Technical Bulletin
CAFRI/2022/01

'Har Med Par Ped'

A Ready Reckoner

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ICAR-Central Agroforestry Research Institute
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The document has been prepared fully in academic spirit for educational and ready reckoning purposes so that apt measures are taken to control diseases in agroforestry trees and bamboo. The information in the document is based on primary observations and secondary information from published sources.

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Foreword

"*Har Med Par Ped*" is a slogan of the Government of India for enhancing tree cover in the country while also enhancing the income of farmers by advocating agroforestry as an alternative and diversified land-use. This calls for mass awareness about the tree plantation on farm bunds and boundaries so that suitable tree species are chosen for different regions without compromising the prevailing land tenure system. This has a larger canvas of provisioning livelihood and environmental securities together. With these viewpoints, ICAR-Central Agroforestry Research Institute, Jhansi along with its centres of the All India Coordinated Research Project on Agroforestry took the challenge to popularize the concept of farm boundary plantation among the masses including school children and other stakeholders. On the 26th April, 2021, the Institute organized a brainstorming session on challenges in enhancing tree plantation on farm boundaries involving different stakeholders, where the system conceived the idea of organising a nationwide tree plantation campaign on the 16th July, 2021 being the Foundation Day of the Indian Council of Agricultural Research (ICAR) under *Azadi ka Amrut Mahotsav*-India@75 programs.

I am happy to see that this technical bulletin not only provides detailed information on the suitable tree species for plantation on farm bunds/boundaries. It also highlights the ownership and land tenure issues that are attached to the farm landholdings requiring attention considering the socio-cultural implications. I feel the document is useful for all stakeholders in the farm and forest sector to have a common ground to work together and address the mission "*Har Med Par Ped*" with a larger perspective of meeting the country's ecological sustainability by provisioning thirty-three per cent tree cover.

(S.K. Chaudhari)
Deputy Director General (NRM)
Indian Council of Agricultural Research
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Govt. of India

Preface

Agroforestry comes as a green development solution for rejuvenating the degraded lands and wastelands, while also provisioning unprecedented opportunities to the farm communities for sustainable livelihoods *vis-à-vis* environmental security. With climate change posing a challenge, making the small and marginal farmers more vulnerable, it is time that we get back to the basics of growing trees on farmlands *per se*. Agroforestry becomes the suitable 5Fs (Food, Fodder, Fuel, Fibre and Fertilizer). Thus, agroforestry is the pathway for livelihood and environmental security.

The Central Agroforestry Research Institute (CAFRI), Jhansi and its constituent All India Coordinated Research Project on Agroforestry is organising awareness campaigns among the farming community, school children and other stakeholders regarding the importance of trees on farmlands. With the proclamation of `*Har Med Par Ped*' by our Hon'ble Prime Minister, a special focus on growing trees on bunds and boundaries is being emphasized. Till now, over 75 such campaigns have been organized by the Institute since 2015. During the campaigns, the focus has been given to the suitability of tree species on farm bunds and boundaries, and their management has been disseminated for public appraisal.

On the 26th April 2021, ICAR-Central Agroforestry Research Institute, Jhansi organized a Brainstorming Session on `*Har Med Par Ped*' on 26th April 2021 in virtual mode inviting experts and practitioners to discuss the constraints and challenges of growing trees on farm bunds and boundaries under the Chairmanship of Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR. The brainstorming session was attended by about 80 participants from different organizations across the country. The proceeding of the session has been annexed to this bulletin.

The present bulletin is an attempt to comprehensively compile the information about benefits of boundary/bund plantation, suitable tree species and their management, its appropriateness on-farm, challenges if any and the success stories from different states of the Indian Union.

Largest ever plantation drive by a research organization in the country was organized by ICAR and ICAR-CAFRI took a lead, planting 9.5 lakh seedlings with support of NARES, SMAF and other stakeholders.

We feel that the document would be useful for the policymakers and practitioners to get appraised of the efforts under '*Har Med Par Ped*' and reinvent the wheel to spearhead the objectives of the National Agroforestry Policy.

- Authors

Acknowledgements

This Bulletin "*Har Med Par Ped*" Bund/Boundary Plantations on Farm is a result of knowledge and expertise shared by the researchers, plantation managers, forest officials and farmers on the subject.

The authors gratefully acknowledge the guidance and motivation received from Dr T. Mohapatra, Secretary DARE and Director General, Indian Council of Agricultural Research, New Delhi to focus on the issues and challenges involved in adopting bund/boundary plantation. We are thankful to Deputy Director General (NRM), ICAR and Assistant Director General (Agronomy, Agroforestry and Climate Change), ICAR, New Delhi for their continued support to the subject of agroforestry. The contribution of the scientists from the Central Agroforestry Research Institute and All India Coordinated Research Project on Agroforestry in the compilation of the information is gratefully acknowledged.

The input provided by the experts during the Brainstorming session on the subject organized on 26th April 2021; the overwhelming support by the whole of the NARS system and the Mission Directors of Agroforestry Mission in different States to the Nation-wide Tree Plantation campaign on 16th July 2021 deserves a special mention in the success of the creating awareness about Bund/Boundary plantation on farm boundaries.

- Authors

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"Har Med Par Ped"

"Trees on Farm Bund"

- Narendra Modi

1 Background

National Forest Policy-1988 clearly envisages maintenance of at least 33 percent forest cover with respect to its geographical area in the country. At present, India has only 24.56 percent forest cover. Notwithstanding our efforts in this regard, the 21st century is witnessing food self-sufficiency, despite deforestation, land degradation, forest fire and other climate-related issues. With its relevance to achieving sustainable development goals too, agroforestry is a promising pathway to bridge the existing gap in forest cover, through bund, boundary and block plantations, thereby appreciating the tree cover outside forests. This was elaborately discussed under the chair of Secretary of DARE and DG, ICAR – Dr. T. Mohapatra on 26th April 2021 (Annexure I); whereby the document on 'Har Med Par Ped' became a reality. Given that All India Coordinated Research Project on Agroforestry centres with its pan-India coverage does regular promotion activities of tree-based farming system across the country including bund/boundary planting (Annexure II). Further, a Nation-wide Tree Planting Campaign was envisaged and it was carried out on 16th July 2021 (Annexure III). It is

About National Agroforestry Policy

India adopted the National Agroforestry Policy (NAP) 2014, a first of its kind to mainstream agroforestry practices. The policy was a cumulative result of many policies and schemes which emphasized agroforestry like National Forest Policy (1988), Planning Commission Task Force on Greening India (2001), National Bamboo Mission (2002), National Policy on Farmers, (2007) and National Mission for a Green India (2010).

The policy aims to,

- encourage and expand tree plantation in complementarity and integrated manner with crops and livestock to improve productivity, employment, income, and livelihoods of rural households, especially the small holder farmers.
- protect and stabilize ecosystems and promote resilient cropping and farming systems to minimize the risk during extreme climatic events.
- meet the raw material requirements of wood-based industries and reduce import of wood and wood products to save foreign exchange.
- supplement the availability of agroforestry products, such as the fuelwood, fodder, non-timber forest produces and small timber of the rural and tribal populations, thereby reducing the pressure on existing forests.
- complement achieving the target of increasing forest/tree cover to promote ecological stability, especially in the vulnerable regions.
- develop capacity and strengthen research in agroforestry and create a massive people's movement for achieving these objectives and to minimize pressure on existing forests.

exemplary that India became the first country to institute National Agroforestry Policy in 2014 whereby the agroforestry development process began countrywide. The policy document provisioned a mechanism to incentivize the farmers for tree-based farming. Boundary plantation/bund plantation is one of several such recognized practices in the policy for financial assistance.

Over 180 trees have been so far listed as multi-purpose trees (MPTs) but their ecological integration into agroforestry systems needs considerable R&D before taking it onto the farm fields. Meanwhile, ICAR-Central Agroforestry Research Institute (CAFRI) advocates agroforestry to be a land-use system itself and has assessed the area under agroforestry in different agro-climatic zones.

Based on the development of successful agroforestry models for different agro-ecological regions of the country by ICAR- and All India Coordinated Research project on Agroforestry (AICRP), agroforestry has emerged as one of the most preferred land-use systems in the country. The area under agroforestry in different agro-climatic zones have been estimated as 26.329 m ha.

Given the prevailing socio-cultural diversity in the country, we do see its reflections on the way the trees are integrated into farm fields. For instance, agroforestry is practised in various ways like the tree on field bund/ boundary, block plantation; alley cropping, scattered trees in the field, homegardens, etc. Among these, bund plantation is a very common practice throughout the country. Bunds on agricultural lands are considered as another potential area for agroforestry. In such conditions, mostly multipurpose tree species are likely to be chosen to plant on field bunds to achieve the benefits like fruits, fibre, fuelwood, fertilizer, food, and medicine. Similarly, the boundary plantation around individual landholding also acts as a demarcation line that acts as a bio fence, timber source, windbreak, shelterbelts, etc.

2 Bund Plantation

According to Nair (1993), a bund is a ridge of earth placed in a line to control water runoff and soil erosion, demarcate plot boundary, or other uses. Bund establishment involves placing narrow-based embankment at intervals across the slope of the land on a level mostly along the contour. This method conserves soil and water in arid and semi-arid areas with high infiltration and permeability. It is commonly adopted on agricultural land up to a slope of about six per cent. They control the effective length of the slope and thereby reduce the gain in velocity of runoff flow to avoid gully formations. Bunding is a low-cost technique that has the dual benefits of soil and water conservation and a means for sustainable agricultural intensification. It helps to increase crop yield, without expanding farmlands (Figure 1).

Figure 1: Bund plantation on farmlands

3 Boundary Plantation

Boundary planting is often referred to as living fences or barrier planting because it involves planting trees along with all types of boundaries including village, farm or factory boundaries (Figure 2). These can be the edges of property, agricultural fields, pastures, or any other place where fences might be located. Nonetheless, boundary plantation under agroforestry includes trees planted along boundaries or on bunds in such a way to hold the soil against erosion and improving soil fertility.

Figure 2: Trees around the farmland

4 Status of bund/Boundary plantations

According to a estimate, trees on boundaries or bunds of agricultural fields through social forestry accounts for 1.58 m ha in India (NRCAF, 2013). A thorough review of the literature revealed the limited work that has been carried out on the status of bund/boundary planting in the country. However, some states such as Karnataka undertook a detailed survey of traditional agroforestry practices in Bagalkot, Gulbarga, Koppal, and Raichur districts in the northern dry tract of Karnataka, and it was found that nearly 76.8 per cent of farmers followed bund planting as the most prominent practice under rainfed situation (Devaranavadagi *et al*., 2010). Similarly in the Northern States of Punjab, Haryana and Western Uttar Pradesh, boundary/bund planting with fast growing industrial tree species such as Poplar and Eucalyptus is very common. However, there is a need to undertake an explorative survey to know the status of bund/boundary plantation in other States as well.

Notwithstanding, the size of bund has been the reducing over the time. These days, the average bund width does not go beyond 2-1.5 feet, thereby challenging the planting of tree species. Further, the ownership of land and tenure issue do challenge the very practice of growing trees on farm fields, particularly on the bunds and boundaries.

5 Scope of bund/boundary plantations

5.1 Soil Conservation and Amelioration

Trees can be planted as biological soil-conservation measures (tree strips), either in combination with grasses or alone. Trees can be planted on physical soil conservation works (grass strips, bunds risers, and terraces), wherein they play two roles: to stabilize the structure and to make productive use of the land. Trees alone are effective enough only on gentle slopes (less than 6%). On steeper slopes combinations with grasses are desirable. Stabilization takes place mainly through the root system.

5.2 On Sloping Lands

In the high hills and sloping lands, bund planting can also be done on terrace edges to stabilize the structure to enhance the maximum use of land. Trees planted on the edge of a terrace will not have ideal moisture conditions but are effective for stabilizing the soil (Figures 3, 4).

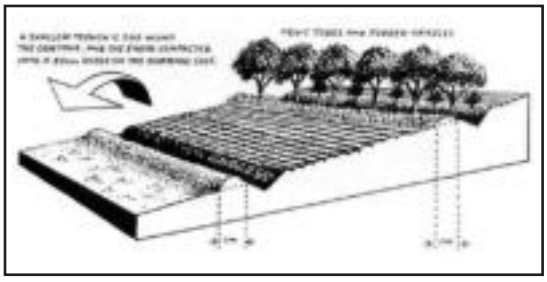

Figure 3: Trees on contour ridges

Figure 4: Trees on the terrace

5.3 Riverbank Stabilization

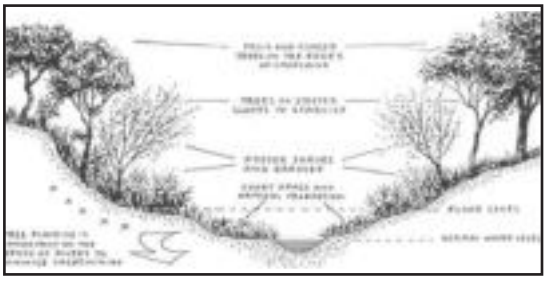

Figure 5: River-bank protection

In India, the agricultural lands are in proximity to water bodies and eventually, there are many areas where river lengths are considerable. The riverbanks are prone to erosion if they are not well covered with vegetation (Figure 5). The ground on either side of the river is partly flooded, particularly the area within the reach of the high level of water during the period. A few of the multipurpose tree species have the potential to check destabilization of the land and therefore warrants plantations to match the water level variation. Thus, bund planting along rivers becomes important both from an environmental point of view and to produce commodities (e.g.) medicine or fruits.

5.4 Aquaforestry

This is a new concept that is evidently found along the coastal regions particularly along the west coast of peninsular India where the farmers cultivate fish in water bodies and grows coconut/areca and other trees on the pond boundaries (Figure 6). These trees help in producing feed in the form of litter to the fishery and generate sustainable income for the farmer.

Figure 6: Aquaforestry in coastal areas

5.5 Canal-side plantation

In many arid countries, wherever rivers are available, efforts have been made to utilize the water for irrigation purposes through the construction of dams or using lift irrigation for agricultural needs. Several kilometers of irrigation canals have been laid in India too. The banks/bunds of such canals are available for planting purposes and constitute a considerable area for the production of timber and firewood for the rural population (Figure 7).

Figure 7: Canal bank protection

5.6 Windbreaks and Shelterbelts

It has been reported that trees grown on field bounds as windbreak or shelterbelt primarily reduce the wind velocity and change microclimate which are reflecting in the growth and development of the nearby crop and ultimately in crop yield. This is particularly important, where the fields are adjacent to factories and corporate services. These trees act as green solutions to noise pollution and also moisture retention while ameliorating the soil for sustained productivity. However, the main effect of a tree windbreak (Figure 8) is to provide shelter, *i.e.,* a windbreak alters the mean wind speed, wind direction, and turbulence of the airflow.

Figure 8: Windbreak on farm fields

5.7 *Bunds for raising nitrogen-fixing plants*

Farm bunds could be resourcefully used for rising nitrogen-fixing shrubs and trees to generate nitrogen affluent lopping. *Gliricidia* on farm bunds (Figure 9) serves the dual purpose of producing green leaf manure rich in nitrogen and also helps in conserving soil through reduced soil erosion. Interestingly, there are non-leguminous tree species that fixes atmospheric nitrogen in the soil. For instance, *Casuarina* and *Alnus nepalensis* are examples that flourish well on loose sandy soils in coastal and in the sloping lands of the Indian Himalaya, respectively.

Figure 9: Nitrogen-fixing plants in the farm fields

5.8 *Trees for bund consolidation*

Trees can be grown widely spaced within rice fields or along either side of bunds. Bunds are earthen constructions that separate paddy fields from each other and drier land at wide, alternate spacing so as not to block access along the bunds. Some trees are grown primarily for holding the bunds together (Figure 10), helping them retain their shape. Sometimes the soils in paddy field areas are mostly sandy and weakly structured, they do not form long-lasting bunds without some reinforcement, such as tree roots.

Figure 10: Teak trees on field bunds in Central India

5.9 *Bund/Boundary plantation for demarcation*

Trees in dryland tracts of agricultural crop fields are often planted on bunds (field risers) and/or borders or boundaries, to demarcate the field boundaries (Figure 11). In this system, the space of the bund is gainfully utilized. If a tree species has an erect growth habit, the associated crop growth is not adversely affected by shading.

Figure 11: Trees for boundary demarcation

6 Benefits to farmers from bund/boundary planting

6.1 *Short-term benefits:*

Farmers plant trees at a high density. This means there are more trees to sequester carbon in a short time. The fast-growing trees also release mineral nitrogen into the soil and prevent soil erosion. The small branches and leaves provide a good source of fodder for cattle, which has been shown to raise milk production.

6.2 *Medium-term benefits:*

After 8-12 years, many of these trees will be so big that they crowd each other out. At this time, farmers can thin out the nitrogen-fixing species, which regrow quickly when they are coppiced. These trees provide farmers with a valuable source of construction material and fuelwood. It discourages them from cutting down forests to meet their needs. Farmers can also sell them locally and earn an additional income.

6.3 *Long-term benefits:*

As the stands grow and regenerate, farmers continue to make occasional thinning to give enough space for the existing trees as they grow. This also provides farmers with additional wood and fuel that can be used or sold. The longer-lived trees are very valuable in that they provide seeds, fruit, and habitat for local flora and fauna. They will also produce highly valued timber, which can be sustainably harvested.

7 Characteristics of woody perennials suitable for bund/boundary plantation

- The tree species should have an erect growth habit so that the associated crop growth is not adversely affected by shading.
- For the bund plantation along paddy fields species that are tall and slim with little shade are likely to be ideal.
- Species with a deep root system that draws their water supply from deep the water table (phreatophyte) are usually preferred.
- For soil conservation purposes, species with deep and extensive root systems are chosen to keep the soil intact and prevent soil erosion.
- Multipurpose tree species with short-, medium- and long-term returns be planted, so that farmers may get additional income at regular intervals.
- In the agroforestry model, a suitable combination of nitrogen-fixing and multipurpose trees with field crops plays a major role in the enhancement of better yield productivity, soil nutrient status, and microbial population.
- For riverbank plantations, the species to be planted should be matched with this water level variation. In the more arid areas, trees with xerophytic habit constitute the outermost rows while those close to the riverbank are the ones with higher water requirements. This facilitate easy establishment of the trees.
- For canal bank plantation, the roots of trees should strengthen the banks of canal and the trees should keep the canal and its banks well shaded to suppress weed growth and reduce evaporation. Species that tend to increase water seepage through the sides and bottom of the canal should be avoided. If canals have an intermittent flow, such as flood discharge canals, only trees able to adjust to varying water levels in the soil can be used. Species that reproduce suckers such as *Robinia pseudoacacia* should not be planted along canals.

8 Species suitable for bund/boundary plantation

- The common tree species grown as boundary plantations in dryland systems are *Tectona grandis*, *Leucaena leucocephala* (pollarded for fodder), *Borassus flabellifer, Cocos nucifera, Acacia nilotica* var. *cupressiformis*, *Dalbergia sissoo,* and *Prosopis juliflora*.
- *Casuarina equisetifolia* and *Acacia auriculiformis* are planted on field bunds and along with sandy coastal areas in Karnataka
- In Andamans, farmers grow *Gliricidia sepium, Jatropha* spp., *Ficus, Ceiba pentandra, Vitex trifolia* and *Erythrina variegata* as live hedges.
- The bund cropping with leguminous trees such as *Leucaena leucocephala* has been most widely used on field bunds for producing mulch material for moisture conservation and nutrient recycling.
- For riverbank plantation, phreatophyte species such as *Populus* spp., *Acacia nilotica*, *Dalbergia sissoo, Prosopis* spp. can be planted.
- The following tree species are used for soil conservation: *Grevillea robusta, Acacia catechu, Prosopis juliflora, Leucaena leucocephala, etc*.
- Trees may also be mixed with staple food crops to produce fruit, fodder, or wood.
- In some places, bund planting with *Azadirachta indica, Acacia nilotica,* and Eucalypts are predominant under rainfed agroeco systems.
- In some cases, the small and marginal farmers give preference for fruit yielding tree species or a mix of timber and fruit yielding tree species on farm bunds.

In general, the following species are recommended for bund plantation:

Trees that can be considered for boundary bunds are:

- *Eucalyptus* spp.
- *Poplar* spp.
- *Salix* spp.
- *Azadirachta indica*
- *Dalbergia sissoo*
- *Bamboo* species
- *Tectona grandis*
- *Thespesia populnea*
- *Albizia lebbeck*
- *Leucaena leucocephala*

Trees for internal bunds

- *Glyricidia sepium*
- *Leucaena leucocephala*
- *Cassia siamea*
- *Sesbania sesban*
- *Erythrina indica*
- *Moringa petrigosperma*
- *Pongamia pinnata*

According to the study carried out by MYRADA (Mysore Resettlement and Development Agency) (2005-06), in Karnataka, the most common tree seen on the fields of both dryland and irrigated land was *Cassia Siamea*, because it was the main species promoted under the project. The farmers reported it to be a quick growing tree yielding good quality fuelwood. The next in order was *Glyricidia*, which accounted for 18 per cent of all trees planted. However, *Pongamia* was greatly appreciated; 82 per cent of farmers reported its ownership though the number of trees noted per farm was fewer than *Cassia siamea* and *Glyricidia*. Pongamia grows under dry farming conditions and its leaves yield better manure though, traditionally, this has been used only in irrigated conditions. Its seeds are oil-bearing and sold in the market. The wood is hard and used in making agricultural implements. However, it is a slow-growing tree, and its leaves take longer to decompose (MYRADA, 2009).

9 Management of bund/boundary plantation

- To be effective as tree strips, trees should be planted in lines along the bunds/boundaries/contours.
- Spacing within and between the rows depends on the characteristics of the species and the rotation planned for the crop.
- Boundary plantations can be single or multiple rows.
- Single row trees grow faster as compared to those in block plantations as they get irrigation and fertilizers along with the crops and get sufficient space to grow.
- Usually, the ideal tree spacing in paired row planting on bunds is one meter between the rows and two meters from tree to tree.
- Tree to tree spacing in single line tree planting on farm boundaries can be 2.0 m.
- If the trees are combined with grasses or shrubs the spacing can be wider, and the spacing should also be wider in dry areas because of moisture competition between the trees.
- The initial establishment can always be denser, and thinning can be carried out later to obtain the final spacing.
- The strip (10-15 m wide) along the tree line should be managed separately to minimize the adverse effect of tree shade.
- Keep water channel along with tree lines.
- Trees should be regularly pruned for fodder and firewood and to reduce the negative shading effect.
- On steeper slopes, an option is to grow trees on every second terrace to avoid having too great a density of trees.
- Trees should be planted preferably on NorthSouth field boundaries to avoid continuous shading effect on the northern aspect in winter (*rabi* season).

10 Basic guidelines for bund plantation in cultivated land

- Cattle should be kept away from the area while establishing saplings, by using live hedge fencing.
- Larger trees can be planted on boundary bunds, and smaller trees that will be harvested more frequently can be planted on internal bunds.
- Internal bunds can be spaced every 20 to 30 meters apart to promote soil and water conservation.
- These bunds should follow the contours of the landscape.
- Trees on internal bunds can be pruned to a height of 5 feet to avoid shading crops, and the harvested biomass can be introduced to the soil to increase the organic content.
- A 15 cm trench should be maintained 0.50 m from the trees on the bunds to encourage the roots to grow downwards, rather than into the fields.
- In sloping lands experiencing heavy rainfall, bunds should not follow the exact contour but should be slightly sloping to allow for drainage along the bunds.

For canal bank plantation:

- Planting can be taken up along canals of irrigation projects. Since water is available for part of the year these sites are suitable for raising fruit yielding and Non-Timber Forest Products species.
- If the site along canals is very poor due to dumped soil, the pits can be filled with imported soil.
- No plantation is raised along the ridges and the edges of the water channel.
- The first row of the trees is generally planted about 7.5 m from the ridge of the canal in case of multiple row planting.
- Subsequent rows are spaced about 5 m or 3 m or 2 m depending upon the species.
- In the case of lined canals, the first row is raised at the toe and consists of species with confined roots as the long and strong roots may damage the lining.
- To keep the fertility levels of the canal strip soils, rotation of non-leguminous species and leguminous trees are preferred.
- At least 12 months old, 7-8 feet tall seedlings raised in 10" × 16" bags to be planted at 10 m apart in pits of 0.75 m^3.
- *Cassia siamea, Dalbergia sissoo, Glyricidia* are raised in 5" × 8" polythene bags and planted in trenches of 4 × 0.5 x 0.5 m in poorer sites.
- Seed sowing is taken up on mounds with *C. siamea* and *Glyricidia.*

11 Crop yield in presence of bund/boundary plantations

Boundary plantation is a prominent feature of the Indian agroforestry system as it is very popular among the farmers due to its less interference, ease in mechanization and demarcation of field boundaries. Commercial trees under agroforestry besides providing the tree products improves soil productivity through ecological and physico-chemical changes Boundary plantations under agroforestry helps in holding the soil against erosion and improving soil fertility by fixing nitrogen or bringing minerals from deep in the soil and depositing them by leaf-fall. Such a suitable combination plays a vital role in the enhancement of better yield productivity, soil nutrient status and microbial population dynamics which plays a major role in nutrient cycling to maintain the ecosystem (Raj *et al.,* 2016). Due to the shading effect and strong root system of trees at bunds and boundaries, which compete for moisture and nutrient with crops resulting grain yield near the tree lines was comparatively low. Trees at the boundary provide extra income to farmers with minimum interference with various agricultural operation and crop. Moreover, the small farmers cannot afford to raise block plantation at the cost of agricultural crop yield because the yield reduction ranges from 30-50 per cent in block plantation whereas 15-20 per cent in boundary plantation. Further, it has been observed that as the distance increases the grain yield also increases.

Many studies have had conclusive evidence proving the beneficial impacts of trees in bunds and boundaries on the crop yield by increasing the physico-chemical properties of the soil. Further, on drylands, most of the farmers can use lopped branches and add to the soil along with farmyard manure in 30-50 per cent proportion to be composted. The branches can be used as fuelwood. On an average, study by MYRADA at the Kolar region in Karnataka reported that farmers have experienced an approximate increase of 98 per cent in rice yields since they started applying leaf matter in increased quantities in irrigated plots, and approximately 67 per cent increase in the yields of dryland crops (MYRADA, 2009). All the farmers emphasized that there had been an increase in the moisture-holding capacity in their fields. This was also identified as one of the reasons for improved crop yields; the crops, which could withstand a longer duration of dry spells without experiencing moisture stress. The trees also act as a source of income in case of crop failure and increase the resilience of the system and the farmer together.

12 Socio-cultural and socio-economic aspects of bund/boundary plantations

Agroforestry is embedded in the socio-cultural practices, which can, in part, determines its social acceptability at the farmer's level, as farmers are the primary beneficiaries of agroforestry practices. The success of any agroforestry project is influenced by public policies and regulations that provide incentives to integrate trees on farms and promote the use of products from these trees. Bund and boundary plantations being part of agroforestry models also face socio-cultural implications. Important socio-cultural factors for adoption of bund and boundary plantations:

Ownership of the bunds or boundaries: Planting trees on the bunds is seen as a sign of ownership.

Farmers' Perceptions of Planting Trees: The success of almost any activity involving trees and people is strongly influenced by government regulations, perceptions, preconceptions, and preferences.

Labour: The practice of tree planting and management most often requires more labour and changes in farm activities from the norms.

Marketing: While income that can be obtained from a land-use system is an important criterion in judging social acceptability, the processing and sale of tree products is an important deciding factor in the value chain.

Other Social Factors

The possibility to grow crops between trees without adverse effects from the trees on food crops is always a point of discussion. Along with this, many other social factors are extremely important in the introduction, development, and scaling-up of technologies. Local knowledge, local organization, and participation in tree management, cultural and eating habits, land tenure, external and internal on-farm income, food security, and demographic factors such as health, well-being, gender, and age of farmers are all critical issues to the successful introduction and development of the plantation.

13 Economic returns of bund/boundary plantation of trees on farmlands

The economic returns from the bund and boundary plantation are also lucurative. Table 1 depicts the net returns from the boundary plantation based on the field experiences from the AICRP on Agroforestry. The B:C ratio ranges from 1.5 to 2.3 generally and the ecosystem services to the farm interms of nutrient cycling, nitrogen fixing, soil and water conservation, *etc*. are added benfits *per se.*

Table 1. Economics of bund/boundary plantations

S.No.	Tree species	Spacing (m)	Age of tree (cut)	No. of plants/ ha	Rate of tree (Rs.)	Expenditure cost (Rs.)	Gross return (Rs.)	Net return (Rs.)
1)	*Tectona grandis* (Sagon)	5 x 5	10 years	200	4500/-	70,000/-	9,00,000/-	8,30,000/-
2)	*Terminalia tomentosa* (Ain)	5 x 5	10 years	200	2000/-	68,000/-	4,00,000/-	3,32,000/-
3)	*Acacia mangium* (Australian sag)	5 x 5	7 years	200	1200/-	40,000/-	2,40,000/-	2,00,000/-
4)	*Dendrocalamus stocksii* (Manga bamboo)	5 x 5	4 years	200 (10 clumps/ plant) = 2000	100/-	34,500/-	2,00,000/- (First harvesting after 4 years)	1,65,500/-
5)	*Melia dubia*	5 x 5	4 years	200	600 /-	38,000 /-	1,20,000 /-	82000 /-

14 Case study on bund/boundary plantation

14.1 *Melia dubia* based agroforestry as a bund planting practice in Karnataka

Melia dubia is planted at a spacing of 2.5 to 3.0 m apart on the bunds which are spaced at 30 m apart in arable lands, where finger millet, soybean, dolichos, red gram, and other field crops are cultivated under rainfed conditions (Figure 12). Under irrigated conditions, vegetable crops, flower crops, and plantation crops are also cultivated.

Crop yield: As *Melia* is spaced wide apart and planted on bunds, not much reduction in yield of the crops is noticed both in rainfed and irrigated conditions.

Timber yield: Under rainfed conditions, the yield of each tree varies between 12 cft and 14 cft at the age of 10 to 12 years. In many situations, *Melia* is often harvested at 10 to 12 years. Under irrigated conditions, *Melia* is harvested at 8 to 10 years, when the timber yield varies between 12 and 15 cft per tree.

Economics: Rs 2,49,000 after 10 to 12 years in rainfed areas; Rs 2,60,000 after 8 to 10 years in irrigated areas.

Area of adoption: Mysore, Ramanagara, Mandya, Hassan, Bangalore Rural, Tumkur, Chitradurga and Chamarajanagar districts of Karnataka.

Suitability: This technology is highly suitable for small and marginal farmers.

Figure 12: Bund planting of *Melia dubia* in a farmer's field

14.2 *Melia dubia* based agroforestry as boundary planting in Karnataka

Technology details: *Melia dubia* planted at a spacing of 3 to 4.5 m apart, at 3 to 5 m within the boundary of lands. Boundary planting is very common in cultivated lands (Figure 13).

Yield: On average, each tree recorded 15 cft in 10 years.

Economics: Net returns: Rs 4,72,500 per acre

Area of adoption: Mysore, Ramanagara, Mandya, Hassan, Bangalore Rural, Tumkur, Chitradurga and Chamarajanagar districts of Karnataka.

Suitability: Irrigated Garden lands.

Figure 13: Boundary plantations of *Melia dubia*

14. 3 Bund/Boundary Plantation of MPTs in banana fields of Tamil Nadu

Farmer Mr. Sadasivam from Vellipalayam village of Mettupalayam taluk in Coimbatore district was provided with *Melia dubia* and *Swietenia macrophylla* seedling from TNAU-Forest College and Research Institute, Mettupalayam for the establishment of bund/boundary plantation in banana crop (Rustali and red banana) fields.

***Melia dubia* as boundary plantation**

***Swietenia macrophylla* as boundary plantation**

Table 2. Economics of *Melia dubia* bund/boundary plantation

S.No.	Details	Yield
1.	Tree species	*Melia dubia*
2.	Plantations	Bund/boundary plantation
3.	Area	1 acre
4.	Spacing	3m x 3m
5.	Total no. of trees	46
6.	Total no. of survived trees	42
7.	Age of the tree	10 years
8.	Average yield of each tree in cft	15 cft
9.	Total yield (Acre)	15 cft x 42 trees = 630 cft
10.	Present market rate per cft	450/- Rs per cft
11.	Average income from each tree	450 Rs x 15 cft = 6750/- Rs
12.	Total income from tree (Acre)	6750 cft x 42 trees = 2,83,500 Rs
13.	Expenditure on individual tree	1000 Rs
14.	Total expenditure (Acre)	42 trees x 1000 Rs = 42,000 Rs
15.	Net income (Acre)	2,83,500-42,000= 2,41,500 Rs

14.4 *A Testimony from an Agroforestry Farmer from Gujarat*

Farmer's Name: Karshanbhai Devabhai Menat
Village: Salempura
Tehsil: Palanpur
Dist.: Banaskantha (Gujarat)

- Karshanbhai Devabhai Menat is an Agroforestry farmer under [illegible] Agroforestry scheme, SDAU, Sardarkrushinagar (Gujarat).
- Before the adoption of Agroforestry the farmer was growing only traditional crops i.e., greengram, clusterbean and castor in their field and earned ₹ 20000-25000 from their 1.50 ha field. But during 2007 the farmer came in contact with Agroforestry centre and planted 165 Ardusa (*Adanthus excelsa*) plants on his 1.50 ha farm bund with 3 m spacing between the plants.
- Presently he is growing their traditional crops along with the Ardusa boundary plantation and earning about ₹ 20000 net income per hectare per year from the intercrops.
- During the year 2020 the farmer sold these all 165 Ardusa plants at the rate of rupees 1500 per tree and earned ₹ 2, 47,500 form the boundary plantation.
- Besides this he is getting about 50 kg green leaves per tree as fodder for their domestic animals (two cows and two buffaloes). The farmer also getting fuel wood from the boundary plantation for their domestic uses.
- He did not get any adverse effect of boundary plantation on intercrops viz., castor, greengram and clusterbean and also improve the fertility status of soil.
- By the adoption of ardusa (boundary plantation) based agroforestry system the farmer got ₹ 12,700 per ha per year as additional income as compared to sole cropping (₹ 20000 net income per hectare per year) in their field.

Signature
Karshanbhai Devabhai Menat

15 Recommendations

The planting of trees on farm bunds and boundaries yields few immediate financial or economic benefits. Although not accounting for a large gross area, boundary planting is extremely common in most agricultural areas. Economic benefits to the household from these kinds of planting are sometimes important in terms of fodder and fuel production. Henceforth, farmers are encouraged to raise plantations on farm boundaries and field bunds to generate additional income without any effect on regular agricultural crop production. Consequently, the adoption of these types of practices cannot be understood solely in terms of their immediate or potential financial or economic benefit. A tree species with faster growth, clear bole, thin canopy, and deeper root system along with lesser water requirements and productive tree-crop interactions are essentially required to suit to the space availability in the bunds and boundaries. Accordingly, the appropriate species are to be identified and prescribed for different agro-ecologies. Based on the studies and experiences, the ICAR-CAFRI prescribes a list multipurpose tree species as suitable for bund/boundary plantation on farmlands in different states (Table 3) and specific list for short-rotation forestry (Table 4).

To this effect, a document on ecologically suitable tree species for promotion under "*Har Med Par Ped*" is presented here for circulation among the implementing agencies and other stakeholders.

Table 3. State-wise suitable trees species for bund/boundary plantations

State/Union territorie	Tree species
ANDHRA PRADESH	*Casuarina equisetifolia, Eucalyptus* spp., *Pterocarpus santalinus, Melia dubia, Dalbergia sissoo, Azadirachta indica, Albizia procera, Acacia nilotica, Azadirachta indica, Capparis deciduas, Ziziphus* spp., *Ailanthus excelsa, Terminalia arjuna, Syzygium cumini, D. latifolia, Pithecellobium dulce, Pongamia pinnata, Butea monosperma, Acacia auriculiformis*
ARUNACHAL PRADESH	*Alnus nepalensis, Bamboo, Terminalia myriocarpa, Morus alba, Ailanthus excelsa, Michelia* spp., *Magnolia* spp., *Artocarpus heterophyllus, Gmelina arborea, Mesua ferrea, Acacia nilotica, Albizia* spp.
ASSAM	*Alnus nepalensis, Parkia roxburghii, Michelia oblonga, Gmelina arborea, Schima wallichii, Lagerstroemia speciosa, Pinus kesiya, Grevillea robusta,* Arecanut, Coconut
BIHAR	*Dalbergia sissoo, Tectona grandis, Pheonix sylvestris, Anthocephalus cadamba, Pongamia pinnata, Acacia auriculiformis, Eucalyptus, Acacia mangium, Syzygium cumini, Terminalia arjuna*
CHHATTISGARH	*Acacia nilotica, Gmelina arborea, Butea monosperma, Terminalia arjuna, T. tomentosa, Albizia procera, Zizyphus mauritiana, Azadirachta indica, Pongamia pinnata*
GOA	*Casuarina equisetifolia, Artocarpus heterophyllus, Azadiracta indica, Cocos nucifera, Eucalyptus* spp.
GUJARAT	*Tectona grandis, Melia dubia, Anthocephalus cadamba, Leucaena leucocephala, Eucalyptus* spp., *Casuarina equisetifolia, Acacia nilotica, Acacia catechu, Dalbergia sissoo, Zizyphus mauritiana, Gmelina arborea, D. latifolia, Pongamia pinnata, Terminalia arjuna, Rhizophora* spp., *Salvadora persica, Salvadora oleoides, Prosopis juliflora, Prosopis cineraria, Aegle marmelos*
HARYANA	*Populus deltoides, Prosopis cineraria, Tecomella undulata, Acacia albida, Azadirachta indica, Melia azedarach, Eucalyptus, Acacia* spp., *Salix* spp., *Dalbergia sissoo, D. latifolia, Pongamia pinnata, Terminalia arjuna, Aegle marmelos*
HIMACHAL PRADESH	*Populus deltoides, Toona ciliata, Juglans regia, Salix* spp., *Melia azedarach, Grewia* spp., *Morus alba, Bamboo* spp., *Quercus* spp.

JHARKHAND	*Azadirachta indica, Madhuca indica, P. pinnata, Artocarpus lakoocha, D. latifolia, T. grandis, T. arjuna, D. sissoo, G. arborea, M. azedarach*
KARNATAKA	*Tectona grandis, Melia dubia, Anthocephalus cadamba, Dalbergia latifolia, Casuarina equisetifolia, Acacia mangium, Acacia auriculiformis, Santalum album, Anogeissus latifolia, Leucaena leucocephala, Sesbania grandiflora, Acacia pycnantha, Acacia nilotica, Pongamia pinnata, Terminalia arjuna, Eucalyptus, D. sissoo, S. cumini, A. marmelos*
KERALA	*Tectona grandis, Acacia mangium, Eucalyptus, Bamboo, Casuarina equisetifolia, Dalbergia latifolia, Swietenia mahogony, Artocarpus heterophyllus, Cocos nucifera, Ailanthus triphysa, Santalum album*
MADHYA PRADESH	*T. grandis, D. sissoo, A. senegal, A. nilotica, A. cadamba, L. leucocephala, M. dubia, A. excelsa, G. arborea*
MAHARASHTRA	*T. grandis, Terminalia paniculata, T. chebula, A. heterophylla, Gliricidia sepium, G. arborea, Madhuca indica, M. dubia, L. leucocephala C. equisetifolia, T. arjuna, Eucalyptus, D. sissoo, D. latifolia, P. pinnata, S. cumini, A. marmelos, Bamboo* spp.
MANIPUR	*Parkia roxburghii, Litsea polyantha, Alnus nepalensis, Albizia* spp., *Artocarpus* spp., *Ficus* spp., *Morus alba, Bamboo* spp.
MEGHALAYA	*Parkia roxburghii, Litsea polyantha, Alnus nepalensis, Albizia* spp., *Artocarpus spp., Ficus* spp.
MIZORAM	*Alnus nepalensis, Michelia* spp., *Litsea* spp., *Pinus kesiya, Schima wallichii, Ficus* spp., *Quercus* spp., *Toona ciliata, Betula* spp., *Embilica officinalis*
NAGALAND	*Alnus nepalensis, Michelia* spp., *Litsea* spp., *Pinus kesiya, Schima wallichii, Terminalia myriocarpa, Duabanga grandiflora, Tectona grandis, Artocarpus integrifolia, Gmelina arborea, Embilica officinalis*
ODISHA	*A. mangium, T. grandis, Eucalyptus* spp., *C. equisetifolia, Sesbania grandiflora, G. arborea, D. sissoo, D. latifolia, P. pinnata, T. arjuna*
PUNJAB	*Prosopis cineraria, Eucalyptus, Anthocephalus cadamba, Dalbergia sissoo, Azadirachta indica, Acacia nilotica, Leucaena leucocephala, Populus* spp., *Salix* spp., *Aegle marmelos*

RAJASTHAN	*Prosopis juliflora, Acacia tortilis, D. sissoo, A. leucophloea, A. nilotica, P. cineraria, Azadirachta indica, Tecomella undulata, Pithecelobium dulci, Salvadora persica, Zyziphus nummularia*
SIKKIM	*Alnus nepalensis, Bamboo (Dendrocalamus), Shorea* spp., *Ficus racemosa, Schima wallichii, Quercus* spp., *Juglans regia, Pinus* spp., *Litsea* spp., *Albizia odoratissima, Albizia procera, Michelia* spp.
TAMIL NADU	*Casuarina equisetifolia, Eucalyptus, Santalum album, Anthocephalus cadamba, Melia dubia, Bombax ceiba, Acrocarpus fraxinifolius, Azadirachta indica, Leucaena leucocephala, Albizia lebbeck, Hibiscus tiliaceaous, Calophyllum ionophyllum, Pongamia pinnata, Terminalia arjuna, Tamarindus indica, Prosopis juliflora, Acacia ferrugenea, Acacia leucophloea, Aegle marmelos*
TELANGANA	*Casuarina equisetifolia, Eucalyptus, Santalum album, Anthocephalus cadamba, Melia dubia, Bombax ceiba, Acrocarpus fraxinifolius, Azadirachta indica, Leucaena leucocephala, Albizia lebbeck, Pterocarpus santalinus, Terminalia arjuna, Syzygium cumini, Dalbergia sissoo, Dalbergia latifolia, Pongamia pinnata, Aegle marmelos*
TRIPURA	*Morus alba, Cocos nucifera, Gmelina arborea, Anthocephalus chinensis, Terminalia myriocarpa, Azadirachta indica, Artocarpus heterophyllus, Albizia procera, Toona ciliata, Tectona grandis, Parkia javanica, Zizyphus jujuba, Artocarpus lakoocha, Emblica officinalis, Gliricidia sepium*
UTTAR PRADESH	*Tectona grandis, Dalbergia sissoo, Acacia senegal, Acacia nilotica, Anthocephalus cadamba, Populus* spp., *Bamboo, Emblica officinalis, Azadirachta indica, Pongamia pinnata, Terminalia arjuna, Anogeissus latifolia, Melia dubia, Leucaena leucocephala, Casuarina equisetifolia, Syzygium cumini, Aegle marmelos*
UTTARAKHAND	*Grewia* spp., *Pinus* spp., *Melia azedarach, Toona ciliata, Shorea robusta, Juglans regia, Celtis australis, Pinus roxburghii, Quercus leucotrichophora, Morus alba*
WEST BENGAL	*Anthocephalus cadamba, Eucalyptus tereticornis, Casuarina equisetifolia, Acacia auriculiformis, Gmelina arborea, Tectona grandis, Zizyphus* spp., *Azadirachta indica, Acacia catechu, Bombax ceiba, Dalbergia sissoo, Shorea robusta, Swietenia mahogoni, Diospyrus, Melanoxylon, Madhuca indica, Terminalia arjuna, D. latifolia, Pongamia pinnata, Syzygium cumini*

ANDMAN & NICOBAR ISLANDS	*Anthocephalus chinensis, Casuarina equisetifolia, Cocos nucifera, Ficus carica, Pandanus odoratissimus, Artocarpus heterophyllus, Lagerstroemia hypoleuca, Thespesia populnea, Calophyllum ionophyllum, Mesua ferrea, Gliricidia sepium, Ceiba pentandra, Vitex trifolia, Erythrina variegata*
CHANDIGARH	*Eucalyptus, Anthocephalus cadamba, Dalbergia sissoo, Azadirachta indica, Acacia nilotica, Leucaena leucocephala, Populus* spp.
DADAR AND NAGAR HAVELI	*Leucaena leucocephala, Eucalyptus, Casuarina equisetifolia, Acacia nilotica, Acacia catechu, Zizyphus mauritiana, Gmelina arborea, D. latifolia, Pongamia pinnata, Terminalia arjuna, Rhizophora* spp., *Salvadora persica, Salvadora oleoides, Prosopis juliflora, Prosopis cineraria, Aegle marmelos*
DAMAN AND DIU	*Cocos nucifera, Casuarina equisetifolia*
DELHI	*Dalbergia sissoo, Azadirachta indica, Acacia nilotica, Pongamia pinnata*
LADAKH	*Poplar, Salix,* Sea buckthorn
LAKSHADWEEP	*Anthocephalus chinensis, Casuarina equisetifolia, Cocos nucifera, Ficus carica, Pandanus odoratissimus, Artocarpus heterophyllus, Lagerstroemia hypoleuca, Thespesia populnea, Calophyllum ionophyllum, Messua ferrea, Gliricidia sepium, Ceiba pentandra, Vitex trifolia, Erythrina variegata*
JAMMU AND KASHMIR	*Populus deltoides, Salix alba, Melia azedarach, Toona ciliata, Pinus* spp., *Grewia* spp., *Shorea robusta, Salix alba, Alnus* spp.
PONDICHERRY	*Casuarina equisetifolia*

Table 4. List of short-rotation tree species for boundary plantation

S.No.	Tree Species	S.No.	Tree Species
1	*Populus* spp.	7	Bamboo spp.
2	*Eucalyptus*	8	*Leucaena leucocephala*
3	*Anthocephalus cadamba*	9	*Sesbania grandiflora*
4	*Casuarina equisetifolia*	10	*Gliricidia sepium*
5	*Salix* spp.	11	*Morus alba*
6	*Melia dubia*	12	*Acacia mangium*

16 Photographic Panorama

Bund/boundary plantation in different parts of the country

Bund planting of coconut is widely practiced in low lying rice fields of Kerala covering an area of around 50,000 hectares. Boundary plantation of timber trees like teak, mahogany and ailanthus; and live fences of *Gliricidia* and *Erythrina* are commonly practiced at homesteads and farmlands in Kerala.

Boundary planting of valuable trees like teak, ailanthus, mahogany, bamboo with improved/good quality planting material is getting greater adoption and acceptance amongst farming community after the boom with start of the *'Har Med Par Ped'* programme. Thus, in a state like Kerala where the per capita land and land available for new tree planting is very low, the hitherto unnoticed and unrecognized boundaries all along the farms and homesteads are becoming potential space for tree growing.

Bund/ boundary planting of coconut and other palms in paddy fields in Kerala

Bund/ boundary planting of Poplar with paddy and wheat in Punjab/ Haryana

Bund/ boundary planting with Banana, arecanut and coconut in Assam

Boundary planting with Teak in Karnataka

Boundary plantation landscape in Himalayan region

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Annexure-I

Proceedings of the Brainstorming Session on *'Har Med Par Ped'* organized by ICAR-CAFRI on 26th April, 2021

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

Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR warranted choice of species to be grown on bunds and boundaries in different agro-climatic regions of the country. While doing so, we need to keep the productivity attributes, environmental services and the socio-economic imperatives of tree growing on farmlands in mind and suggest remedies to the constraints and challenges in implementing the objectives of National Agroforestry Policy, he added. He stressed upon bridging of existing gap in our lab to land programs and suggested to involve all stakeholders including KVKs and State Departments to upscale the program attributes for enriching the '*Har Med Par Ped*' objectives and devise mechanisms to ensure availability of quality planting materials.

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

Dr. A. Arunachalam, Director, CAFRI highlighted the theme of discussion as one of the seven-point strategies given by our Hon'ble Prime Minister in 2015 for Doubling Farmers' Income by 2022. He further extended the scope of the discussion by narrating that about 17 lakh trees are cut in our country every year against planting of 26 lakh trees, most of them in lands outside forest governance, thereby conforming the scope and role of agroforestry in this endeavour of bund/boundary plantations using tree species.

This was followed by presentations by a Panel of Experts who spoke on prospects of bund planting and boundary plantations in different ecological zones such as Himalaya, Indo-Gangetic, North-East, Semi-arid and Coastal regions. In addition, an industry representative and a progressive farmer also shared their field experiences.

The glimpses of their discussions are documented below.

The Himalayan Region

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

NEH Region

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

Indo-Gangetic Region

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

Semi-Arid Region

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

Coastal Region

Dr. T.K. Kunhamu, Professor and Associate Director of Research, KAU, Thrissur presented Boundary/Bund Plantations: Prospects and challenges in humid and coastal regions of the country. He mentioned that homegardens, aquaculture with trees,

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

Industry Perspective

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

Farmers Perspective

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

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

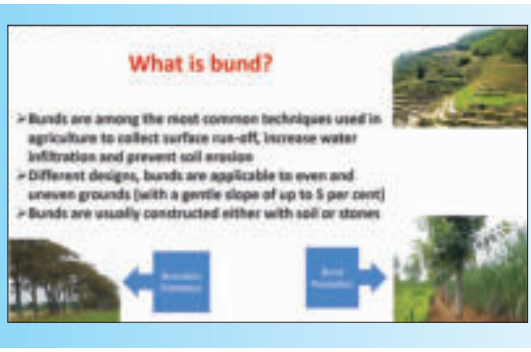
- A tree species with faster growth, clear bole, thin canopy, and deeper root system along with lesser water requirements and productive tree-crop interactions are

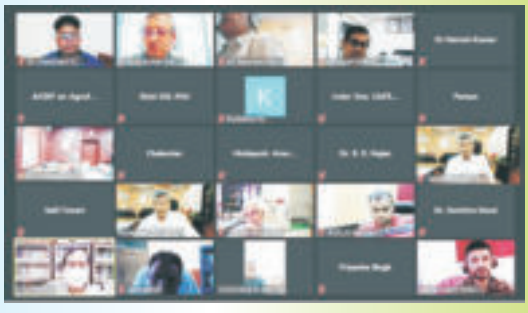
essentially required to suit to the space availability in the bunds and boundaries. Accordingl, the appropriate species are to be identified and prescribed for different agro-ecologies. To this effect, a document on ecologically suitable tree species for promotion under '*Har Med Par Ped*' to be prepared and circulated to the implementing agencies and other stakeholders. **(Action: CAFRI & AICRP-Agroforestry Network)**

- A pan-India mega campaign to be organized to promote tree culture. 16th July, being the ICAR Foundation Day was identified as the day of operation to this effect. **(Action: SMDs –NRM & Extension, ICAR HQ under ICAR' 75 week-program)**
- Interface with KVKs for agroforestry extension including bund/boundary plantations. **(Action: CAFRI)**
- Detailed study on the economics of bund planting and boundary plantations and evaluate their ecological services in an agroforestry system. **(Action: CAFRI)**

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

The session ended with thanks to one and all.





Annexure-II

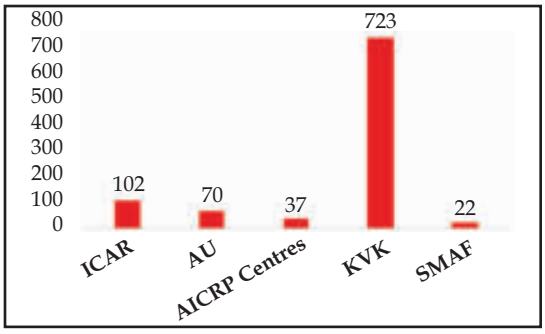
Glimpses of Monthly Campaign by CAFRI and AICRP on Agroforestry Centres for Awareness on ***'Har Med Par Ped'***

Annexure-III

Report on the Nation-wide Tree Planting Campaign

ICAR being a pro-active R&D organization led this mission of planting trees for the national cause by involving the entire National Agricultural Research System that includes ICAR Research Institutes, Agricultural Universities and KVKs, and the State Units of the sub-Mission on Agroforestry (SMAF).

Participating organizations



About ICAR

ICAR - the governing body of Agricultural Research and Education in India (https://icar.org.in/), working on the national cause for food security. Today's agriculture is inseparable from environmental and human well-being. ICAR has been working on developing green technologies to recover degraded lands and supplement with tree plantation activities. Since its establishment in 1929, ICAR was the centre of the agricultural revolution in India – green revolution, white revolution, blue revolution, *etc.* As of food security is concerned, the country is surplus with 310.74 metric tons. However, in the ecological crisis of the 21st century, the ICAR has resolved to focus on productivity on a holistic level *i.e.* agroecology of the food production system. In this context, incorporation of the trees and other woody perennials in farm bund and boundaries will benefit in multi-dimensions and the council has aligned itself it with the call of the Honorable Prime Minister '*Har Med Par Ped*' – to encourage farming community to grow trees on bunds and boundaries. To achieve this agenda, the entire ICAR with its 100 plus institutes and 723 KVK's is working on it and this national wide tree planting campaign will ensure in achieving the agenda.

CAFRI led this Movement

Often, the scientists quote phrases like 'Nature-based climate solutions', 'Ecosystems based approaches' or 'Natural climate solutions' to refer to any mitigation efforts centered around production, protection and management of various ecosystems facing the impediments of climate change. Tree planting become the most eligible and eco-friendly nature-based solution to restore and manage degraded ecologies, particularly in the terrestrial environment. To this endeavour, agroforestry comes as an ecological model system for ensuring food, nutrition, and environmental securities. Thus, it is widely believed that massive tree-planting programme can mitigate the ecological crisis in the 21st century.

Tree planting has now become a global exercise for regulating the hydrological processes balancing the ecosystem stability per se. A study from Yale University has quantified that there are 3.04 trillion trees throughout the globe with an average tree to person ratio of 61:1.A global-scale assessment has been completed by Bastin *et al.* (2019)* claims that 0.9 million hectares are available for reforestation activity across different continents excluding urban settlements. India has 55.76 m ha of wastelands and degraded lands including that of the protected area network of nature reserves. Not withstanding, the agricultural lands should also be roped in, for enabling this tree cover increase in the country, as it strives to have 33% forest cover. So, tree planting becomes the only ecological route to achieve that, where every citizen has a role to play. Dr. APJ Abdul Kalam had earlier called on every citizen to plant a tree and take care of it during his/her lifetime.

About CAFRI

ICAR-Central Agroforestry Research Institute (ICAR-CAFRI), formerly the National Research Centre for Agroforestry, is a multidisciplinary premier research institute of the Indian Council of Agricultural Research (ICAR) with a major focus on integrating trees, crops, and livestock on the same farmland. CAFRI is the only dedicated research institute of the country working on key research areas of agroforestry with 31 scientists, 16 technical, 12 administrative and 8 skilled supporting staff as its sanctioned cadre strength. CAFRI has developed robust agroforestry models and package of practices for different agro-climatic conditions covering small and marginal farmers and provides technical backstopping to the states and stakeholders.

Agroforestry is a dynamic, ecologically sound natural resource management system that through the integration of woody perennials on farms and in agricultural landscapes, diversifies and sustains production for increased social, economic, and environmental benefits for land users at all levels Agroforestry is even stated as the best strategy as well as a tool for managing the natural resources sustainably. Modern-day intensive agricultural practices led to the evasion of trees from the farmlands. And today, we take concerted effort to bring the trees back on the farmlands to provision resilience to the system while also improving the livelihoods of the farming community.

*Bastin, J.F. *et al.* 2019. The global tree restoration potential. Science 80, 365 (6448): 76–79. doi:10.1126/science.aax0848.

Largest ever plantation drive by a research organization

TARGET: Planting 10 lakhs seedlings

"Everyone should plant and grow atleast one tree if he wants to be a human being."

"Trees are my guru. They continue to give unconditionally even when you pelt them with stones to take their fruit, and even if you cut them down. Trees give life. Let's reciprocate that. Plant more trees."

- APJ Abdul Kalam

Tree Plantation Campaign

16th July, 2021

Target 2

Planting 10 lakhs tree seedlings/saplings

ICAR-CAFRI initiated Nationwide Tree Plantation Campaign under the theme "Har Med Par Ped" on the 16th July, 2021 to celebrate the of 93rd Foundation Day of the Indian Council of Agricultural Research (ICAR).

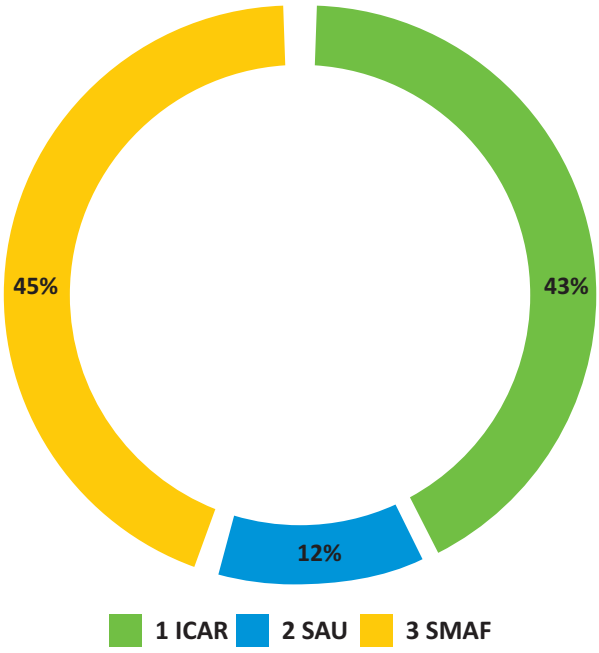
Dr. Trilochan Mohapatra, Secretary, DARE & Director General, ICAR inaugurated the event by virtually planting a tree in CAFRI premises and he opined that Tree Plantation is one of the noble activities by mankind for making the planet greener, livelier, and healthier.

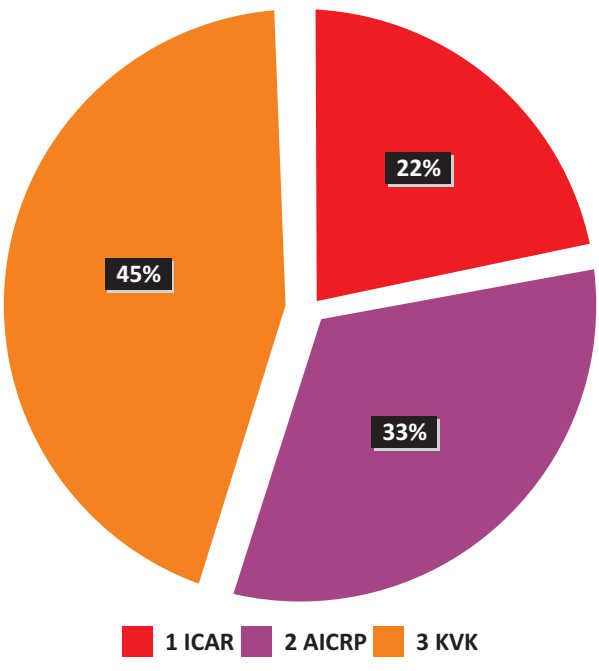
Dr. S.K. Chaudhari, Deputy Director General (NRM), ICAR appreciated CAFRI's efforts to initiate and coordinate this largest-ever tree plantation campaign by a research organization in the country and appealed everyone to actively participate in the tree plantation drive. All the eight DDGs of ICAR, New Delhi participated in the event and planted a virtual tree sapling in the CAFRI premises. This campaign was observed as an important event in the light of India@75 celebrations of *Azadi Ka Amrut Mahotsav*.

Over 900 participants joined the virtual platform on the occasion to appreciate the mission and vision of the tree plantation campaign by involving the representatives of ICAR institutes, Submission on Agroforestry, National Bamboo mission, Central and State Agricultural Universities, Forest Departments and KVKs. Dr. A. Arunachalam, Director, CAFRI underlined that around 10 lakhs tree seedlings/saplings will be planted across various agro-climatic zones of the country that will contribute to the enhancement of trees outside forests. The Director reiterated the wisdom of Dr. APJ Abdul Kalam appealing to all the citizens to plant at least one tree in their life and maintain it for sustaining the future generation.

National Level Tree Plantation Campaign was eventually taken up by the NARES and State Agroforestry Mission Units in their respective locations/states

Tree Plantation Campaign Gave Results





Contribution of NARES and SMAF Units

भाकृअनुप
ICAR

केकृवाअनुसं
CAFRI

TARGET: 10 Lakhs

ACHIEVED: 9.54 Lakhs

Swachh Bharat Abhiyan

एक कदम स्वच्छता की ओर

भारत अमृत महोत्सव

हर राह पर बढ़ते कदम

Agri-research with a human touch

CENTRAL AGROFORESTRY RESEARCH INSTITUTE

"AGROFORESTRY PATHWAY FOR RESTORATION OF DEGRADED LANDS"

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