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# Inventorization of existing agroforestry systems in different farming situation of Chhattisgarh

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**Abstract**
In India Agroforestry has been recognized as one of the important systems for supporting the livelihood of rural people. Different agroforestry practices fulfilled the demand of rural households and extra income sources. Chhattisgarh is a state in Central India has very diverse forest ecosystem and long history of traditional agroforestry. In the state the agroforestry practice is location specific and it's depends on nature of agro-climatic zones. In Chhattisgarh, farmers are doing this farming practices based on fulfilling their diverse need and improvement of socioeconomic condition but still data is insufficient to explore more agroforestry practices in the state. In this context, inventorization of different agroforestry systems gives not only sufficient data but also open a door for conservation of biological diversity. Different systems like's Boundary plantations, *Agrisilviculture* system, *Hortisilviculture*, *silvopasture*, Kitchen garden and Block plantation are used by farmers in Chhattisgarh State. All systems are dependent on location characteristic, land use type, soil type, climate and market requirement. This paper highlights the different systems of agroforestry, specific system for the specific sites, lacuna in system faced by farmers and role of agroforestry systems in socioeconomic upliftment.

**Keywords:** Inventorization, agroforestry systems, farming practices and land use type

## Introduction
In India more than 175 million hectares of arable land is facing degradation of different kinds. Such an alarming scenario of forest and land degradation has resulted in acute shortage of fuel wood, fodder, timber and other non-wood forest products, which support rural economy to the greatest extent. The ever-increasing population has been exerting enormous pressure on forests for various biomass needs, leading to faster depletion of forests. The possible way to reduce the dependence of rural people on natural forests is to grow fuel wood and fodder species on private lands to make farmers self-sufficient.

Under these conditions, tree based farming systems; particularly agroforestry is one of the technologies to overcome the shortage of food, fodder, fuel wood, minimizing adverse effects of environmental degradation and to achieve the national target of one third area under the tree cover. In recent years, farmers have emerged as major suppliers of wood, especially as the supplies from the state forests have declined due to greater emphasis on conservation and imposition of green felling ban in several states. There are 105 million operational holdings in the country and while it is not possible to determine the number of farmers engaged in farm and agroforestry, their involvement is substantial as it is estimated that 50% of wood supply in the country is currently coming from non-forest sources.

It has been an age old practice to maintain trees and grass lands in and around human settlements in rural areas in the form of grazing lands, village wood lots (commons), road side plantations, plantations in tank foreshores and bunds, plantation in private lands, etc. There were meant for meeting the needs, on a sustainable basis, of fodder, fuel, green manure and small timber of household and of the rural industries (Singh, 1993; Raj *et al.*, 2017) [20, 16].

Traditional agroforestry is the result of farmers' innovation and experimentation over centuries (Rafiq *et al*., 2000) [15]. Adoption of innovations in agroforestry technology is a complicated process determined by both environmental and socioeconomic factors (Garforth *et al*., 1999; Malla, 2000; Neupane *et al.*, 2002; Sharma *et al.*, 2011) [4, 9, 14, 19]. Most previous studies on agroforestry adoption have been concerned with *ex post* evaluations of projects in which social forestry or farm forestry programs funded by third parties or the government were implemented without taking account of both pre-project and traditional agroforestry practices. A comprehensive review of studies on agroforestry adoption by Sood (2003) [22] shows that empirical investigations into the influence of economic and farming aspects on adoption of traditional agroforestry systems are non-existent. There is a tendency to emphasize biophysical aspects and tree-based needs in design of agroforestry technologies, without reference to

economic and farming aspects of households (Scherr, 1995b; Nair, 1998) [18, 12]. In most developing countries, the level of participation in any production activity can be linked to the socioeconomic status of households (Agarwal, 1986) [1]. Keeping this in mind, it is essential to examine adoption of traditional agroforestry in relation to economic and farming conditions of households.

The efforts by the government are still going on to popularize agroforestry that can meet the basic needs of rural people. But people are still reluctant to grow tree species with other agricultural crops. Hence there is need to study and understand the performance for tree species by the rural poor in Chhattisgarh State. The concerted efforts have yielded results in certain parts and in certain parts the results are not encouraging. Hence there is need to know the factors responsible for the success and failure of agroforestry. It is equally essential to identify the constraints hindering the adoption of agroforestry practices, which can help in designing effective plans/programmes for popularizing agroforestry. In the light of the above, the present study has been undertaken to inventories existing agroforestry practices in Chhattisgarh State.

The present investigation was undertaken with the following objectives:

1. Survey and documentation of the existing agroforestry practices in the selected district of Chhattisgarh State.
2. To study the impact of urbanization on adoption of agroforestry practices.
3. To study the influence of socio-economic traits on adoption of agroforestry practices.
4. To elicit the constraints in adoption of agroforestry practices.

## Material and Methods

Chhattisgarh is a state in Central India was carved out of Madhya Pradesh in the year 2000. It is the ninth-largest state in India with an area of 1, 35,192 sq. km., which is 4.11% of the geographical area of the country. The State is bordered by the Madhya Pradesh in the northwest, Uttar Pradesh in the north, Jharkhand in the northeast, Maharashtra in the southwest, Telangana in the south and Odisha in the southeast. The State falls under East Deccan physiographic zone and can be divided into three agro-climatic zones, viz. the Chhattisgarh Plains, the Northern Hills of Chhattisgarh and the Bastar Plateau are the prime geographical landmarks that have been marked as the productive areas of Chhattisgarh agriculture. The State lies between 17º47' N to 24º06' N latitude and 80º15' E to 84º24' E longitude. It has a tropical hot and humid climate. The average annual rainfall varies from about 1,100 mm to about 1,700 mm and the average annual temperature ranges between 11ºC to 47ºC.The State is drained by number of rivers which include Rihand, Hasdeo (a tributary of Mahanadi) and Indravati. Paddy, maize, jowar, groundnut, gram, and wheat are major crops grown in Chhattisgarh. Chhattisgarh known for rice cultivation and called “rice bowl” of India. There are 28 districts, out of which 13 are tribal districts. The State does not have any hill district. As per the 2011 census, Chhattisgarh has a population of 25.55 million accounting to 2.11% of India's population. The urban, rural and tribal population comprise 23.24%, 76.76% and 30.62% respectively. The average population density of the State is 189 per sq. km., which is much lower than the national average of 382 persons per sq. km. The 19$^{th}$ Livestock census 2012 has reported a total livestock population of 15.04 million. The State has reported extent of recorded forest area (RFA) 59,772 sq. km. which is 44.21% of its geographical area. The reserved, protected and unclassed forests are 43.14% and 40.21% and 16.65% of the recorded forest area in the State respectively (ISFR, 2019) [7].

For the present investigation an in-depth survey was conducted in seven districts of Chhattisgarh namely Bilaspur, Korba, Janjgir-Champa, Mungeli and Kabirdham district in Chhattisgarh Plain zone & Korea and Surguja district in Northern hills to know the distribution, socio-economic status, existing agroforestry practices and adoption behavior of different category of farmers adopting agroforestry system in their farmland (Fig. 1). Only those farmers raising different tree species at their farmlands since long time were selected. In each district of State, 25 farmers were selected on the basis of purposive sampling method, thus making 175 farmers from the seven districts of Chhattisgarh. Data were collected with the help of a pre-tested interview schedule. The structured interviews were conducted on farmer’s field during 2016-2018. Questionnaire for design and diagnosis survey was prepared as per the guidelines laid down by ICRAF for ICARF’s global inventory of agroforestry system (Nair, 1989) [13].

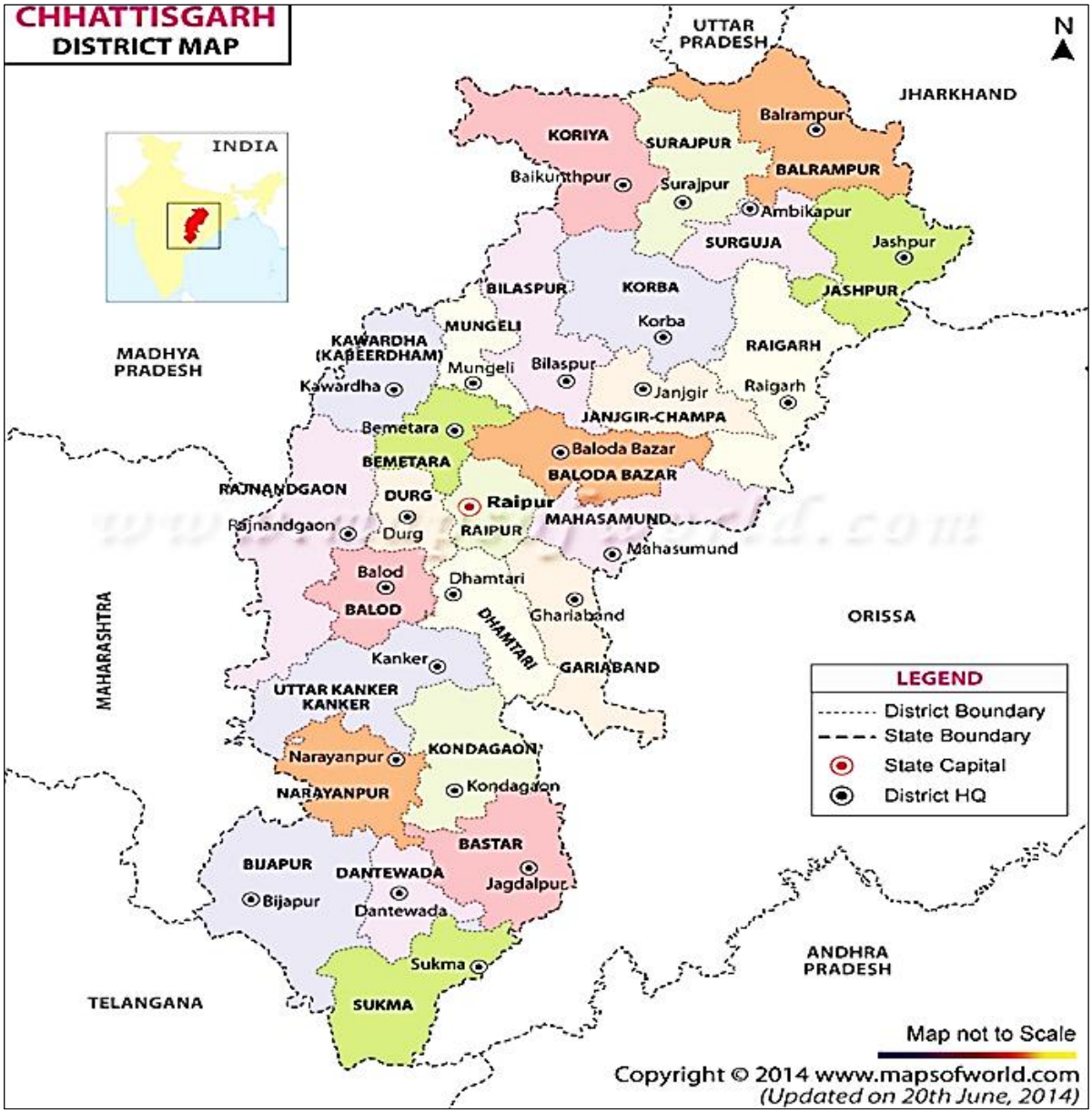


**Fig 1:** Map of Study Area

## Results and Discussion

### Population of the study site, selection of villages and respondents

The detailed information of villages, population, infrastructural details, household distribution, enterprises, land use pattern, area under different crops, tree cover and details of other plantations activities was recorded.

### Analysis of existing agroforestry systems in different regions

The traditional agroforestry systems in different villages of Bilaspur, Korba, Janjgir-Champa, Mungeli and Kabirdham district in Chhattisgarh Plain zone & Korea and Surguja district in Northern hills are revealed that trees are integral part of their farming. Many trees species like *Acacia nilotica*, *Butea monosperma*, *Albizia procera*, *Terminalia arjuna* etc. are commonly distributed in paddy fields and trees like *Madhuca indica* and *Azadirachta indica* are commonly seen in upland areas.

Results regarding different agroforestry systems practiced by farmers in different regions are presented in table 1. Majority of the farmers had adopted *Agrisilviculture* systems for planting tree species. The second most adopted systems were *Agri horticulture* and the least adopted systems was *Silvi horticulture*. With regards to practice of other systems, not much difference was found among the farmers in different region.

The data revealed that different systems that are practiced by rural people/farmers in different villages of study area consumed for meeting their diverse needs i.e. food, fodder, fuelwood and timber. But the landholding sizes are low which is not sufficient to get all their consumption needs from the farm in adequate quantities. These observations have also been reported by Mughal *et al.* (2000) [10] and Mughal and Bhattacharya (2002) [11]. Also, the production per unit area of food grains except paddy and oil seeds is also less, besides people do not practice agroforestry wholeheartedly on all the available land area of their available landholding.

**Table 1:** Different Agroforestry models prevailing in Chhattisgarh Plains and Northern Hill Zone

| S. No. | Area | Models | Tree Component | Fruit Tree Component | Agricultural Crop Component | |
|---|---|---|---|---|---|---|
| | | | | | ***Rabi* Crop** | ***Kharif* Crop** |
| 1. | Chhattisgarh Plain Zone (Bilaspur, Korba, Janjgir-Champa, Mungeli and Kabirdham District) | *Agrisilviculture* system | *Acacia nilotica, Albizia procera, Butea monosperma, Gmelina arborea, Tectona grandis, Dalbergia sissoo* and *Madhuca indica* | - | Wheat, Gram, Mustard, Linseed, Lathyrus and Sugarcane | Paddy, Soybean and Maize |
| | | *Agri horticulture* | - | *Mangifera indica, Artocarpus heterophyllus, Psidium guajava and Emblica officinalis* | Wheat, Gram and Mustard | - |
| | | *Silvi Horticulture* | *Acacia nilotica, Gmelina arborea* and *Tectona grandis* | *Mangifera indica, Artocarpus heterophyllus, Emblica officinalis* and *Psidium guajava* | - | - |
| | | *Silvopasture* | *Acacia nilotica, Albizia procera* and *Madhuca indica* | - | - | Maize |
| | | Boundary plantations | *Acacia nilotica, Butea monosperma, Dendrocalamus strictus, Terminalia arjuna, Gmelina arborea* and *Tectona grandis* | - | Wheat, Gram, Mustard, Linseed and Lathyrus | Paddy, Soybean and Maize |
| | | Homegarden | *Gmelina arborea, Tectona grandis, Azadirachta indica, Emblica officinalis, Moringa oleifera, Syzygium cuminii* and *Dendrocalamus strictus* | *Mangifera indica, Artocarpus heterophyllus, Psidium guajava, Musa paradisica, Carica papaya, Citrus limon, Aegle marmelos, Punica granatum* and *Annona reticulata* | Cabbage, Cauliflower, Radish and Carrot | |
| | | Block plantation | *Dalbergia sissoo, Eucalyptus* spp., *Gmelina arborea* and *Tectona grandis* | - | - | - |
| 2. | Northern Hill Zone (Korea and Surguja District) | *Agrisilviculture* system | *Acacia nilotica, Albizia* spp., *Tectona grandis, Gmelina arborea, Melia azedarach* | - | Wheat, Gram, Mustard, Lentil, Lathyrus, Linseed, Field Pea and Safflower | Paddy, Arhar, Til, Maize and Kulthi |
| | | *Agri horticulture* | - | *Mangifera indica, Litchi chinensis, Artocarpus heterophyllus, Psidium guajava and Emblica officinalis* | Wheat, Gram and Mustard | - |
| | | *Silvi Horticulture* | *Acacia nilotica, Gmelina arborea and Tectona grandis* | *Mangifera indica, Litchi chinensis, Artocarpus heterophyllus, Emblica officinalis* and *Psidium guajava* | - | - |
| | | Boundary plantations | *Tectona grandis, Eucalyptus* spp., *Gmelina arborea, Bambusa bambos* | - | Wheat, Gram, Mustard, Lentil, Lathyrus, Linseed, Field Pea and Safflower | Paddy, Arhar, Til, Maize and Kulthi |
| | | Homegarden | *Gmelina arborea, Tectona grandis, Azadirachta indica, Emblica officinalis, Moringa oleifera, Syzygium cuminii* and *Bambusa bambos* | *Mangifera indica, Artocarpus heterophyllus, Psidium guajava Musa paradisica, Carica papaya, Citrus limon, Aegle marmelos, Punica granatum* and *Annona squamosa* | Cabbage, Cauliflower, Radish and Carrot | Chilli, Tomato, Brinjal, Sponge gourd, Bottle gourd, Bean, Pumpkin, Cow pea, Bitter gourd, Ivy gourd, Pointed gourd, Cluster bean etc. |
| | | Block plantation (Multipurpose tree based production system) | *Tectona grandis, Eucalyptus* spp., *Dalbergia sissoo* | - | - | - |

**Tree Species preferred for Field bunds and homestead in different regions**

In homesteads, *Dendrocalamus strictus*, *Gmelina arborea*, *Tectona grandis*, *Emblica officinalis*, *Psidium guava*, *Zizyphus martuiana* and *Syzygium cumini* are commonly raised by the farmers. In Bhata soils the tree cover is very poor mainly covered by seasonal grasses and occasionally the trees like *Eucalyptus* spp., *Annona squamosa*, *Emblica officinalis* and *Dalbergia sissoo* are planted. The tree plantations in fields are mainly protected by large farmers because they have permanent fencing and tube wells for irrigation. However, small farmers raise and protect tree plantations in homesteads.

The distribution of different species both in field and homestead are mentioned in table 2. In fields (mostly on bunds) among the different species *Acacia nilotica* is most predominant followed by *Butea monosperma*, *Terminalia arjuna*, *Albizia* spp., *Dendrocalamus strictus*, *Gmelina arborea* and *Tectona grandis*. In homesteads fruit tree like *Psidium guava*, *Emblica officinalis*, *Syzygium cuminii*, *Zizyphus* spp. and *Moringa oleifera* are mostly distributed. Among the other tree species *Dendrocalamus strictus*, *Gmelina arborea and Azadirachta indica*, *etc*. are predominant.

The choice of planting of species by the farmers in the fields and homesteads ranked according to their preference. Among the different species, *Acacia nilotica* and *Dendrocalamus strictus* ranks first and second, respectively for bund planting, whereas *Dendrocalamus strictus*, *Gmelina arborea* followed by fruit trees like Mango, guava, sitafal, ber, citrus and vegetables.

There are many agroforestry systems prevailing in the different districts of the study area. The choice of tree species depends upon the soil, area to area; farmers need circumstances and socio-economic factors (Choudhary *et al*., 2012; Hemrom and Nema, 2015) [3, 6]. This provides a number of examples of the traditional agroforestry systems and indigenous practices successfully employed by farmers in the different districts. Traditional agroforestry systems and practices associated with them plays an important role in securing the sustainable livelihood security of the farmers. The tree species provide various outputs at low cost and are easily accessible; however, utilization pattern varies according to season and from altitudinal ranges (Rawat and Vishvakarma, 2010) [17]. Several traditional practices have already been reported which supports the findings of the present investigation (Bhagat *et al*., 2006; Kanwar and Sharma, 2006; Slathia and Paul, 2012; Choudhary *et al*., 2012; Hemrom and Nema, 2015; Toppo *et al*., 2016) [2, 8, 21, 3, 6, 23]. Based on the preference, agroforestry and fruit bearing tree species based system were most preferred system in the study region. Similar finding were also made by Hemrom and Nema (2015) [6] and Choudhary *et al*. (2012) [3], they reported that most prevalent system in their study area was *agrisilviculture* and *agri horticulture* system, respectively. Based on findings of the present study it was revealed that farmers prefer the species which have multiple output and farmers maintain naturally re-generating tree species, particularly on edges of terraced agriculture fields/bunds without any significant input of manpower. *Agrisilvipastoral* and *silvipastoral* systems are mostly practiced on the marginal and wastelands (Choudhary *et al*., 2012) [3] which support the present study.

**Table 2:** Preferences for the choice of species on field bunds and homestead in different villages of Bilaspur, Korba, Janjgir- Champa, Mungeli, Korba, Korea and Surguja district

| S. No. | Trees | Fields bunds | Homesteads |
|---|---|---|---|
| 1. | *Dendrocalamus strictus* | II | I |
| 2. | *Acacia nilotica* | I | - |
| 3. | *Gmelina arborea* | V | III |
| 4. | *Butea monosperma* | III | - |
| 5. | *Tectona grandis* | VI | IV |
| 6. | *Syzygium cuminii* | XI | VII |
| 7. | *Emblica officinalis* | VIII | V |
| 8. | *Madhuca indica* | VII | - |
| 9. | *Eucalyptus spp.* | XII | - |
| 10. | *Albizia spp.* | X | VIII |
| 11. | *Azadirachta indica* | IX | VI |
| 12. | *Terminalia arjuna* | IV | - |
| 13. | Miscellaneous (fruit trees) Mango, Guava, Sitafal, Ber, Citrus etc. | - | II |

**Analysis of source influencing the adoption of agroforestry practices**

Adoption of any innovation depends on certain motivational factors. Various sources influencing adoption of agroforestry practices were examined at field level and identified nine factors and are presented in table 3. Gupta and Das (1965) [5] revealed contradictory findings for the farmers who had higher education, socio-economic status etc. were more change oriented and had higher adoption scores.

**Table 3:** Sources influencing adoption of Agroforestry practices

| S. No. | Source of motivation | Number of Farmers | Percentage | Rank |
|---|---|---|---|---|
| 1. | Self-motivation | 45 | 25.71 | I |
| 2. | Forest Department | 10 | 5.71 | VII |
| 3. | Agricultural department/ Horticulture | 08 | 4.58 | VI |
| 4. | Govt. Scheme | 07 | 4.00 | V |
| 5. | Village Forest Committee | 30 | 17.14 | IV |
| 6. | Members of village Panchayat | 35 | 20.00 | II |
| 7. | Others | 40 | 22.86 | III |

**Identification and analysis of constraints faced by the farmers in adoption of agroforestry**

Various factors contributing for the success/failure of agroforestry practices were examined at field level and are presented in table 4. It can be refereed from the table that the major constraint faced by the majority of farmers was long gestation period (no immediate returns) of agroforestry species. Therefore, there is need to supply quality and fast growing planting stock. Second major constraint was non-availability of planting material followed by lack of technical information and stray cattle's. Other constraints expressed by farmers are poor marketing and labour problem.

**Table 4:** Factors hindering the practice of agroforestry/constraints faced in adoption of agroforestry practices

| S. No. | Nature of Constraint | Number of Farmers | Percentage | Rank |
|---|---|---|---|---|
| 1. | Competition | 15 | 8.58 | V |
| 2. | Low Rainfall | 14 | 8.00 | VI |
| 3. | Lack of irrigation | 12 | 6.86 | VIII |
| 4. | Small size of holdings | 13 | 7.42 | VII |
| 5. | Stray Cattle | 17 | 9.71 | IV |
| 6. | Labour Problems | 10 | 5.71 | X |
| 7. | Long gestation period | 26 | 14.86 | I |
| 8. | Planting material | 24 | 13.71 | II |
| 9. | High initial expenditure | 06 | 3.42 | XII |
| 10. | Lack of technical information | 19 | 10.86 | III |
| 11. | Poor marketing | 08 | 4.58 | XI |
| 12. | Stringent Laws | 11 | 6.29 | IX |

**Suggestion offered for better adoption of agroforestry practices**

An effort has been made to seek the suggestion of the farmers for effective implementation of agroforestry programmes and is presented in table 5. Majority of the farmers have expressed that timely availability of planting material should be ensured. This seems to be a practical suggestion as timely availability of planting material is important aspect for establishment of plantations.

**Table 5:** Suggestions offered for better adoption of Agroforestry practices

| S. No. | Suggestions | Number of Farmers | Percentage | Rank |
|---|---|---|---|---|
| 1. | Timely availability of planting material | 35 | 20.00 | I |
| 2. | Supply of quality and fast growing planting stock | 30 | 17.14 | II |
| 3. | Supply of fruit trees for agroforestry | 05 | 2.86 | VIII |
| 4. | Provide cash incentives/ subsidies | 24 | 13.71 | IV |
| 5. | Provision of loan for forestry and agroforestry | 26 | 14.86 | III |
| 6. | Made available planting material at nearest point/ Kisan nurseries | 20 | 11.42 | V |
| 7. | Extension service | 15 | 8.58 | VI |
| 8. | Relax rules pertaining to marketing | 10 | 5.71 | VII |
| 9. | Improve marketing facility | 06 | 3.42 | IX |
| 10. | Others | 04 | 2.30 | X |

**Conclusion**

It can be concluded from the present study that most prominent and prevalent systems of the study sites were bund based agroforestry and kitchen garden followed by *agrisilviculture* system, *horti silviculture, and silvopasture* system and block plantation. But systems like orchard and block plantation are least practiced by farmers. Systems like *agrisilviculture* are not well managed in comparison to boundary plantation, orchard and kitchen garden which are well managed and retain by farmers. Whereas, *horti silviculture* system is moderately managed and have overall low adoption of agroforestry practices which can sustain their income besides food, timber and fodder production security. There is a need to encouraged farmers to adopt these agroforestry systems scientifically and technically for betterment of peoples. Therefore, scientific research and proper extension work is needed in this area before practicing of different agroforestry systems and better management practices comprises tending operation should be used properly for a long way in improving the productivity of lands and also in increasing the resources of the area. Efficient use of land and labour resources, opportunities for diversification, reduced dependence on natural forests for fuel and fodder are some of the direct benefits that contribute towards the increase of income and thus living standards of the farmers of the state. Moreover, adoption of agroforestry allows taking up of subsidiary occupations like, apiculture, sericulture, basket, rope and furniture making. Increased availability of fodder would also allow the dairying in an improved manner. On the other hand, these activities will also generate market infrastructure and employment in other related activities. Similarly, incorporation of research related to different systems as per locality factors and their extension will help to make sustainability in different land use systems. It is therefore, necessary to adopt agroforestry practices for the socio-economic upliftment of the farmers of state...

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