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TECHNICAL AND FINANCIAL APPRAISAL OF AGROFORESTRY SYSTEM – A STUDY FROM VILLAGES AROUND BHOPAL, MADHYA PRADESH (INDIA)

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Abstract

Farmers in India have practised agroforestry in many forms for years, but the various systems have not been scientifically documented. The detailed technical and financial appraisal of different agroforestry models is essential to evolve a proper strategy for its promotion and in identifying the capacity development needs of farmers. The paper documents different agroforestry models being practised around the villages of Bhopal, the capital of Madhya Pradesh (MP), and estimates on financial returns of different models. The agroforestry systems in the study area can be classified as Agri-silvicultural and agri-hortisilviculture. The farmers are familiar with only a limited number of trees, which can be incorporated in the agricultural fields. Farmers give high priority in agriculture crop management as compared with tree management. Tree components are often ignored in agroforestry system. The study reveals that agroforestry in this region is still in its infancy. A farmer knows how to plant a tree but fails to identify the right mix of crops and trees. Awareness about management options is inadequate. This has emphasized on the need to promote agroforestry in the region to maintain and enhance per unit productivity of land by multiple-use management. Hence, agroforestry support programme should be designed to assist agroforestry farmers to manage their land to meet their management objectives through educational and technical support while providing environmental, economic and social benefits.

Background

In India, agroforestry has been recognized as an important farming system since time immemorial. In recent years, scope of agroforestry has increased significantly as an ecologically based natural resources management system which diversifies and sustains production for increased social, economic and environmental benefits (Nair 1984). Apart from this, decrease in per capita land holding, rapid population growth, increasing trend of poverty, conversion of forestland to agriculture uses has created lot of opportunities to promote agroforestry. Though agroforestry has been recognized as an effective means to improve the livelihoods and energy demands, its contribution has not been documented scientifically. Past studies reflect on inadequate information related to management aspects of different agroforestry models, specially on technical and financial aspects. The situation of MP is not exceptional to this (Bhattacharya 2003).

Farmers in MP have been practising many innovative systems to meet their daily demands of forest products as well as increase their productivity of land. However, these systems have not been scientifically documented (Bhattacharya *et al* 2003). Very few studies had been carried out to document agroforestry practices being practised in MP, specially the indigenous ones. Technical and financial appraisal is one of the most ignored aspects in these studies. The detailed appraisal of technical and financial aspects of the various agroforestry models is essential to evolve a proper strategy for the promotion of the agroforestry and identifying the capacity building needs of farmers. The paper documents different agroforestry models being practised around the villages of Bhopal and estimate on financial returns of different agroforestry models.

Study Approach and Methodology

Considering the nature of study, the exploratory research design was followed. After reviewing the concepts and past efforts on agroforestry development in India and in MP in specific, knowledge institutions working for the cause of promotion of forestry or agroforestry in the MP were consulted to know about different agroforestry systems being practised, implemented or promoted by them as well as to understand the problems and constraints of agroforestry development. The review and consultations call for operationalizing the definition of agroforestry since it is a traditional practice. Trees are spontaneously grown and no management interventions is being carried out. Hence with a view to narrow down the scope of study, as well as for better documentation of agroforestry practice, the study adopted the agroforestry definition as proposed by Nair (1984)

"Agroforestry is a land use system that involves deliberate retention, introduction or mixture of trees or other woody perennials in crops / animal production to benefit from the resultant ecological and economic intersections". Even if a farmer has deliberately planted or retained a single tree, he/she has been considered as the agroforestry farmer.

The study adopted two approaches in identifying the agroforestry farmers, which include the knowledge institutions consultations and rapid field survey. Knowledge institutions were consulted to identify the pocket areas or location, where agroforestry has been promoted and identify individual farmers or groups who have been practising agroforestry or has been either approached or are getting support. The list obtained form those institutions were verified with the concerned farmers and detailed survey was carried out. Rapid survey was conducted in 15 villages around Bhopal following the direction of road network. Transect walk was done with Sarpanch and Forest Beat Guard to understand about village farming system and identify the potential farmers for detailed survey. The farmers were then consulted for the detailed discussions with the help of checklists and schedules. After completion of field survey, focus group discussion was carried out to supplement the findings of study as well as to identify potential areas of interventions for managing the agroforestry. This approach not only helps to triangulate the findings of study, but also helps to make farmers aware about the situation of agroforestry development in the village. Dual approach was used in analyzing the data and information collected during the study. This implies use of both quantitative and qualitative methods of analysis. Simple statistical parameters such as frequency and percentages were used, as applicable. The financial analysis was carried out by following cash flow analysis, and discounted cost / benefit analysis.

Results and Discussion

Agroforestry practice

Trees with annual crops or agri-silviculture are perhaps the most easily recognized and most widely employed agroforestry practice in the studied villages. Agri-silviculture was found to be more popular with the farmers followed by agri-horti-silviculture. It was observed that limited tree species are grown with staple food crops. *Eucalyptus, Phoenix* and *Acacia nilotica* are the most commonly found species in combinations with wheat, soyabeans, gram and maize. The major function of the woody component was demarcation of boundaries and commercial wood production. Fences not only provide fencing for livestock, protection and privacy but also serve as windbreaks that produce wood and foliage products. Thorny species such as *Acacia* and *Prosopis* spp. were the most common ones on boundary. Commercial trees like Eucalyptus and Mango were always found in the form of boundary plantations protecting the various horticultural species. The different agroforestry models and tree-crop combinations found in the study areas include following combinations:

- **Eucalyptus + Wheat + Soyabean**

  One of the most popular and common tree-crop combinations is Eucalyptus and wheat. Eucalyptus trees have been found in the form of boundary plantations and are mainly planted for commercial purposes.

- **Mango + Wheat + Soyabean**

  Mango, being an evergreen, perennial tree, is preferred significantly. Mango trees are found in either separate patches on croplands or in the form of rows between crop areas. Wheat and soyabean are cultivated in different seasons annually while fruiting in mango trees starts around the fifth year.

- **Gram + Wheat + Orange + Mango**

  Horticultural trees too are gaining popularity among farmers as fruiting starts early and returns are good. They are grown generally with wheat and gram.

- **Wheat + Khejari**

  Khejri, a small to medium sized thorny tree, is grown with wheat. Farmers are fully convinced that this tree species improves fertility beneath its canopy and has no competition with arable crop for soil moisture and nutrients.

- **Soyabean + Jamun + Aonla + Neem**

  Although this combination was not a popular one, it was found to be existing in a small area.

- **Eucalyptus + Wheat + Teak**

  This combination was found at some places and was one of the few successful ones.

Other tree species most commonly found and integrated with agriculture crops included *Emblica officinalis (Aonla)*, *Tectoria grandis (Teak)*, *Azadiracta indica (Neem)*, *Madhuca indica (Mahua)*, *Diospyros melanoxylon (Tendu)*, *Tamarindus indica*, *Terminalia arjuna Koha / Arjun)*, *Zizyphus mauritiana (Beri)*, *Pongamia pinnata (Karanj)* and *Acacia nilotica (Babul)* etc.

Technical Appraisal

This section documents technical or management interventions carried out by farmers. The farmers are more concerned and providing high inputs on crop management compared to tree management. On intensive enquiry about these issues the most common answers of the farmers were as follows- *"We have planted trees not to supplement the farm income but to fence our boundary. We are less concerned about it because we did not know when we would get returns from those trees."* This statement itself reflects on level of management interventions practised by farmers. Trees wherever existing on croplands, planted or natural, are mainly grown to demarcate the croplands and act as live fences. Food crops invariably have priority, followed, if possible, by other seasonable crops that can generate cash easily.

Crop Management

The farmers are cultivating grams, wheat and Soyabean along with woody component. They are cultivating these crops on the basis of their traditional knowledge and skills. None of the farmers in the study areas have been cultivating improved varieties of wheat or Soyabean. Most of the farmers use bio-fertilizers. Very few farmers reported of applying chemical fertilizers. Application of fertilizers and irrigation is almost negligible for both of crops. Weeding is generally done for Soyabean. No intensive care is given for either of the crops as these are planted. Once the crop is ready to harvest, the farmers harvest it. The crops are either stored for subsistence use or sold to the local market.

Table 1: Management interventions practised by farmers.

Interventions	Agro-Silvo-horticulture	Agri-silviculture
Site preparation	Manually and ploughing up to 10 cm suitable for cultivation of crops	Manually and ploughing up to 10 cm suitable for cultivation of crops
Planting materials	Seedlings available at local nurseries	Seedlings available at local nurseries
Manuring	Use of organic fertilizer and chemical fertilizer during plantation only	Use of organic fertilizer and chemical fertilizer during plantation only
Pit size	30 - 45 cu. cm	30 - 45 cu. cm
Pit preparation	Mechanical means	Mechanical means
Lay out of plots	Row	Row / Block
Soil working	Up to the third year of plantation	Up to the third year of plantation
Irrigation / Watering	Rain fed	Rain fed
Soil and moisture conservation	None	None
Weeding	As required based on weed growth and intensive care is given until establishment of seedlings	As required based on weed growth and intensive care is given until establishment of seedlings
Silviculture operations	None	Thinning and pruning rarely followed
Grazing	Not allowed	Not allowed
Insect pest / diseases	Use of chemicals as and when required	Use of chemicals as and when required
Fire	Fire control lines	Fire control lines
Harvesting	Annual for crops and selection system for trees	Annual for crops and selection system for trees

Tree Management

Tree management practices are quite traditional with very little technical inputs. Though, tree management starts from the selection of species to its final harvest, farmers are ignorant of the scientific management practices. When asked about the tree management, *most of the farmers put back the questions to the researchers and asked what exactly it meant. For him the tree management is just the planting and collecting the product out of it.* The study reflects that farmers have less technical knowledge and skills in managing the tree component. Table 1 presents the different management interventions carried out by farmers. There exists no difference on management interventions though they have practised different agroforestry models. The differences were observed on harvesting of products. Farmers get fruits and fodder annually where as timber are harvested once the rotation age is completed or gets severely attacked by insects.

Selection of species

Most of the farmers had selected the species on the basis of their traditional knowledge and beliefs. The choices of species were governed by the purpose of planting trees, for example commercial trees like Eucalyptus and Mango were planted on boundary to protect the various horticultural species where as thorny species such as *Acacia* and *Prosopis* were planted for fencing. Specific tree characteristics received high priority compared to its multiple purpose utility.

Spacement and tree density

This is governed by different sets of factors such as objectives of management, agriculture crops to be grown and vehicular or machinery movement such as tractor, cart to be taken during the land preparation and species itself. Based on the specific requirements, farmers keep different spacement and tree density. The common patterns adopted in the study are as follows:

- *Eucalyptus* **spp.** The plantations are done mostly on the boundaries. It is most preferred for growing on farmlands due to its high production of wood and sparse shade. Eucalyptus, usually, occupies 40% of the cropland leaving rest of the area for agricultural crops. The spacing varies from 10 to 20 ft.

- *Mangifera indica.* Mango trees have always been found in separate patches along with agricultural crops and have not been found to exist in a spatially mixed form. Wherever Mango trees were found, they were in large numbers occupying almost an equal area. Spacing is usually kept as 30 x 30 ft. Mango is mainly cultivated for its fruits and firewood.

- *Prosopis cineraria.* Khejari, as it is commonly called in the region, is a small to medium sized tree which is grown on the boundaries only as it is considered to be a very effective live fence. Leaves are collected, dried and stored to feed livestock. Trees are not normally thinned, as they are usually not grown for wood purposes.

- *Citrus spp.* The most popular species for horticultural purposes is citrus species such as Oranges and Lemon. Planting is mainly in the form of intercropping with rows of trees between agricultural crops.

- *Syzygium cumini.* Jamun, a common name, is an evergreen fast growing tree. The spacing is usually wide, around 30 x 30 ft. Trees are usually not trained and cultivated mainly for fruits.

Preparation of Land

Woody perennials usually demand more thorough land preparation than seasonal crops. Farmyard manure, chemical fertilizers are usefully incorporated in the soil before planting. Planting pits are dug with varying depths and widths. Farmers are not aware of pit size or nutrient requirement of different tree species. They prepare the land on the basis of their local traditional skills and knowledge and most of them have not approached concerned departments or offices for the management of species.

Early plant protection

For the early plant protection, most of the farmers carried out timely weeding, application of chemical herbicides and pesticides, and control of the grazing. Some of the farmers have also been conducting soil working depending upon the weed growth. Almost all the farmers have controlled or prohibited grazing to protect the plant. The source of the chemical herbicides and pesticides are the local agrovets present around the vicinity of their villages.

Thinning / Prunning

Thinning and prunning procedures are probably the least understood practices. They did not know what exactly both these terms meant. Transect walk reflected that farmers had been practising thinning and prunning operations in their fields. But for them, removal of the crowded trees or cutting of lower branches is just to increase the sun penetration on the field rather than from tree improvement aspects. Though farmers are to some extent aware of possible tree crop interactions and their effects, they hardly practise tree management. Most of the farmers are only collecting the dead wood or dried branches of

the trees. This clearly reflects that farmers have their own traditional knowledge in tree management but do not understand technical terms of forest management.

Pests and Diseases

Though farmers apply regularly insecticides or pesticides as a preventive measure to their agriculture crops, it is hardly applied in case of forestry crops. They are applied only when the tree is severely infected by diseases. Most common methods of the pest and disease control are to just remove the infected trees and use for the fuelwood. Farmers hardly approach any institutions if their tree crops get diseased. Most of the farmers either render support or prefer to go to the local agro-vet centers rather than to different institutions working for the cause of agroforestry promotion. For them visiting these institutions would not be effective from all the aspects such as cost, time and suggestions or inputs provided.

Logging and Harvesting

Logging and harvesting operation is one of the most neglected aspects of tree management. As the purpose of planting of tree was either to fence the agriculture land or to provide shade to horticulture crops, farmers are least concerned for its harvesting. They are not practising any scientific harvesting and logging operations. Trees are only harvested when they are dead or severely infected by diseases. Trees are generally felled when the land is fallowed.

Financial appraisal

Technical appraisal of the agroforestry systems revealed the absence of any technical or scientific management of agroforestry. Under this situation, it was extremely difficult to collect economic details and estimate the cost and benefits of agroforestry. Hence the study adopted cash flow analysis methods to calculate the financial appraisal of different agroforestry models. Benefit cost ratio (BCR) based on farmers' recall methods was used to calculate on the yield over last five years by different crops and woody component. BCR of different agro forestry models has been summarized in Table 2. The BCR is maximum in fruit trees with soyabean followed by fruit tree and gram. The return from agri-silviculture model is low because farmers are not getting benefits from tree economically though it might have contributed ecologically by preventing erosion or increasing the productivity of soil.

Table 2: BCR of Different Agroforestry models after five years of plantation

Rupees per acre

S.No.	Model	Cost	Return	Benefit	BCR
1	Orange and Soyabean	9540	26000	16460	2.7
2	Eucalyptus and Soyabean	8640	24000	15360	2.7
3	Lemon and Soyabean	9540	24000	14460	2.5
4	Orange and Gram	11165	26000	14835	2.3
5	Eucalyptus and Gram	10265	24000	13735	2.3
6	Orange and Wheat	10765	24000	13235	2.2
7	Eucalyptus and Wheat	9865	22000	12135	2.2
8	Guava and Soyabean	8940	20000	11060	2.2
9	Lemon and Gram	11165	24000	12835	2.1
10	Mango and Soyabean	12210	26000	13790	2.1
11	Guava and Gram	10565	20000	9435	1.9
12	Mango and Gram	13835	26000	12165	1.8
13	Guava and Wheat	10165	18000	7835	1.7
14	Mango and Wheat	13435	24000	10565	0.5
15	Lemon and Wheat	10765	22000	11235	0.4

Issues and problems

A farmer who plants trees or other woody perennial plants instead of seasonal crops has a different set of commitments. Trees, however, are not a panacea for all ills. To achieve the full potential, a farmer must be able to carry out all those operations that control how an agroforestry system functions in a timely and skillful way. But it was found that farmers were not really aware of any new technological or management systems. This can be one of the reasons why agroforestry is still struggling. Some of the specific issues or problems which agroforestry should address are as follows:

Technical knowledge and skills

Tree management practices are quite traditional with very minimal technical inputs. Farmers have given high priority in crop management compared to tree management. Most of the farmers implement different management inventions till trees are established. The farmers are familiar with a limited number of trees, which can be incorporated in the agricultural fields. Hence, present study reflects that farmers have less technical knowledge and skills in managing the tree component.

Technical support

When asked about the key institutions providing the support to farmer or in the village for the promotion of agroforestry, most of the farmers were not able to even list the name of those knowledge institutions consulted earlier. For them, the private nursery or seed suppliers from where they either purchased seed or approached them for any technical interventions is the key institution for the promotion of agroforestry. They hardly recall even the name of Forest Department. Thus, there is a complete absence of extension activities for agroforestry.

Marketing system

Of the agriculture and forestry products, agriculture crops are sold in village markets or at Bhopal. Very few farmers have sold forest products specially the timber to the local people. Though there was highest return from the combination of soyabean with orange, farmers are not able to get the direct benefits from the marketing of the products. There exists no special marketing channel for the promotion of the marketing aspects of agroforestry.

Operated land size

Agroforestry, a means of minimizing risk, is actually associated with a lot of risks. Farmers associate risks with agroforestry and try to avoid the consequences of making a wrong decision. Farm size is an important issue because farmers with access to small areas of land want to protect their families' subsistence needs and plant food and other preferred crops. Thus agroforestry options were found to be more readily accepted as the farm size increased. Thus the aim of the agroforestry would be to increase more trees on landscape rather than changing the farming system.

Risk diversification

Agroforestry is not covered by the extension services, and is never considered as a potential intervention. Moreover farmers are more interested in the tangible economic benefits from agroforestry and care little for the long term ecological benefits derived from incorporating trees on farmlands. Younger farmers are more inclined to plant crops, while tree planting is favored by the older generation

Research and development

Very little has been done in terms of agroforestry research because of various complexities like methodological, ecological and socio-economic aspects associated with agroforestry research. Of these, tree crop interaction and its possible effects are one of the most neglected one. Agroforestry is not simply mixing a few trees and crops together and hoping for the best. Different tree-crops and their interaction with crops have to be understood, and this hasn't received any research inputs. There is a critical need to allocate scarce resources in the right way.

Potential areas for intervention

The review of above situation clearly reflects the need to promote agroforestry to maintain and enhance per unit productivity of land by multiple-use management and effective utilization. Thus the agroforestry support programme should be designed to assist farmers to manage their land to meet their management objectives, such as timber production, fuelwood and forage production, recreation, livestock grazing, soil and water conservation, fruit and small wood etc through educational and technical support while providing environmental, economic and social benefits. The aim of the agroforestry should be to incorporate more trees into the farmland rather than changing the farming system. Some of the potential areas, where the agroforestry programme should focus on, are as follows:

Extension and publicity

Extension and publicity programme is essential to increase awareness about agroforestry. The development and implementation of participatory approaches towards public awareness and sensitization is an important activity for the promotion of agroforestry. Extension is carried to increase awareness about planting trees in existing agriculture system as well as on community land. Some of the possible ways are as under:

- Develop and disseminate information related to agroforestry in local languages through use of different extension media.

- Organize exposure visits and study tours to understand agroforestry and tree crop interaction and its management carried out by peer groups.

- Provide assistance (material and financial) for establishing information resource center at each Panchayat for dissemination of different extension materials.

Training and capacity development

Agroforestry farmers have limited skill and technical knowledge in managing their forests or for initiating multiple use forestry activities. This requires strengthening of their skills in managing farms for sustainable utilization rather than protection. Thus capacity building should be taken up as a continuous process through identifying the priority areas that are likely to have the greatest overall impact and as identified or needed by the farmers themselves. Some of the possible ways are as follows:

- Enhance agroforestry farmers' capacities through effective information network, exposure visits, study tours, trainings, workshops at village and district levels to provide them a platform for exchange of ideas, experience and knowledge.

- Provide skill-based trainings on silvicultural operations, multi storey management, plantation techniques, disease and pest control, NTFPs management, tree crop management, criteria for selection of species and crops, diagnosis and design of agroforestry projects etc.

- Provide follow up and post training support for effective implementation of learned skills in the field as well as to disseminate information and technical advice.

On-farm Demonstration plots for different agroforestry models

Agroforestry is still at a very rudimentary stage. An appropriate and properly managed species mix will result into sustainable land use system that can produce as well as conserve. Hence existing agroforestry practice needs to be documented and among these best and efficient ones need to be identified and replicated in other similar domains. Some of the possible methods to achieve above are explained below:

- Establish different *on-farm agroforestry demonstration plots* of different agroforestry systems to show the tree crop interactions and its resultant benefits.

- Encourage and help farmers to establish on-farm agroforestry demonstration plots and plantations.

- Disseminate and share information / experiences of different agroforestry systems to concerned stakeholders.

- Document different management systems followed in each demonstration plot and calculate its financial rate of return to assess the financial feasibility of the activity.

- Develop detailed guidelines for practising different agroforestry systems based on results of different demonstration plots and farmers' field school practice.

Management Assistance

The management of agroforestry includes mainly protection and use. Very few farmers have reported to apply fertilizer, irrigation and herbicides. There is lack of technical knowledge for management of agroforestry. Hence, management assistance is necessary to meet their personal management objectives while providing environmental, economic and social benefits. The main thrust of the programme should be to provide technical assistance and support farmers interested in agroforestry for multiple resource benefits rather than providing technical packages.

- Identify potential service provider for agroforestry and agree on roles and responsibilities based on comparative advantage and complementary in delivering the services.

- Provide information on organizational support for tree planting, credit facilities available from different banking institutions, and potential service provider for management of agroforestry.

- Support farmers to meet their management objectives by suggesting methods on proper management of species and appropriate selection of species based on local conditions and situation.

- Provide technical advice and on-farm visits to assist farmers in management of land according to their management objectives.

- Explore the local market places, demands of forest products and market price for different products and provide market information.

- Promote and strengthen the *Lok Vanaki (Private forestry) concept* in agroforestry management as well.

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