rate of carbon storage in poplar based agroforestry has been found to be 113 per cent higher

		than sole agriculture. The rate of carbon storage was found to be 25.2 t $ha^{-1}year^{-1}$ in poplar based agroforestry system and 11.8 t $ha^{-1}year^{-1}$ in sole agriculture, which is very imperative in changing climate.
6	Status of commercialization/IP rights etc.	Technology has been popularized through conducting kishan mela, kishan ghosthi, trainings and research fields demonstration to farmers of Haryana and bordering states.
7	Efforts for technology dissemination	The farmers of Haryana particularly districts of Yamuna Nagar, Karnal, Kurukshetra, Kaithal, Sonepat, Panipat have adopted this technology very successfully and are earning remunerative prices from this technology.
8	Special requirement for its successful realization; any other standards etc.	As the present technology (poplar based agroforestry) needs good soil with adequate irrigation facilities. Therefore, this technology did not work in problematic soils particularly in saline soils.
9	Indicative photographs	 **Poplar + agricultural crops**
10	Contact details of person from whom technology and further details can be obtained	R. S. Dhillon, OIC, AICRP on Agroforestry Department of Forestry, CCS Haryana Agricultural University, Hisar-125004 Phone: 01662-255255 Fax: 01662-234613
11	Source of availability of technology/expertise	R. S. Dhillon, OIC, AICRP on Agroforestry Department of Forestry, CCS Haryana Agricultural University, Hisar-125004 Phone: 01662-255255 Fax: 01662-234613 E-mail: rsdhillon@hau.ernet.in
Name of Contributors: Dr. R S Dhillon, Dr D P S Nandal and Dr. K K Bhardwaj		

3.4.4: MPKV, Rahuri (Maharastra)

3.4.4.1: Eucalyptus plantation in shallow soils of Western Maharashtra

Sl. No.	Item	Details
1	Specifications and salient technical features	In Western Maharashtra for obtaining higher timber yield and net monitory returns the experiment was planned with seven tree species *viz., Azadirachta indica, Eucalyptus camaldulensis, Melia azadirachta, Tectona grandis, Hardwickia binnata, Acacia nilotica and Zizyphus mauritina*) at MPKV, Rahuri under shallow soil during *Kharif* 1996 and the experiment was concluded during 2010.
2	Performance results	In Siviculture system of Agroforestry in shallow soil after 12 years *Eucalyptus camaldulensis* produced timber yield 178.86 t ha^{-1} resulting net monitory returns Rs. 2,15,278/- ha^{-1} followed by *Acacia nilotica* produced timber yield 90.07 t ha^{-1} resulting net monitory returns Rs. 1,44,339/- ha^{-1} .
3	Likely cost	The total cost of cultivation in twelve years in Siviculture system of Agroforestry in shallow soil *Eucalyptus camaldulensis* required cost of cultivation Rs. 17,244/- ha^{-1}. followed by *Acacia nilotica* required cost of cultivation Rs. 17,799/- ha^{-1}.
4	How the new technology will impact the income of the farmer and its benefit over conventional technologies / knowhow in terms of saving in cost of production, inputs, timeliness and other pertinent information	The overall net income per hectare after 12 years from *Eucalyptus camaldulensis* recorded Rs.1,93,189/- and followed by *Acacia nilotica* Rs.1,22,250/- over conventional technology.
5	Social/ environmental/other benefits	In western Maharashtra for obtaining higher timber yield and net monitory returns in silviculture agroforestry system and improve the organic carbon of soil, water holding capacity and thereby protects soil erosion and improve the infiltration of soil.
6	Status of the commercialization /IP right etc	Technology has been popularized through training of Farmer Scientist Forum of University/ member of Social Forestry and Forestry Department of Maharashtra.

7	Efforts for technology dissemination	The technology has been transferred to progressive farmers under Farmers Scientist Forum and social forestry department of Maharashtra.
8	Special requirement for its successful realization, any other standard etc.	As technology is based on utilization of shallow soils of Maharashtra for getting higher timber yield and net monitory returns the users must be ensured by the concerned social forestry/ forestry department of Maharashtra.
9	Indicative photographs	
10	Contact details of person from whom technology and further details can be obtained	Prof. N. D. Bangar, Officer Incharge, AICRP on Agroforestry, MPKV, Rahuri-413 722, Dist. Ahmednagar. (M.S.) Phone: 02426-243252, Fax:02426-243216
11	Source of availability of technology /expertise	Officer Incharge, AICRP on Agroforestry, MPKV, Rahuri-413 722, Dist. Ahmednagar. Phone: 02426-243252, Fax: 02426-243216
Name of Contributers: Prof. C.J. Sonawane, Dr. M.R. Manjare, Dr. R.S. Wagh, Dr. D.B. Lad, Shri. N.T. Kunjir, Er. N.A. Jadhav, Dr. S.A. Anarase and Sh. R.E. Todmal		

3.4.5: COA, PDKV, Nagpur (Maharastra)

3.4.5.1: Design and fabrication of ecofriendly bamboo tree guards for plant protection and employment generation in rural area

Sl. No.	Item	Details		
1	Specifications and silent technical features	Sl. No.	Particulars	Specification
		1	Shape	Triangular mounted on rigid bamboo tripod
		2	Size	18” X18” X18”
		3	Height	5’ above ground, total height 5.6” including height supports /tripods
		4	Cross support	Provided with cross support of half cut bamboo on three sides for extra firmness and ease in handling.
		5	Mat Type	Woven by half cut bamboo strips of 1” wide bamboo for support and fixed with nail on three triangular, tightened with Nut bolt
		6	Material used	Bamboo material treated with preservatives and anti-termite . Tripods supports bamboo treated with creosote at bottom (up to 1.00 feet).
		7	Title Plate	PVC Plate of 6” X 4” and 2.00 mm fixed at top
2	Performance results	Bamboo are known good soil binders owing to their particular clump formation and fibrous root system and hence also play an important role in soil conservation. It is also known to play major role in carbon sequestration and hence useful in environmental protection. There by fabricating tree guards of bamboo is an ecofriendly, economical and employment generating activity. Planning authorities are requested to make it compulsory to use bamboo tree guards only in all plantation activities.		
3	Likely cost	Cost of Product: Rs. 450/- piece		

4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness and other pertinent information	In process the fabrication of one unit (i.e. one thousand) bamboo tree guard require 4000 to 5000 No. green bamboos. It requires 1000 to 1500 mandays. Rural unemployed youth were trained to fabricate tree guards. They are paid @ Rs. 300/-per day. Thus for fabricating one unit (1000 No.) tree guards of bamboo, a cultivator can get Rs. 1, 60,000/- to Rs. 200,000/- for producing raw material and employment of Rs. 300,000/- to Rs. 4,50,000/- is generated.
5	Social /environmental/ other benefits	Wasteland management, watershed development programme, eco-restoration of degraded lands.
6	Status of commercialization/ IP rights etc.	Technology have been adopted by Municipal Corporation, Panchyat for protecting plants under different afforestation programmes.
7	Efforts for technology dissemination	Recommended in state level committee for adoption in different afforestation programmes.
8	Special requirement for its successful realization; any other standards etc.	Government organizations i.e. national highway divisions, power stations, NMC, PWD, grampanchayat, schools, cantonment board and NGO's etc are prompted to use these tree guards in their plantation programmes.
9	Indicative photographs	
10	Contact details of person from whom technology and other details can be obtained	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur. Maharashtra, Ph. 0712 2521276, Mob: 9422831053 E-mail: ilorkar @ yahoo.co.in
11	Source of availability of technology/ expertise.	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur. Maharashtra, Ph. 0712 2521276, Mob: 9422831053 E-mail: ilorkar @ yahoo.co.in
Name of Contributors: Dr. V. M. Ilorkar, Shri S. B. Suroshe and Shri I. M. Nagrare		

3.4.5.2: Standardization of fertilizer requirement for higher production of bamboo

Sl. No.	Item	Details
1	Specifications and silent technical features	Bamboo is most commonly used woody material. It is fastest growing perennial grass. Its wide applications in agriculture, wood based industries, handicrafts, packaging and cottage industries make it suitable for cultivation on farm and wastelands. Therefore for meeting the growing demand of bamboo as raw material, bamboo production is required to be increased. Therefore it was necessary to develop technology for increasing bamboo production.
2	Performance results	To get higher number of harvestable bamboo it is recommended to apply 50 Kg Nitrogen per hectare at the start of monsoon every year to bamboo plantation in central Vidarbh Zone.
3	Likely cost	With the application of recommended quantity/ dose of fertilizer the production of harvestable bamboo is increased by 21.83 percent.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness and other pertinent information	For afforestation of Agroforestry, wasteland management, watershed development programme, Eco restoration of degraded lands.
5	Social /environmental/ other benefits	Bamboo plantations helps in ecorestroration – soil water conservation of degraded landscapes.
6	Status of commercialization/ IP rights etc.	-
7	Efforts for technology dissemination	Recommended in state level committee for adoption in arid and semiarid region.
8	Special requirement for its successful realization; any other standards etc.	-
9	Indicative photographs	

10	Contact details of person from whom technology and other details can be obtained	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur. Maharashtra, Ph. 0712 2521276, Mob: 9422831053 E mail: ilorkar @ yahoo.co.in
11	Source of availability of technology/ expertise.	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur. Maharashtra, Ph. 0712 2521276, Mob: 9422831053 E mail: ilorkar @ yahoo.co.in
Name of Contributors: Dr. V. M. Ilorkar, Shri S. B. Suroshe and Shri I. M. Nagrare		

3.4.5.3: Teak based agroforestry system

Sl. No.	Item	Details
1	Specifications and silent technical features	Teak is the most preferred timber species. Large scale teak plantations were carried out in the region on wastelands and farm lands. Agricultural land was also brought under teak plantation to some extent. Therefore it was necessary to assess the suitability of crops when grown on farm lands.
2	Performance results	Black gram (Urd) can be taken as intercrop in sag planted at 8m X 2m distance in central Vidarbha Zone.
3	Likely cost	--------
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness and other pertinent information	For the development of wasteland with suitable tree and crop combinations have been recommended.
5	Social /environmental/ other benefits	Agroforestry, wasteland management, watershed development programme, eco-restoration of degraded lands.
6	Status of commercialization/ IP rights etc.	--------
7	Efforts for technology dissemination	Recommended in state level committee for adoption in arid and semiarid region.
8	Special requirement for its successful realization; any other standards etc.	-------

9	Indicative photographs	 
10	Contact details of person from whom technology and other details can be obtained	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur, Maharashtra, Ph: 0712 2521276 Mob: 9422831053, Email: ilorkar @ yahoo.co.in
11	Source of availability of technology/ expertise.	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur, Maharashtra, Ph: 0712 2521276 Mob: 9422831053, Email: ilorkar @ yahoo.co.in
Name of Contributors: Dr. V. M. Ilorkar, Shri S. B. Suroshe and Shri I. M. Nagrare		

3.4.5.4: Cultivation of eucalyptus for production of poles

Sl. No.	Item	Details
1	Specifications and silent technical features	Eucalyptus is one of the fast growing tree species. Its suitability as raw material for production of paper and pulp, agriculture implements, mine probes, construction industries provides wide opportunities for growing eucalyptus on large scale. Therefore a systematic research was needed to evolve suitable cultural practices for growing eucalyptus.
2	Performance results	For harvesting large size poles of eucalyptus, the planting distance of 2m X 1 m is recommended for central Vidarbha Zone
3	Likely cost	----------
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness and other pertinent information	This technology is recommended for the production of large size poles of eucalyptus. With application of technology the yield of eucalyptus poles has increased to 100 percent compared to earlier practice of growing of eucalyptus on 2m X 1 m spacing.
5	Social /environmental/ other benefits	Agroforestry, wasteland management, watershed development programme, eco-restoration of degraded lands.

6	Status of commercialization/ IP rights etc.	-------
7	Efforts for technology dissemination	Recommended in state level committee for adoption in arid and semiarid region.
8	Special requirement for its successful realization; any other standards etc.	-------
9	Indicative photographs	
10	Contact details of person from whom technology and other details can be obtained	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur, Maharashtra, Ph: 0712 2521276, Mob: 9422831053 Email: ilorkar @ yahoo.co.in
11	Source of availability of technology/ expertise.	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur, Maharashtra, Ph: 0712 2521276, Mob: 9422831053 Email: ilorkar @ yahoo.co.in
Name of Contributors: Dr. V. M. Ilorkar, Shri S. B. Suroshe and Shri I. M. Nagrare		

3.4.5.5: Teak clone suitable for the region

Sl. No.	Item	Details
1	Specifications and silent technical features	Teak is most preferred timber species. The increased demand for quality teak has attracted farmers for growing it on farm and wastelands. However teak being slow growing species it is a delayed paying crop. Therefore need was felt to evaluate the suitability of teak clone for early maturity for growing under afforestation programmes.
2	Performance results	The teak clone PDKV/AF/1 is recommended for cultivation in Vidarbha.
3	Likely cost	----------

4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness and other pertinent information	The recommended teak clone has showed potential for producing 11 percent more timber than the local type under study.
5	Social /environmental/ other benefits	Agroforestry, wasteland management, watershed development programme, eco-restoration of degraded lands.
6	Status of commercialization/ IP rights etc.	--------
7	Efforts for technology dissemination	Recommended in state level committee for adoption in arid and semiarid region.
8	Special requirement for its successful realization; any other standards etc.	--------
9	Indicative photographs	
10	Contact details of person from whom technology and other details can be obtained	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur, Maharashtra, Ph: 0712 2521276 Mob: 9422831053 E mail: ilorkar@yahoo.co.in
11	Source of availability of technology/ expertise.	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur, Maharashtra, Ph: 0712 2521276 Mob: 9422831053 E mail: ilorkar@yahoo.co.in
Name of Contributors: Dr. V. M. Ilorkar, Shri S. B. Suroshe and Shri I. M. Nagrare		

3.4.5.6: Silvipasture development

Sl. No.	Item	Details
1	Specifications and silent technical features	Wastelands are abundantly found in the region for meeting the fodder requirement of cattle in the region it is necessary to produce more quantity of fodder from the wastelands by adapting suitable silvipastoral system.
2	Performance results	For establishment of silvipasture system, *Acacia nilotica* + *Cenchrus ciliaris* + *Stylo hamata* for light soils and *Annona squamosa* + *Cenchrus ciliaris* + *Stylo hamata* for medium soil in rainfed area is recommended.
3	Likely cost	--------
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness and other pertinent information	Productivity of wastelands may be increased with establishment of silvipasture by recommended technology.
5	Social /environmental/ other benefits	Wasteland management, watershed development programme, eco-restoration of degraded lands.
6	Status of commercialization/ IP rights etc.	--------
7	Efforts for technology dissemination	Recommended in state level committee for adoption in arid and semiarid region.
8	Special requirement for its successful realization; any other standards etc.	--------
9	Indicative photographs	
10	Contact details of person from whom technology and other details can be obtained (information on the postal address, email, telephone, fax etc.)	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur, Maharashtra, Ph: 0712 2521276, Mob: 9422831053 Email: ilorkar @ yahoo.co.in
11	Source of availability of technology/ expertise.	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur, Maharashtra, Ph: 0712 2521276, Mob: 9422831053 Email: ilorkar @ yahoo.co.in
Name of Contributors: Dr. V. M. Ilorkar, Sh. S. B. Suroshe and Sh. I. M. Nagrare		

3.4.5.7: Teak based Agrisilviculture system for wasteland afforestation

Sl. No.	Item	Details
1	Specifications and silent technical features	Agroforestry has been traditionally a part of small holder farm system as a source of fuel, small timber, and agricultural implements and restore soil fertility. Areas where agricultural productivity is poor, demand for agricultural output is going up. Teak is the most preferred timber species. Wasteland in the region brought under teak plantation in recent past. Therefore it was necessary to develop the agrisilvicutre system with teak as tree component.
2	Performance results	For the afforestation of wasteland through agroforestry system planting of teak at 8m X 2 m spacing in alleys and black gram as intercrop and the first 50% thinning of teak trees at seventh year from planting is recommended.
3	Likely cost	Agroforestry, wasteland management, watershed development programme, eco-restoration of degraded lands.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness and other pertinent information	For the production of agricultural crops and timber from the wasteland The system is developed and is recommended. It has a potential to improve the fertility status of soil and productivity of land as a whole.
5	Social /environmental/ other benefits	Wasteland management, watershed development programme, eco-restoration of degraded lands.
6	Status of commercialization/ IP rights etc.	-------
7	Efforts for technology dissemination	Recommended in state level committee for adoption in arid and semiarid region.
8	Special requirement for its successful realization; any other standards etc.	--------

9	Indicative photographs	 
10	Contact details of person from whom technology and other details can be obtained	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur, Maharashtra, Ph: 0712 2521276, Mob: 9422831053 E mail: ilorkar @ yahoo.co.in
11	Source of availability of technology/ expertise.	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur, Maharashtra, Ph: 0712 2521276, Mob: 9422831053 E mail: ilorkar @ yahoo.co.in
Name of Contributors: Dr. V. M. Ilorkar, Sh. S. B. Suroshe and Sh. I. M. Nagrare		

3.4.5.8: Construction of gabion check dam with clay blanketing for storage of runoff and control of gully erosion

Sl. No.	Item	Details
1	Specifications and silent technical features	Concentration of runoff from higher areas leads to development enlargement and deepening of gullies leading to loss of productive soil. This network of gullies can be stabilized constructing series of check dams. Watershed areas up to 20 ha and length of gully from 100 – 1000 m should be provided with one gabion dam with clay blanketing and one counter dam for storing runoff and control of erosion.
2	Performance results	It controls erosion along the gully bed stores water in to gully. Stored water can be use for irrigating plantation in the vicinity of the area for establishing forestry base life support system. Enhance better percolation for raising ground water.
3	Likely cost	----------

4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness and other pertinent information	Gabion check dams with clay blanketing are constructed in the gully across the shape of land. It is suitable for areas where there is no stable foundation since it offers flexibility for settlement.
5	Social /environmental/ other benefits	Wasteland management, watershed development programme, eco-restoration of degraded lands.
6	Status of commercialization/ IP rights etc.	-------
7	Efforts for technology dissemination	Recommended in state level committee for adoption in arid and semiarid region.
8	Special requirement for its successful realization; any other standards etc.	--------
9	Indicative photographs with proper lighting	  **Gabion Check Dam**
10	Contact details of person from whom technology and other details can be obtained	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur, Maharashtra, Ph: 0712 2521276 Mob: 9422831053, E mail: ilorkar @ yahoo.co.in
11	Source of availability of technology/ expertise.	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur, Maharashtra, Ph: 0712 2521276 Mob: 9422831053, E mail: ilorkar @ yahoo.co.in
Name of Contributors: Dr. V. M. Ilorkar, Sh. S. B. Suroshe and Sh. I. M. Nagrare		

3.4.5.9: Vegetative contour bunds for water conservation and for increased productivity of teak plantation

Sl. No.	Item	Details
1	Specifications and silent technical features	Increasing population is mounting pressure for supply of food fodder, fuel and timber for human and animal consumption. Therefore in addition to increase production form agricultural land, degraded lands and waste lands need to be utilize for generating additional resources. These areas can be used successfully adopting appropriate measures like vegetated contour bund for establishing teak plantation for higher timber production.
2	Performance results	Contour bunds are used for storing generated runoff. It controls soil erosion maintains soil fertility. Thus, create better atmosphere for growth of teak plants. It helps better infiltration of water into soil for recharging ground water table. Fifty three percent higher timber productions was achieved with this technique.
3	Likely cost	In Agroforestry for maximum wood production in teak establishment of narrow based contour bunds along with vegetative barrier at horizontal interval of 30 m is recommended.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness and other pertinent information	Vegetated contour bunds are useful for water conservation in areas where water is limiting factor for growth of crops/plants. These bunds are use for establishing forestry teak plantation successfully for higher timber production on degraded areas where agricultural crop production is not economically.
5	Social /environmental/ other benefits	Wasteland management, watershed development programme, eco-restoration of degraded lands.
6	Status of commercialization/ IP rights etc.	-------
7	Efforts for technology dissemination	Recommended in state level committee for adoption in arid and semiarid region.
8	Special requirement for its successful realization; any other standards etc.	-------

9	Indicative photographs	 NARROW BASE CONTOUR BUND IN TEAK PLANTATION
10	Contact details of person from whom technology and other details can be obtained	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur, Maharashtra, Ph: 0712 2521276 Mob: 9422831053 E mail: ilorkar @ yahoo.co.in
11	Source of availability of technology/ expertise.	Dr. V. M. Ilorkar, Senior Scientist & OIC, AICRP on Agroforestry, PDKV, College of Agriculture, Nagpur, Maharashtra, Ph: 0712 2521276 Mob: 9422831053 E mail: ilorkar @ yahoo.co.in
Name of Contributors: Dr. V. M. Ilorkar, Sh. S. B. Suroshe and Sh. I. M. Nagrare		

3.4.6: PJTSAU, Hyderabad (Telangana)

3.4.6.1: High azadiractin Neem line suitable for semi-arid condition

Sl. No.	Item	Details
1	Specifications and salient technical features	Neem a MPT's is very suitable to arid and semi-arid areas of combined Andhra Pradesh State and it is mandate tree species allotted to the centre. The timber, medicinal and pharmaceutical value of neem has highly economic importance.
2	Performance results	In multi-location trial (MLT), the performance of L-115 is good and identified for higher azadiractin content (0.5343%) on kernel basis over check line. After 7 years of planting (DP 2004) the tree height (6.5m) and girth (62.2 cm) with fruiting score 5 was recorded during 2012.
3	Likely cost	As such no expenditure is involved in maintenance of MLT trial on neem. Only minimum expenditure is involved in maintenance of neem trees.
4	How the new technology will impact the farmers and its benefits over conventional technologies / know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information.	The local neem trees are slow growing with less fruit scoring and low azadiractin content. In MLT number of lines are tested. Out of this some promising lines with high azadiractin content is recorded. This is definitely very useful because of high pharmaceutical value.
5	Social / environmental / other benefits	Neem is very hardy tree species with multipurpose uses. Superior line is involved in terms of high azadiractin content along with straight bole having good timber quality will be for timber industry and it is affordable by common man compared with other costly timber.
6	Status of commercialization / IP rights etc.,	So far the line-115 identified is giving good results because of good characters for future ensuing some years. After confirming results for few more years the progeny has to be tested and multiplied in farmer fields and department nurseries.
7	Efforts for technology dissemination	Villages under the control of KVK and DATTAC centres of RARS Southern Telangana Zone, Telangana State.
8	Special requirement for its successful realization; any other standards etc.,	Need the help of extension departments, KVK's for further popularizing of the system.

9	Indicative photographs	  
10	Contact details of person from whom technology and further details can be obtained	KVK and DATTAC centres, Regional Agricultural Research Station Palem, Mahaboobnagar, Telangana.
11	Source of availability of technology / expertise	Principal Scientist (Agronomy) & OIC AICRP on Agroforestry Rajendranagar, Hyderabad-500030, Telangana
Name of Contributors: Dr. A. Krishna, Dr. M.A. Aariff Khan, Dr. B. Joseph, Dr. K. Prabhavathi, Dr. R. Raghavaiah, Dr. L.G. Giri Rao, Dr. B. Sreemannarayana and Dr. M.V.R. Subramanyam.		

3.4.6.2: Tamarind based Agrihorticulture system for improving sustainability in semi-arid area

Sl. No.	Item	Details
1	Specifications and salient technical features	For semi-arid areas of marginal lands tamarind is very suitable hardy tree species. Earlier dry land farmers were cultivating seedlings of Tamarind which are poor yielders with long gestation period. When graftings of PKM-1 were planted in the system the early optimum yields were obtained with less gestation period. As spacing of tamarind is very wide (10 M X 10 M) upto 6 years filler plants such as custard apple and curry leaf (within row) and between rows rainfed crops such as red gram, cluster bean, sorghum and cowpea were grown to get some economic returns.

2	Performance results	In tamarind plantation (6 years old) higher raw pod yield of tamarind (1.7 t ha^{-1}), filler plant yield of custard apple (0.7 t ha^{-1}) and intercrop yield of redgram (1.7 t ha^{-1}) was realized. The entire system has produced net returns of Rs. 26,815/- ha^{-1} which was significantly superior when compared with other intercrops.
3	Likely cost	1.75 t ha^{-1} (pods) 0.7 t ha^{-1} (custard apple) 1.7 t ha^{-1} (red gram) Rs. 26,815/- ha^{-1} net returns Age of trees 6 years
4	How the new technology will impact the farmers and its benefits over conventional technologies / know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information.	Risk management and Input use is very less. Assured income every year from grown up trees and intercrops.
5	Social / environmental / other benefits	Suitable and viable for dry land agroforestry farmers. Accumulation of continuous fall of leaf litter will enrich the low fertility status of marginal lands.
6	Status of commercialization / IP rights etc.,	The dry land famers are realizing the importance and benefits of agri-horti system for sustaining production.
7	Efforts for technology dissemination	Villages under the control of KVK and DATTAC centres of RARS Southern Telangana Zone, Telangana.
8	Special requirement for its successful realization; any other standards etc.,	Need the help of extension departments, KVK's for further popularizing of the system.
9	Indicative photographs	 
10	Contact details of person from whom technology and further details can be obtained	KVK and DATTAC centres, Regional Agricultural Research Station Palem, Mahaboobnagar, Telangana.
11	Source of availability of technology / expertise.	Principal Scientist (Agronomy) & OIC AICRP on Agroforestry Rajendranagar, Hyderabad-500030, Telangana
Name of Contributors: Dr. A. Krishna, Dr. M.A. Aariff Khan, Dr. B. Joseph, Dr. K. Prabhavathi, Dr. R. Raghavaiah, Dr. L.G. Giri Rao, Dr. B. Sreemannarayana and Dr. M.V.R. Subramanyam.		

3.4.6.3: Land utilization in Tamarind plantation with economically important plants.

Sl. No.	Item	Details
1	Specifications and salient technical features	In the agri-horti system with Tamarind, after five years onwards as the tamarind tree size (canopy spread) and shade effect is increased, the filler plants were also removed as it is not possible to cultivate agricultural crops economically. Then it was converted to silvi-horti system keeping in view of the available space with least managed hardy species having demand such as henna was selected to grow with one or two rows in between Tamarind trees.
2	Performance results	In tamarind plantation (12 years old) highest raw pod yield of tamarind (2.4 t ha^{-1}) was recorded. Whereas, henna with double rows produced significantly higher biomass (0.7 t ha^{-1}) when compared with single row (0.6 t ha^{-1}). The total system has produced net returns of Rs. 58,200/- $ha^{-1.}$
3	Likely cost	2.4 t ha^{-1} (Pods) 0.7 t ha^{-1} (biomass) Rs. 58,200/- ha^{-1} (net returns) Age of trees 12 years.
4	How the new technology will impact the farmers and its benefits over conventional technologies / know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information.	The inter spaces can be utilized for getting additional income in addition to fruit yield.
5	Social / environmental / other benefits	The system gives insurance against vagaries of low rainfall conditions.
6	Status of commercialization / IP rights etc.	This agri-horti system utilized land effectively with economically profitable crops.
7	Efforts for technology dissemination	Villages under the control of KVK and DATTAC centres of RARS Southern Telangana Zone, Telangana.
8	Special requirement for its successful realization; any other standards etc.	Need the help of extension departments, KVK's for further popularizing of the system.

9	Indicative photographs	 **Tamarind +Henna (2 rows)**
10	Contact details of person from whom technology and further details can be obtained	KVK and DATTAC centre, Regional Agricultural Research Station Palem, Mahaboobnagar, Telangana.
11	Source of availability of technology / expertise	Principal Scientist (Agronomy) & OIC AICRP on Agroforestry Rajendranagar, Hyderabad-500030, Telangana
Name of Contributors: Dr. A. Krishna, Dr. M.A. Aariff Khan, Dr. B. Joseph, Dr. K. Prabhavathi, Dr. R. Raghavaiah, Dr. L.G. Giri Rao, Dr. B. Sreemannarayana and Dr. M.V.R. Subramanyam.		

3.4.6.4: Performance of medicinal herbs and trees in silvi medicinal system for eco-restoration of degraded lands

Sl. No.	Item	Details
1	Specifications and salient technical features	In Silvi-medicinal system, with *Terminelia bellerica* trees grown on less fertile soil, economic yield could be obtained after 3 years. The spacing adopted is 3.6 m x 3.6 m. The trees grown produces partial shade in the system. In between trees, medicinal herb like Andrographis was grown. This system has produced good economic yield upto 5 years. Similarly, *Emblica officinalis* (Amla) trees grown on marginal lands. Higher, economic yield could be obtained after 3 years. The spacing adopted was 3.6 m x 3.6 m. the trees grown produces partial shade covering the space provided. The intercropping of Andrographis has produced higher herbage yield in the initial years.
2	Performance results	Among the two medicinal crops tested *Terminelia bellerica* + Andrographis has produced significantly higher pod yield of 4.0 t ha^{-1} and Herbage 4.1 t ha^{-1} when compared with *Emblica officinalis* + Andrographis system (up to 5 years) . Among the manures, application of vermicompost @ 1.5 t ha^{-1} produced significantly higher seed yield than other manures.

3	Likely cost	*Terminelia bellerica* + Andrographis system (up to 5 years) 4.0 t ha^{-1} (pod yield) 4.1 t ha^{-1} (herbage yield) Rs. 68,505/- ha^{-1} (net returns) *Emblica officinalis* + Andrographis system (up to 5 years) 2.8 t ha^{-1} (fruit yield) 4.2 t ha^{-1} (herbage yield) Rs. 66,897/- ha^{-1} (net returns)
4	How the new technology will impact the farmers and its benefits over conventional technologies / know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information.	In marginal lands, growing of medicinal crops like andrographis with *Terminelia bellerica* sps gives good economic returns over *Emblica officinalis* system (Fruit species).
5	Social / environmental / other benefits	It is a viable system for improving marginal lands. In the long run, continuous leaf fall of leaf litter of medicinal trees will enrich the fertility status of marginal lands.
6	Status of commercialization / IP rights etc.,	The dry land farmers are realizing importance of this Silvi-medicinal system for getting higher returns. The andrographis herbage is useful commercially for preparation of medicine for fevers.
7	Efforts for technology dissemination	Villages under the control of KVK and DATTAC centres of RARS Southern Telangana Zone, Telangana State.
8	Special requirement for its successful realization; any other standards etc.,	Need the help of extension departments, KVK's for further popularizing of the system.
9	Indicative photographs	 ***Terminelia bellarica* + Andrographis**
10	Contact details of person from whom technology and further details can be obtained	KVK and DATTAC centre, Regional Agricultural Research Station Palem, Mahaboobnagar, Telangana.
11	Source of availability of technology / expertise	Principal Scientist (Agronomy) & OIC AICRP on Agroforestry Rajendranagar, Hyderabad-500030, Telangana
Name of Contributors: Dr. A. Krishna, Dr. M. A. Aariff Khan, Dr. B. Joseph, Dr. K. Prabhavathi, Dr. R. Raghavaiah, Dr. L. G. Giri Rao, Dr. B. Sreemannarayana and Dr. M. V. R. Subramanyam.		

3.4.6.5: Production potential of rainfed castor with INM practices in *Pongamia* based Agri silviculture system

Sl. No.	Item	Details
1	Specifications and salient technical features	Castor is one of important and economical oil seed crop in Southern Telangana districts of state. The area under castor cultivation is large and it is very suitable in red chalka soils under rainfed conditions during *kharif*. Now high yielding, improved and hybrid varieties are available, by which production potential is increased. Castor such a crop will respond to nutrient management practices, as such high yields are obtained in farmers fields. Though pongamia is a multipurpose tree, but now a days more emphasis is given as a source of biodiesel. The tree species is suitable in all type of soils and grow well in dry land situations in semi-arid areas. In young plantations up to 3rd to 4th year castor is successfully cultivated as rainfed crop during *kharif* in red chalka to sandy loam soils. The productivity and soil fertility is sustained by following nutrient management practices.
2	Performance results	Conjoint use of 75% RD N + Vermicompost 2 t ha^{-1} significantly influenced the higher seed and stalk yield (0.897 and 1.835 t ha^{-1}) over farmers practice i.e FYM alone 12 t ha^{-1} (0.476 and 1.059 t ha^{-1}). The same nutrient management practice registered the higher OC content (0.72%) and available N (184.0 kg ha^{-1}).
3	Likely cost	The gross and net returns by castor is Rs. 12,600/- ha^{-1} and Rs. 5,600/- ha^{-1} as compared to farmers practice. Rs. 6,712/- ha^{-1} and Rs. 1,212/- ha^{-1}. The B:C ratio was of best practice is 1.8 as compared to farmers practice 1.2.
4	How the new technology will impact the farmers and its benefits over conventional technologies / know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information.	Nutrient management practices adoption will be definitely influence higher seed yield of castor in agroforestry system than farmers practice where only FYM is applied. Still farmers are using traditional poor yielding varieties. Whereas the improved variety Kranthi is responding to fertilizers and vermicompost. In red chalka soils the performance of all rainfed crops in *kharif* are poor due to lack of nutrient availability. But castor with improved variety by nutrient management practice perform well in agroforestry system.

5	Social / environmental / other benefits	Castor with broad leaf nature reduces the impact of rain drop and covers land surface entirely which allow rain water to move slow over the soil surface there by protects the soil erosion and increase infiltration. Falling of leaf litter by pongamia and castor act as mulch on soil surface there by conserving the rain water and soil moisture resulting the improvement of physical conditions of soil and improvement of fertility. Both pongamia and castor can be used as biofuel purpose with the establishment of oil extracting units. The local labour will be involved in pod collection there by employment generation is increased.
6	Status of commercialization / IP rights etc.,	Technology will be transferred to small and marginal farmers under various Govt. programmes under department of waste lands development and rural development as well as through NGO's in nearby districts.
7	Efforts for technology dissemination	Villages under the control of KVK and DATTAC centres of RARS Southern Telangana Zone, Telangana State.
8	Special requirement for its successful realization; any other standards etc.,	Need the help of extension departments, KVK's for further popularizing of the system.
9	Indicative photographs	 **Castor in Pongamia based agri silvi cultural system with INM practices**
10	Contact details of person from whom technology and further details can be obtained	KVK and DATTAC centres, Regional Agricultural Research Station Palem, Mahaboobnagar, Telangana.
11	Source of availability of technology / expertise	Principal Scientist (Agronomy) & OIC AICRP on Agroforestry Rajendranagar, Hyderabad-500030, Telangana
Name of Contributors: Dr. A. Krishna, Dr. M. A. Aariff Khan, Dr. B. Joseph, Dr. K. Prabhavathi, Dr. R. Raghavaiah, Dr. L. G. Giri Rao, Dr. B. Sreemannarayana and Dr. M. V. R. Subramanyam.		

3.4.6.6: Performance of *rabi* sweet sorghum in Pongamia based agri-silvi culture in red sandy loam soil

Sl. No.	Item	Details
1	Specifications and salient technical features	In dry land areas of Southern Telangana region, sorghum is one of the important and suitable multipurpose millet crop in red sandy loam (Chalka) soils. The fertility status of soil is very low to medium. Even in that condition it is one of the best crop to fit in to agroforestry system. The input cost and water requirement is low. Compared to other crops. Year by year the area under millets is decreasing, hence millets are recommended to increase the area. *Pongamia pinnata* is suitable MPT's and promoting as biodiesel tree species in marginal lands with low fertility status. Up to juvenile period there is no income from young plantations. To get some quick returns sorghum crop is recommended.
2	Performance results	Integrated use of 75% RD N + 25% N through poultry manure resulted the highest grain (3.192 t ha^{-1}) and stover (8.595 t ha^{-1}) yield over control (2.070 and 4.405 t ha^{-1}) of *rabi* sweet sorghum in pongamia based agri silvi system. Regarding quality parameters the same treatment registered the highest brix (12.48%) and sucrose content (9.59%). The nutrient management practice also influenced the better soil fertility improvement in terms of organic carbon (0.69%) and available NPK (247.0, 26.7, 238.0 kg ha^{-1}).
3	Likely cost	The total gross and net returns Rs. 44812/- ha^{-1} and Rs. 22,312/- ha^{-1} as compared to farmers practice (Control) Rs. 27,307/- ha^{-1} and Rs.19,000/- ha^{-1}. The B:C ratio was 2 as compared to farmers practice 1.4.
4	How the new technology will impact the farmers and its benefits over conventional technologies / know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information.	The integrated nutrient management practice will definitely improve the yield and sustain the fertility. Cultivating inter crop in young plantations will control the soil erosion and weed problem. Farmers were motivated to choose millet crop useful for food and fodder risk involvement and input use is low.

5	Social / environmental / other benefits	Pongamia based agri silvi culture system is useful for production of biodiesel as well as for soil enrichment of low fertility soils. In future the rural lively hood is increased as employment generation in collecting pods and extraction of oil units.
6	Status of commercialization / IP rights etc.,	The technology was popularized through the training programme conducted KVK and DATTAC centers of Southern Telangana Zone, T.S.
7	Efforts for technology dissemination	Villages under the control of KVK and DATTAC centres of RARS Southern Telangana Zone, Telangana State.
8	Special requirement for its successful realization; any other standards etc.,	Need the help of extension departments, KVK's for further popularizing of the system.
9	Indicative photographs	 **Pongamia + Sweet sorghum**
10	Contact details of person from whom technology and further details can be obtained	KVK and DATTAC Centres, Regional Agricultural Research Station Palem, Mahaboobnagar, Telangana.
11	Source of availability of technology / expertise	Principal Scientist (Agronomy) & OIC AICRP on Agroforestry Rajendranagar, Hyderabad-500030, Telangana
Name of Contributors: Dr. M.A. Aariff Khan, Dr. K. Prabhavathi and Dr. M.V.R. Subramanyam		

3.4.6.7: Nutrient management of pearl millet in Pongamia based Agri-silvi culture in marginal lands.

Sl. No.	Item	Details
1	Specifications and salient technical features	In dry land areas of Southern Telangana regions the pearl millet is important and suitable short duration crop in red sandy loam (Chalka) soils. The fertility status of marginal lands is very poor. It is one of the best rainfed millet crop fit in to agroforstry system. The input cost is low compared to other rainfed crops. Pongamia a multipurpose tree species promoting as a source of biodiesel in future and suitable for marginal lands in semi-arid conditions. In addition, it is NFT having high N content in leaf. Therefore, the application of green leaf manure is used as a source of nutrient and enrichment of fertility. In young plantations of pongamia, to get quick returns the pearl millet is recommended as rainfed crop in *kharif*.
2	Performance results	Significant higher grain (2.160 t ha^{-1}) and stover (3.601 t ha^{-1}) yield of pearl millet was recorded in conjunctive use of 80 kg N ha^{-1} + pongamia green leaf manure (PGLM) 10 t ha^{-1} in Agroforestry system as compared to sole crop without trees (1952 and 3349 kg ha^{-1}). The same nutrient management practice showed higher organic carbon content (0.56%) and available NPK (173.0, 28.7, 280.0 kg ha^{-1}).
3	Likely cost	The gross (Rs. 31,321/- ha^{-1}) and net (Rs. 13,821/- ha^{-1}) returns of pearlmillet in pongamia based agroforestry system as compared to sole crop without trees (Rs. 28,447/- and 14,697/-). The B:C ratio are Rs. 1.8 :1 and 2.1:1.
4	How the new technology will impact the farmers and its benefits over conventional technologies / know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information.	Use of green leaf manure is emphasized as source of nutrient and lot of quantity is available in the existing pongamia plantations. Which influence the productivity of inter crop and enrich soil fertility. The inputs use in the nutrient management practice is low. For production of biodiesel plantation of pongamia is having good future. For marginal lands and low fertility soil pongamia is recommended.

5	Social / environmental / other benefits	In future the demand for biodiesel is more. The dry land and agroforestry farmers who are showing interest in future are in good position. As such their economic status will be improved. Regarding environmental benefits as pongamia is good for soil binding effect hence soil erosion is minimized. Due to rise of pongamia plantation area in future there is scope for establishment of oil extracting units. Through which employment generation will takes place.
6	Status of commercialization / IP rights etc.,	The practices of nutrient management in intercrop pearl millet in agri silvi system is popularized to farmers through training programmes conducted by KVK and DATTAC centers of Southern Telangana Zone, T.S.
7	Efforts for technology dissemination	Villages under the control of KVK and DATTAC centres of RARS Southern Telangana Zone, Telangana State.
8	Special requirement for its successful realization; any other standards etc.,	Need the help of extension departments, KVK's for further popularizing of the system.
9	Indicative photographs	  **Pongamia + Pearl millet**
10	Contact details of person from whom technology and further details can be obtained	KVK and DATTAC centres, Regional Agricultural Research Station Palem, Mahaboobnagar, Telangana.
11	Source of availability of technology / expertise	Principal Scientist (Agronomy) & OIC AICRP on Agroforestry Rajendranagar, Hyderabad-500030, Telangana
Name of Contributors: Dr. M.A. Aariff Khan, Dr. R. Raghavaiah, Dr. K. Prabhavathi and Dr. M.V.R. Subramanyam.		

3.4.6.8: Response of finger millet to nutrient management in *Melia* based Agri silvi system in marginal lands

Sl. No.	Item	Details
1	Specifications and salient technical features	The dry land areas of Southern Telangana Districts are suitable for cultivation of millets. Among them finger millet is preferred during *kharif* as rainfed crop in marginal lands because of short duration less inputs use and low water requirement. The risk involvement is less with assured income in short time. *Melia azaderach* is a new fast growing tree species gaining importance among dry land farmers. The tree species is coming up well in marginal lands mainly for wood and timber. In young plantations cultivation of millets under rainfed condition is possible with less input expenditure. To get optimum yield and sustain fertility adopting nutrient management practices is recommended.
2	Performance results	Significantly higher grain and straw (1.985 and 4.010 t ha^{-1}) yields resulted in 75% RDN + 25% N poultry manure over farmers practice in agroforestry system and on par with sole crop without agroforestry. Regarding soil aspects the same nutrient management practice influenced the highest OC content (0.89%) and available NPK (296.0, 40.5 and 357.0 kg ha^{-1}).
3	Likely cost	The total gross and net returns of finger millet Rs. 34,957/- ha^{-1} and Rs. 19,540/- ha^{-1} as compared to control. The B:C ratio obtained 2:1 and 1:1 respectively.
4	How the new technology will impact the farmers and its benefits over conventional technologies / know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information.	Off late dry land farmers of agroforestry are showing interest to grow fast growing tree species with economic importance. The tree species are performing well in marginal lands. In young plantations cultivation of finger millet is possible as the input expenditure is low and performing well in red sandy loam soils of marginal lands. It obtain optimum yields and improvement of soil fertility, adoption of nutrient management practices is very ideal and feasible. Recent times there is great demand for wood and timber. As *Melia azaderach* species is fast growing with short rotation is preferred in marginal lands and dry land areas. Under such situation the economic status of agroforstry farmers will definitely improved to some extent. Finger millet crop is useful for grain/ food and fodder for livestock. The risk involvement is less and assured income to farmers is helpful to family needs.

5	Social / environmental / other benefits	Off late the demand for wood and timber is more, hence the popularizing fast growing tree species such as Melia sps. is the need of the hour. Under these conditions areas of marginal and waste lands are brought in to tree plantations. By establishment wood and timber industries, employment generation is created. Presently the area under millets is decreasing year by year. Consumption of millets as food will overcome the wealth problems. Fodder is useful for livestock maintenance during off season.
6	Status of commercialization / IP rights etc.,	The practices of nutrient management in finger millet as intercrop in agri silvi system is popularized to dry land farmers through training programmes conducted by KVK's and DATTAC centers of different agro climatic zones of State.
7	Efforts for technology dissemination	Villages under the control of KVK and DATTAC centres of RARS Southern Telangana Zone, Telangana State.
8	Special requirement for its successful realization; any other standards etc.,	Need the help of extension departments, KVK's for further popularizing of the system.
9	Indicative photographs	 ***Melia azaderach* + Finger millet**
10	Contact details of person from whom technology and further details can be obtained	KVK and DATTAC centres, Regional Agricultural Research Station Palem, Mahaboobnagar, Telangana.
11	Source of availability of technology / expertise	Principal Scientist (Agronomy) & OIC AICRP on Agroforestry Rajendranagar, Hyderabad-500030, Telangana
Name of Contributors: Dr. A. Krishna, Dr. M.A. Aariff Khan, Dr. B. Joseph and Dr. K. Prabhavathi.		

3.4.7: JNKVV, Jabalpur (Madhya Pradesh)

3.4.7.1: Eucalyptus based Agri-silviculture system

Sl. No.	Items	Details
1	Specification and salient technical features	Kymore plateau and Satpura hills- Agro-climatic zone Jabalpur is situated at 21°04' North latitude and 74°02' and 82°49' East longitude with an altitude of 411.78 meters above the mean sea level. The climate of locality is characterized by hot dry summer and cool dry winter. It is broadly known as rice-wheat crop zone of MP. The mean annual rainfall, based on last 20 years data is 1350 mm, which is mostly received from south west monsoon between mid-June to end of September. The pedons were very deep and their texture varied from sandy loam to clay in surface horizons and clay loam to clay in sub soil. Sub- angular and angular block were the dominant structure. The soil are calcareous and nature to mildy alkaline in soil reaction. Organic carbon is low to medium in surface layer and decreased with depth. Cat ion exchange capacity and Ca++ and Mg++ ion is high in horizons having high clay. The soil is poor in organic matter and having poor productivity. About 60 % area is under rainfed condition. The distribution of rainfall is very erratic hence farmers are facing problem of heavy rainfall, long and frequent, dry spell, drought condition, frost and untimely occurrence of rains hail storm, hence agricultural crops are in some pocket, generally failed and farmers gets poor return. On the other side, due to increasing population, there is shortage of fuel, fodder and timber. Hence agro-forestry the only option which can additionally supply fuel, timber wood and raw material for industries (paper mill and cottage industry) as additional benefit. Growing of crop like paddy, wheat, arhar with eucalyptus helps in conservation of soil and water because as it work as shelterbelts, protection of soil, supply of timber, fuel wood as pole and raw material for paper industries. Eucalyptus is very popular in MP especially in Kymore plateau and planted by farmers in good and poor soil. It is planted in field bund and culturable

		wasteland. It can be grown in un-irrigated as well as irrigated condition. In commercial plantation drip irrigation provided by the farmers for saving of water and higher tonnage in short time.
2	Performance results	Eucalyptus based agri-silviculture system where paddy, wheat, arhar grown (as intercrop) with eucalyptus produce paddy 2.5 t ha^{-1}, wheat 2.5 t ha^{-1} and arhar 1.5 t ha^{-1} (1st year)- 0.3 t ha^{-1} (4th year) and eucalyptus tree @ Rs. 250-750 tree resulting higher net profit. Besides this there has been reduction in weed population and regular inter culture of operation help in conservation of moisture.
3	Likely cost	Total cost of cultivation in eucalyptus + paddy & wheat in 6 year vary from Rs 10,000-15,000/- $ha^{-1}yr^{-1}$ giving output in terms of net profit per unit area from eucalyptus (planted in field bund 2m apart) + paddy + wheat was 82,000/- $ha^{-1}yr^{-1}$. When eucalyptus planted in field 8m x 1.5 m (paired row) with arhar crop produce net profit per unit area was Rs. 1,26,000/- $ha^{-1}yr^{-1}$ as compared to arable cropping i.e., Rs 53,000/- $ha^{-1}yr^{-1}$ was obtained with paddy-wheat and Rs 34,500/- $ha^{-1}yr^{-1}$ with arhar grown alone (with eucalyptus).
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know- how in terms of saving the cost of production, inputs, timeliness; and other pertinent information.	Over all net income per hectare per year with Eucalyptus (planted in field boundary 5m apart)+ paddy+ wheat raised from Rs 53,000/- (paddy+ wheat alone) to Rs 82,000/- $ha^{-1}yr^{-1}$ (eucalyptus + paddy + wheat). Similarly net income per hectare per year with eucalyptus planted in fields 8m X 1.5 m (paired row) raised from Rs 34,500/- ha^{-1} yr^{-1} to Rs 1, 26,000/- ha^{-1} yr^{-1}.
5	Social/environmental/other benefits	Eucalyptus is tall, narrow canopy spread plant, hence it work as shelterbelt, protect the field crops from hot blowing wind result conservation of moisture, improvement in soil health, environment security, help in drain out excessive water in water logged soil. Besides Co_2 sequestration and soil improvement, it increases organic matter and also increases bulk density and infiltration. Farmers believe that eucalyptus plantation reduced water table, but it is not true. It is shallow rooted tree hence no adverse effect on water table has been observed. This plant is very useful where soil is suffering due to water logging continuous saturation. Such ill drained soil can be reclaimed successfully with eucalyptus based agri-siviculture system.

6	Status of commercialization/ IP rights etc.	This technology has already been reached to the farmer's field through team of KVK Jabalpur, Umeria and adjoining part of Jabalpur.
7	Efforts for technology dissemination	A large number of farmer's used this technology in large scale Mr. Deepankar Agrawal village Majeda (Bheraghat, Jabalpur) planted Eucalyptus in 160 acre and different kharif crop like paddy some medicinal plant like Buch and wheat crop in rabi season was taken. Mr. R K Nema in new Bharaghat, Jabalpur planted Eucalyptus in 100 acre and taking crop. Mr. Manesh Choubey, village Muskura planted Eucalyptus in 20 acre area and taking wheat, soyabean, mustard, gram, chilli etc.
8	Special requirement for its successful realization; any other standards etc.	This technology is suitable for rainfed, poor land, undulating soil even in water logged soil. According to different situation, selection of suitable intercrop like paddy in water logged condition. In initial stages besides paddy, wheat, soyabean, mustard, chilli can be taken. As the plant grows (3rd year onward and produced shade) turmeric and oat (fodder) crop can be taken successfully.
9	Indicative photographs	   
10	Contact details of person for whom technology and further details can be obtained	Dr. L.D. Koshta, Principal Scientist, Department of Forestry, CoA, JNKVV, Jabalpur, Phone: 08602380500
11	Source of availability of technology/ expertise.	OIC, AICRP on AF, JNKVV, Jabalpur
Name of Contributors: Dr. L.D. Kostha, Dr. M. L. Sahu and Dr. R. Dongre		

3.4.7.2: Guava based Agri-horticulture system in central India (Kymore plateau)

Sl. No.	Items	Details
1	Specification and salient technical features	Guava is second most popular fruit tree of Madhya Pradesh. It can be grown successfully in variety of soil and climatic condition. Guava is generally cultivated by farmers as orchards or grown mostly on bund and in the field with different arable crops. Farmers and their family are generally suffered due to malnutrition and fruits are the main sources of nutrition. In the state of Madhya Pradesh 60 % area under rainfed hence cultivation depends on rains and moisture conservation practices. The rainfall pattern is very erratic hence crops are generally adversely affected by weather condition, hence in arable cropping farmers not getting sufficient return for their livelihood. Introduction/ inclusion of fruit tree with arable cropping (agri-horticulture) not only provide nutritional security but also assure employment and livelihood security besides conservation of soil and moisture. Under rainfed condition mustard can be grown successfully, hence mustard crop were introduced with guava. The plantation of guava (variety L-49) with mustard crop can be continuously grown for 3 years.
2	Performance results	Fruit based agri-horticulture system produce mustard yield vary from 0.24 to 0.424 t ha^{-1} and fruit yield 2.10 t ha^{-1} to 3.90 t ha^{-1} resulting higher net profit. Besides this, crop residue of crop and litter fall of fruit tree helps in increasing organic matter through decomposition along with conservation of moisture and improvement in physical condition of soil.
3	Likely cost	Total cost of cultivation in 14 year is approx. Rs. 42,000/- i.e., (3,000/- $ha^{-1}yr^{-1}$), output in term of net profit per unit area is Rs 11,000/- ha^{-1} yr^{-1} as compared to orchard alone (Rs 8,700/- $ha^{-1}yr^{-1}$). In farmer's field also agri-horticulture system (guava + wheat) gave higher profit/ unit area (Rs 23,000/- ha^{-1} yr^{-1}) as compared to wheat alone (19,000/- $ha^{-1}yr^{-1}$).
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know- how in terms of saving the cost of production, inputs, timeliness; and other pertinent information.	The overall net income ha^{-1} yr^{-1} with guava + mustard raised from Rs 8,700/- $ha^{-1}yr^{-1}$ (guava alone) to Rs 11,000/- $ha^{-1}yr^{-1}$ (guava + paddy) under partial irrigation condition. Similarly for the net income ha^{-1} yr^{-1} with guava + wheat raised from Rs 19,000/- ha^{-1} yr^{-1} crop alone i.e., farmers practices to Rs 23,000/- $ha^{-1}yr^{-1}$ under agri-horticulture system.

5	Social/environmental/other benefits	Tree cover reduces the free flow of runoff; reduce velocity of runoff, water erosion, increase infiltration and help in water retention and conservation (storage) in the field/ soil. Organic residue of crops and tree also improves the physical condition of soil.
6	Status of commercialization/ IP rights etc.	This technology has been popularized through training, SMS and also through wasteland development programme. TSP programme through AICRP on Agroforestry also promotes the adoption and popularization of Agri-horticulture system.
7	Efforts for technology dissemination	Technology has already been transferred to the farmers field through training by KVK's, wasteland development project and TSP scheme under AICRP AF but not at commercial scale, Mr. Rajkumar Darpan, village Jodhpurtola (Tilwara) is taking different crop like gram, wheat with guava. Growing of wheat in guava orchards is prevalent in Sehora block where most of the farmers grown guava in their field.
8	Special requirement for its successful realization; any other standards etc.	This technology is suitable under un irrigated, irrigated as well as in partial irrigated condition, poor land. The farmers are generally planted Guava in field bunds and in kitchen garden and taking number of crops like paddy, wheat, arhar, soyabean, even vegetables as intercrop.
9	Indicative photographs	 **Guava + mustard**  **Guava + wheat**
10	Contact details of person for whom technology and further details can be obtained	Dr. L.D. Koshta, Principal Scientist, Department of Forestry, CoA, JNKVV, Jabalpur Phone: 08602380500
11	Source of availability of technology/ expertise.	OIC, AICRP on AF, JNKVV, Jabalpur
Name of Contributors: Dr. L.D. Kostha, Dr. M.L. Sahu and Dr. R. Dongre		

3.4.7.3: Aonla-Bael based horti-medicinal system in central India (Kymore plateau)

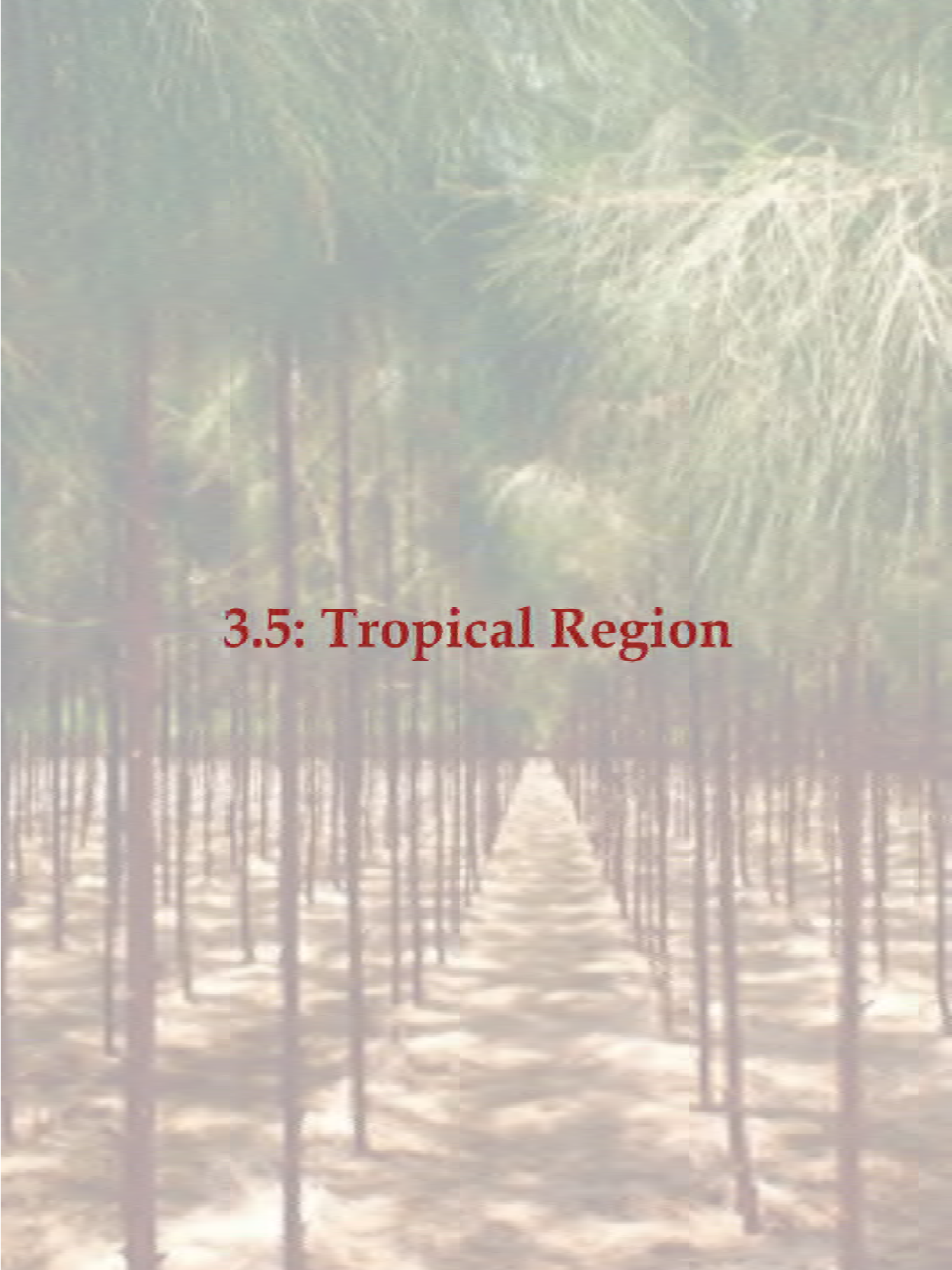
Sl. No.	Items	Details
1	Specification and salient technical features	Aonla or Indian gooseberry *(Emblica officinalis)* and bael (*Aegle marmelos*) are hardy in nature and suitable for growing in dry and wasteland area. Fruits are nutritive and having medicinal value. Aonla has sparse foliage which allow 87.5 percent area for inter cropping during initial 10 years. As the plant grow, produced shade hence shade tolerant crops like turmeric can be grown successfully. In dry area where most of cultivated fruit plant cannot perform well under such condition such wild fruits (aonla and bael) can grow successfully. The fruits are required less nutrient, low water requirement grow well under adverse condition. This soil having poor water holding capacity, shallow in depth gravel, undulation not suitable for agriculturable crops, wild fruit tree grow successfully with higher return. Hence in MP quite good amount of area under wasteland (11%). Thus these areas can be utilized for efficiently and economically by fruit based horti-medicinal system. Turmeric crop was introduced in aonla-bael plantation this system helps in utilization of waste land, culturable wasteland, dry area, undulating, poor soil, shallow in depth and poor water holding capacity. At the time of establishment of orchard, recommended package of practices for cultivation of wild fruit tree was followed and plantation was made 5m x 5 m row to row spacing. No irrigation is required to crop during kharif but in rabi irrigation is required as & when water require.
2	Performance results	Wild fruit based horti- medicinal system (where fruit plant were planted 5m x 5 m) produced turmeric yield 8.3-9.4 t ha^{-1}, aonla 8.0 t ha^{-1} and bael 75-80 fruit /tree resulting higher net profit. Turmeric grown in ridge bed method and higher yield (9.3 t ha^{-1}) as compare to flat bed method (8.5 t ha^{-1}). This system facilitate in conservation of soil (through checking soil erosion) and water (reduce runoff, increase percolation and conservation of soil moisture.
3	Likely cost	The average cost of cultivation in fruit tree is Rs. 2,000- 3,000/- ha^{-1} and field crop Rs 70,000- 80,000/- ha^{-1} output in term of net profit per unit area with aonla + turmeric was Rs 84,000/- $ha^{-1}yr^{-1}$ (at the age of 22 years).

4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know- how in terms of saving the cost of production, inputs, timeliness; and other pertinent information.	The overall net income ha^{-1} yr^{-1} with horti- medicinal system (i.e., aonla + turmeric) is Rs 84,000/- ha^{-1} yr^{-1} and Rs 95,000/- ha^{-1} yr^{-1} (bael + turmeric) as compare to growing of crop alone (turmeric) i.e., Rs 73,000/- ha^{-1} yr^{-1} (arable cropping farmer's practices) under partial irrigated condition.
5	Social/environmental/other benefits	Aonla, bael and turmeric reduces the impact of raindrop by covering the entire soil surface which reduce runoff velocity and protect the soil against soil erosion and improvement in infiltration/peculation of water in soil. Due to continuous fall of leaves add organic matter, improve physical condition of soil, and make soil healthy and productive.
6	Status of commercialization/ IP rights etc.	This technology has been popularized through training SMS of KVK, officers of Agriculture department through training organized in Agriculture institutes and Krishi Vigyan Kendra of JNKVV.
7	Efforts for technology dissemination	Technology has been transferred to farmers field through KVK under various training programme, field visit and through TSP also Mr. Deepankar Agrawal village Majeda (Bheraghat, Jabalpur) grown turmeric with aonla during year 2011-2012 in 7 acre. Mr. Manish Jha, village Seonitola taking wheat with aonla in 3 acre area.
8	Special requirement for its successful realization; any other standards etc.	As technology is based on utilization of degraded land by plantation of aonla and tropical fruit tree. Farmers are taking other crop like wheat with aonla under partial irrigation condition.
9	Indicative photographs	
10	Contact details of person for whom technology and further details can be obtained	Dr. L.D. Koshta, Principal Scientist, Department of Forestry, CoA, JNKVV, Jabalpur Phone: 08602380500
11	Source of availability of technology/ expertise.	OIC, AICRP on AF, JNKVV, Jabalpur
Name of Contributors: Dr. L.D. Kostha, Dr. M. L. Sahu and Dr. R. Dongre		

3.4.7.4: *Dalbergia sissoo* + paddy-wheat based Agri-silviculture System

Sl. No.	Items	Details
1	Specification and salient technical features	*Dalbergia sissoo* is most suitable tree for agroforestry, having fast growth, clear bole and nitrogen fixing capacity besides providing protein rich fodder. This species is famous for afforestation/reforestation both in social forestry and in agroforestry. In State of Madhya Pradesh, there is a huge gap in between supply and demand of wood for fuel and timber *D. sissoo* can be grown successfully in variety of soils (light, medium, heavy, poor, shallow even in water logged) and climatic condition. In MP soil are vary from clay loam to clay, medium to heavy in nature, cracking when dry, good water holding capacity but poor drained. *D. sissoo* can be grown successfully in this soil. Jabalpur is situated in Kymore plateau broadly known rice-wheat crop zone of MP. Rice and wheat are the major crop hence, this area is most suitable for *D. sissoo* +paddy- wheat based agri-silviculture system. This system facilitate in improvement in soil fertility through nitrogen fixation, addition of nutrient through decomposition of legumes leaves, provide fodder to animals, fuel and food grain on suitable basis. It is a dominant species of MP hence soil and climatic condition favours its establishment and growth. There is heavy demand of *D. sissoo* wood in furniture. It grown in cultivable wasteland, field bund, poor soil, dry and moist conditions.
2	Performance results	*D. sissoo* based agri-silviculture system (on the basis of 3 year data) produced paddy grain 0.3-2.6 t ha^{-1}, wheat 1.5-2.4 t ha^{-1} and wood production 5.5-12.0 t ha^{-1} yr^{-1} resulting higher net profit. Besides this dry fodder in the form of paddy-wheat straw and pruned material 0.9 to 1.3 t $ha^{-1}yr^{-1}$ for fuel wood.
3	Likely cost	The total cost of cultivation per year with *D.sissoo* + paddy-wheat varies from Rs 19,000-21,000/- $ha^{-1}yr^{-1}$ under irrigated condition at 12 year age. Output (monetary return) in terms of net profit per unit area is Rs 41,000/- $ha^{-1}yr^{-1}$ under agrisilviculture system (*D. sissoo* + Paddy) as compare to crop alone (Rs. 28,000/- $ha^{-1}yr^{-1}$) and tree alone (Rs 27,000/- ha^{-1} yr^{-1}). Similarly *D. sissoo* + wheat gave output in term of net profit per unit area approximately Rs. 35000/- $ha^{-1}yr^{-1}$ under agri-silviculture system as compare to crop alone (Rs. 18,000/- $ha^{-1}yr^{-1}$) and tree alone (Rs 27,000/- $ha^{-1}yr^{-1}$).

4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know- how in terms of saving the cost of production, inputs, timeliness; and other pertinent information.	The overall net income per hectare per year with *D. sissoo* + paddy raised from 28,000/- $ha^{-1}yr^{-1}$ (paddy alone) to Rs 41,000/- $ha^{-1}yr^{-1}$ (*D. sissoo* + paddy). Similarly in *D. sissoo* + wheat net income per hectare per year increased from Rs 18,000/- $ha^{-1}yr^{-1}$ (wheat alone) to Rs. 35,000/- $ha^{-1}yr^{-1}$ (*D. sissoo* + wheat) under irrigated condition.
5	Social/environmental/other benefits	*D. sissoo* +paddy-wheat reduce velocity of raindrop covers land surface entirely, which reduce surface runoff, allow more time water to stay on the soil, increase infiltration and help in conservation of soil and moisture. Organic residues added by crops residues as well as decomposition of litter fall improve the physical properties of soil healthy by increasing bulk density, porosity and water holding capacity.
6	Status of commercialization/ IP rights etc.	This technology is adopted by farmers since long time where *D. Sissoo* was mostly planted by farmers in field bund. However this technology can be popularized through training of farmers via KVK, distribution of literature, field visit and demonstration. For popularization in large scale quality planting material of *D. sissoo* should be ensured.
7	Efforts for technology dissemination	Technology has been transferred to farmer's field through training, demonstration and through TSP programe.
8	Special requirement for its successful realization; any other standards etc.	As technology can be more popularized by increasing of high value like turmeric, ginger which can grow well under shaded condition. Inclusion of superior plantation material in the system also helps for increasing yield and tree monetary return/unit area/unit time.
9	Indicative photographs	 
10	Contact details of person for whom technology and further details can be obtained	Dr. L.D. Koshta, Principal Scientist, Department of Forestry, CoA, JNKVV, Jabalpur Phone: 08602380500
11	Source of availability of technology/ expertise.	OIC, AICRP on AF, JNKVV, Jabalpur
Name of Contributors: Dr L D Kostha, Dr M L Sahu and Dr R Dongre		

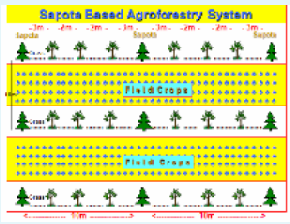
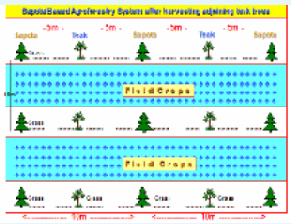


3.5: Tropical Region

3.5.1: UAS, Dharwad (Karnataka)

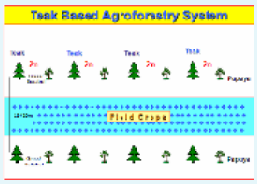
3.5.1.1: Sapota - teak based agroforestry system for hill zone of Karnataka

Sl. No.	Items	Details
1	Specifications and salient technical features	In order to develop a sustainable agroforestry model for the high rainfall /assured rainfall areas of Karnataka state, a multi component agroforestry system involving sapota as a base crop was planted at a recommended spacing of 10m x 10m. Three teak plants were planted in between two sapota plants. The tree rows are to be across the slope. The first teak at 3m from sapota and subsequent 2 trees of teak 2m, thus leaving 3m again between last tree and sapota. On either side of the sapota and teak, guinea grass is to be planted in a strip of 1m width. In between two rows of sapota + trees, field crop is to be grown for initial 8 – 10 years based on canopy coverage. Initially paddy is grown for 5 years and South African maize for 3 years and sunhemp for next 3 years until crown coverage. The perennial component was silviculturally managed and at the end of 17 years, two trees adjoining sapota were felled for pole purpose and the central one retained for timber purpose (28 years).
2	Performance results	The economic evaluation was worked out (28 years) by estimation of standing trees (timber, fuel wood etc.), income from fruit yield of sapota, receipt from felled trees at the end of 17 years and income from grass and crop yield. After felling teak trees adjoining sapota at the end of 17 years, the benefit cost ratio was 9.31 in sapota teak based agroforestry system.
3	Likely cost	The average cost of sapota + teak cultivation is Rs. 6486/- ha^{-1} yr^{-1}. Paddy yield obtained for initial 5 years is 2.5-3.0 t. $ha^{-1}yr^{-1}$ and the yield of South African maize is 2.5-2.6 t. $ha^{-1}yr^{-1}$ for 3 years. The result at the end of 28 years revealed that net returns was higher (12% discounted interest) in sapota+teak+field crop (Rs. 38,977/- $ha^{-1}yr^{-1}$) and benefit cost ratio was 3.23. Yield from sapota fruit yield at the end of 28 years is 10.42 t. $ha^{-1}yr^{-1}$.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Sapota can be used for juice, pulp and canning industries in addition to table purpose. Teak can be used for pole purpose and also teak timber is used for furniture and agricultural implements. In the initial years farmer can get the income from crop yields.

5	Social / environmental / other benefits	There was a marked improvement in soil fertility over the years as indicated by improvement of bulk density, pH and electrical conductivity (EC) of soil and also increase in organic carbon, potassium and phosphorus due to incorporation of leaf litter fall/decomposition.
6	Status of commercialization/IP rights etc.	Technology has been popularized through conducting agroforestry training programmes for the farmers / officers of the developmental departments from the Dharwad district and also farmers of the transitional and protective irrigation tract of Karnataka.
7	Efforts for technology dissemination	Technology has been transferred to farmer's field under agroforestry / biofuel training programs conducted by the department and also demonstrated in farmer's field under Technology Extension project on Agroforestry funded by National Wasteland Development Board (NWDB), Government of India, New Delhi.
8	Special requirement for its successful realization; any other standards etc.	The technology is based on sapota and teak trees, the availability of seedlings and required input for planting must be ensured by the concerned state departments.
9	Indicative photographs	  **Felling teak trees adjoining Sapota**  *Tectona grandis* with Sapota
10	Contact details of person from whom technology and further details can be obtained	Dr. S. M. Mutanal Principal Scientist and OIC, AICRP on Agroforestry University of Agricultural Sciences, Dharwad – 580005 (Karnataka) Ph: 0836-2442085 (O) 09449042937 (M)
11	Source of availability of technology/expertise	OIC, AICRP on AF, UAS, Dharwad – 580005 (Karnataka) Phone:0836-2442085 Fax:0836-2442085 E-mail: aicrpafdwd@uasd.in
Name of Contributors: Dr S M Mutanal, Dr S J Patil, Dr H Y Patil and Dr Sunita Johri		

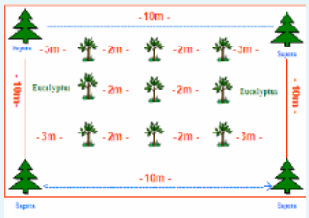
3.5.1.2: Teak based Agroforestry system

Sl. No.	Items	Details
1	Specifications and salient technical features	In order to develop a suitable agroforestry system for red gravely soil in transitional tract of Karnataka, an experiment was initiated during the year 1984 with teak at an alley of 20 m / 10 m and 2 m apart within the line. The interspace was used for raising a set of arable crops *viz*, chilli, ragi, sorghum and groundnut in a sequence. Papaya was planted in between teak to harness the extra resources available in the initial three years. If slope is more than 1%, guinea grass slips and subabul at 60 cm x 60 cm and 60 cm x 20 cm respectively, along with teak row. Fodder can be harvested at regular interval at 15 cm height, forming a live bund which serves as a barrier for runoff of rain water and to conserve soil and moisture.
2	Performance results	In the initial 3 years Papaya yield obtained was 30 kg $tree^{-1}$. Whereas at the end of 22 years timber yield obtained was 24.35 m^3 ha^{-1} in 10 m alleys and 13.46 m^3 ha^{-1} in 20 m alleys. The yield of the field crops *viz.*, Sorghum was 0.8-1.5 t. $ha^{-1}yr^{-1}$ and groundnut was 0.7-1.2 t. $ha^{-1}yr^{-1}$. The fodder yield obtained was 3.42 t. ha^{-1} at 10m alley and 1.89 t. ha^{-1} at 20m alley.
3	Likely cost	The economic evaluation was worked out (22 years) by estimation of standing trees (timber, fuel wood etc.), income from fruit yield of papaya, income from fodder and crop yield. The results at the end of 22 years revealed that highest net returns of Rs.12,316/- $ha^{-1}yr^{-1}$ were realized with Field crop + teak + papaya and unit cost of Rs. 5,838/- $ha^{-1}yr^{-1}$ (average of 10 and 20 m alley). The contribution of income from various components was 39 to 47% by arable crops and 48 to 58% by teak. Hence this system was recognized as a sustainable and viable system suitable for transitional and irrigated areas with red/shallow black soils.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Teak can be used for pole purpose and also Teak timber is used for furniture and agricultural implements. In the initial years farmer can get the income from crop yields and fodder. In the initial 3 years, Papaya can be used for juice, pulp and canning industries in addition to table purpose.

5	Social/environmental/other benefits	There was a marked improvement in soil fertility over the years as indicated by improvement of bulk density, pH and electrical conductivity (EC) of soil and also increase in organic carbon, potassium and phosphorus due to incorporation of leaf litter fall/decomposition. It also helps to increase green cover of the land. This technology is suitable for red gravely soil in transitional and irrigated tract of Karnataka.
6	Status of commercialization/IP rights etc.	The Technology helps for subsistence farming along with commercial cultivation of teak. Technology has been popularized through conducting agroforestry training programmes for the farmers / officers of the development departments from the Dharwad district and farmers of the transitional tract of Karnataka.
7	Efforts for technology dissemination	Technology has been transferred to farmer's field under agroforestry / biofuel training programs conducted by the Department and also demonstrated in farmer's field under Technology Extension project on Agroforestry funded by National Wasteland Development Board (NWDB), Government of India, New Delhi.
8	Special requirement for its successful realization; any other standards etc.	The technology is based on teak trees, the availability of seedlings and required input for planting must be ensured by the concerned state departments.
9	Indicative photographs	  **Teak + Groundnut**  **Teak + Sorghum**
10	Contact details of person from whom technology and further details can be obtained	Dr. S. M. Mutanal Principal Scientist and OIC AICRP on Agroforestry University of Agricultural Sciences, Dharwad – 580005 (Karnataka) Ph: 0836-2442085 (O) 09449042937 (M)
11	Source of availability of technology/expertise	OIC, AICRP on AF, UAS, Dharwad – 580005 (Karnataka) Phone:0836-2442085 Fax:0836-2442085 E-mail: aicrpafdwd@uasd.in
Name of Contributors: Dr S M Mutanal, Dr S J Patil, Dr H Y Patil and Dr Sunita Johri		

3.5.1.3: Horti-silvi pastural system under degraded soils

Sl. No.	Item	Details
1	Specifications and salient technical features	The experiment was conducted in degraded shallow clayey soils of hilly zone of Karnataka under rainfed conditions. Sapota was planted at 10 m x 10 m spacing. In between two rows of sapota, 3 rows of eucalyptus trees were grown. First eucalyptus row at 3 m from sapota and subsequent two rows at 2 m and thus leaving 3 m again between last eucalyptus row and sapota. Intra row spacing given for eucalyptus is 2 m apart. Natural grass was allowed to grow between plantation. All the trees were felled after 8-10 years and sapota was allowed for further growth.
2	Performance results	From this technology timber yield of eucalyptus and grass yield can be obtained. Sapota fruit yield can be obtained on an average of 0.354 t. ha^{-1} and grass yield 1-2 t. ha^{-1}.
3	Likely cost	The economic evaluation was worked out by estimation of standing trees (timber, fuel wood etc.), income from fruit yield of sapota, income from the grass. The results revealed that highest net returns of Rs. 9,864/- ha^{-1} yr^{-1} were obtained with the unit cost of Rs. 4,183/- ha^{-1} yr^{-1}. Benefit Cost ratio in this technology was 2.24. Hence this system was recognized as a sustainable and viable system suitable for degraded shallow clayey soils of hill zones of Karnataka.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Eucalyptus can be used for pole / timber purpose and also used for furniture and other medicinal purpose. In the initial years farmer can get the income from grass yield. Sapota can be used for preparation of juice, pulp and canning industries in addition to its table purpose.
5	Social / environmental / other benefits	The technology is helpful for increasing green cover, soil fertility and increasing income of the farmers having 'D' type of land holding. This technology is also suitable for low fertile/degraded soils/ wasteland area.

6	Status of commercialization/IP rights etc.	Technology has been popularized through conducting agroforestry training programmes for the farmers of the Dharwad district and farmers / officers of the developmental departments of the transitional tract of Karnataka.
7	Efforts for technology dissemination	Technology has been transferred to the farmer's field under agroforestry and biofuel training programs conducted by the department.
8	Special requirement for its successful realization; any other standards etc.	The technology is based on the availability of seedlings of eucalyptus and grafts of sapota and required input for planting must be ensured by the concerned state departments.
9	Indicative photographs	 
10	Contact details of person from whom technology and further details can be obtained	Dr. S. M. Mutanal Principal Scientist and OIC AICRP on Agroforestry University of Agricultural Sciences Dharwad – 580005 (Karnataka) Ph: 0836-2442085 (O) 09449042937 (M)
11	Source of availability of technology/expertise	OIC, AICRP on AF, UAS, Dharwad – 580005 (Karnataka) Phone: 0836-2442085 Fax:0836-2442085 E-mail: aicrpafdwd@uasd.in
Name of Contributors: Dr S M Mutanal, Dr S J Patil, Dr H Y Patil and Dr Sunita Johri		

3.5.1.4: Melia (*Melia azaderach*) based agroforestry system

Sl. No.	Item	Details
1	Specifications and salient technical features	The field trial on *Melia azaderach* based agroforestry system was initiated at main Agricultural Research Station, University of Agricultural Sciences, Dharwad on medium black clay soil under rainfed conditions during 2002. The experiment consisted of *Melia azaderach* planted at four spacings *viz*, 5m x 1 m, 5m x 2 m, 5m x 3 m and 5m x 4 m. Soybean (JS - 335) crop was grown in the interspace of *melia* rows during *Kharif* every year. Recommended package of practices were followed for soybean. Fertilizer dose of 100:50:100 NPK kg ha^{-1} was applied to *melia* in the initial four years. All the silvicultural practices were followed for better development of *Melia azaderach*.
2	Performance results	The diameter at breast height and crown area was significantly higher in wider spacing (5m x 4 m) as compared to narrow spacing (5m x 1 m). At the end of 10th year the soybean yield were significantly decreased in 5m x 1m and 5m x 2m spacing of melia as compared to 5m x 4m spacing. After 10 years, productivity of *Melia azaderach* was higher in 5m x 4m spacing.
3	Likely cost	Economic viability is one of the essential considerations for adoption of any technology by the farmer. Gross returns from soybean were higher in sole crop as compared to soybean with *Melia azaderach* agroforestry system. At the end of the experiment, income from *Melia azaderach* was worked out based on pole / biomass. The income from tree species was higher in wider spacing (5m x 3m) of *Melia azaderach* as compared to narrow spacing (5m x 1m). The economic evaluation was made based on prevailing market rate during the different years. At the end of 10th year net returns and BCR were higher in *melia* at 5mx4m+ field crop (Rs.10,502/- $ha^{-1}yr^{-1}$ and 1.86:1 respectively) followed by sole field crop (Rs.6,410/- $ha^{-1}yr^{-1}$ and 1.73:1 respectively) as compared to *Melia azaderach* at 5x1m + field crops (Rs.4,351/- $ha^{-1}yr^{-1}$ and 1.27:1 respectively).

4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The findings of the investigation depicts that the *Melia azaderach* can be grown at a wider spacing of 5m x 4m and the inter space can be used to raise agricultural crop. The system is economically viable. Farmer can get the income from soybean raised in the inter space and also from the *Melia azaderach*.
5	Social/environmental/other benefits	The technology is helpful for increasing green cover, soil fertility and increasing income of the farmers. *Melia azaderach* is considered as a multipurpose tree because of its multi directional and wide uses in agriculture. It is commonly planted along the bund / canal in irrigated area and its foliage is used for fodder purpose. It also has fungicidal, bacterial, antitumor and other medicinal properties.
6	Status of commercialization/IP rights etc.	Technology has been popularized through conducting agroforestry training programmes for the farmers and officers of the developmental departments of the Dharwad district and farmers of the transitional tract of Karnataka.
7	Efforts for technology dissemination	Technology has been transferred to the farmer's field under various agroforestry training programs conducted by the department.
8	Any special requirement for its successful realization; any other standards etc.	The technology is based on the availability of seedlings of *Melia azaderach* and required input for planting must be ensured by the concerned state departments.
9	Indicative photographs	
10	Contact details of person from whom technology and further details can be obtained	Dr. S. M. Mutanal Principal Scientist and OIC AICRP on Agroforestry University of Agricultural Sciences Dharwad – 580005 (Karnataka) Ph: 0836-2442085 (O) 09449042937 (M)
11	Source of availability of technology/expertise	OIC, AICRP on AF, UAS, Dharwad – 580005 (Karnataka) Phone: 0836-2442085 Fax:0836-2442085 E-mail: aicrpafdwd@uasd.in
Name of Contributors: Dr S M Mutanal, Dr S J Patil, Dr H Y Patil and Dr Sunita Johri		

3.5.2: FCRI, TNAU, Mettupalayam (Tamil Nadu)

3.5.2.1: Multifunctional agroforestry technology for adoption by farmers

Sl. No.	Item	Details
1	Specifications and salient technical features	*Melia dubia* + Banana Banana is one the major crops cultivated in the western agroclimatic zone of Tamil Nadu. Growing interest in *Melia dubia* cultivation in this zone was capitalized by integrating banana as the intercrop leading to a very successful and profitable silvihorticultural system. This system could be replicated in all the banana growing districts of the state. TNAU released variety *Melia dubia* MTP1 was planted at a spacing of 5m x 5m accounting for 160 seedlings acre^{-1} while banana was planted at 2m x 2 m spacing accounting for 1000 suckers acre^{-1}. Recommended cultural operations like fertilizer application, weeding, irrigation and IPDM were carried out in banana crop.
2	Performance results	At 12 months after planting, *Melia* attained an average diameter of 14.5cm and height of 9.2 m and the first harvest in banana fetched a gross return of Rs.1.95 lakhs acre^{-1}. Based on the first year growth of the main crop, the minimum anticipated returns from *Melia* on five year rotation is Rs.4.48 lakhs acre^{-1}. (Wood yield 64 t acre^{-1}; Price Rs.7,000/-t^{-1}). Regular annual returns from banana under *Melia* was observed to be reduced by 13 – 21% during the first three years. Return from the main crop after five years resulted in enhanced net income to the farmer besides ensuring improved efficiency and sustainability of the system.
3	Likely cost	**Input cost** Main crop (*Melia dubia* MTP1) : Rs.3,500/- acre^{-1} Intercrop (Banana) : Rs.60,000/- acre^{-1} **Output per unit area** Main crop (*Melia dubia* MTP1) : Rs.4.48 lakhs acre^{-1} after five years

		Gross income from intercrop (Banana) : Rs.1.95 lakhs acre^{-1} (first crop) Rs. 1.84 lakhs acre^{-1} (second crop) Rs. 1.78 lakhs acre^{-1} (third crop) Net income from intercrop (Banana): Rs. 1.35 lakhs acre^{-1} (first crop) Rs. 1.24 lakhs acre^{-1} (second crop) Rs. 1.18 lakhs acre^{-1} (third crop)
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Conventionally, banana cultivation alone provides a net income in the range of Rs.1.5 to Rs.1.75 lakhs acre^{-1}. This technology involves judicious integration of *Melia* with banana @ 160 seedlings acre^{-1}. Integration of *Melia* does not involve any additional input cost except for the cost of the seedlings as the inputs (fertilizers and irrigation) provided for banana was efficiently utilized by *Melia* which resulted in enhanced growth during the initial two years. Intensive management of the components could favourably reduce the rotation of *Melia* by one year resulting in additional income to the farmer.
5	Social/environmental/other benefits	Helps to increase the net income of the banana growing farmers by integration of *Melia dubia* as the main crop; Environmental benefits include carbon sequestration in the main crop which gets ultimately converted into stored carbon by conversion in the plywood industry. Banana being a crop susceptible to winds in this region, presence of *Melia dubia* as a main crop was able to protect banana from wind damage and enhanced the farmer's income substantially.
6	Status of commercialization/IP rights etc.	Success of this technology has generated great interest among farmers who traditionally cultivate banana in the western agroclimatic zone of Tamil Nadu. This technology has been commercialized through the Consortium of Industrial Agroforestry which resulted in expansion of over 100 acres of *Melia dubia* based banana models and thus witnessed successful adoption of this technology.

7	Efforts for technology dissemination	Sh. S.V. Ganesan, Sambaravallipudhur, Sirumugai block, Mettupalayam taluk, Coimbatore district Sh. Anandhan, Annur, Coimbatore district Sh. Madhan Kumar, M/s Ambiply Panels and Doors, Mettupalayam Sh. Rajkumar, Therampalayam, Mettupalayam taluk, Coimbatore district Sh. Thangavel, Annur, Coimbatore Sh. Palanisamy, Perumanallur, Erode district Sh. Shanmugam, Pallipalayam, Erode district
8	Special requirement for its successful realization; any other standards etc.	Not applicable
9	Indicative photographs	 
10	Contact details of person from whom technology and further details can be obtained	Professor & Head, Department of Agroforestry, Forest College and Research Institute, Mettupalayam – 641 301 Email: deanformtp@tnau.ac.in Tel: 04254 271541
11	Source of availability of technology/expertise	Professor & Head, Department of Agroforestry, Forest College and Research Institute, Mettupalayam – 641 301 Email: deanformtp@tnau.ac.in
Name of Contributors: Dr. Jude Sudhagar, Dr K.T. Parthiban and Dr. R.K. Kaleeswari		

3.5.3: KAU, Thrissur (Kerela)

3.5.3.1: Multipurpose trees based black pepper production system for humid tropics

Sl. No.	Item	Details
1	Specifications and salient technical features	Agroforestry systems and practices that effectively integrate trees with agricultural crops assume greater importance particularly in the sensitive soils of the tropics. Black pepper (*Piper nigrum*) cultivation in Kerala is such a prominent agroforestry system where, the tree component forms an integral part of the production system. It is traditionally grown in the homegardens and farm lands usually on a wide range of support tress (e.g. Erythrina, Moringa, Ceiba, Ailanthus etc.). However, the performance of many such MPTs as support trees has not been tested especially when planted in dense blocks. The functional role of the support trees in pepper based intensive production systems has been little studied beyond their physical suitability for trailing pepper. In this backdrop a multipurpose tree based black pepper production technology has been developed at KAU centre that ensures economic and ecological sustainability. Apart from the optimization of pepper yields this technology ensures biophysical benefits to the system through the integration of tree components. **The technology**: *Acacia auriculiformis* and *Artocarpus heterophyllus* are two multipurpose tree species suitable for block cultivation of black pepper (*Piper nigrum* L.). Results showed that *Acacia auriculiformis* and *Artocarpus heterophyllus* are promising especially when grown in high density (3m x 3m spacing; 1111 trees ha^{-1}) block plantations. Three months old tree seedlings to be planted in pits of size 30cm x 30cm x 30cm during the onset of monsoon. Black Pepper (var. Karimunda) trailed on all support trees from the second year of tree planting. The trees should be subjected to annual lopping (70 % of the canopy) during May. Farmyard manure and cow dung (each @ 25 kg/tree) applied annually once before the onset of monsoon showers. Black pepper cultivation in dense blocks was found to be a very profitable and viable land use practice both for the marginal and large-scale farmers.

2	Performance results	The multipurpose trees base black pepper production technology suggest that multipurpose trees such as *Acacia auriculiformis* and *Artocarpus heterophyllus* (Jack) are promising support trees for black pepper especially when grown in high density (3m x 3m spacing) block plantations. Average annual black pepper yield was 2.56 and 1.91 Mg ha^{-1} for *Acacia auriculiformis* and *Artocarpus heterophyllus* respectively. At final rotation of the crop, apart from the pepper yields *Acacia auriculiformis* and *Artocarpus heterophyllus* yielded standing volume of 282 and 253 m^3 ha^{-1} generating additional revenue of Rs. 33.84 lakhs and 30.36 lakhs respectively.
3	Likely cost	Input cost Initial establishment cost of the system(1st year) = Rs. 1,60,030/- ha^{-1} Average annual maintenance cost (20 year basis with 5% annual cost escalation) = Rs. 1,67,418/- Output Annual revenue from black pepper (Rs. 600/- per kg dry pepper) *Acacia auriculiformis* system= Rs. 15.36 lakhs *Artocarpus heterophyllus* = Rs. 11.46 lakhs *Acacia auriculiformis* system (timber revenue at final harvest) = Rs. 33.84 lakhs *Artocarpus heterophyllus* (timber revenue at final harvest) = Rs. 30.36 lakhs
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The average net returns ha^{-1} when the present black pepper production technology followed is considerably higher when compared to the conventional systems. This is primarily because of the intensive closely spaced block cultivation followed in the present technology. The conventional system of pepper cultivation on staggered support trees laborious, cost intensive and less production due to lesser number of support trees per ha. The present technology assures the farmer with optimum returns from unit area. Furthermore, the conventional standards used for pepper cultivation are short rotation tree species such as *Erythrina indica* which could bear pepper only for short span of 10-12 years while the suggested species (Acacia and Jack) can economically bear pepper upto 20-22 years).

5	Social/environmental/other benefits	The main attributes contributing to the sustainability of these systems are biophysical advantages such as efficient nutrient cycling offered by multispecies composition, conservation of bio-cultural diversity, product diversification as well as market values of products and services, and social and cultural values including the opportunity for gender equality in managing the system. Annual lopped out turn in terms of dry biomass (branch wood + foliage) was 1.28 Mg ha^{-1} for *Artocarpus heterophyllus* and 1.08 Mg ha^{-1} *by Acacia auriculiformis* which returns considerable nutrients to the soil. For instance, nitrogen addition through branch lopping was 38.81 kg for *A. auriculiformis* and 33.08 kg ha^{-1} yr^{-1} for *A. heterophyllus* respectively. Moreover, the tree component in the system contributes high nutrient and carbon inputs through litter fall. For instance *A. heterophyllus* yielded 4.65 and *A. auriculiformis* 3.0 Mg ha^{-1} leaf litter annually. House hold women play active role in the processing of black pepper ensuring the gender equity through this technology.
6	Status of commercialization/IP rights etc.	The Technology has been popularized through on farm demonstration at selected locations. Farmer awareness programmes on the technology are made through seminars and krishaka mela held during auspicious occasions such as world environment day and Chingam festival. Furthermore, the establishment of a model multitier integrated farming systems is in progress at AICRPAF fields in which the technology has been well demonstrated for farmer benefits.
7	Efforts for technology dissemination	The Technology has been adopted at small and medium scale by farmers. However, large scale adoption of the technology is yet to be achieved. High demographic pressure on the land and associated land fragmentation are the potential limitations in the large scale promotion of this technology.
8	Special requirement for its successful realization; any other standards etc.	The tree management in this technology especially the annual lopping and manuring should be undertaken by skilled personnel. Proper understorey light management is indispensible for optimum realization of the pepper yields.

9	Indicative photographs	 *Acacia auriculiformis* based black pepper stand  *Artocarpus heterophyllus* based black pepper stand
10	Contact details of person from whom technology and further details can be obtained	Dr. T. K. Kunhamu, Associate Professor & Head, Dept of Silviculture & Agroforestry, OIC, AICRP on Agroforestry, CoF, KAU (PO), Thrissur, Kerala-680656, Phones: 0487-2370050; 09495331771 E mail: kunhamutk@gmail.com
11	Source of availability of technology/expertise	Dean, College of Forestry, Kerala Agricultural University, KAU (PO), Thrissur-680 656 E mail: deanforestry@kau.in
Name of Contributors : Dr. T. K. Kunhamu, Dr. V. Jamaludheen and Dr. Asha K. Raj		

3.5.3.2: Homestead based intensive silvopasture system in humid tropics of Kerala

Sl. No.	Item	Details
1	Specifications and salient technical features	Prospects for dairy farming are immense in the state of Kerala as it is a milk deficit state. But high cost of feeds and scarcity of fodder are the major factors hindering the growth of the dairy sector in the state. Hence along with cattle rearing, farmers should produce quality green fodder in the available space in the farm itself for profitable milk production. However, small holding size do not easily permit farmers to adopt large scale fodder cultivation. Intensive silvopasture systems with high yielding grass and high density trees/shrubs make a valuable contribution to quality forage production for small holder dairy farms in the humid tropics of Kerala. Two- tier silvopastoral systems with hybrid napier grass (variety CO-4) + trees (mulberry + calliandra; @ 11111 trees/ha), planted in 3:2 ratio area wise, yields higher dry matter and almost double crude protein than grass monoculture in Kerala. Trees are intensively managed and maintained as hedges of 1m height by close planting (60 cmx 60 cm) and frequent pruning at 3 months interval. Similarly, 3- tier grass-legume-tree systems (mulberry/calliandra+ hybrid napier + stylosanthes/desmanthus) also produce more crude protein yield and quality forage than grass monoculture.

2	Performance results	Intensive silvopastoral systems with hybrid napier + mulberry + calliandra improved the productivity (31.5 tons dry matter ha^{-1}) and quality (4.75 tons of crude protein ha^{-1} on dry matter basis) of forage in comparison with hybrid napier monoculture (30.18 tons of dry yield and 2.83 tons of crude protein ha^{-1}). Hybrid napier + calliandra+ desmanthus system yielded 42 % more crude protein than grass monoculture which can substantially reduce the cost on concentrate feeds.
3	Likely cost	The total cost of cultivation of silvopasture systems for three years is about Rs. 6,24,190/- ha^{-1}. Output in terms of net profit is Rs. 9,64,892/- ha^{-1} for 3 years.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The above technology can bring down the cost of milk production by about 35 %. Farmers also report that there is an increase in milk yield by ¾ to 1 litre per cow and saving of concentrate feed by $3/4^{th}$ kg by feeding combinations of mulberry/calliandra+ hybrid napier + stylosanthes/desmanthus combinations, in addition to an appreciable improvement in fat content of milk.
5	Social/environmental/other benefits	Apart from fodder production, silvopasture systems have the potential to offer many ecosystem services and environmental benefits. Biodiversity and sustainability of Kerala home gardens has declined drastically during the last four or five decades, due to commercialization. Incorporation of silvopasture systems, which integrate trees with forage and livestock production, can improve the biodiversity and can contribute for the sustainable use of natural resources. Tree-based pasture system has greater potential to store more stable carbon in the soil compared with the treeless system. Besides, the nitrogen fixing ability and soil conservations abilities of trees and legumes will augment soil fertility status.
6	Status of commercialization/ IP rights etc.	The Technology has been developed recently and its popularization among dairy farmers is in progress.
7	Efforts for technology dissemination	Technology has been transferred to the following farmers' field. 1. Sh. Unnikrishnan, Nadathara, Thrissur. 2. Sh. Biju Thonookkkara, Thrissur
8	Special requirement for its successful realization; any other standards etc.	Availability of fodder tree/legume seeds should be ensured.

9	Indicative photographs	 **Hybrid napier + calliandra+ desmanthus**  **Hybrid napier+stylosanthus + mulberry**  **Calliandra + hybrid napier + mulberry**
10	Contact details of person from whom technology and further details can be obtained (information on the postal address, email, telephone, fax etc.)	Dr. Asha K. Raj Assistant Professor, AICRP on AF, CoF, KAU, Vellanikkara – 680656 Mob: 9496164414
11	Source of availability of technology/expertise	Dean, College of Forestry, Kerala Agricultural University, KAU (PO), Thrissur- 680 656 E mail: deanforestry@kau.in
Name of Contributors : Dr. Asha K. Raj, Dr. T.K. Kunhamu and Dr. V. Jamaludheen		

3.5.3.3: Calliandra and mulberry based hedge row fodder production systems in coconut gardens of Kerala

Sl. No.	Item	Details
1	Specifications and salient technical features	Integrating fodder trees like mulberry and calliandra in mature coconut gardens provides protein rich quality forage thereby saving costly concentrate feeds. Management factors such as plant spacing, pruning height and pruning frequency not only affect fodder yield per unit area but also the total long-term productivity and quality of the forage, under hedge row fodder production systems. Maximum yield and quality can be attained by planting trees at close spacing of 60cm x 60cm, harvesting at an interval of 12 weeks at a pruning height of 100 cm, and with intensive management.

2	Performance results	Annual fresh fodder yield of 60- 70 t ha^{-1} from second year onwards in addition to coconut yield. Economic yield up to 10 years.
3	Likely cost	Net profit of about Rs. 1.5 lakh ha^{-1} from second year onwards, in addition to the income from coconut.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Production of quality fodder especially during lean period. Improvement in milk yield and saving of concentrate feeds thereby increasing net returns to farmer.
5	Social/environmental/other benefits	Integration of fodder trees in agricultural farms offers numerous ecological services that help to maintain better soil properties and overall productivity of the system.
6	Status of commercialization/IP rights etc.	Technology recently developed. Publication in progress.
7	Efforts for technology dissemination	-------
8	Special requirement for its successful realization; any other standards etc.	Availability of quality planting materials of trees.
9	Indicative photographs	  **Calliandra in coconut gardens** **Mulberry in coconut gardens**
10	Contact details of person from whom technology and further details can be obtained	Dr. Asha K. Raj Assistant Professor, AICRP on AF, CoF, KAU, Vellanikkara – 680656 Mob: 9496164414
11	Source of availability of technology/expertise	Dean, College of Forestry, Kerala Agricultural University, KAU (PO), Thrissur- 680 656 E mail: deanforestry@kau.in
Name of Contributors : Dr. Asha K. Raj, Dr. T.K. Kunhamu and Dr. V. Jamaludheen		

3.5.4: Dr. BSKVV, Dapoli (Maharashtra)

3.5.4.1: Mango based Horti-agricultural system in Konkan region

Sl. No.	Item	Details
1	Specification and salient technical features	Konkan region of Maharashtra is a narrow strip of land which is surrounded by the Arabian Sea on the west and mountain ranges of Sahyadri (Western Ghats) on the west. This region receives heavy rainfall around 3500 mm within 95-100 days. In Konkan region most farmers were interested in planting more fruit trees on their farms; Preference was in the order of *Mangifera indica, Anacardium occidentale, Cocus nucifera, Emblica officinalis, Garcinia indica*. Mango is generally a spreading type of trees crop and requires lot of space for its canopy spread. The planting is recommended at a spacing of 10m X 10m. The plants take minimum 9-10 years to cover the entire allotted space. In the initial years such space can be made use of for planting suitable intercrops which would help in generation of additional income, conservation of soil and moisture and utilization of space and other natural resources more effectively in the juvenile stage of orchard life. Initially intercropping received little attention in the mango but inter-cropping has become popular with the systematic establishment of large-scale orchards.
2	Performance results	Agricultural crops viz. *Eleucine coracana* (finger millet), *Panicum miliaceum* (proso millet) *Guizotia abussinica* (niger) and *Arachis hyopgea.* (ground nut) were tried as intercrop in mango orchard of 10m x 10m spacing. By studying 5 years yield data of agricultural species it was found that performance of groundnut was best without affecting the mango crop.
3	Likely cost	The BC ratio of different tree crop combination varied from 1.22 to 0.85. It was found highest in mango + ground nut combination (1.22) and lowest in mango + finger millet combination (0.85).
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information.	The overall net income per hectare per year with mango + groundnut is about Rs. 19,033/-. Groundnut performed better in juvenile phase of mango cultivation. Proved its superiority over other intercrops in terms of yield and returns under rainfed condition in Konkan region.

5	Social/ environmental/ other benefits.	The typical topography (slightly sloppy land) associated with high rainfall in Konkan region. Groundnut crop covers the entire surface which reduces the speed of the rainfall drops which make water to crawl over the surface instead of running of water and thereby protects from soil erosion and improve infiltration. Organic residues added by groundnut improve the physical conditions of soil health by improving bulk density and help in generation of additional income and conservation of soil
6	Status of commercialization/ IP rights etc.	Technology has been popularized through training and giving demonstration on farms of farmers in the Konkan region.
7	Efforts for technology dissemination	It is popularized by undertaking large scale demonstration through AICRP on oil seeds and KVKs working under this university.
8	Special requirement for its successful realization; any other standards etc.	In konkan region comprises upland with sloppy wasteland state government has initiated a subsidized projects by making the provision of fruits crops to cover the cultivable wasteland under cultivation. Therefore most of the farmer has cultivated mango and cashew under subsidized schemes. However there is a special attention required for large scale adoption of a technology developed through agroforestry system.
9	Indicative photographs	 **Standing stage of groundnut in juvenile phase of mango orchard.**
10	Contact details of person	Dr. V.V. Dalvi, Sr. Scientist, AICRP on AF, Dr. B.S.K.K.V., Dapoli, Ratnagri- 415 712 (Maharashtra). Phone: 9422544085, 9423806486.
11	Source of availability of technology/ expertise	Dr. V.V. Dalvi, Sr. Scientist, AICRP on AF, Dr. B.S.K.K.V., Dapoli, Ratnagri- 415 712 (Maharashtra). Phone: 09423806486. E mail: vjy_dlv@yahoo.co.in
Name of Contributors: Dr V V Dalvi, Dr P R Pawar, Dr G Bhave and Dr S S Narkhede		

3.5.4.2: Cashew based Horti-agricultural system in Konkan region

Sl. No.	Item	Details
1	Specification and salient technical features	Cashew is generally a spreading type of tree crop and requires lot of space for its canopy spread. The planting is recommended at a spacing of 8m X 8m. The plants take minimum 6-7 years to cover the entire allotted space. In the initial years such space can be made use for planting suitable intercrops which would help in generation of additional income, conservation of soil and moisture and utilization of space and other natural resources more effectively in the juvenile stage of orchard life.
2	Performance results	Agricultural crops *viz. Eleucine coracana, Panicum miliaceum, Guizotia abyssinica* and *Vigna mungo* were tried as intercrop in cashew plantation of 8m x 8m spacing. By studying 5 years yield data of agricultural species it was found that performance of Niger was best without affecting the cashew crop.
3	Likely cost	The BC ratio of different tree crop combination varied from 1.07 to 0.85, it was found highest in cashew + niger combination (1.07), followed by and lowest in cashew + finger millet combination (0.85).
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information.	The overall net income per hectare per year with cashew + niger is about Rs. 1,969/- as a additional income during juvenile period under rainfed condition in Konkan region
5	Social/ environmental/ other benefits.	The typical topography (slightly sloppy land) associated with high rainfall in Konkan region. Niger crop covers the entire surface which reduces the speed of the rainfall drops which make water to crawl over the surface instead of running of water and thereby protects from soil erosion and improve infiltration. Organic residues added by niger improve the physical conditions of soil health by improving bulk density and help in generation of additional income and conservation of soil

6	Status of commercialization/ IP rights etc.	Technology has been popularized through training and giving demonstration on farms of farmers in the Konkan region.
7	Efforts for technology dissemination	It is popularized by undertaking large scale demonstration through AICRP on oil seeds and KVKs working under this university.
8	Special requirement for its successful realization; any other standards etc.	Konkan region comprises upland with sloppy wasteland. State government has initiated a subsidized project by making the provision of fruit crops to cover the cultivable wasteland under cultivation. Therefore most of the farmer has cultivated mango and cashew under subsidized schemes. However there is a special attention required for large scale adoption of a technology developed through agroforestry system.
9	Indicative photographs	 **Standing stage of Niger in juvenile phase of Cashew cultivation**
10	Contact details of person	Dr. V.V.Dalvi, Sr. Scientist, AICRP on AF, Dr. B.S.K.K.V., Dapoli, Ratnagri- 415 712 (Maharashtra). Phone: 09422544085, 09423806486.
11	Source of availability of technology/ expertise.	Dr. V.V. Dalvi, Sr. Scientist, AICRP on AF, Dr. B.S.K.K.V., Dapoli, Ratnagri- 415 712 (Maharashtra). Phone: 09423806486. E mail: vjy_dlv@yahoo.co.in
Name of Contributors: Dr V V Dalvi, Dr P R Pawar, Dr G Bhave and Dr S S Narkhede		

3.5.4.3: Cultivation of *Dendrocalamus stocksii* (Manga) in Konkan region

Sl. No.	Item	Details
1	Specification and salient technical features	In Konkan region, bamboo is grown as kitchen garden, border plantation species. Bamboo occupies an important place in socio-cultural and religious life of Indian communities. Being a fast growing material available in the tropics its significance importance is increasing day by day. Portion of bamboo production goes for production of handicrafts providing livelihood to the rural poor mostly tribal peoples. The rural and tribal population also uses bamboo for housing and household products and even in urban area it is being used in building construction on large scale. Bamboo has been also called as poor mains timber as it is available at much lower price compared to wood. There are nearly 135 species occurring naturally in the country, but a only some species *viz., B. nutans B. tulda, B. arudinacea, B. Polymorpha, B. burmanica, B. Vulgaris, Dendrocalamus strictus, D. longispathus, Pseudoxytenanthera stocksii, Yushania waghtiana* are more important from commercial availability point of view. Therefore, present study was planned to identify and screen promising bamboo species suitable under rainfed conditions of Konkan region.
2	Performance results	There were significance differences for culm yield among the ten species during all the six years except 2011-2012. The highest culm yield given by *Dendrocalamus stockii* (10.33 culms clump^{-1} year^{-1}) which is significantly superior over all except *Bambusa nutans* (9.83) which is at par with Manga spc.
3	Likely cost	At the age of 11 years old plantation the maximum NPV (Net Present Value) of Rs. 1,89,404/- given by *Dendrocalamus stockii* by considering discounted cost at 8%.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information.	The total cost of cultivation after 10 years was around Rs.13,000/- ha^{-1}. Output in terms of total income will be around rupees 99,000/- ha^{-1} year^{-1} after 11 years.

5	Social/ environmental/ other benefits.	It is easily available for fencing, building structure/ temporary farm sheds to the local farmers.
6	Status of commercialization/ IP rights etc.	*Dendrocalamus stockii* is identified as a best species for commercial cultivation as it has solid culm. Propagation technique is also generated by using three nodal culm cutting. This will help to the nursery man to increase their income source.
7	Efforts for technology dissemination	Technology has been popularized through training and giving demonstration on farms of farmers in the Konkan region.
8	Special requirement for its successful realization; any other standards etc.	It is necessary to make the availability of seedlings by propagating on large scale.
9	Indicative photographs	  ***Dendrocalamus stockii***
10	Contact details of person	Dr.V.V.Dalvi, Sr. Scientist, AICRP on AF, Dr. B.S.K.K.V., Dapoli, Ratnagri- 415 712 (Maharashtra). Phone: 09422544085, 09423806486.
11	Source of availability of technology/ expertise.	Dr. V.V. Dalvi, Sr. Scientist, AICRP on AF, Dr. B.S.K.K.V., Dapoli, Ratnagri- 415 712 (Maharashtra). Phone: 09423806486. E mail: vjy_dlv@yahoo.co.in
Name of Contributors: Dr V V Dalvi, Dr P R Pawar, Dr G Bhave and Dr S S Narkhede		

3.5.5: TNVASU, Kattupakkam (Tamil Nadu)

3.5.5.1: Coconut (*Cocus nucifera*) / Guava (*Psidium gujava*) / Mango (*Mangifera indica*) with fodder crops based hortipasture in degraded waste lands for North Eastern Agro-climatic zone of Tamil Nadu

Sl. No.	Item	Details
1	Specifications and salient technical features	Tamil Nadu has a long history of shortage of fodder for livestock. The problem has been the result of low land productivity, preference by farmers for growing non-forage crops, high population of non-producing animals, dwindling of grazing land, lack of awareness on efficient land utilisation etc. The North Eastern zone comprising the revenue districts of Thiruvallur, Vellore, Kancheepuram, Thiruvannamalai, Villupuram, Cuddalore, Perambalur and Ariyalur in Tamil Nadu, are situated between l8º5' and 13º.2' of North latitude and 76º15' and 80º22' East longitude. It has an area of 31065 sq. km. The climate in the zone is basically semi-arid tropical. The principal rivers of the zone entirely depend on rainfall received in five to six months in a year and almost dry in the hot weather. Livestock farmers in this region face acute fodder shortage especially during summer. Horticulture is a common practice amongst farmers in this zone. Thus the idea of cultivating fodder understorey fruit trees to supply fodder to livestock has evolved. The fruit tree component of this hortipasture is a permanent one and it is coconut (*Cocus nucifera*), guava (*Psidium guajava*) and mango (*Mangifera indica*). Both, leguminous (*Stylosanthes hamata, Desmanthus virgatus*, fodder cowpea (*Vigna sinensis*), sunhemp (*Crotolaria juncea)* and *Calopagonium muconoides* and non leguminous (*Cenchrus ciliaris)*, bajra napier hybrid and guinea grass (*Panicum maximum*) fodder can be cultivated as understorey adopting rotational system.

2	Performance results	*Desmanthus virgatus* cultivated under coconut (*Cocus nucifera*), guava (*Psidium guajava*) and as sole crop in four harvests yielded 51.28 t ha^{-1}, 79.16 t ha^{-1} and 81.12 t ha^{-1} respectively and can hold 70, 108 and 111 calves respectively fed at 2 kg $calf^{-1}$ day^{-1} apart from reducing the requirement of concentrate feed by 37.5%. *Stylosanthes hamata,* under coconut (*Cocus nucifera*) trees in the hortipasture system yielded 23.5 t ha^{-1} and can hold 60 adult sheep / goats per year fed at 1kg day^{-1} $animal^{-1}$. *Crotolaria juncea* (sunhemp) under coconut (*Cocus nucifera*) trees harvested yielded of 5 ha^{-1} and can hold 12 -14 adult sheep / goats $year^{-1}$ fed at 1kg day^{-1} $animal^{-1}$ or 50 -55 rabbits $year^{-1}$ fed at 0.25kg day^{-1} $animal^{-1}$. The hortipasture having coconut (*Cocus nucifera*) with *Cenchrus ciliaris* yielded 6.02 t of dry fodder and 0.409 t of protein ha^{-1} which is sufficient for 9-10 adult sheep. The hortipasture having mango (*Mangifera indica*) with cowpea (*Vigna sinensis*) yielded 0.975 t of dry fodder and 0.169 t of protein ha^{-1} which is sufficient for 10-11 adult sheep. The *Calopagonium muconoides* integrated as understorey in mango (*Mangifera indica)* plantation yielded 0.969 t of dry fodder, 0.116 t of digested protein and can hold 3-4 sheep ha^{-1} $year^{-1}$.
3	Likely cost	The total cost of cultivation for the production of Co(CN)4 cumbu napier grass under Coconut *Cocus nucifera* (1 acre), *Cenchrus ciliaris* under guava *Psidium guajava* (1 acre) and *Stylosanthes scabra* under mango *Mangifera indica* (1/2 acre) is Rs. 28,000/-. Total output from the production of Co(CN)4 cumbu napier grass under coconut *Cocus nucifera* (1 acre) (50 t / $acre^{-1}$ $year^{-1}$ sold at the rate of Rs. 2/- kg^{-1}), *Cenchrus ciliaris* under guava *Psidium guajava* (1 acre) (12 t $acre^{-1}$ $year^{-1}$ sold at the rate of Rs.2/-kg^{-1}) and *Stylosanthes scabra* under mango *Mangifera indica* (1/2 acre) (2.5 t $acre^{-1}$ $year^{-1}$ sold at the rate of Rs. 4/-kg^{-1}) is about Rs. 1,34,000/-. This is the additional income generated through the hortipasture model.

4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Rams could be reared by grazing in natural grazing land and with one hour complementary grazing in hortipasture. In addition to fruits, Rs.3,380/- could be saved through animal integration (15 rams ha^{-1}) in the coconut (*Cocus nucifera*), guava (*Psidium guajava*) and mango (*Mangifera indica*) plantations with *Stylosanthes hamata* pasture. The complementary grazing provided about 26% additional growth rate to sheep grazing in natural grazing land. The complementary grazing in one hectare hortipasture could generate additional income of Rs 15,000/- $annum^{-1}$ due to improved growth rate. Similar complementary grazing could be adopted with goats generating the same benefit.
5	Social/environmental/other benefits	Social – Farmers establishing this agroforestry model will be able to meet out the green fodder requirement of their livestock. The livestock productivity will be enhanced as their nutritional requirement will be satisfied. Farmers will be benefitted economically by the enhanced productivity of livestock. Environmental - Over a period of time there will be an improvement in the soil quality of the land. More efficient recycling of nutrients by trees, improvement of microclimate, such as lowering of soil surface temperature and reduction of evaporation of soil moisture through shading, increment in soil nutrients through addition and decomposition of litter fall and improvement of soil structure through the constant addition of organic matter from decomposed litter. Ecologically sound agro forestry systems such as intercropping and mixed arable livestock systems can increase the sustainability of agricultural production and lead to sustainability of production.
6	Status of commercialization/IP rights etc.	Establishment of hortipasture model has been popularized to the farmers through conducting training at peripheral centre's of Tamil Nadu Veterinary and Animal Sciences University.
7	Efforts for technology dissemination	---------
8	Special requirement for its successful realization; any other standards etc.	---------

9	Indicative photographs	 **Fodder cowpea (*Vigna sinensis*) as understorey in the Guava (*Psidium guajava*) based hortipasture**  **Cumbu Napier hybrid grass as understorey in the Coconut (*Cocus nucifera*) based hortipasture**  ***Desmanthus virgatus* as understorey in the Coconut (*Cocus nucifera*) based hortipasture**  ***Cenchrus ciliaris* as understorey in the Guava (*Psidium guajava*) based hortipasture**
10	Contact details of person from whom technology and further details can be obtained	Professor and Head, Institute of Animal Nutrition, Kattupakkam, Kancheepuram, Tamil Nadu Email: ian@tanuvas.org.in
11	Source of availability of technology/expertise	Professor and Head, Institute of Animal Nutrition, Kattupakkam, Kancheepuram, Tamil Nadu Email: ian@tanuvas.org.in
Name of Contributors: Dr. C. Valli, Dr. Karu. Pasupathi and Dr. V.S. Mynavathi		

3.5.5.2: Three tier system of Agroforestry model with fodder tree species for North Eastern Agro-climatic zone of Tamil Nadu

Sl. No.	Item	Details
1	Specifications and salient technical features	India has one of the largest livestock populations in the world and most of its entire feed requirement is met from crop residues and byproducts. Land allocation to cultivation of green fodder crops is less than 5 per cent of the gross cropped area. Feed scarcity as the main limiting factor to improving livestock productivity. Based on tenth five year plan document Govt. of India expected deficit in green fodder (64.87%) and dry fodder (24.92%) at 2025. So there is a need to produce more green fodder per unit of land. In this context AICRP on Agroforestry, Institute of Animal Nutrition, Kattupakkam Centre introduced three tier system of Agroforestry model in North Eastern Agro-climatic zone of Tamil Nadu. The North Eastern zone comprising the revenue districts of Thiruvallur, Vellore, Kancheepuram, Thiruvannamalai, Villupuram, Cuddalore, Perambalur and Ariyalur in Tamil Nadu, are situated between l8º5' and 13º.2' of North latitude and 76º15' and 80º22' East longitude. It has an area of 31065 sq. km. The climate in the zone is basically semi-arid tropical.The principal rivers of the zone entirely depend on rainfall received in five to six months in a year and almost dry in the hot weather. Livestock farmers in this region face acute fodder shortage especially during summer. To augment fodder availability throughout the year this agroforestry model has been developed for this region. The surplus fodder harvested from this model can be conserved as hay / silage / complete feed block and provide quality fodder to livestock during scarcity period. The agroforestry model has three tiers with following components Tier 1: *Gliricidia sepium, Leucaena leucocephala, Lannea coromandelicia* and *Erythrina indica* Tier 2: Fodder Sorghum – Co(FS) 29 variety Tier 3: *Stylosanthes scabra, Cenchrus ciliaris*

2	Performance results	Biomass yield of *Leucaena leucocephala* and *Gliricidia sepium* per annum was 2.08 t acre^{-1} and 5.8 t acre^{-1} respectively. Fodder sorghum yield (in three tier Vs sole crop) was 68.7 Vs 69.8 t acre^{-1}, *Stylosanthes scabra* yield (in three tier Vs sole crop) was 18.0 Vs 20.8 t acre^{-1}, *Cenchrus ciliaris* grass yields (in three tier Vs sole crop) was 14.5 Vs 16.0 t acre^{-1}. The biomass yield was higher for the crops cultivated as sole crop compared to the crops cultivated at three tier system but the total biomass yield was higher in three tier system which comes from the tree leaves. Significant seasonal effect on nitrogen level was observed in tree fodders in summer season. Decrease in the nitrogen content in tree fodders could be due to depletion of soil nitrogen status.
3	Likely cost	In three tier agroforestry model, in one hectare land area, a fodder grass species *viz.*, Fodder Sorghum Variety Co(FS)29/ *Cenchrus ciliaris* and legume *viz.*, *Stylosanthes scabra* and tree species viz., *Gliricidia sepium* / *Leucaena leucocephala* can be raised in the same piece of land. As a sole crop Fodder sorghum Variety Co(FS)29 yields about 174.5 t ha^{-1} year^{-1} and it costs about Rs. 3,49,000/- and *Stylosanthes scabra* yields about 52 t ha^{-1} year^{-1} and it costs about Rs.2,08,000/- and tree fodder yields about 18.5 t ha^{-1}year^{-1} and it costs about Rs.13,875/-. In three tier agroforestry model, in one hectare land area, all the above components are integrated. Fodder sorghum variety Co(FS)29 yields about 171.75 t ha^{-1} year^{-1} and it costs about Rs. 3,43,500/- and *Stylosanthes scabra* yields about 45 t ha^{-1}year^{-1} and it costs about Rs.1,80,000/- and tree fodder *Gliricidia sepium* yields about 14.5 t ha^{-1}year^{-1} and it costs about Rs.10,875/- and it gives revenue of Rs. 5,33,875/-. Three tier agroforestry system can be used for maximizing resources as compared to monoculture cropping systems. The improved use of resources results in greater total fodder crop yield as compared to sole crops of the same species grown on the same area.

4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	The fodder sorghum in this model could support 36 calves when fed at 8 kg day^{-1}animal^{-1}. *Leucaena leucocephala* can replace 20 % of green fodder and can hold 6 -7 cows year^{-1} ha^{-1} without adverse effect on its milk yield and composition in dairy animals *Gliricidia sepium* can replace 15 % of green fodder and can hold 14 -15 cows year^{-1} ha^{-1} without adverse effect on its milk yield and composition in dairy animals.
5	Social/environmental/other benefits	Social – Farmers establishing this agroforestry model will be able to meet out the green fodder requirement of their livestock. The livestock productivity will be enhanced as their nutritional requirement will be satisfied. Environmental - Balanced utilization of nutrients is seen in three tier agroforestry model. Fodder crops utilize nutrients from upper 6 inch soil which is continuously enriched by litter fall and pruning materials and root residues decomposition from trees.
6	Status of commercialization/IP rights etc.	Establishment of three tier agroforestry model has been popularized to the farmers through conducting training at peripheral centre's of Tamil Nadu Veterinary and Animal Sciences University.
7	Efforts for technology dissemination	--------
8	Special requirement for its successful realization; any other standards etc.	-------
9	Indicative photographs	 **Three tier agroforestry model with *Glyricidia sepium*, Fodder sorghum and *Stylosanthes scabra***  **Three tier agroforestry model with *Leucaena leucocephala*, Fodder sorghum and *Stylosanthes scabra***
10	Contact details of person from whom technology and further details can be obtained	Professor and Head, Institute of Animal Nutrition, Kattupakkam, Kancheepuram, Tamil Nadu Email: ian@tanuvas.org.in
11	Source of availability of technology/expertise	Professor and Head, Institute of Animal Nutrition, Kattupakkam, Kancheepuram, Tamil Nadu Email: ian@tanuvas.org.in
Name of Contributors: Dr. C. Valli, Dr. Karu. Pasupathi and Dr. V.S. Mynavathi		

3.5.5.3: Silvipasture in degraded calcareous wastelands of North Eastern Agro-climatic zone of Tamil Nadu for livestock integration

Sl. No.	Item	Details
1	Specifications and salient technical features	Livestock farming along with agriculture is the main occupation for most of the farmers in Tamil Nadu. Acute fodder scarcity is inevitable during summer due to inefficient land management system and poor resource utilization. Tamil Nadu has 2,997 thousand ha degraded wastelands which is about 23% of total geographical area. Water erosion is the major causative factor for land degradation in the state. The degraded wasteland of the state has acidic / sodic /saline soil cover. The calcareous land available in Tamil Nadu is usually being kept as barren land. In an attempt to reclaim the degraded wasteland agroforestry systems such as silvipastoral and hortipastoral systems have been propagated and implemented. In Silvipastoral system, the inter spaces between forest trees species are utilized for cultivation of grasses and grass legume mixtures, which provides a two tier grazing. The North Eastern zone comprising the revenue districts of Thiruvallur, Vellore, Kancheepuram, Thiruvannamalai, Villupuram, Cuddalore, Perambalur and Ariyalur in Tamil Nadu, are situated between l8º5`. and 13º.2` of North latitude and 76º 15’ and 80º 22’ East longitude. It has an area of 31065 sq. km. The climate in the zone is basically semi-arid tropical.The principal rivers of the zone entirely depend on rainfall received in five to six months in a year and almost dry in the hot weather. Livestock farmers in this region face acute fodder shortage especially during summer. Certain parts of the zone have degraded calcareous wastelands. Utilization of these wastelands for cultivation of fodder trees is a desirable alternative. Putting these lands under multipurpose tree species will fulfill the twin objectives of biological amelioration and harvesting biomass to meet the fodder requirements of livestock of this region.

		Hence, trials in calcareous land has been conducted at AICRP on Agroforestry, Kattupakkam centre to maximise the utilization of calcareous land for fodder production. Silvipasture with *Leucaena leucocephala, Gliricidia sepium, Inga dulces, Erythrina indica, Albizzia lebbeck* with *Stylosanthes scabra* as understorey has been established and biomass study were conducted to assess the fodder production and carrying capacity for different species of livestock. Fodder production at different periodical interval of lopping, different water harvesting technology was introduced. Soil profile of the land before and after introducing silvipasture was analysed. Based on that suitable technology has been established. 2.5 acre of calcareous wasteland was selected for establishing silvipasture with *Leucaena leucocephala, Gliricidia sepium, Inga dulces, Erythrina indica, Albizzia lebbeck* with *Stylosanthes scabra* as understorey. The trees were planted in 24 rows in 3 X 3 meter spacing.
2	Performance results	The biomass yield recorded (t ha^{-1} $year^{-1}$) were *Leucaena leucocephala:* 9.5 *Gliricidia sepium :*18.5 *Inga dulces :*3.5 *Erythrina indica :*1.5 *Albizzia lebbeck :*2.0 *Stylosanthes scabra:*5.84 The tree fodder produced could support 50 goats $year^{-1}$. One hour supplementary grazing in the silvipasture on rotation, in addition to normal grazing improved 19 per cent more weight gain in goats. Field based units were established with two or three species suitable to the locality of the farmer and accordingly advised to rear species and number of animals. Periodical pruning, lopping and pollarding techniques and time interval are advised. The technical know-how is being continuously given from this unit. The unused barren land being utilized supported the beneficiaries livelihood and improved their social status.

<table>
<tr><td>3</td><td>Likely cost</td><td>Initial establishment during first year requires Rs. 25,000 – 30,000/- to prepare land, purchase seeds and seedlings. The output from the silvipasture obtained after 10 months.
Cost of return in terms of biomass production
(Rs. 4/- kg^{-1} of Stylosanthes and Rs. 2/- kg^{-1} of tree fodder)
<table>
<tr><th>Species</th><th>Yield (Kg)</th><th>Amount (Rs.)</th></tr>
<tr><td>Leucaena leucocephala</td><td>9500</td><td>19,000/-</td></tr>
<tr><td>Gliricidia sepium</td><td>18500</td><td>37,000/-</td></tr>
<tr><td>Inga dulces</td><td>3500</td><td>7,000/-</td></tr>
<tr><td>Erythrina indica</td><td>1500</td><td>3,000/-</td></tr>
<tr><td>Albizzia lebbeck</td><td>2000</td><td>4,000/-</td></tr>
<tr><td>Stylosanthes scabra</td><td>5840</td><td>11,680/-</td></tr>
<tr><td colspan="2">Total (Rs.)</td><td>95,040/-</td></tr>
</table>
Rs.95,040/- (Rupees Ninety five thousand and forty only) has been obtained from the agroforestry model as additional revenue.
Otherwise the farmer can hold 50 Nos. of goats with its followers. From these 75 kids (@ 1.5 kidding percentage) can be sold at 6 months of age with 15-20 kg body weight and sold @ 200 – 250/- kg^{-1} live weight and it accounts Rs. 4000/- per kid will be earned. Hence, Rs.3,00,000/- (Rupees Three lakhs only) is an additional income to the farmers by rearing goats.</td></tr>
<tr><td>4</td><td>How the new technology will impact the income of the farmers and its benefits over conventional technologies/know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information</td><td>First, the unutilized barren calcareous land becomes cultivable for fodder production. Soil status and fertility is improving. By sale of fodder or milk or meat the farmers get an additional income. Thereby the livelihood security to the poor farmers and social status improving.
100g of concentrate feed could be replaced by tree leaves (Leuceana leucocephala / Inga dulces) without change in the growth rate of kids. By this Rs.1.70/- per day can be reduced in goat rearing by feeding tree leaves.
Leucaena leucocephala + Gliricidia sepium leaf meal (1:1) based concentrate feed as protein source partially replaced (30%) the soybean meal, deoiled rice bran, sunflower oil cake mixture in conventional goat concentrate feed and thereby reducing the cost of feed by Rs.4.86/- kg^{-1}.</td></tr>
</table>

5	Social/environmental/other benefits	The unutilized calcareous lands are being under cultivation of fodder/tree fodder and fodder shortage has been met out. Soil erosion prevented and soil fertility improved. The livelihood security to the poor farmers through silvipasture model has been achieved. The farm animal productivity improved through regular supply of fodder. Social – Farmers establishing this agroforestry model will be able to meet out the green fodder requirement of their livestock. The livestock productivity will be enhanced as their nutritional requirement will be satisfied.
6	Status of commercialization/IP rights etc.	Establishment of silvipasture model has been popularized to the farmers through conducting training at peripheral centre's of Tamil Nadu Veterinary and Animal Sciences University.
7	Efforts for technology dissemination	---------
8	Special requirement for its successful realization; any other standards etc.	---------
9	Indicative photographs with proper lighting	 **Established silvipasture model at Institute of Animal Nutrition**  **Supplementary grazing of goats in silvipasture system**
10	Contact details of person from whom technology and further details can be obtained	Professor and Head, Institute of Animal Nutrition, Kattupakkam, Kancheepuram, Tamil Nadu Email: ian@tanuvas.org.in
11	Source of availability of technology/expertise	Professor and Head, Institute of Animal Nutrition, Kattupakkam, Kancheepuram, Tamil Nadu Email: ian@tanuvas.org.in
Name of Contributors: Dr. C. Valli, Dr. Karu. Pasupathi and Dr. V.S. Mynavathi		

3.5.6: UAS, Bangalore (Karnataka)

3.5.6.1: Selection of improved clones in Tamarind

Sl. No.	Item	Details
1	Specifications and salient technical features	Livelihood and income security of farm families in rainfed areas of Karnataka assumes greater importance in view of uncertainty in rainfall distribution. This necessitates introduction of high yield germplasm of tamarind, in this regards efforts were made to identify and select suitable high yielding germplasms of tamarind.
2	Performance results	The variety GKVK-17 was identified and released in collaboration with scientist at ARS Chintamani. This variety consistently recorded higher yield with an average yield of 75.8 kg $tree^{-1}$ $year^{-1}$.
3	Likely cost	Rs 45-50 monthly grafted seedling and planting.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	As GKVK-17 recorded 15-25 per cent higher yield, eventually this would benefit in getting higher income.
5	Social/environmental/other benefits	Tamarind, as a dry land fruit tree performing better even under marginal and low fertile soils. The canopy cover in these types of soils could minimize land degradation and improve environmental condition, besides providing livelihood security for the farmers in dry land areas.
6	Status of commercialization/IP rights *etc*.	This variety is adopted by the farmers for commercial cultivation.
7	Efforts for technology dissemination	6642 grafted seedlings were distributed to76 farmers
8	Special requirement for its successful realization; any other standards *etc*.	1. Grafted seedlings 2. Crescent bunding with trenching

9	Indicative photographs	
10	Contact details of person from whom technology and further details can be obtained	Officer In Charge, AICRP on Agroforestry, University of Agricultural Sciences, GKVK, Bangalore-560 065 Dr. P. Venkataramana Senior Plant Breeder and Farm Superdent, ARS, Chintamani.
11	Source of availability of technology/expertise	University of Agricultural Sciences GKVK, Bangalore-560 065
Name of Contributors : Dr. Narayana Reddy, Mr. Narashimha Reddi, Dr. Shivanandam, Dr. P. Venkataramana, Dr. Nagaraju, Mr. V. Bhaskar, Miss Noor Asma, S., and Mr. Vishwanath, B.R.		

3.5.6.2: Wedge/soft wood grafting in Simarouba

Sl. No.	Item	Details
1	Specifications and salient technical features	Simarouba, a very hardy species, its distribution in Karnataka acquired greater importance due to involvement of department of forestry and environment, Government of Karnataka and interested farmers. A Simarouba tree seed oil content is 60-65 per cent, thus tree is cultivated and performing better under divers agro-climatic conditions like dry zone, transition zone, hilly zone and coastal zones in Karnataka. The farmers in these areas are voluntarily taken up cultivation as sole plantation or on bund planting. However, recently it was observed that more than 20-30 per cent of the total populations in the plantations have male plants. In order to overcome these problems wedge/soft wood grafting technique was developed for converting the male plants into productive female plants.

2	Performance results	Wedge/soft wood grafting technology was tested consecutively for three years under controlled and open field conditions, the results indicated that success and establishment which varied from 80-90 per cent.
3	Likely cost	Rs. 20-50/- additional cost for topping, grafting and subsequent maintenance.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Due to conversion of male plants in to female plant with an average of 80-90 per cent success, increase in yield and income could be around 15-20 per cent.
5	Social/environmental/other benefits	Simarouba as its find places in low fertile and rainfed areas, the canopy cover would indirectly protecting the environment besides getting additional income.
6	Status of commercialization/IP rights *etc.*	Partially being followed in forestry.
7	Efforts for technology dissemination	-------
8	Special requirement for its successful realization; any other standards *etc*.	--------
9	Indicative photographs	--------
10	Contact details of person from whom technology and further details can be obtained	Officer In Charge, AICRP on Agroforestry, University of Agricultural Sciences, GKVK, Bangalore-560 065
11	Source of availability of technology/expertise	University of Agricultural Sciences, GKVK, Bangalore-560 065
Name of Contributors: Dr. Nagaraju, Mr. V. Bhaskar, Miss Noor Asma, S., and Mr. Vishwanath, B.R.		

3.5.6.3: Tree Borne Oil seeds (TBO's) based Agroforestry system

Sl. No.	Item	Details
1	Specifications and salient technical features	Tree borne oil seeds are rich source of oil content (>30-40 %), Hence, assumes wider perspective in cultivation of these trees in most of the agroclimatic zones of Karnataka. The TBO's are *Pongamia pinnata, Madhuca latifolia, Callophylum inophylum, Azadirachta indica, Simarouba glauca* and *Melia azaderach*. These TBO's are planted on the bunds or in wider alleys. The food crops like finger millet, soyabean, pegion pea, field bean, cowpea and fodder grass (Co-3 & Co-4) are cultivated in association with TBO's.
2	Performance results	In addition to field trails participatory programmes are taken up under bio fuel park, Hassan through bund planting nearly 60-75 trees of TBO's are planted in one ha.
3	Likely cost	Additional cost (Rs. 15–20/- including seedling and planting cost)
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Bund planting with intra row spacing of 5 m is recommended for better performance.
5	Social/environmental/other benefits	The canopy cover will improve environmental benefit in addition to additional income.
6	Status of commercialization/IP rights *etc.*	----------
7	Efforts for technology dissemination	----------
8	Special requirement for its successful realization; any other standards *etc*.	----------

9	Indicative photographs	
10	Contact details of person from whom technology and further details can be obtained	Officer In Charge AICRP on Agroforestry, University of Agricultural Sciences, GKVK, Bangalore-560 065, Karnataka
11	Source of availability of technology/expertise	University of Agricultural Sciences GKVK, Bangalore-560 065, Karnataka
Name of Contributors: Dr. Nagaraju, Mr. V. Bhaskar, Miss Noor Asma, S., and Mr. Vishwanath, B.R.		

3.5.6.4: Dry land orchard fruit crop based Agroforestry system

Sl. No.	Item	Details
1	Specifications and salient technical features	The fruit crop based orchard constitutes 44 per cent of the cropped area in rain fed areas of Karnataka which plays greater role in sustaining income and livelihood security of the farmers. The study was initiated to analyze production and economics of fruit crop based agro-forestry. The fruit crops consisting of mango, jamun, cashew and tamarind were selected and analyzed for system productivity and income from the tree based agro-forestry.
2	Performance results	Fruit crop based agro-forestry system recorded higher income as compared to sole crop of finger millet or red gram.
3	Likely cost	Rs. 50-60/- which includes cost on seedlings, pitting, planting and maintenance.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies/ know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Regular annual income. Overcome risk due to crop failure. Insurance against drought. Sustainable livelihood and income.

5	Social/environmental/other benefits	Fruit trees planting improves tree coverage. Improvement in the socio economic condition of the farmer.
6	Status of commercialization /IP rights *etc*.	Common practice in rain fed and dry land areas.
7	Efforts for technology dissemination	----------
8	Special requirement for its successful realization; any other standards *etc*.	1. Good quality samplings. 2. Soil and moisture conservation. 3. Timely plant protection measures. 4. Cresent bunding and trenching.
9	Indicative photographs	
10	Contact details of person from whom technology and further details can be obtained	Officer In Charge, AICRP on Agroforestry, University of Agricultural Sciences, GKVK, Bangalore-560 065, Karnataka
11	Source of availability of technology/expertise	University of Agricultural Sciences, GKVK, Bangalore-560 065, Karnataka
Name of Contributors: Dr. Nagaraju, Mr. V. Bhaskar, Miss Noor Asma, S., and Mr. Vishwanath, B. R.		

3.5.6.5: *Melia dubia* based Agroforestry system

Sl. No.	Item	Details
1	Specifications and salient technical features	*Melia* is a fast growing tree and yields good quality industrial timber in a short rotation. This tree is promoted under block plantation and bund planting under agro forestry system. In addition, the seeds of *Melia* are also being used for extraction of bio pesticides. In Karnataka, this tree is cultivated in all the agro climatic zones, on an average 14-15 cu. feet of timber was recorded within a short rotation of 10-12 years besides 20 per cent top for chip wood and for fuel. Moreover, the tree leaves are also used as fodder for ruminants. In view of this, the field study on performance of *Melia* under different spacing was conducted.

2	Performance results	The results indicated that in block plantation planting of *Melia* at 5 x 5 m or 6 x 6 m recorded on par yield per tree. However, 5 x 5 m recorded 15-20 per cent higher yield as compared to 6 x 6 m. Further bund planting 3 m, 4 m and 5 m intra row spacing with 24 m or 30 m apart sustain the productivity of associated crops like ragi, red gram and field bean *etc*.
3	Likely cost	Seedling cost Rs 15-20/-. Planting cost Rs 20-25/-.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies /know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	*Melia dubia* intervention in block plantation recorded Rs. 12-15/- Lakhs and bund planting Rs. 4 - 6.5/- Lakhs in 10-12/- years rotation.
5	Social/environmental/other benefits	Improves the socio-economic condition of the farmer. Besides providing the tree coverage.
6	Status of commercialization/IP rights *etc*.	Commercially this tree is cultivated.
7	Efforts for technology dissemination	Hunsur plywood company is promoting for commercial production, in addition some of the farmers are voluntarily cultivated this tree either on bund or block plantation. Some of the examples are Raghunath from Hiriyur and Channabasappa, Hunsur of Mysore District.
8	Special requirement for its successful realization; any other standards *etc*.	-------
9	Indicative photographs	
10	Contact details of person from whom technology and further details can be obtained	Officer In Charge AICRP on Agroforestry, University of Agricultural Sciences, GKVK, Bangalore-560 065, Karnataka
11	Source of availability of technology/expertise	University of Agricultural Sciences GKVK, Bangalore-560 065, Karnataka
Name of Contributors: Dr. Nagaraju, Mr. V. Bhaskar, Miss Noor Asma, S., and Mr. Vishwanath, B. R.		

3.5.6.6: Fodder tree based Agroforestry system

Sl. No.	Item	Details
1	Specifications and salient technical features	Livestock is an important component in farming system for improving livelihood and economic security of the farm families in the rain fed areas. The quality fodder availability in regular and off season hampers the productivity of livestock in general and milk production in particular. Hence, the study on quantification of forage production of sesbenia on bund planting was taken up. The sesbenia trees were planted 1.5 -2 m apart with in the row on the bunds. The forage was harvested twice a year in rotation and yield was recorded.
2	Performance results	The sesbenia planted on bund recorded 10-12 t of additional fodder yield.
3	Likely cost	Rs. 8-10/- per tree including seedling and planting cost.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies /know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Sesbenia being a leguminous tree which is having high protein content and appropriate proportion of Sesbenia along with cereal fodder enhanced the yield by 10-15 per cent.
5	Social/environmental/other benefits	Tree planting on bunds. Reduce the pressure of natural forest their by forest degradation is minimized.
6	Status of commercialization /IP rights *etc*.	Some of the farmers have taken up in small area in plantation crops and bund planting.
7	Efforts for technology dissemination	-------
8	Special requirement for its successful realization; any other standards *etc*.	--------

9	Indicative photographs	 
10	Contact details of person from whom technology and further details can be obtained	Officer In Charge AICRP on Agroforestry, University of Agricultural Sciences, GKVK, Bangalore-560 065, Karnataka
11	Source of availability of technology/expertise	University of Agricultural Sciences , GKVK Bangalore-560 065, Karnataka
Name of Contributors: Dr. Nagaraju, Mr. V. Bhaskar, Miss Noor Asma, S., and Mr. Vishwanath, B. R.		

3.5.6.7: Agroforestry based integrated farming system in rain fed and irrigated farming system approach

Sl. No.	Item	Details
1	Specifications and salient technical features	The nutrition food**,** economic and livelihood security of small and marginal farmers is affected in a view of ill distribution of rain fall in rain fed situation and non availability of required water in tube well irrigation. Further, though the farmers are adopting improved crops and cropping system because of the variation in resource availability and fluctuation in market prices, the farmers are not getting expected income. The agro-forestry based IFS which ensures nutritional food requirement, economic returns and employment for the family besides improving the environmental condition. In this regard one ha agro-forestry based IFS under rain fed and irrigated condition was initiated.
2	Performance results	1. Sustain production of nutritional food, cereals, pulses, oilseeds, vegetables, milk *etc*. 2. 4-5 times improvement in the family income. 3. Minimization in the cost of production due to emphasis on internal input production, compost, FYM *etc*. 4. Improvement in the employment opportunity. 5. Self-dependency on cooking (bio gas).

3	Likely cost	Rs. 50,000 to 1,25,000/- initial cost, if animal component/tree components are the main interventions.
4	How the new technology will impact the income of the farmers and its benefits over conventional technologies /know-how in terms of savings in cost of production, inputs, timeliness; and other pertinent information	Over improved crops and cropping system there is a possibility to sustain nutritional food production, enhance income with reduce cost on production besides improving the livelihood condition and environmental condition due to tree planting on the bunds.
5	Social/environmental/other benefits	Improvement in the socio-economic condition besides improving the environment of the farm.
6	Status of commercialization /IP rights *etc.*	----------
7	Efforts for technology dissemination	----------
8	Special requirement for its successful realization; any other standards *etc*.	----------
9	Indicative photographs	 
10	Contact details of person from whom technology and further details can be obtained	Officer In Charge AICRP on Agroforestry, University of Agricultural Sciences, GKVK, Bangalore-560 065, Karnataka
11	Source of availability of technology/expertise	University of Agricultural Sciences GKVK, Bangalore-560 065, Karnataka
Name of Contributors: Dr. Nagaraju, Mr. V. Bhaskar, Miss Noor Asma, S., and Mr. Vishwanath, B. R.		

NOTE

Map showing location of AICRPAF Coordinating Centres and PC Unit.

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद
Agrisearch with a human touch

Contact

Project Coordinator AICRP on Agroforestry
ICAR-Central Agroforestry Research Institute, Jhansi (UP) - 284 003
Email : krishivaniki@nrcaf.res.in, krishivaniki@nrcaf.res.in
Website : http://www.nrcaf.res.in, www.nrcaf.res.in
Phone : 0510-2730214, Fax : 0510-2730364

army printing press
www.armyprinthouse.com
Lucknow (0522) 6565333