Bund and Boundary Plantation: A Prominent Feature of Indian Agroforestry

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ABSTRACT: *Mission on Agroforestry under National Mission for Sustainable Agriculture "Har Medh Par Pedh" - tree planting with agricultural crops is gaining importance in the recent days. The advantages of integrating trees into agricultural farms had been recognized and owing to this prospect, bunds and boundary plantations are encouraged under agroforestry practice. The large areas available on bunds, river banks and canal banks provide a great scop and opportunity for the tree planting and have proven to benefit the farmers in bith economic and ecological ways. Multipurpose tree species with short, medium, and long-term returns can be planted so that farmers may get additional income at regular intervals. However, a comprehensive information on the importance, scope and management guidelines is still lacking. This review includes the importance, scope of bund and boundary plantation in farmland, suitable species to be recommended for different areas, and guidelines and management followed for tree planting.*

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1. INTRODUCTION

Agroforestry can also be defined as a dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels. . Agroforestry is the deliberate integration of trees and shrubs into crops and animal farming arranged in some spatial or temporal manner on the same unit area (FAO., 2015). They are of high conservation importance due to their structural complexity, high floral diversity, and considerable similarity to natural forest ecosystems. The wide spectral potential of agroforestry practices in sustenance of agriculture as they provide food, fodder, fruit, vegetables, fuel wood, timber, medicines, fibre *etc.* from the same piece of land at a time which not only fulfils the demand of people but also elevate their socioeconomic status and standard of life (Pathak *et al.,* 2000). In India, agroforestry is practiced in various ways like the trees on farmlands, windbreaks, shelterbelts, different tree-based agroforestry practices, homegardens, pasturelands, block plantations, alley cropping, scattered trees in the field, *etc.* (Handa *et al.*, 2015).

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Furthermore, the Government of India is promoting tree-based farming for maximizing farm returns and providing sustainable livelihood to farmers, which include: A Sub-Mission on Agroforestry launched in 2016-17 to encourage tree plantation on farmland "Har Medh Par Ped," along with crops/ cropping system (Department of Agriculture, Cooperation & Farmers' Welfare. 2020-21). In this view, bund and boundaries in a farm lands offers a great scope to implement the objectives of the mission without causing greater competition to the agricultural crops. Bunds on agricultural lands are considered as one of the potential areas 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, medicine *etc.* Boundary plantation around individual holding, which also acts as a demarcation line, may include trees and shrubs that constitute fence, source of timber, windbreak, shelterbelts, etc.

A bund is a ridge of earth placed in a line to control water runoff and soil erosion, demarcate plot boundary, or other uses (Nair, 1993). They control the effective length of the slope and thereby reduce the gain in velocity of runoff flow to avoid gully formations. Bunding is thus considered a low-cost technique with dual benefits of soil/water conservation and sustainable agricultural intensification. It helps increase crop yield without actually expanding farmlands (Birhanu *et al.*, 2019).

Boundary planting is often referred to as living fences or barrier planting because it involves planting trees along

with all types of boundaries. Boundary plantations are usually including the trees planted alongside boundaries which in turn also helps to check the soil erosion, and in turn, the soil fertility is enhanced. The extensive root system of most of the tree species and the fibrous root system of some species, like bamboos, help in conserving the soil against erosion and runoff. Tree root systems increases the soil fertility by N-fixation and bringing minerals from deep soil and depositing them in the surface soil in the form of litter fall. In most agroforestry practices, a suitable combination of multipurpose and nitrogen-fixing trees with field crops plays a crucial role in enhancing better crop productivity, improving soil nutrient status, and microbial activities, which in turn plays a pivotal role in nutrient cycling to maintain ecosystem balance.

2. STATUS OF BUND/ BOUNDARY PLANTATION

The Forest Survey of India (FSI) has estimated India's total forest and tree cover to be 80.73 million ha (including 4,975 km^2 mangrove area), which is 24.56 percent of the geographical area (FSI, 2019). Of this, Trees Outside-Forest (TOF) consists of about 2.89 per cent of geographical area, *i.e*., 9.50 million ha area. Nair (2007) has reported that the area under agroforestry worldwide was 1,023 m ha. The estimated area under agroforestry in India was found to be 25.32 mha, or 8.2 per cent of the country's total geographical area (Dhyani *et al.,* 2013). Based on data from CAFRI, Jhansi and Bhuvan LISS III, the area under agroforestry is 13.75 m ha (Rizvi *et al*., 2014). According to the estimates, trees on bunds or boundaries of agricultural fields through social forestry accounts for 1.58 mha (NRCAF, 2013). In Maharashtra state, of the total 143.21 lakh farmers, 85 per cent were dry land farmers, and their main occupation is seasonal agriculture integrated with perennial woody components along boundaries and bunds of the crop fields. In a survey of traditional agroforestry practices in Bagalkot, Gulbarga, Koppal, and Raichur districts in the northern dry tract of Karnataka, it was found that nearly 88.4 per cent of farmers followed bund planting as the most prominent practice under the rainfed situation. The major traditional agroforestry practice is boundary planting in all four districts, with 76.8 per cent of farmers adopting in the Gulbarga district of Karnataka alone (Devaranavadagi *et al*., 2010).

3. SCOPE OF BUND/BOUNDARY PLANTATIONS

Trees in dryland tracts of agricultural crop fields are often planted on bunds (field risers) and/or borders or farm boundaries to demarcate the field boundaries. 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 tree shade. The trees being planted in linear strips have always been considered the best measure for the biological conservation of soil, either solely or in combination with some herbs or grasses. The trees planted along with grasses on the bunds or boundaries play two significant roles *viz.,* stabilize the structure and make productive use of the area they occupy. Usually, where there is an area with a gentle slope (less than 6%), trees alone are very effective. Whereas, if the area has a steeper slope, there is the necessity of combining with herbs or grasses (with fibrous root system), as the stabilization generally takes place through the roots of both trees and grasses. Apart from this, bund planting on the terrace edges can usually be taken up to stabilize the structure and check the erosion on the contour terraces. This, in turn, provides maximum land available for taking up farm cultivation on contour terraces. However, the trees planted on the edges will have a meager role in moisture conservation but are found to be effective for soil stabilization. Sometimes the soils in paddy field areas are primarily sandy and weakly structured; they do not form long-lasting bunds without some reinforcement, such as from tree roots. In such cases, these bund plantations help them to retain their shape.

In many arid and semi-arid countries, efforts have been made to utilize the river water for irrigation purposes by constructing dams canal system of several thousand kilometres. The banks/bunds of such canals are available for planting purposes and constitute a large area for timber and firewood production for the rural population. Further, there is a vast area on the river banks itself which are usually prone to erosion if not covered with suitable vegetation. The river banks also provide scope for taking up bund plantations. The ground on either side of the river is partly within reach of the high-water level during flood. The species to be planted should be matched with this water level variation. Thus, bund planting along rivers is essential both from an environmental point of view and/or for producing particular commodities, e.g., NTFP's. Throughout the coastal regions, particularly along the West coast, farmers cultivate fish in water and grow coconut/ areca and other trees on ponds. These trees help in producing feed in the form of litter to the fishes and generate extra income for the farmers. It has been reported that trees grown on field bunds as windbreak or shelterbelt primarily reduce the wind velocity and change microclimate, reflecting in the growth and development of the nearby crop and ultimately in crop yield. The main effect of a tree windbreak is reduce the wind velocity effect, *i.e.,* a windbreak alters the mean wind speed, wind direction, and airflow turbulence. As a result, the surrounding aerial, plant, and soil

environments are modified. It is unlikely that the ideal orientation for windbreak will conform perfectly to the field boundary. If the boundary is nearly perpendicular to the prevailing wind, windbreak as a form of boundary planting. The most effective windbreaks are those that stretch across boundaries and are the cooperative efforts of a number of farmers. Along with this, farm bunds could be resourcefully used for rising nitrogen-fixing shrubs and trees to generate nitrogen affluent lopping. *Gliricidia* on farm bunds serves the dual purpose of producing green leaf manure rich in nitrogen and also helps in conserving soil through reduced soil erosion.

4. BENEFITS TO FARMERS FROM BUND/BOUNDARY PLANTING

i. Short-term benefits

The major distinction between agroforestry and these other terms is that agroforestry emphasizes the interactive association between woody perennials (trees and shrubs) and agricultural crops and/or animals for multiple products and service. One of such practice is that bund and boundary plantations which offers variety of benefits to the farmers. Planting of linear strips of trees in bund and boundary plantations results in a interactive zone of fprest trees and agricultural crops resulting in both complementary and competitive effects. For example: The fast-growing trees release nitrogen into the soil and prevent soil erosion, increasing the quality of the cattle pasture as a positive effects whereas the high shade also results in the reduction in crop yield. Further, the small branches and leaves provide a good source of fodder for cattle, which has been shown to raise milk production. A considerable number of trees are found on the farm bunds, which add up to the total number of Trees Outside Forest (TOF). However, proper selection and management of specific tree crop combinations is essential for the success of bund and boundary plantations.

ii. Medium-term benefits

Trees on bunds and boundaries bring significant medium and long term economic benefits to the farmer and the community. The system provides the outputs of food, fuelwood, fodder, fertilizer and timber which in turn results in increased levels of farm incomes due to improved and sustained productivity. The multiple benefits and the all-season products by the trees planted in bunds and boundaries reduce the risk of crop failure which is very common to monocropping system. The agricultural farm with trees on bunds and boundaries ensures the more efficient recycling of nutrients by deep-rooted trees on the site and thereby reduction of surface run-off, nutrient leaching and soil erosion through impending effect of tree roots and stems of these processes. It ensures the better protection of ecological systems by improvement of microclimate, such as lowering of soil surface temperature and reduction of evaporation of soil moisture through a combination of mulching and shading.

Further, thinning of crowded plantations may result in harvesting of nitrogen fixing species which regrow quickly when they are coppiced. Thus, the thinned-out material will provide farmers with a valuable source of construction material and fuelwood, which will decrease the pressure on the natural forests to meet their needs. Farmers are also allowed to sell the wood material in the local market, thus making additional income. These trees strengthen the capacity economic security of poor people in case of disasters and emergencies by selling trees for cash,

iii. Long-term benefits

The ecological and economic short and medium term benefits from trees on farm lands leads to improvement in rural living standards from sustained employment and higher incomes. It also improves the nutrition and health of people due to increased quality and diversity of food outputs. The sustained income and stabilized soil productivity secures the livelihood of upland communities through elimination of the need to shift sites of farm activities. Trees on bunds play an effective role in global carbon sequestration, involved in carbon capture and the long-term storage of atmospheric carbon dioxide. The longer-lived trees are precious because they provide seeds, fruit, and habitat for local flora and fauna. They will produce highly valued timber, which can be sustainably harvested by the farmers and sold.

5. CHARACTERISTICS OF SPECIES SUITABLE FOR BUND/BOUNDARY PLANTATION

The trees that are to be grown under bunds and boundary plantations around the farmlands for various purposes, as explained in the scope, are usually taken up as linear strips. Hence, it is necessary to consider the following characteristics of tree species that would be suitable for such 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 alongside agricultural crops, tall and slim species with little shade are likely to be ideal.
- Species with a deep root system that draws their water supply from near the water table (phreatophyte) are usually preferred.

- Species with robust, extensive and fibrous root systems improve soil conservation and 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 models, a suitable combination of nitrogen-fixing and multipurpose trees with field crops plays a significant role in enhancing better productivity, soil nutrient status, and microbial population.

For riverbank plantations, the species to be planted should be matched with water level variation. In the more arid areas, trees with xerophytic habit constitute the outermost rows, while those close to the river bank have higher water requirements. Species suitable are: *Eugenia jambolana, Dalbergia sissoo, Mangifera indica, Acacia arabica. Ailanthus excelsa, Terminalia arjuna, T belerica, Pongamia glabra, Muduca latifolia, Tamarindus indica, Azadirechta indica, Sesbania species, Eucalyptus species and Casuraina equisitifolia etc.,*

For canal bank plantations, the roots of the trees should strengthen the banks of the 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. Where 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 by suckers such as *Robinia pseudo acacia* should not be planted along canals. Suitable species for canal bank plantations are: *Eucaluptus hybrid, Acacia nilotica, Mangifera indica, Pongamia pinnata, Azadirchta indica, Populus deltoids, Syzizium cumini, Tectona grandis, Toona ciliata, Artocarpus heteropyllus, Albizzia lebbeck, Terminalia sps, Dalbergia sissoo, Morus alba, Tecoma undulata, Acacia tortilis etc.,*

6. SPECIES SUITABLE FOR BUND/ BOUNDARY PLANTATION

Through a careful review of literature, few articles focused on the species that have been shortlisted and grown under bund and boundary plantations all over India. Eucalypts and poplar are among the important species gaining their importance in northern parts of India, predominantly in Haryana and Punjab, which are frequently grown along the field's boundary or bunds. According to Chauhan *et al.* (2015), poplar has been accepted and adopted by the farmers on the agricultural landscape in irrigated agro-ecosystem in Punjab due to its high economics than traditionally followed rice-wheat rotation. Farmers with large landholdings prefer to raise poplar in blocks whereas; small farmers grow the trees on bunds only to secure regular livelihood. *Populus deltoides* bund-based agroforestry system has received wide recognition throughout the globe. It was found that the carbon sequestration ability of *P. deltoides* increases with age and variation observed in carbon sequestration potential of poplar with different planting patterns (Yasin *et al*., 2018).

Eucalypts is a perennial and mostly evergreen tree, extensively used under the agroforestry, either on farmland or as a boundary plantation. *Eucalyptus globulus* trees are unbrowsable to goats, sheep and cattle (Pohjonen and Pukkala, 1990). Thus, they have a distinct advantage as boundary planting in recommended inter-row spacing and are aligned east-west or north-south direction. In this environment, eucalypt boundaries produce a harvestable tree crop within four to five years after planting because of its fast-growing habit and short rotation age (Kidanu *et al*., 2005). The yield outcome depends upon the spacing adopted, density, type, and nature of existing bund plantation and their shading effects, including effects on morphology (internodes length, leaf area) and effects on flower initiation/fruit-set of associated crops (Jhariya *et al*., 2013). Other than eucalyptus, some other multipurpose tree species *viz.*, *Terminalia arjuna*, *T. tomentosa*, *Albizia procer*a, *Mangifera indica*, *Butea monosperma, Zizyphus mauritiana, Azadirachta indica,* and *Gmelina arborea* are also recommended for bund and boundary plantation. Neem (*Azadirachta indic*a) is important tree for social forestry, agroforestry, reforestation, and rehabilitating the wasteland and degraded industrial lands.

Boundary plantations also help as shelterbelts and wind breaks particularly in fruit orchards. In Bihar, *Dalbergia sissoo* and *Wendlandia exserta* are most common plantations. *Casuarina equisetifolia* and *Acacia auriculiformis* are extensively planted on field bunds and along sandy coastal areas in Orissa. Farmers of Sikkim grow bamboo (*Dendrocalamus*) all along irrigation channels. In coastal areas of Andhra Pradesh, *Borassus* is most preferred species for bund and boundary plantation.

Considering the additional income in the form of timber, fuelwood, and plantation on field bunds is desirable. In Andaman, farmers grow *Gliricidia sepium, Jatropha* spp., *Ficus, Ceiba pentandra, Vitex trifolia* and *Erythrina variegate* 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.

Sharma, (1992) opined that the nine-year-old *A. nilotica var. jaquemontii* bund plantation evaluated, which was grown in East-West direction along the northern boundary of the field along with wheat variety HD 2009 had a positive influence on the crop. The typical 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 Gulbarga and Raichur districts of Karnataka, bund planting with neem, *Acacia nilotica*, and eucalypts was predominant under rainfed agroecosystems.

Most of the villages of both Karnataka and Tamil Nadu practice agroforestry on irrigated as well as rainfed croplands–either as bund or block plantations. Trees may also be mixed with staple food crops to produce fruit, fodder, or wood. In the Bidar and Raichur districts of Karnataka, the preference was for fruit-yielding tree species, whereas in the Gulbarga district highest priority was for timber and fruit-yielding tree species. 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 and yielding good quality fuelwood tree. 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 through the number of trees noted per farm was fewer than *Cassia siamea* and *Gliricidia*. 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 have marketable values. The wood is hard and used in making agricultural implements. However, it is a slow-growing tree whose leaves take longer time to decompose (MYRADA, 2009). In general, the following species are recommended for bund plantation:

Trees that can be considered for planting in boundary and bunds are:

- *Eucalyptus* spp
- *Thespesia populnea*
- *Albizia lebbek*
- *Leucaena leucocephala*
- *Annona squamosa*

Trees for internal bunds

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

7. MANAGEMENT OF BUND/ BOUNDARY PLANTATION

The management of trees in any agroforestry practice is crucial for the overall productivity of the tree, as well as for the crop grown on the farm. In traditional agroforestry systems, trees managed for fuelwood, fodder, fibre, and other household needs for which these trees are lopped or pollarded by the farmers. In addition, the following management measures are necessary for bund and boundary plantations:

- To be effective as tree strips, trees should be planted in lines along the bunds/boundaries/ contours.
- Tree to tree spacing to be adopted mainly depends on the characteristics of the species and the rotation planned for the crop
- Usually, the ideal tree spacing in paired row planting on bunds is one meter between the rows and two meters from tree to tree.
- Spacing in single line tree planting on farm boundaries should be 2.0 m from tree to tree.
- Wider spacing can be adopted if the trees are combined with grasses or shrubs, and the spacing should also be wider in dry areas to reduce moisture competition between the trees.
- The initial establishment can always be denser, and thinning can be carried out later to obtain the final spacing.
- Trees should be regularly pruned for fodder and firewood and to reduce the shading effect.
- On steeper slopes, it is required to grow trees on every second terrace to avoid dense tree population and competition between them.

Basic Guidelines for Bund Plantation In Cultivated Land

As the bunds and boundary plantation are usually grown in and around the farmland, it is clear that it is in the vicinity of the human dwelling and his cattle; hence following guidelines will help in managing the plantation:

- Cattle should be kept away from the area by using live hedge fencing during initial establishment phase.
- Larger trees can be planted on outer bunds/boundary, and smaller and fast growing trees should be grown 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 at 0.50 m apart 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.

In a special case of canal bank plantation, it would be virtuous to follow the below-mentioned guidelines:

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 NTFP species.
- The pits can be filled with imported soil if the site along canals is deplorable due to dumped soil.
- No plantation should be 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 5m or 3m or 2m depending upon the species.
- In case of lined canals, the first row should be planted at the toe and species with strong roots may damage the lining, hence such type of tree species should be avoided.
- 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 × 0.5 m in poorer sites.
- Seed sowing is taken up on mounds with *C. siamea* and *Gliricidia.*

8. CROP YIELD IN PRESENCE OF BUND/ BOUNDARY PLANTATION

According to Bhardwaj *et al.* (2017), boundary plantation is a prominent feature of Indian agroforestry as it is very popular among the farmers due to its less interference, ease in mechanization, and demarcation of field boundaries and also aids in sustaining the soil health by improving various soil parameters.

Besides providing the tree products, commercial trees under agroforestry improve soil productivity through ecological and physico-chemical changes. Boundary plantation under agroforestry helps hold the soil against erosion and improve 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 enhancing yield productivity, soil nutrient status, and microbial population dynamics, which plays a significant role in nutrient cycling to maintain the ecosystem balance (Raj *et al.,* 2016). Due to the shading effect and strong root system of trees at bunds and boundaries they compete for available resources with crops resulting in comparatively lower grain yield near the tree lines. Trees at the boundary provide extra income to farmers with minimum interference with various agricultural operations and crops. Besides there are number of small and marginal farmers in India and they find it quite unaffordable to raise forest plantations 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, as a distance increases, the grain yield also increases.

Many studies have conclusive evidence proving the beneficial impacts of trees in bunds and boundaries on the crop yield by increasing the physicochemical properties of the soil. Further, on drylands, most 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 average, the study by MYRADA at Kolar region in Karnataka reported that farmers had 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 could withstand the longer duration of dry spells without experiencing moisture stress. The trees also act as a source of income in case of crop failure and insure the farm income. This can help the farmers to invest in other livelihood options and to diversify the income generation activities.

Growth and yield of the wheat crop as influenced by single row bund plantation of *Populus deltoides* 'G-3' grown on the southern aspect of the field in the east-west direction were investigated. Results revealed that wheat grain yield improves in the vicinity of trees (Sharma and Singh, 1992). Similarly, Sahoo *et al.* (2009) opined that after the plantation of *Jatropha curcas* on the bunds, the agricultural production had remained the same, but there was an additional biomass and seed production from these plants. Hence, they confirmed that bund plantation of *Jatropha* does not affect wheat crop yield and can be an additional source of income.

9. SOCIO-CULTURAL ASPECTS OF BUND-BOUNDARY PLANTATION

Agroforestry, as a whole, has to consider socio-cultural aspects of the practice, which can, in part, be determined by its social acceptability at the farmer's level, as farmers are considered to be 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, mainly for demarcation.
- ***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 work and changes in farm activities from the norms.
- ***Marketing of NTFPs and AFTPs:*** The income obtained from a land-use system is an important criterion in judging social acceptability. The processing and sale of tree products is a significant potential source of income for people involved in the market chain.
- ***Other Social Factors:*** The possibility to grow crops between trees without adverse effects on food crops. Many other social factors are critical 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 the health, well-being, gender, and age of farmers are all critical issues to the successful introduction and development of the plantation.

10. CONCLUSION

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 fodder and fuel production but are minor for the most part. 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. The use of bund or boundary plantation and its impact should be investigated. This method would be particularly relevant to the farmers with small fields as it provides a additional source of income to uplift their soci economic status. Consequently, the adoption of these practices cannot be understood solely in terms of their immediate or potential financial or economic benefit to the household. Further, land such as bund and boundaries that are hitherto not cultivated would increase the tree cover of the landscape.

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