Socio-Economic analysis of different Agroforestry Systems in Mayurbhanj District of Odisha

A

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MASTER OF SCIENCE IN FORESTRY(FOREST BUSINESS MANAGEMENT)

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CERTIFICATE – I

This is to certify that the thesis entitled **"Socio-economic analysis of different Agroforestry Systems in Mayurbhanj District of Odisha"** submitted in partial fulfillment of the requirement for the award of degree of **MASTER OF SCIENCE IN FORESTRY (FOREST BUSINESS MANAGEMENT)** to the Odisha University of Agriculture and Technology is a faithful record of bona fide and original research work carried out by **SUBASIS BISWAL** under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma.

It is further certified that the assistance and help received by him from various sources during the course of investigation has been duly acknowledged.

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CERTIFICATE – II

This is to certify that the thesis entitled **"A Study on Socio-economic analysis of different Agroforestry Systems in Myurbhanj District of Odisha"** submitted by **SUBASIS BISWAL** to the Odisha University of Agriculture and Technology, Bhubaneswar in the partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN FORESTRY (FOREST BUSINESS MANAGEMENT)** has been approved by the student's advisory committee and the external examiner.

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With this report, I want to shed some light on what is the status of agroforestry practices, what factors influence its adoption and whether adopted agroforestry models are profitable or not to the farmers of Mayurbhanj District, Odisha. This also clarifies what current factors are important in establishment and adoption of agroforestry. Hopefully, this will provide additional information on status of agroforestry in Odisha. A better understanding of socioeconomic factors and viable agroforestry models give handles for successful application of agroforestry in the region. This report would not have been what it is without the support of many people.

With the blessing of God, I have completed a successful journey of my research work on the meandering road with an unswerving destination.

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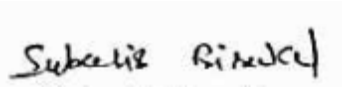
Last but not least,

"A farm can be regarded as a food factory and the criterion for its success is saleable products. Or, it can be regarded as a place to live, and the criterion for its success is harmonious balance between plants, animals and people."

Aldo Leopard



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C O N T E N T S

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

%	Percentage
MD	Man days
qtl	quintal
BCR	Benefit- Cost Ratio
CBA	Cost- Benefit Analysis
ETP	Entire Transplant
FAO	Food and Agriculture Organization
FSI	Forest Survey of India
GOI	Government of India
ICRAF	International Centre for Research in Agroforestry
IRR	Internal Rate of Return
ISFR	Indian State of Forest Report
NAF	National Agroforestry policy
NPV	Net Present Value
OBC	Other Backward Castes
OFDC	Odisha Forest Development Corporation
SC	Scheduled Caste
ST	Scheduled Tribe
WAC	World Agroforestry Congress

ABSTRACT

In Shyamakhunta and Badasahi Block of Mayurbhanj district of Odisha, the present study entitled "A Study on Socio-economic Analysis of Different Agroforestry Systems in Mayurbhanj District, Odisha" was conducted during 2020-21 with the objectives

1. To analyse economics of different Agroforestry Systems in Mayurbhanj district
2. To study different Agroforestry systems adopted by villagers
3. To assess the socio-economic characters of farmers

From the study it was found that mainly seven major agroforestry practices adopted in the area including Silvi-horti, Agri-Horti, Agri- Silvi-Horti, Bund Plantation, Agrisilviculture, Homestead and Block Plantation.

Among the selected agroforestry systems, it had been found that Blockplantation system was most profitable having BCR of 5.38 followed by > Agrisilviculture (2.04) > Bund Plantation (2.01) >Homestead (1.92) > Silvihorti (1.48) >Agri Horti (1.40) > Agri Silvi Horti (1.27). The study also revealed that the highest economic benefit, as well as resource conservation was possible when tree crops are in monoculture or with associated with different crop species along with NPV of Homestead (Rs10,75,637/-) morethan Blockplantation (Rs 9,99,013/-) followed by AgriHorti (Rs5,46,080/-), Agrisilviculture (Rs 3,20,812/-), Silvihorti (Rs2,64,959/-), Bund Plantation(Rs 2,04,413/-) and AgriSilvi Horti (Rs84,572/-).

The IRR of different systems were calculated maximum for Homestead (84.32%) followed by Bund plantation (61.76%) > Block plantation (58.15%) > Agri silvi (49.86%) > Agri silvi horti(48.75%) > Silvi horti (48.52%) and least for Agri horti (45%).

The most preferred forest tree species was *Acacia* sp, Teak (*Tectona grandis),* Subabul (*Leucaena leucocephala*) etc while the most preferred fruit tree species adopted by farmers were Mango (*Mangifera indica*), Guava (*Psidium guajava*), Banana (*Musa paradisiaca*), Papaya *(Carica papaya).* Various inter crops were grown mostly Cowpea, Ragi and horticultural crops like Turmeric, Ginger , Mango ginger , Garlic etc mostly preferred by farmers in the study area.

As far as land area under farming practices observed in the study field, around 22 ha under Agrihorti followed by Homestead (19.1 ha), Bund plantation (18.5 ha), agrisilviculture (17 ha), Agri silvi horti (16.1 ha), Silvihorti (15 ha) and Block plantation (14.6 ha) and it shown the adoption of different systems by the farmers in the study area.

The findings of the study revealed the importance of socio-economic factor while

designing agroforestry models for the study area. The existing agroforestry practices also need improvement by incorporating more high yielding fruit, fodder and timber trees as per farmers' choice.

Through multi-stage randomized selections, the agroforestry practices and socio-economic aspects were surveyed for 116 households in the two selected blocks. The present research was designed to examine the significance of agroforestry through agroforestry interventions for the socio-economic upliftment of rural households. The data was collected through a structured interview schedule by personal interviews of the respondents along with through a farm visit, data on current agroforestry practices was collected. Demographic details of the villages were analyzed, including details of the family structure of the households, occupational profile, income, livestock status and poultry rearing.

In the study area, the majority of respondents were middle-aged (37.9%) of 30-40 yrs age, illiterate (71.6%), unemployed (49.1%) and low-income(31%), married(87.1%). Most of them belonged to the Scheduled Tribe (57.8%) and all of the land were fully irrigated (100%) because of Govt. Scheme "Pradhan Mantri Jal Sinchai Yojana" Majority of people lived in thatched house (52.6%). The main sources of livelihood were agriculture and livestock rearing. Most of the farmers were either small (35.3%) or marginal farmers (27.6%). Agriculture was the primary occupation for their livelihood and revenue generation followed by agroforestry.

From the correlation study of different socio-economic variables of the respondents found that marital status is positively correlated with literacy as well as employment status and literacy is positively correlated with types of family, household type was only significantly correlated with employment status and employment status is also significantly correlated with income and employment status is the only contributing variable for the income generation of the respondents. It was evident that there is only 17% contribution to the income generation of the respondents. The R square value i.e. 0.170 and it represented the overall contribution of socioeconomic variables to the annual income i.e. 17% . From the objective third it was found a strong link between the socioeconomic factors that were looked at and the adoption of agroforestry and these socioeconomic factors play an important role in the adoption of agroforestry activities.

INTRODUCTION

Agroforestry can be defined as a complex, ecologically based method of natural resource management that diversifies and sustains development through the incorporation of trees on farms and in the agricultural landscape for increased social, economic and environmental benefits for land users at all levels (ICRAF, 1996).

"Agroforestry is a collective name for land use systems and technologies in which woody perennials are purposefully mixed with herbaceous crops and possibly animals in the same land management unit," according to the definition (Nair *et al.,* 2008). As a purposeful practice of mixing crops, trees, and or animals into a single unit of land in where the physical and biological interactions between components that are segregated from other structures.

Agroforestry systems can be categorized according to structural, functional, socioeconomic and ecological basis and include silvopastoral, agrisilvopastoral and agrisilvicultural systems, which are temporally or spatially arranged. Based on the socioeconomic criteria of production, it is grouped as commercial, intermediate and subsistence agroforestry systems.

These practices are designed to suit different environmental conditions from humid/sub-humid to, arid/semi-arid or highlands, and have both protective (soil conservation, wind breaks etc.) and productive functions like food, fuel wood, fodder, water (Missouri Centre of Agroforestry 2013; Tewari, 2008).

Agroforestry systems can provide provisioning, regulating, and supporting services while also receiving beneficial ecosystem services such as insect pollination. The integration of trees, crops, and animals on agricultural land is viewed as a wide sense of multiple land use and layered output in space and time (Howes and Rummery, 1998), which will enhance rural communities' livelihoods.

Adoption of different agrforestry system and socio economic impact

Tree-crop management is traditionally practiced by villagers and farmers who maintain trees on their farmlands to meet their subsistence and commercial requirements for their livelihood in order to receive tangible and intangible benefits. Due to an ever-increasing population, there is pressure on land resources leading to dependence on

forests as well as agricultural land to provide food, shelter, commercial lumber, and other products for livelihood and income generation.Conversionof forest land for agricultural land and developemental activities had reduced the forest coverage, agricultural productivity and climatic condition. This leads to the development of modern concept of agroforestry i.e., which combines traditional knowledge, tree science, and associated technology to produce a significant amount of agricultural output and other benefits from same patch of land. Adoption of Agroforestry methods by rural farmers when choosen upon information available to farmers from available sources, which leads to the development of a positive or negative decision regarding agroforestry, and when this occurs, adoption of agroforestry may occur (Himshikha,2017).

Socio-Economic evaluation is the way to learn about social and economic situation of the Individuals, groups, communities, or organisations (Abdrabo and Hassan, 2003). It is critical to do socioeconomic research on farmers' fields and their relationship to agroforestry (Irshad *et al.,* 2011). Farmers' socioeconomic status influences specific management techniques, such as farm management and agroforestry practices, which are related to the economic potential of agroforestry methods used by farmers.

Individual and social attributes such as age, gender, caste, family size, ownership type, literacy level, work participation and economic parameters such as household type-living conditions, total primary and secondary sources of income, employed members of the family, land-holding, employment opportunities, labour availability and farm produce sale are among the many variables that make up a farmer's socio-economic status. In a nutshell, socio-economic aspects are the characteristics that relate to the social and economic elements of a community's livelihood and well-being. Adoption of agroforestry techniques understanding of the socio economic parameters of farmers in order to improve the contribution of agroforestry to the adoption, socio-economic well-being of farmers. Other factors that are directly or indirectly connected to a farmer's socioeconomic situation in the context of agroforestry such as the degree of technical knowledge among farmers, government policies, and the aim of growing tree species on their farmlands(Himshikha,2017)

While analyzing socio-economics of management practices like agroforestry; two types of studies can be considered. First to study the effect of agroforestry practice

adoption on socio-economic conditions of the farmers and second can be to study the influence of certain socio-economic factors upon adoption of agroforestry practice done by the farmers. Certainly, a wide range of these socio-economic attributes when combined together can influence farmers‟ decision on adoption of agroforestry.

Keeping in view the above factors, the present study has been taken up with respect to 13 socio-economic factors and their association with the adoption of agroforestry and its impact on the socio economic attributes of farmers

Another essential part of agroforestry adoption is to see if it can provide farmers with higher economic returns. Diverse agroforestry models reflecting various agroforestry approaches have already been constructed in various agro-climatic settings. The economics of these tree-crop combinations determines the most efficient input and output that may be used and created throughout a rotation period. This, in turn, not only answers the issues of economic theories in agroforestry, but also makes it easier to put these agroforestry models into practise in farming systems. When capital invested and received are the key characteristics of economics, cost-benefit analysis (CBA) is a useful tool for evaluating relative inputs and outcomes. The economics of agroforestry models need all projected expenses to be paid and benefits to be gained**.**

Agroforestry in the study area

Both farmer groups, those who practice agroforestry and those who do not practice agroforestry, can better describe agroforestry. Farmers have traditionally looked to boost productivity in order to enhance profit while lowering cost production and management crops, either directly or indirectly. In this study consideration is given to the economics of boundary and block plantation agroforestry models used by farmers in the study area, namely Mayurbhanj district of Odisha..

There is huge potential in India, which are characterised by diversified, complicated, and resource-limited farming practices. India is one of the world's developing countries that has shown diverse agroforestry capabilities in different agro-climatic zones. Nair (1990, 1993), Mughal and Bhattacharya (2002), Kumar and Nandal (2004), Dwivedi (2009), Tewari (2008), Karemulla (2009) and Singh (2014) had studied the importance of different agroforestry systems. Some examples include (a) agri-silviculture, in which trees and agricultural crops are grown together, (b) silvi-pastoral, in which trees are

raised on pastoral lands or fodder crops are grown alongside them, and (c) agri-silvi-horticulture, in which silviculture trees, horticulture crops, and agricultural combinations are managed on the same piece of land.

Significance of the study

The farmers in eastern India adopt various agroforestry methods, distinct types of agroforestry practices and their features are yet to be researched with respect to the study region. Many distinct types of agroforestry have been described by various scientists in the past, but there is a scarcity of data on the economics of agroforestry models used by farmers in this region. These studies, when taken together, do not give a whole picture of agroforestry and its socioeconomic potential, particularly in the Mayurbhanj area of Odisha. There is no baseline research has been undertaken that is really based only on farmer answers, taking into account the scope of agroforestry, variables that impact adoption of agroforestry, the Benefit-Cost, and profitability with respect to agroforestry in the region.

To understand factors like increasing costs like labour charges and decreasing benefits from components due to certain reasons such as decreasing soil productivity, not understanding of economics of agroforestry models, decreasing land holding, migration of rural population to cities, un-awareness of the potential of the agroforestry and above all, single family system. Which decide the feasibility of agroforestry models/practices, it is essential to study the prevalent agroforestry practices.

There is also a need for study and assess the advantages, costs, and net benefits in terms of cost and benefit, as well as the profitability and feasibility of agroforestry models used by farmers in their areas. These factors make it important to do a research on the socioeconomic aspects of agroforestry. Understanding the reason that is associated with adoption will help us in determining the region's agroforestry growth potential. The research provides a baseline data for creating alternatives that focus on key socioeconomic variables, as well as assisting in increase the adoption and usage of agroforestry in farming in Mayurbhanj district.

Keeping in view the above factors, the present study entitled “Socio-economic analysis of different Agroforestry systems in Mayurbhanj District of Odisha” has been taken up with respect to different socio-economic factors and their association with the

adoption of agroforestry and its impact on the socio economic attributes of farmers. The present study was undertaken in the Mayurbhanj district for following objectives;

Objectives of the study

- To analyse economics of different Agroforestry Systems in Mayurbhanj district
- To study different Agroforestry systems adopted by villagers
- To assess the socio-economic characters of farmers

REVIEW OF LITERATURE

2.1 To analyse economics of different Agroforestry System

Nayak *et al.,*(2021) conducted a study where Bund plantation, homestead and agrisilviculture are the top three models that produce the highest BCR. Among the selected agroforestry systems, it had been found that bund plantation system was most profitable having BCR of 3.77 followed by homestead (3.51) >agrisilviculture (3.29) > block plantation (2.66) > silvihorti (2.60) > others (2.44) >aquaforestry (2.29) > silvipasture (2.18). The study also revealed that the highest economic benefit, as well as resource conservation, is possible when crops are associated with different tree species rather than a monoculture.

Rahman *et al.,* (2020) studied the costs and benefits of three agroforestry systems in Kaharole Upazila, Dinajpur district, Bangladesh: homestead, farmland, and orchard agroforestry. Agroforestry based on sissoo-rice is a financially feasible approach. From July 2017 to January 2018, a comprehensive field survey and measurements were carried out throughout Kaharole upazila's various unions and villages. The survey region was chosen using a multistage random sampling approach in this study. The benefits and cost data were collected using a pre-structured questionnaire. A total of 60 agroforestry techniques were analysed for cost and benefit analysis, comprising 20 homesteads, 20 orchards, and 20 croplands. The field survey provided the first three years of cost and income data.

Rani *et al.* (2016) reported that tree-based land use systems are economically viable and more profitable than pure agricultural crops. The highest B:C ratio was recorded in pure *E. tereticornis* plantations (3.30) after 5 years. During the study period, the P.deltoides+T.aestivum crop-based land use system had the highest B:C ratio (2.02) followed by T. grandis plantations (2.06), T. aestivum+ O. sativa (1.89), T. aestivum+P. glaucum+fruit crop (1.72), B. napus+fruit crop (1.56) and B. napus+ O. sativa (1.27).

Mombo *et al.* (2016) calculated the cost and profits of agroforestry practices. The CBA was carried out using the benefits and costs acquired. Their findings demonstrated that the village's selected agroforestry systems had a positive net present value per hectare. The BCR of agroforestry models was found to be more than one. The IRR in all systems was substantially greater than the World Bank's mandated rate of interest, which was 10%. So, they came to the conclusion that investing in agroforestry methods is a good idea.

Handa *et al. (*2016) demonstrated that poplar planted on field bunds is harvested after a six to eight-year cycle in Punjab and the average economic return of poplar-based agroforestry is enormous when compared to a single agriculture crop.

Bijarpas *et al.* (2015) analysed the socioeconomics of four agroforestry systems. They found a substantial difference in NPV between monoculture and other agroforestry systems using the NPV criterion. The results showed that agroforestry investment was more efficient than monoculture alone. Farmers in the upper Gangetic plains, particularly in Haryana, Punjab, and Western Uttar Pradesh, have embraced very profitable agroforestry schemes.

Basu (2014) illustrated the potential for different agroforestry systems in India to generate employment. Additional employment (person-days/ha/yr) ranged from 30 (agri-silviculture, agri-silvi-horticulture, and silvi-pastoral) to 50 (agri-horticulture) days per ha per year, while total annual employment (million person-days) ranged from 20.3 (irrigated agri-horticulture) to 167.4 million person-days (silvi-pastoral).

Nayak *et al.,*(2014) conducted an economic assessment of a sissoo-rice based agroforestry system,Jawaharlal Nehru Krishi Vishwa Vidyalaya in Jabalpur (India) can be economically successful If correctly maintained. In 2010, three rice types (IR-36, MR-219 and WGL-32100) were cultivated with sissoo, including in open conditions, and the trees were pruned at varied levels (0, 25, 50, and 75 percent intensity). Regardless of rice variety, sissoo 50 percent pruning + rice crop (Rs40311/ ha) had the highest net monetary return, followed by 75 percent pruning (Rs 40186/ ha), 25 percent pruning (Rs36517/ ha), and lowest in no pruning + paddy (Rs25859/ ha) and MR-219 had a much larger monetary return (Rs38715/ ha) than IR-36, regardless of pruning intensity.

Mercer *et al.* (2014) went into further detail about the economics of agroforestry. According to them, the number of specialised activities necessary for agroforestry determines its economics and adoption.

Atangana *et al.* (2013) utilised a CBA technique for understanding the economics of agroforestry. They listed NPV, BCR, and IRR, as well as return on labour, return on land, farm models, opportunity cost, payback period, and equivalent periodic value as per criteria.

According to them, the key factors in agroforestry production are to provide data for economic analysis of capital goods, land, and labour.

Dharamsena and Bhat (2012) used an economic method to investigate the economics of multi-purpose agroforestry plantations. As an analytical tool, they computed BCR, NPV, and IRR. The study inferred that, according to discounting procedures, computed BCR, NPV, and IRR for agroforestry plantations are acceptable at discounted prices.

Singh *et al.* (2011) investigated the economics of agroforestry models in Orissa, India. Standard economic analysis methods were used to assess the benefits of various tree crop systems for teak and cashew nut based agroforestry combinations. The projections were made at the 15th and 45th year of rotation, respectively, using a discounting rate of interest of 7% and 15%. They employed economic parameters such as NPV and BCR to assess economic profitability. In the instance of silvi-agriculture (Teak-cashew nut), the BCR was found to be higher at 3.64:1 and 1.98:1 at the 15th and 45th years, respectively, at a discounting rate of 7% and 15%.

According to Lal *et al.* (2011), poplar agroforestry plantations are concentrated in Punjab's northern districts, Haryana, North-Western Uttar Pradesh, and Uttarakhand's plains, owing to higher returns per unit of land.

According to Mandal *et al. (2011),* In Haryana and Punjab, a large number of farmers are implementing poplar-based agroforestry systems to strengthen their economies. Poplar has made a significant contribution to fastening the economy. In Haryana's Ambala, Kurukshetra, and Yamuna Nagar districts, poplar planting has been estimated to be more profitable than traditional agricultural crops. Farmers may increase their yields of grain, forage, and wood by using agroforestry systems (Mandal et al., 2011). Poplar is the best agricultural product in terms of yields and how much farmers like it. It also grows quickly, loses its leaves, and can be sold quickly (Chandra, 2011).

Khullar *et al.* (2010) assessed the economic analysis of poplar-based agroforestry models in Punjab's plain area. The study found that poplar-based agroforestry is more economically feasible and lucrative than paddy-wheat rotation alone. In comparison to the paddy-wheat rotation method, BCR was found to be 4.41:1 in block planting and 3.32:1 in

boundary plantation (2.88:1). They also said that block plantings were good for big farmers and that border plantings were good for small farmers.

According to Karemulla (2009), the study of farm management efficiency, which is of three types: farm income/comparative analysis, farm management analysis, gross margin analysis, and analysis of returns to investment, which includes cost–benefit analysis, is another economic analysis in agroforestry.

Chauhan *et al.* (2009) conducted research to learn about farmers' attitudes toward poplar-based agroforestry systems in order to determine the components and yield potential of the most common poplar wheat combination. They discussed the factors that influence adoption and non-adoption of poplar-based agroforestry interventions. He used the BCR method for cost-benefit analysis to look at how much agroforestry would cost and how much it would help.

Dwivedi *et al.* (2007) conducted a study about systemic analysis of agroforestry, taking into account the rotation duration, cropping pattern, and the number of farmers who harvested the produce in the previous three years. For the two main tree species, i.e., Poplar and Eucalyptus, the study was done individually for the bund and agri-silviculture systems. Bund planting with poplar and eucalyptus was used by the farmers. for the purpose of comparing the economics of poplar and eucalyptus-based systems with the average population maintained per hectare. The system's cropping pattern was sugarcane for the first two years and a paddy-wheat system for the remaining years.

Newaj and Rai (2005) studied an Aonla-based Agroforestry System on marginal lands under rainfed circumstances and found that it had a higher BCR of 3.28, indicating that it is profitable. Molua (2005) investigated the economics of tropical agroforestry systems and found the importance of market prices and farm operational costs.

Alavalapati *et al.* (2004) evaluated the phenomenal work done by many experts on economics, household constraints, agroforestry adoption, and macro-economic and institutional analysis. When they compared different agroforestry land use systems, they highlighted different types of economic approaches that are commonly used in agricultural and/or forest economics literature that evaluate profitability using parameters such as NPV, BCR and IRR.

Abdrabo and Hassaan (2003) highlighted assessments of economic evaluations of agroforestry projects in their handbook, indicating that cost-benefit analysis is still an area where substantial more study is needed. Farmers were earning an average of Rs. 23916 to Rs. 31466 per acre (0.45 ha) per year from one acre of agroforestry plot, according to Gangadharappa et al. (2003), compared to the initial returns of Rs. 2250 to Rs. 3000 per acre (0.45 ha) from any other conventional crop. Their findings clearly show that agroforestry may attain social, economic, and environmental sustainability.

Verma *et al.,* (2002) computed the highest economic returns in terms of revenue, BCR, and net returns for three tree species: almond, beul and mulberry, as well as wheat-based agri-horticultural systems.

Jain and Singh *et al.* (2000) found that the employed conventional cost and revenue indicators, such as farm business income and net income, to analyse economics in agroforestry and to compute the costs and returns of agroforestry and single agricultural crops to assess the efficiency of poplar-based agroforestry in India's northern areas. They looked at the financial feasibility of agroforestry at three different discount rates: 10%, 12%, and 15%, using BCR, NPW, and IRR. They said that agroforestry based on poplars is more economically viable and profitable than many of the crop rotations used in the area.

2.2 To study different Agroforestry Systems adopted by villagers

Kumar *et al. (*2018) reported that the goal of this research was to look at the agroforestry adoption trend, farmer preferences for fruit and tree species, and the challenges they face while practicing agroforestry. This survey found that five agroforestry approaches, namely agri-silviculture (trees in the field), silvi-pasture, horti-pastoral, bund planting, and homestead gardening, were most commonly applied, with the majority of farmers opting for the homestead/homegardens system (58.57%). Also, most of the people who answered (79%) said they want to plant trees in their backyards.

Viswanath *et al.* (2018) found that traditional agroforestry systems (TAFS) are a group of age-old agroforestry systems that have been practiced around the world with varying structure, function, socioeconomic attributes, and ecological services and are normally devoid of intentional intensified cultivation of agricultural or forage crops. TAFS are found across India's several areas, each with its own set of rituals. Agroforestry systems are particularly common in the country's arid and semiarid areas. Agroforestry practices

from the highlands of Ziro valley to the humid and sub-humid regions of Tamil Nadu and Karnataka, arid and semiarid regions of Central India, Rajasthan, and Karnataka, and multi-tier cropping systems typical of the humid tropics represented by homegardens and homesteads in Kerala and Northeast India are discussed in this review paper.

Singh (2016) conducted study on agroforestry practices in Bhandra block of Lohardaga district in Jharkhand. He identified agrisilviculture, agrihorticultural, silvipastoral and home garden as prevalent agroforestry systems on farmers' land.

According to Anand *et al.* (2016), who conducted a study on the adoption of traditional agroforestry among farmers in District Sonbhadra, Uttar Pradesh, Under the agroforestry system, farmers choose between border planting and dispersed planting when they want to grow different kinds of trees on their farms.

Sangeeth *et al.* (2016) conducted in their research that variables affecting Adoption Rate of Agroforestry Technologies in Tamil Nadu. Farmers were mostly aware of agroforestry practices and had implemented in silviculture/agrisilviculture technique.

Kumar (2016) conducted study on agroforestry practices in bishunpur block of Gumla district in Jharkhand. He identified trees on homestead, trees on field bunds, silvipasture, MPTs plantations and trees scattered in agricultural fields(in between crops) of Farmers lands.

Traditional agroforestry practices include home gardens, composite shifting cultivation while innovative systems include alley cropping, wind breaks and shelter belts and taungya systems (National Agroforestry Policy, 2014).

Devaranavadgi *et al.* (2010) conducted a study where traditional agroforestry systems were used in the northern dry tract of Karnataka. Bund planting was determined to be the most frequent agroforestry practise both in rainfed and irrigated conditions in all five districts. Bund planting was followed by nearly 88.4% of respondents, compared to 86.1 percent in an irrigated one. In all five districts, border planting and dispersed planting were the two viable agroforestry approaches. Neem and babul (Acacia nilotica) are common tree species in both rainfed (82.9% and 46.2%) and irrigated ecosystems in all five districts (74.4% and 35.4%).

Bijalwan *et al.* (2011) discovered a traditional agroforestry system such as agrisilviculture, agrihortisilviculture and agrihorticulture were the most common traditional agroforestry systems identified in garhwal area of India.

Anjulo (2009) described apple (*Malus pumila*)-based agroforestry in Himachal Pradesh's Kullu area. It was discovered when high-value crops included into the system, such as tomato (*Solanum lycopersicon*), pea (*Pisum sativum*), French bean (*Phaseolus vulgaris*) and mustard (*Brassica juncea*) was extremely profitable.

Panwar (2007) conducted research in West Bengal, house gardens consist of 3–4 levels of coconut (*Cocos nucifera*), areca nut (*Areca catechu*), banana (*Musa paradisiaca*), vegetables, and flowers. Every house has an Areca nut tree in the backyard; however, there isn't a single tree in the agricultural fields. Home gardens are traditionally found in W. Bengal, Eastern Uttar Pradesh, and Bihar, where diverse crops are available under a multitier canopy design.

According to Sarlach *et al.* (2007), fodder trees such as beul (*Grewia optiva*), bahera (*Terminalia bellirica*), kachnar (*Bauhinia variegata*), dhak (*Butea monosperma*), dhau/chhal (*Anogeissus latifolia*), khirak (*Celtis australis*), jharber (*Ziziphus nummul*). These trees are grown on field bunds and their branches are lopped to provide healthy leaf feed in the winter.

According to Sood (2006) and Michael(2009)Agrisilvicultural,agrisilvihorticultural, silvipastoral and hortiagricultural systems were determined to be the most common types of traditional agroforestry. Conventional agroforestry systems were found in Mandi area of Himachal Pradesh in the Indian Western Himalaya.

Oraon *et al.,* (2005) investigated the effectiveness of several land use systems in Kumharia village, Ranchi district and concluded that agrisilviculture was the most widely approved agroforestry system.

In Jharkhand, Lakra and Sah (2008) compared tribal and non-tribal farmers' agroforestry strategies and reported traditional agroforestry practices in Ranchi, Gumla and West Singhbhum districts. Homestead and tree-crop mix i.e. growing trees on field bunds and around farm boundaries were the two types of traditional agroforestry methods identified in the three districts. On the farmland, homesteaders maintain a little garden around the house where they cultivate vegetables and fruits. It was noticed that despite the

fact that home gardens only occupied a small percentage of the land, their produce was critical to the households' survival.

According to Chaturvedi *et al.* (2001) and Chaturvedi and Das (2007), the average size of a home garden in Bihar varies between 0.05 and 0.42 ha, with common species including *Dendrocalamus strictus*, *Dalbergia sissoo*, *Mangifera indica*, *Litchi chinensis*, *Musa paradisiaca*, and *Carica papaya*. These home gardens also contain a variety of veggies and spices.

Nautiyal (1998) investigated the energy and economic efficiency of distinct land use-land cover types composing the landscape in a mid-altitude (700–1200 MSL) community in the Garhwal Simultaneous agroforestry, sequential agroforestry, home gardens and communal woods took up 27.47 %, 1.1 % and 43.96 % of the village's total geographical area respectively. The most prominent tree species in this system were *Grewia optiva* and *Boehmeria rugulosa* with a total average density of 390 trees per hectare. Slash-burn technique and cultivation on under raced slopes without tillage are used in a sequential agro-forestry system.

2.3 To assess the socio-economic character of farmers

Nayak *et al., (*2021) conducted a study in Socio economic analysis of different agroforestry systems, Nayagarh district where 79% male and 21% of female were involved in agro-forestry practices in the research area. The study areas literacy level was highest in high school and primary level. The maximum number of family member was 4 to 8 members (48%) engaged in agroforestry. It was also determined that 87% of the respondents were landless, marginal or possessed a few acres of land. Most of the respondents were illiterate, middle aged, low income and unemployed. Most of the respondents were scheduled tribe. Agriculture was their primary occupation and followed by agroforestry. In the study area eight major agroforestry practices were widely used. The outcomes of this study showed that while designing agroforestry models for the study and socio economic factors should be taken into consideration for farmers socioeconomic upliftment. Vivek *et al.,* (2021) conducted a study with two APMCs in Karnataka: Shivamogga of Shivamogga district and APMC, Bheemasamudra of Chitradurga district, which was done in the year 2020. The main data were collected at random from 50 farmers in each of the designated APMCs who participated in areca nut e-tendering, for a total sample size of 100 farmers. More than half of the farmers (59.00%) were in their forties

and one-third of the farmers (37.00%) had completed high school, followed by PUC (24.00%) and graduation (19.00%). The majority of the farmers were in the small farmer group (42.0%) with medium trade experience (73.00%). Hughes *et al. (*2020) found that from participation in an agroforestry program, modest gains in asset accumulation, especially among female participant households and particular sites with agroforestry adoption, are likely responsible to a significant extent, as well as intermediate outcomes such as agroforestry product income, fuelwood access, milk yields among dairy farmers,

Kaur *et al*. (2020) conducted a study in rural punjab where socio-economic characteristics of farm households in the rural areas of Punjab. For this purpose, the data were collected from the 510 farm households from the villages which were further randomly selected from the high, medium and low productivity regions of Punjab. About 70 percent of persons appeared in the economically active age group of 15 to 59 years. The proportion of farm households living in the joint type family was positively associated with the farm size. Most of the persons of the marginal and small farm-size categories were illiterate and with relatively low level of education as compared to the semi-medium, medium and large farm-size categories.. About 99 percent of sampled farmers owned either pucca or semi-pucca houses. The proportion of sampled farmers who owned good condition houses, bathrooms and toilets were directly related to the farm size

Basamba *et al. (*2012), who focused on the marketing elements of agroforestry, found that just a few adopters participated in the selling of their agroforestry goods. Age, family size, education level, farm size, access to financing, and the frequency of extension visits were shown to be socio-economic characteristics that influence farmers' involvement in the agro-forestry market.

According to Pandit *et al.* (2014), agroforestry has been regarded as one of the major methods for supporting the lives of a significant number of rural farmers in the Nepalese highlands. However, it has received little attention in terms of conservation and socioeconomic importance.

Islam *et al.* (2013) conducted surveys to study the livelihood contributions of forest resources to the tribal communities of Bundu block in the Ranchi district of Jharkhand state. The forest resources were a viable source of subsistence in both the districts. Cash income from the forests contributed significantly to the livelihood generation of the households. The average annual income of households obtained from agriculture

and forest resources was reported to be 36.23% and 25.05%, respectively. It was found that the forest resources were the second most important source of income.

According to Kareemulla (2012), a socio-economic analysis of poplar agroforestry systems in western Uttar Pradesh, northern India, poplar-based agroforestry systems were more lucrative than pure agricultural crop systems, with employment creation of about 11 man-days ha^{-1} yr^{-1}.

According to Natha *et al.* (2012), an agroforestry system based on Areca catechu and Piper betel has been progressively established by farmers in northern rural Bangladesh. Indigenous practises and the socio-economics of agroforestry systems are viewed as a potential land use plan in the region. In five villages in Panchagarh district, data was obtained through interviews with household members and visits to their agroforestry plots, as well as focus group discussions. Farmers put some of their land and homesteads into Areca and betel-based agroforestry because they thought it was both sustainable and profitable, the findings show.

Ibrahim *et al.* (2011) assessed the tree diversity and agroforestry practices in the selected char region (Kalibari), as well as their influence on farmer livelihood improvement. In the Char (kalibari), ten distinct agroforestry practises were found within the agrisilvicultural system. Residents of Kalibari Char have improved their way of life and economic standing by using appropriate agroforestry techniques and putting the right crops and trees together.

MATERIALS AND METHOD

STUDY AREA

Odisha was established on April 1, 1936, as India's fifth state. It covers 155,707 km^2 of territory and is divided into 30 districts with 51,313 inhabited villages. According to the 2011 census, the state the population was 41,974,218 people, accounting for 3.47 percent of the country's total population. Administratively the Mayurbhanj district divided into 26 blocks and sub divided into 31 tahasils and comprising of 3966 villages,it situated in northern part of Odisha

3.1. Geographical location of the study area

Mayurbhanj is land locked with a geographical area of 10,418km^2 and lies in the North East corner of the state.It is bordered on the Northeast by Jhargam district of West Bengal and East Singhbhum district of Jharkhand, to the north by Seraikela Kharswan district of Jharkhand, on the west, Jharkhand's West Singhbhum district, Kendujhar district on the southwest and Balasore district on the southeast.

The Simlipal National Park, which is located in the district's centre, defines Mayurbhanj's geography. These forests, which cover more than a quarter of the district's land, surround the Simlipal Hills, which serve as the district's watershed. The hills in the south reach a height of 3824 feet at Meghasani and also have many more peaks above 2500 feet.

The district is situated between 21^o 16' N to 22^o 34' 'North latitude and 80^o 40' E to 87^o to 11' East longitudes. Mayurbhanj districts total area 10,418 km^2. Total population of this area is 25, 19,738 out of which 23, 26,842 rural population and 1, 92,896 is urban population. Total density of this location is 240km^2 according to 2011 census report. Literacy rate stands for 65.98% and total cultivable area of 4,47,214 hectares out of it 1,95,441 hectares (43.7 %) are under high land 1,24,730 hectares (27.9%) are medium land and 27,043 hectares (28.4%) are low land. In general, the response of the soil is acidic with Sandy loam and lateritic soils having light grained and poor water retentive capacity have been identified in this area. Around 1,65,423 members of people mainly employed in agriculture and allied sectors.

3.1.1. Details about the Study sites:

Out of 26 no of blocks in Mayurbhanj district, 2 blocks i.e. Shyamakhunta and Badasahi were selected for the study due to those blocks mainly practiced different agroforestry systems for livelihood sustenance.

- Distrct-Mayurbhanj
- Block-Shyamakhunta and Badasahi
- Villages-2 nos/block
- Respondents-Total 116 nos.

A. Shyamakhunta Block: The villages which were selected for study as followed;

i **Kishandahi-** Kishandahi is a medium-sized village with a total of 120 families residing in the Shyamakhunta block of Mayurbhanj district, Odisha. According to the 2011 population census, the village of Kishandahi has a population of 543 out of which 263 are males while 280 are females.

ii **Valki-** Valki is a medium-sized village with a total of 88 families residing in the Shyamakhunta block of Mayurbhanj district,Odisha. According to the 2011 population census, the village of Valki has a population of 344 out of which 182 are males and 162 are females.

B. Badasahi Block: The villages which were selected for study as followed;

i **Chelia** –Chelia is a medium-sized village with a total of 80 villages residing in the Badasahi Block of Mayurbhanj district of Odisha.According to the 2011 population census,the Village of Chelia has a population of 322 out of which 173 are males and rest are females.

ii **Singtia-**Singtia is a medium sized village with a total of 112 villages residing in the Badasahi block of Mayurbhanj district of Odisha. According to the 2011 population census the village of Singtia has a population of 516 out of which males are 273 and rest are females.

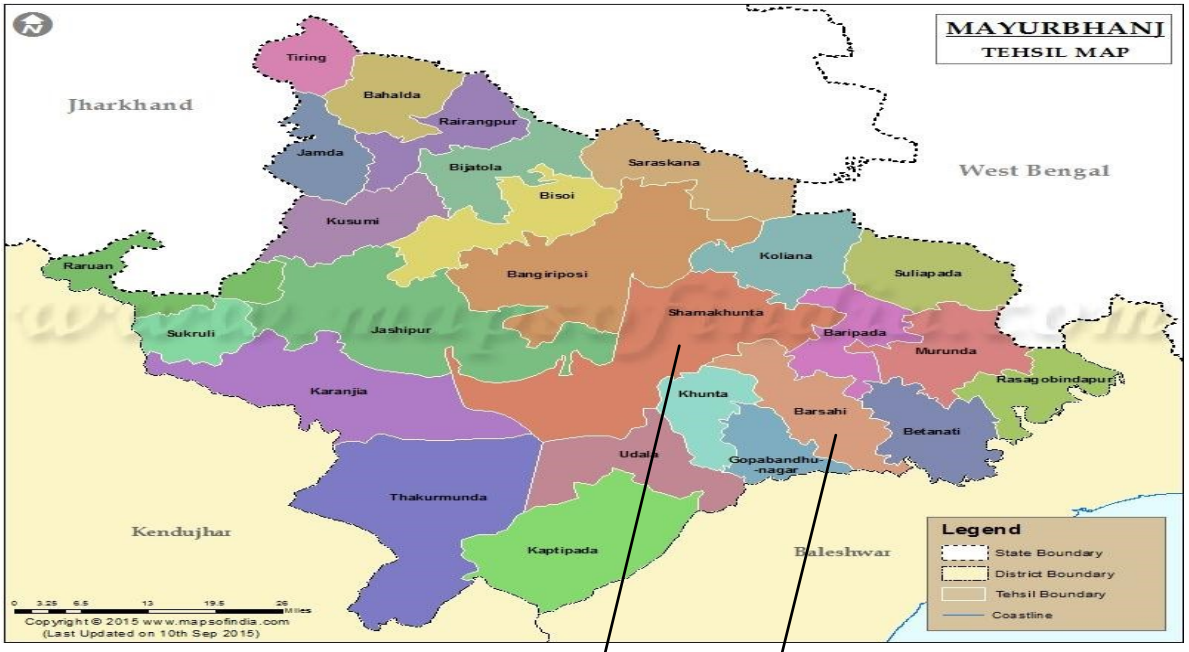

Fig 3.1 Tahasil map of Mayurbhanj district

Fig 3.2 Study Region of Kishandahi village in Mayurbhanj District

Fig3.3. Study region of singtia village in Mayurbhanj District

Table 3.1: Number of Households in different villages under study area

Si No	Block Name	Name of the village	Number of Households
1	Shyamakhunta	Kishandahi	34
		Valki	26
2	Badasahi	Chelia	24
		Singtia	32
Total			**116**

3.2 Procedure for sampling

3.2.1. Method of sampling

An effective data collection system is required to collect data with high precision to get relevant information. In the study area, In this study, multi-stage sampling was used to get the different information and to find out the data for the study site structured questionnaire prepared (Annexure-I).

Method of Multi-Stage Sampling

DISTRICT→ BLOCKS ► GRAM PANCHAYAT→VILLAGES→RESPONDENT →FARMER

3.3. Data collection methodology

3.3.1. Data sources and materials

This study collected both quantitative and qualitative data from both primary and secondary sources. The household survey of each respondent (farmers) was the major source for getting the primary data. Quantitative data was primarily acquired through the use of surveys, with observation, interview-discussion, and group discussion with farmers, whereas qualitative data was collected through the use of structured questionnaires and field surveys.

Secondary data was gathered from resources like documents, books, reviewed literature, journal articles, and web databases. Individual farmer interests, interactions, expectations, and future perspectives on the research site were conducted through a structured questionnaire survey

3.3.2 Criteria of data collection

I. Data collection criteria for objective-I (To analyse economics of different agroforestry systems)

Costs associated with the production and procurement of planting products, plant purchases, irrigation and fertiliser costs, tillage costs, and costs associated with labour participation in organisational and management strategies required for the management and harvesting of trees and crop hybrid crops.

Agroforestry practitioners were also asked for the economics of agroforestry models in order to get information on the details of their selected agroforestry practises and tree crop combinations. Costs expended and advantages received for both summer (kharif) and winter (rabi) crops were reviewed over the complete plantation period (first to last year of model rotation). Data was gathered from radical farmers who kept year-by-year records on how their agroforestry schemes were working.

II. Data collection criteria for objective-II (To study different agroforestry systems adopted by villagers)

Agroforestry activities were based on the existence of data and scale of agroforestry activities; land preservation under each type of agroforestry practice; preferred plantation patterns; agroforestry components (tree-crop) and their adopted combinations in agricultural fields (agroforestry models); planting pattern-wise plant distribution; and tree crop management were required. Agroforestry households were requested to analyse information on various kinds of agroforestry in local lands, including major components of agroforestry, including grown crops and their planting patterns during surveys to collect the essential data.

III. Objective-III Data collection criteria (To assess the socio-economic characters of farmers)

The data collection during investigation and research The guidelines were created after a review of the literature and a brief discussion.An exploratory field survey was conducted in conjunction with questionnaire research. In order to learn more about the respondents, different parameters such as socioeconomic profile and economic factors

such as age, gender, caste, family size, and social status were included in the questionnaire format along with education, land ownership, and economic parameters such as major source of income, profession, and earnings. In addition to that, respondents gave information about agroforestry knowledge, practices, expertise, farm decision- making etc. In order to get the essential information above, surveys were conducted thoroughly.

3.4 Tools for data collection

3.4.1 Questionnaires

I. Questionnaire development and design

Questionnaires were created based on the socioeconomic and economic factors discussed previously. Respondents were asked to indicate their favorite technique or activity, or "none of the above." These questions have been changed to make them easier for farmers to understand. In order to verify the replies, questions were asked in an indirect manner. Changes have been made to the study evidence to ensure that it is accurate and trustworthy. Information from pre-testing and focus group meetings was used to update the questionnaire and other information.

II. Execution of the questionnaire

The new structured surveys were converted into the local language to make them easier to use for these farmers, who couldn't read or write English and relied on someone else to ask questions and gather information. To evaluate socioeconomic characteristics, activity styles, and agroforestry practices and their economics, like the benefit-cost ratio (BCR), both qualitative and quantitative data were needed.

3.4.2. Quantitative data gathering and surveys

The quantitative data was collected on direct interviews with persons in order to assure a high rate of responses and the seriousness of the respondents. The exploratory survey approach was employed to collect primary data from farmers. Data collection was done both with field and household survey.

3.4.2.1 Questionnaire pre-testing

The exploratory field survey is a useful tool for undertaking socio-economic inventories in agricultural systems like agroforestry. A pre-test of questionnaires on 10 agricultural groups in the research region was conducted and clarified to ensure that the questionnaire was handled appropriately.

3.4.2.2 Household surveys, like formal and exploratory

The first study was conducted to investigate diverse agroforestry activities and socioeconomic studies as well as surveys for different agroforestry models. Adult participants or family heads were interviewed using pre-tested standardized questionnaires with focused group discussion and interview plans in the villages.

3.4.2.3 Farm/field visits

Field visits were also conducted to validate present agroforestry operations and tree-crop combinations in farmers' fields and to know the popular agroforestry adoption and practices in the study area with success rate among the farmers.

3.5. Data analysis methodology

The current study is being carried out in the district of Mayurbhanj because many agroforestry systems are popular in the region. Socioeconomic factors affect whether or not farmers use agroforestry, and agroforestry models help farmers who are trying to improve their socioeconomic situation.

The study is based on information provided by the farmers themselves. As a result, there are three components to the statistical analysis of data produced from numerous questionnaire surveys.

1. To analyse economics of different Agroforestry Systems

2. To study different Agroforestry systems adopted by villagers

3. To assess the socio-economic characters of farmers

Operational definitions of examined variables (socioeconomic factors) and their subcategories

In this analysis, various socioeconomic factors has been looked at to see if they affect the acceptance of agroforestry or not. The operational description of these factors and their subcategories is given. This includes the list of socio-economic factors (variables) that were looked at, the possible reasons why they were looked at, the subcategories, and the questions that needed to be asked to confirm the relationship between these factors and agroforestry adoption.

Table 3.1. Operational definition of variables-studied (socio-economic factors) and their sub-categories (if any) and related questions asked

Sl no	Factors/Attribute	Purpose– linkage to adoption of agroforestry	Sub-category indicators	Question asked to farmers (1 = answer category, 0 = other category/categories)
1	Age	To see age distribution of sample farmers	Young (<30 years) Middle (30-55 years) Old (<55 years)	What is your age ?
2	Education	To know their level of education of each farmer in order to understand its importance in adoption of agroforestry	Fifth Eighth Tenth Twelve Graduation Post-graduation Others None	Last formal education class attended by you or if you have done any other course
3	Occupation	To know occupation of each farmer	Student Govt. Employee Business Housewife other	What is your occupation
4	Annual income	To understand level of income and its distribution that indicates wealth status of a family	Nil 0 – 1lakh 1lakh-5lakh 5lakh – 10 lakh Above 10 lakh	Your expected annual income from all sources (mention in Rupees)
5	Family size	To understand family size of sample farme	Large (above 8) Medium (5-8) Small (5 and below)	How many member are there in your family?
6	Types of House	To know living standard of farmers	Kuccha Pucca	House type possessed by you Kuccha or Pucca?
7	Land Holding	To understand landholding/farm size present in study area	Marginal (<1 ha.) Small (1-2 ha.) Medium (2-4 ha.) Large (> 4 ha	How much landholding/ farm size is obtained by family?
8	Livestock Asset	To know wheather keeping livestock or not	Cow BuffaloGoat Ship Hen Duck others	Which type of livestock you have?

9	Land use practice	To know the purpose to which the the land cover is committed	Minimum tillage Direct drilling Stubble disposal Tillage rotation Others	How you use your land?
10	Agroforestry system	To know which type of agroforestry practices carried out by farmers	Agrisilvicultural Silvipastural Agrisilvipastural Homegardens others	Which type of Agroforestry practices you carried out?
11	Standard wood	To know about the standard wood obtained		How to use standard wood?
12	Small wood	To know about the small wood obtained		How much small wood obtained?
13	Fuel wood	To know the fuel wood obtained		When and how much fuel wood is obtained?
14	Fruits and vegeta bles	To know about the fruits and vegetables obtained	Mango Jack fruits Guava Banana Brinjal Tamato Ladies finger others	Which type of Fruits and vegetables they obtained fron their land?
15	Crops	To know the types of crops carried out		Which type of crops you practiced in your land?

Volume/Biomass calculation:

I) The Biomass of standing tree was calculated by applying following formula :

Biomass of tree (above ground) = 0.2145 × (DBH)$^{(2.4163)}$

(Hung *et al.* 2012)

Where, DBH = Diameter at breast height in cm.

The total biomass of tree is calculated by adding the above mentioned formulae.

II) Volume of the stem wood of standing tree was calculated by Huber's Formula Accordingly, **V = Sm × l**

Where, V = Volume in m^3

Sm = sectional area at the middle in m^2

l = height ofthe solid in m

Use of statistical method

For statistical analysis of the data, the SPSS 16.0 statistical software was employed. In the research region, the respondent's socioeconomic profile was examined, which included age, gender, caste, marital status, literacy, family size, land holding, types of land, land ownership, type of family, type of household, and employment. Microsoft Excel was used to evaluate the money generated by various systems.

Data analysis of economic parameters of different Agroforestry System

The economics of each component was calculated based on the economic produce of the farmers. To measure the techno-economic performances of developed Agroforestry models, the capital budgeting tools such as BCR, NPV and IRR were used. The formulae used of those analyses are given below. One crucial point of this study's research is to examine whether farmers really benefit from the introduction of agroforestry models in their sector. Benefit net and benefit-cost ratio (BCR) are the most widely used parameters in Cost Benefit Analysis (CBA). These parameters were also used in this study to test agroforestry models in the CBA. The figures for kharif (summer crops) and rabi (winter crops) were reported on the basis of the questionnaire. For one year, all the expenses and profits were counted.

Cost-Benefit Analysis (CBA)

Many different metrics are used to quantify agroforestry models, but the CostBenefit Analysis (CBA) is the most widely used as an economic tool to determine the economic returns of a period of plantation. The net benefit and benefit-to-cost ratio (BCR) are the most commonly used criteria. These economic measures were used to examine the economics of several agroforestry schemes. The creation of the agroforestry model has both benefits and drawbacks. These measures may be used to assess the economic efficiency of agroforestry and to assess the success of agroforestry operations by both manufacturers and economists (Godsey, 2010). The predicted BCR values for each agroforestry model examined are included in the CBA findings. The components of the CBA are mentioned below.

A. **Net benefit (Net yield)-** The net benefit was calculated by subtracting all annual costs from all annual benefits (at current prices) for each year.Formula is given below.

$$\text{Net benefit} = \sum_{t=0}^{t} Bt/(1+i)t - \sum_{t=0}^{t} Ct/(1+i)t$$

Where, ∑Bt=total occurred benefits for a period of t years

∑Ct=total occurred cost for a period of t years

I=discounted rate, t=time period

B. **Benefit-Cost Ratio (BCR)**- The Benefit-Cost Ratio (BCR) compares discounted costs and benefits (Jain and Singh, 2000; Alavalapati *et al.,* 2004; Kumar et al., 2004; Dwivedi *et al.,* 2007; Dharamsena and Bhat, 2012; Mombo *et al.,* 2016; Chauhan *et al.,* 2009). If the BCR is more than one, the project is profitable; if the BCR is less than one, the project is losing money.

$$BCR = \sum_{t=0}^{t} Bt/(1+i)t / \sum_{t=0}^{t} Ct/(1+i)t$$

Where, ∑Bt=total occurred benefits for a period of t years

∑Ct=total occurred cost for a period of t years

I=discounted rate, t=time period

The law of judgement for the BCR is that every initiative must have a ratio larger than one in order to be economically viable. The agroforestry project should also be allowed since every rupee invested generates a profit. However, if BCR is less than one, the project should be rejected because each rupee spent has resulted in a loss (Godsey, 2010)

C. **Net Present Value (NPV) -** Net Present Value, or NPV, is a common method used in economics. It is the difference between the present values of cash inflows and cash outflows (Jain and Singh, 2000; Alavalapati *et al.,* 2004; Kumar *et al.,* 2004; and Dharamsena and Bhat, 2012). NPV can be written as an annual amount, and it is used to compare the economic returns from investments in forestry with those from farming crops or other ways of using land that produce annual returns (Grado and Husak, 2004). The NPV of an agroforestry model is used to compare the NPV of other models (alternatives) to see which practise is more profitable. The best option would be the one with the highest NPV (Godsey, 2010). Here's how to figure it out.

$$NPV = \sum_{t=1}^{n} (B_n - C_n)/(1+i)^n$$

Where B_n=benefit in each year,

C_n=Cost in each year

n=number of year and $_i$= interest(discount) rates

The formal selection norm for the NPV is to accept the investment with NPV greater than zero. It means an agroforestry model is technically and economically feasible if the NPV is positive. NPV also determines the financial viability of agroforestry investments (Godsey *et al.,* 2009).

D. Internal Rate of Return (IRR):

The Internal Rate of Return (IRR) is the rate of return on an investment that makes the present value of costs and benefits equal to the rate of return (Avila, 2016). It is a discount rate where NPV equals zero. This is the maximum discount rate at which an alternative like agroforestry can pay for itself. IRR is calculated by figuring out the NPV of an investment at different discount rates to interest rates. One discount rate at which the NPV is positive and another at which it is negative must be chosen to figure out the IRR (Godsey, 2010). It figures out the discount rate that makes the present value of the incremental net benefit stream or incremental cash flow equal to zero. It shows how much interest a project could pay on the resources it uses in order to recoup its investment and operating costs and break even (Gittinger, 1982).The following Formula can be used to figure it out.

$$IRR=\sum_{t=1}^{n} (B_n-C_n)/(1+i)^n=0$$

Where B_n=benefit in each year, C_n=Cost in each year

n=number of year and i=interest(discount) rates

Alternatively, the internal rate of return for each model was also checked by using the IRR formula function in the Ms. Excel programme. If the farmer's acceptable rate of return is less than or equal to IRR, the alternative should be considered. Or if the minimum acceptable rate of return is greater than the IRR, the alternative should be rejected. This is because the minimum acceptable rate of return, which is higher than IRR, will result in a negative NPV, indicating a financial loss for the agroforestry options (Godsey *et al.*, 2009).

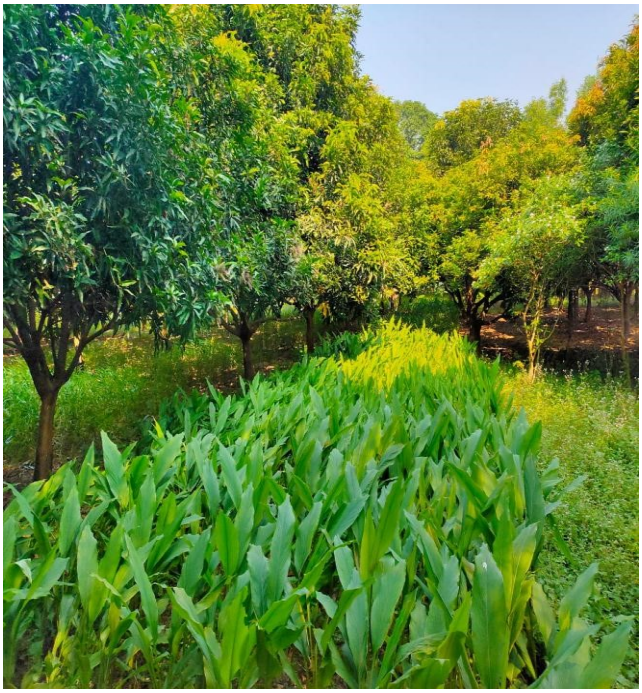

Fig 3.4. Agri horticultural system (Mango+ Turmeric)

Fig 3.5. Bund plantation at Valki village

Fig 3.6.Interaction with farmer

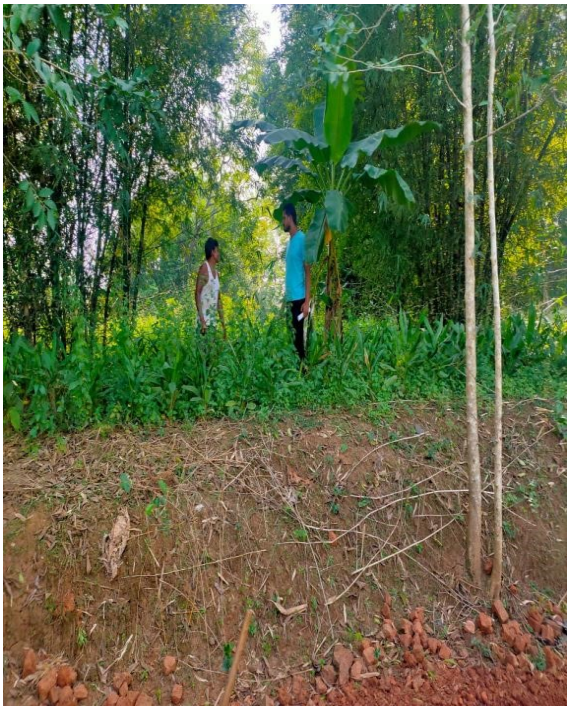

Fig 3.6.Agrisilvi horticultural system (Bamboo +Banana+Turmeric)

Fig 3.7. Field survey at Kishandahi village

Fig 3.8.Block plantation of *Acacia mangium*

RESULTS AND DISCUSSION

This chapter deals with the major facts and finding of the study entitled "Socio-economic analysis of different agroforestry systems in Mayurbhanj District, Odisha". It includes observations collected with the help of questionnaire on existing agroforestry practice and analysis of the observations collected.

The study has been carried out for the following objectives:

- To analyse economics of different Agroforestry Systems in Mayurbhanj district
- To study different Agroforestry systems adopted by villagers
- To assess the socio-economic characters of farmers

4.1 To analyse economics of different Agroforestry Systems in Mayurbhanj district

A variety of tree species was found in the study area. It was observed that single tree crop was not found whereas combined varieties of trees were found on farm field and homestead garden and other systems as given in Figure 3 and Table 4.1.Farmers in the study area were looked at to see how they grew different combinations of crops, fruits, and vegetables with trees. There are many different kinds of agroforestry that have been found in farm plantations, including Acacia and Subabul. Most of the time, farmers in the study area these three types of trees observed either on the bund or in blocks with different distances between them in the fields. Growing Acacia has been shown to be profitable, both in large blocks and in single rows. Arnold (1987) showed that agroforestry is good for the economy because it has low costs for capital and labour, increases the value of production, and gives a region a wider range of products. Farmers in India have used many different types of agroforestry (combinations of trees and crops) models.

From the collected data it was observed that Acacia are often planted in and around the fields. This was mostly because Acacia grows quickly in farm upto 6 to 7 years because it is a fast growing species and preferable because of its medium market value. In block plantation, farmers expand their plantations and crop combinations over the course of the year. In later years, most farmers tend to take only one crop. These tree species also give good economic return along with intercrops. Major recorded combination of crops included rice, turmeric, ginger, mango ginger, cowpea, ragi, mushroom etc. found in the farmers field.

Table 4.1 Yield from Different Components

Agroforestry models		No.of trees/ ha	Dia under bark (cm)	Sm (m^2) (Cross-sectional area)	Length (m)	Tree volume (m^3)	Tree Yield/ha				Price (Rs)			
							Timber Vol (m^3)	Biomass (Kg)	Fruit (qtl)	Intercrop Yield/ ha(q)	Timber	Biomass	Fruit	Inter crop
Subabul+Mango ginger		1800	08	0.01538	3	0.04615	-	0.0010	-	50	-	1,50,000	-	3,00,000
Mango+Turmeric		100	30	0.07065	7	0.49455	49.45	-	40	52	-	-	100000	1,80,000
Acacia +Cowpea		400	11	0.00949	6	0.05699	22.79	-	-	20	2,41,414	-	-	40,000
Bamboo+Banana+ Turmeric		50 clumps	07	0.00384	14	0.05385	-	0.303	20	50	-	45,000	40,000	2,47,500
Acacia+Ragi		420	12.2	0.01168	7	0.08178	34.35	-	-	20	3,63,877	-	-	40,000
Home stead	Gambhar+ Mango+ Ginger	120	9.5	0.00708	4	0.02833	3.40	-	30	45	84,053	-	90,000	1,80,000
	Teak+Guava+Tur Meric	140	10.3	0.00832	4.3	0.03581	5.01	-	15	63	2,20,042	-	45,000	3,78,000
	Acacia+ Pineapple +Garlic	136	10.6	0.00882	5	0.04410	5.99	-	30	30	1,05,890	-	1,50,000	1,20,000
Acacia mangium		2270	11	0.00949	6.2	0.05889	133.68	-	-	-	-	-	-	14,16,092

Under silvi-horticultural system tree crops were grown along with horticultural crops like Subabul and mango ginger. Total no. of tree species Subabul (1800) were grown along with horticultural crop mango-ginger and yield 50 quintal.Under agri-horticultural system 100 mango trees were grown with turmeric with a spacing of 5mx5m where fruit yield and turmeric yield were 40 q and 52 q respectively.

Under bund plantation Acacia were grown along with cowpea with a spacing of 4mx2m where cowpea yield of 20 q and timber yield of 22.79 m^3 .Under agi-silvihorticultural system bamboo, banana and turmeric were grown simultaneously where bamboo clumps were grown with a spacing of 10mx10m with 30 culms per clump and a fruit yield of 20q and intercrop yield of 50 q shown in the upper table 4.1.

Under agrisilvicultural system Acacia were grown with ragi with a spacing of 4mx 2m and per hectare 420 no. of trees were present and 34.35 m^3 timber volume were produced along with 20 q of ragi.

Under homestead agroforestry system (Gambhar + Mango + Ginger), (Teak + Guava + Turmeric), (Acacia + Pineapple + Garlic) models were predominantly grown along with many other models where3.40m^3 of timber volume with 30q of fruit crop and 40 q of intercrop produced in first model, 5.01 m^3 of timber volume with 15 q of fruit crop and 63 q of intercrop were produced in second model and 5.99 m^3 of timber volume with 30 q of fruit crop and 30q of intercrop were produced in 3rd model

Under block plantation *Acacia* species were grown solely with a spacing of 2mx2m where 133.68 m^3 of timber volume produced. The same investigation was carried out by Saxena (1990) where a majority of households in villages of northwest India prefer *Dalbergia sisso, Acacia nilotica and Populus deltoides* to get better economic and other benefits. Similar finding was observed by Madiwalar *et al.,* (2007) conducted a study in three districts (Bidar, Gulbarga and Raichur) in Karnataka state in India and reported that the farmers prefer fuel wood yielding species, fruit yielding species, fodder yielding species, timber yielding species, short rotation duration species

Table 4.2 Costs incurred (Rs) in Silvihorti (Subabul+ Mango Ginger) system

Sl. No	Particulars	Unit	Quantity	Year wise expenditure (Rs)						
				1	2	3	4	5	6	Total
1	Site preparation	MD	50MD initial yr then , 20MD/yr@ Rs315/MD	15,750	6,300	63,00	6,300	6,300	6,300	47,250
2	Initial ploughing by tractor	HR	40 hr initially then5hr/ha@Rs.400/hr	16,000	2,000	2,000	2,000	2,000	2,000	26,000
3	Seed (rhizome planting)sowing	MD	10 MD/yr@RS315/MD	3,150	3,150	3,150	3,150	3,150	3,150	18,900
4	Cost of fertilizer (120:60:60::N:P:K kg/ha)	kg/ha	N=Rs18/kg P=Rs25/kg K=15Rs/kg Total cost =Rs4560	4,560	4,,560	4,560	4,560	4,560	4,560	27,360
5	Cost of insecticide /Fungicides including applications	lt/ha	16 lt/ha@125/lt	2,000	2,000	2,000	2,000	2,000	2,000	12,000
6	Cost of seedlings	No.	Rs10/plant	25,000	2,500	2,500	2,500	_	_	32,500
7	Cost of seed rhizome	Qtl.	20 qtl@Rs 3000/qtl	60,000	60,000	60,000	60,000	6,000	6,000	3,60,000
8	Weeding and tending operation	MD	15MD/yr@315/MD	4,725	4,,725	4,725	4,725	4,725	4,725	28,350
9	Water management cost	MD	20MD/yr@RS.315/MD	6,300	6,300	6,300	6,300	6,300	6,300	37,800
10.A	Harvesting of rhizome	MD	20MD/yr@RS.315/MD	6,300	6,300	6,300	6,300	6,300	6,300	37,800
10. B	Harvesting Of Wood	MD	60MD/yrRS.315/MD	-	-	-	-	-	18,900	18,900
11.	Maintenance and miscellaneous	MD	5MD/yr@RS.315/MD	1,575	1,575	1,575	1,575	1,575	1,575	9,450
Total				**1,45,360**	**99,410**	**99,410**	**99,410**	**96,910**	**1,15,810**	**6,56,310**

60

Here in table 4.2, it was observed that in Silvi-horticultural system, where Subabul were grown along with Mango ginger with a spacing of 2mx3m in which capital paid for labour involvement for site preparation 50 men days (MDS) initially, after that 20 MDS required for 5 years that total sum of Rs. 47,250/ha. For initial ploughing by tractor, 40 hrs/ha required after that by 5 hr/ha for 5 years. For seed sowing Rs 18,900 /ha was required and the cost of fertilizer was Rs. 27,360 /ha.,cost incurred for insecticides and fungicides Rs 12,000/ha and cost of seedlings and seed rhizome combinely Rs. 68,500/ ha. There is a cost expense of Rs. 28,350/ha for weeding and tending operation along with cost incurred Rs 37,800/ha and Rs. 18,900/ ha for irrigation and harvesting of rhizome and wood respectively.

Sarlach *et al.* (2007) reported that in Kandi areas of Punjab, fodder trees like beul (*Grewia optiva*), bahera (*Terminalia bellirica*), kachnar (*Bauhinia variegata)* dhak (*Butea monosperma*), dhau/chhal (*Anogeissus latifolia*), khirak (*Celtis australis*) for feeding cattle and jhar-ber (*Ziziphus nummularia),* ber (*Ziziphus mauritiana*) are used for feeding goats. These trees are raised on the field bunds and their branches are lopped during winter to get nutritious leaf fodder.

Table 4.3 CBA of Silvi horti (Subabul+ Mango Ginger) system

Year	Total Cost of cultivation (Rs)	Total Returns (Rs)	Annual B:C Ratio	Discounted Total Cost (Rs)	Discounted Total Return (Rs)	NPV (Rs)
1	1,45,360	88,000	0.61	1,27,917	77,440	-50,477
2	99,410	61,000	0.61	87,481	53,680	-33,801
3	99,410	1,50,000	1.51	87,481	1,32,000	44,519
4	99,410	1,53,400	1.54	87,481	1,34,992	47,511
5	96,910	1,61,000	1.66	85,281	1,41,680	56,399
6	1,15,810	3,44,000	2.97	1,01,913	3,02,720	2,00,807
Total	6,56,310	9,57,400	8.90	577,553	8,42,512	2,64,959
Avg	1,09,385	1,59,566.67	1.48			
IRR	49.02%					

Table 4.4 Cash flow (Rs) and benefits/ha received from Silvihorti (Subabul+ Mango Ginger) system

Cash flow (Rs) and benefits/ha from (Su babul+ Mango Ginger) system							
Years	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Cost of cultivation	1,45,360	99,410	99,410	99,410	96,910	1,15,810	6,56,310
Income from agriculture	88,300	60,000	1,50,000	1,53,400	1,61,000	1,64,000	11,36,700
Income from woods	-	-	-	-	-	1,80,000	1,80,000
Net income	-	-	-	-	-	-	4,80,390
NPV	-50,213	-34,681	44,519	47,511	56,399	2,00,807	2,64,343
BCR	0.61	0.60	1.51	1.54	1.66	2.97	1.48
IRR	49.02%						

Economic cash flow and benefits from Silvihorti (Subabul+ Mango Ginger) system were presented in table 4.4 where returns from tree species and intercrops and NPV, BCR,IRR were shown. In table 4.3 It shown that during first year, the annual B:C ratio was 0.61 was indicating that there was a loss against investment in silvi-horticulture system. In 2nd year the B:C ratio remains same but Gradually there was increase in B:C ratio and reached up to 2.97 in 6th year of plantation Summary of discounted cost, returns and B:C ratio, NPV, IRR, has been given in table 4.3. To neutralize the impact of inflation, the discounted rate was assumed as 12%. The discounted cost for model of 6 year was found to be Rs.5,77,553/ha. And discounted returns was found as Rs 8,42,512/ha. The discounted B:C ratio was found to be 1.48 this for model. The NPV of model was found Rs 2,64,959/ ha and from the model the IRR was found as 49.02% which was sufficiently above rate of interest of 12%.

Similar result was obtained in the study entitled Socioeconomic analysis of different Agroforestry systems, Nyagarh Dist, Odisha conducted by Das, S (2020) where the total cost of production silvihorti was Rs.7,50,554/ha and BCR was 2.60.The study also revealed that the highest economic benefit, as well as resource conservation, is possible when crops are associated with different tree species rather than a monoculture. In 2018, an experiment was carried out by Patel and Tandel in South Gujrat on economics of Cucurbitacea vegetable crop under teak based silvihorticultural system where net realization was (Rs 1,42,315/ha) and B:C ratio was 2.05.

Table 4.5 Costs incurred(Rs) in Agrihorti (Mango+Turmeric) system

Sl. No	Particulars	Unit	Quantity	Year wise expenditure (Rs)															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1	Site preparation	MD	40MD/yr initially then 36 MD/yr for 5 yrs then 30 MD/yr last 5 yrs@RS 315/MD	12,600	12,600	12,600	12,600	12,600	11,340	11,340	11,340	11,340	11,340	9,450	9,450	9,450	9,450	9,450	1,66,950
2	Initial ploughing by tractor	HR	12 hours/yr for 5 yrs then 4hr/yr@ Rs 400/hr	4,800	4,800	4,800	4,800	4,800	1,600	1,600	1,600	1,600	1,600	–	–	–	–	–	32,000
3	Seed (rhizome planting)so wing	MD	10 MD/yr RS 315/MD	3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150	47,250
4a	Cost of fertilizer(120:60:60::N P:K kg/ha)	kg/ha	N=Rs18/kg P=Rs25/kg K=15Rs/kg Total cost=4560	4,560	4,560	4,560	4,560	4,560	4,560	4,560	4,560	4,560	4,560	4,560	4,560	4,560	4,560	4,560	
4b	Cost of fertilizer(DOS E 73:18:68::N:P :K g/tree) 100 trees/ha		N=Rs18/kg P=Rs25/kg K=15Rs/kg Total cost=278	278.4.	278.4	278.4	278.4	278.4	278.4	278.4	278.4	278.4	278.4	–	–	–	–	–	85,104

4c	Cost of fertilizer(DOSE 730:180:680::N:P:K g/tree)		N=Rs18/kg P=Rs25/kg K=15Rs/kg Total cost=2780	–	–	–	–	–	–	–	–	–	–	2,78 4	2,784	2,78 4	2,78 4	2,78 4	
5	Cost of insecticide / Fungicides including applications	lt/ha	16 lt/ha @125/lt	3,000	3,000	3,000	3,000	3,000	3,600	3,600	3,600	3,600	3,600	4,000	4,000	4,000	4,000	4,000	53,000
6	Cost of seedlings(mango)	No.	100 plants@Rs25/plant	2,500	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2,500
7	Cost of seed rhizome(turmeric)	Qtl.	10 QTL@Rs4000/qtl	20,000	20,000	20,000	20,000	20,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	5,00,000
8	Weeding and tending operation	MD	15MD/yr @315/MD	4,725	4,725	4,725	4,725	4,725	4,725	4,725	4,725	4,725	4,725	4,72 5	4,725	4,72 5	4,72 5	4,72 5	70,875
9	Water management cost	MD	30MD/yr initially then 20MD/yr@RS.315/MD	9,450	9,450	9,450	9,450	9,450	6,300	6,300	6,300	6,300	6,300	6,30 0	6,300	6,30 0	6,30 0	6,30 0	1,10,250
10.A	Harvesting of rhizome	MD	10 MD/yr initially then 40MD/yr @RS.315/MD	3,150	3,150	3,150	3,150	3,150	12,600	12,600	12,600	12,600	12,600	12,6 00	12,600	12,6 00	12,6 00	12,6 00	1,41,750
10.B	Harvesting of fruits	MD	2MD/yr initially then 40MD/yr@RS.315/MD	630	630	630	630	630	12,600	12,600	12,600	126,00	12,600	12,6 00	12,600	12,6 00	12,6 00	12,6 00	1,29,150
11.	Maintenance And Miscellan Eous	MD	5MD/yr@RS.315/MD	1,575	1,575	1,575	1,575	1,575	1,575	1,575	1,575	1,575	1,575	1,57 5	1,575	1,575	1,575	1,575	23,625
Total				**70,418.4**	**67,918.4**	**67,918.4**	**67,918.4**	**67,918.4**	**1,02,328.4**	**1,02,328.4**	**1,02,328.4**	**1,02,328.4**	**1,02,328.4**	**1,01,744**	**1,01,744**	**1,01,744**	**1,01,744**	**1,01,744**	**13,62,454**

In the above table 4.5 for agri-horticlutural system showing that Mango trees were grown along with turmeric with land ratio of 0.5:0.5 ha with a spacing of 5mx5 m. Total sum of Rs 1,66,950 / ha was required for site preparation where initially for first 5 years 200 MDS and there after 150 MDS for next 5 years onwards required. For seed sowing there was a cost of Rs 47,250/ha was required where cost of fertilizer dose for fruit trees and intercrops were combinely Rs 85,104 / ha and cost of insecticides and fungicides were Rs. 53,000 / ha and cost of seedlings and seed rhizomes were Rs 5,00,000 / ha. An amount of Rs. 70,875 /ha was required for weeding and tending operation where as for Rs 1,10,250 / ha required for irrigation. For harvesting of rhizome, harvesting of fruits and maintenance cost incurred was Rs 1,41,750/ha,Rs 1,29,150/ha and 23,625/ha respectively.

Table 4.6 CBA of Agri horti (Mango+ Turmeric) system

Year	Total Cost of cultivation (Rs)	Total Returns (Rs)	Annual B:C Ratio	Discounted Total Cost (Rs)	Discounted Total Return (Rs)	NPV (Rs)
1	70,418.4	55,000	0.78	61,968	48,400	-13,568
2	67,918.4	57,000	0.84	59,768	50,160	-9,608
3	67918.4	70,000	1.03	59,768	61,600	1,832
4	67,918.4	75,000	1.10	59,768	66,000	6,232
5	67,918.4	80,000	1.18	59,768	70,400	10,632
6	1,02,328.4	1,23,000	1.20	90,049	1,08,240	18,191
7	1,02,328.4	1,28,000	1.25	90,049	1,12,640	22,591
8	1,02,328.4	1,30,000	1.27	90,049	1,14,400	24,351
9	1,02,328.4	1,40,000	1.37	90,049	1,23,200	33,151
10	1,02,328.4	1,55,000	1.51	90,049	1,36,400	46,351
11	1,01,744	1,62,000	1.59	89,535	1,42,560	53,025
12	1,01,744	1,68,000	1.65	89,535	1,47,840	58,305
13	1,01,744	1,75,000	1.72	89,535	1,54,000	64,465
14	1,01,744	1,85,000	1.82	89,535	1,62,800	73,265
15	1,01,744	2,80,000	2.75	89,535	24,64,000	1,56,865
Total	13,62,454	19,03,000	21.07	11,98,959.52	17,45,040	5,46,080
Avg	90,830	126867	1.40			
IRR	45%					

Table 4.7 Cash flow(Rs) and benefits from Agri horti (Mango+Turmeric) system

Cash flow(Rs) and benefits from Agri horti (Mango+Turmeric) system																
Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Costof cultivation(Rs)	70,418.4	67,918.4	67918.4	679184.4	679184.4	1,02,328.4	102328.4	1,02 , 328 .4	1,02, 328.4	1,02, ,328.4	1,01, 744	1,01, 744	1,01 ,744	1,01, 744	1,01, 744	13,62,454
Total income from fruit and agriculture crop combinely	55,000	57, 000	70, 000	75,000	80, 000	1,23000	128000	130000	140000	15000	162000	168000	175000	185000	200000	19,03,000
Net income(Rs)	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	5,40,546
NPV	- 13568	- 9608	1832	6232	10632	18191	22591	24351	33151	46351	53025	58305	64465	73265	156865	5,46,080
BCR	0.78	0.84	1.0 3	1.1 0	1.1 8	1.20	1.25	1.27	1.37	1.51	1.59	1.65	1.72	1.82	2.75	1.40
IRR	45%															

Economic cash flow and benefits from Agri horti (Mango+Turmeric) system were presented in table 4.7where returns from tree species and intercrops and NPV,BCR ,IRR also shown here.

Benefit-cost analysis has been presented in table. 4.6. It showed that during first year, the annual B:C ratio was 0.78 was indicating that there was a loss against investment in agrihorticulture system. In 2nd year the B:C ratio was 0.84. Gradually there is increase in B:C ratio and reached up to 2.75. Summary of discounted cost, returns and B:C ratio, NPV, IRR, has been given in table 4.6. To neutralize the impact of inflation, the discounted rate was assumed as 12%. The discounted cost for model of 15 year was found to be Rs.11,98,959.52/ha. And discounted returns was found as Rs 17,45,040/ha. The discounted B:C ratio was found to be 1.40 for model. The NPV of model was found Rs 5,46,080/ha. The IRR is rate of returns or profit from the model the IRR was found as 45% which was sufficiently above rate of interest of 12%.

Sonkhlet (2001) reported that high economic returns from agri horticultural system. Easy return from horticultural crop reported by various researchers Jha and Ranjan(1993) and Mary *et al.* (1998). Some similar type of study were conducted in (Mango+Cowpea) model where B:C ratio was found 1.34 in an annual report of All India Coordinated Research Project on Agroforestry, OUAT, 2020.

Table 4.8 Costs (Rs) incurred in Bund plantation (Acacia + cowpea) system

Sl.No	Particulars	Unit	Quantity	Year wise expenditure (Rs)						
				1	2	3	4	5	6	Total
1	Site preparation	MD	45MD initial yr then 18MD/yr@ Rs 315/MD	14,1 75	5,670	5,670	5,670	5,670	5,670	42,525
2	Initial ploughing by tractor	HR	5hr/ha@Rs.400/ hr	2,00 0	2,000	2,000	2,000	2,000	2,000	12,000
3	Seed sowing	MD	3 MD/ha RS 315/MD	945	945	945	945	945	945	5,670
4	Cost of fertilizer(20:40:40::N:P:K kg/ha)	kg/h a	N=Rs18/kg ,P=Rs25/kg K=15Rs/kg Total cost=1960	1,96 0	1,960	1,960	1,960	1,960	1,960	11,760
5	Cost of insecticide / Fungicides including applications	lt/ha	8 lt/ha @125/lt	1,00 0	1,000	1,000	1,000	1,000	1,000	6,000
6	Cost of seedlings including mortality replacement	No.	Rs10/plant	2,00 0	200	200	_	_	_	2,400
7	Cost of seed	Kg	20kg@Rs 200/kg	4,00 0	4,000	4,000	4,000	4,000	4,000	24,000
8	Weeding and tending operation	MD	15 MD/yr@ Rs 315/MD=Rs.472 5	4,72 5	4,725	4,725	4,725	4,725	4,725	28,350
9	Water Management cost	MD	10 MD/yr@ Rs 315/MD=Rs.315 0	3,15 0	3,150	3,150	3,150	3,150	3,150	18,900
10.A	Harvesting of green pod	MD	20 MD/yr@ Rs 315/MD=Rs.6300	6,30 0	6,300	6,300	6,300	6,300	6,300	37,800
10.B	Harvesting of Wood	MD	25MD@ Rs 315/MD=Rs.	-	_	_	_	_	7,875	7,875
11.	Maintenance and Miscellaneous	MD	05 MD/yr@ Rs 315/MD=1575	1,575	1,575	1,575	1,575	1,575	1,575	9,450
Total				**41,8 30**	**31,52 5**	**31,525**	**31,32 5**	**31,32 5**	**39,20 0**	**2,06,730**

Cost incurred in bund plantation were discussed in the table 4.8 where acacia were grown along with cowpea with a spacing of 4mx 2m required. There was requirement of Rs 42,525 / ha for site preparation where initially for first year 45 MDS and there after 18 MDS uniformly for next 5 years. Initial ploughing by tractor 5 hr/ ha/ yr and expends a calculated sum of Rs12,000/ha. For seed sowing there was a cost of Rs 5,670/ha was required where cost of fertilizer dose for fruit trees and intercrops were combinely Rs 11,760 / ha and cost of insecticides and fungicides were Rs. 6,000 / ha and cost of seedlings and seed were Rs 26,400/ ha. An amount of Rs. 28,350/ha was required for weeding and tending operation where as for irrigation Rs 18,900/ ha was required. For harvesting of Green pods, harvesting of woods and maintenance cost incurred was Rs 37,800/ha, Rs7,875/ha and Rs9,450/ha respectively.

Table 4.9 CBA of Bund Plantation (Acacia+ Cowpea) system

Yr	Total Cost of Cultivation (Rs)	Total Returns (Rs)	Annual B :C Ratio	Discounted Total Cost(Rs)	Discounted Total Return(Rs)	NPV (Rs)
1	41,830	19,600	0.47	36,810	17,248	-19,562
2	31,525	25,741	0.82	27,742	22,652	-5,090
3	31,525	34,652	1.10	27,742	30,494	2,752
4	31,325	37,542	1.20	27,566	33,,037	5,471
5	31,325	40,000	1.28	27,566	35200	7,634
6	39,200	2,81,482	7.18	34,496	2,47,704	2,13,208
Total	2,06,730	4,39,017	12.04	1,81,922	3,86,335	2,04,413
Avg	34,455	73,169.50	2.01			
IRR	61.76%					

Table 4.10 Cash flow (Rs) and benefits from Bund plantation (Acacia + cowpea) system

Cash flow (Rs) and benefits from Bund plantation (Acacia + cowpea) system							
Years	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Cost of cultivation(Rs)	41,830	31,525	31,525	31,325	31,325	39,200	2,06,730
Income from agriculture(Rs)	19,600	25,741	34,652	37,542	40,000	40,068	2,40,000
Income from woods(Rs)	_	_	_	_	_	2,41,414	2,41,414
Net income(Rs)	_	_	_	_	_	_	2,74,684
NPV	-19,562	-5,090	2,752	5,471	7,634	2,13,208	2,13,208
BCR	0.47	0.82	1.10	1.20	1.28	7.18	2.01
IRR	61.76%						

Economic cash flow and benefits from Bund plantation (Acacia + cowpea) system were presented in table no 4.10 where returns from tree species and intercrops and NPV, BCR, IRR also shown here Data analyzed form the table 4.9 during 1st year the annual B:C ratio was 0.47 inclined that there was net loss against investment in Bund plantation. In 2nd year also it showed a negative growth in B:C ratio but in 6th year it showed a significant growth of B:C ratio 7.18 which is due to a total of return of woods in harvesting year . For totals 6 years period the annualized B:C ratio was stand out to be 2.01. Summary of discounted cost returns in B:C ratio, NPV, IRR, has been given in table 4.9. To neutralize impact of inflation the discounted rate was assumed 12%. The total discounted cost for model of 6 years was found to be Rs 1,81,922/ha and the discounted total returns was found to be Rs 3,86,335/ha. The NPV of model was found Rs 84,572/ha. The IRR was found as 61.76% which was sufficiently above the rate of interest 12%. Thus, the model was also suitable for small hold farmers. Economic cash flow and benefits from Agri horti (Mango+Turmeric) system were presented in table 4.10 where returns from tree species and intercrops and NPV,BCR ,IRR also shown.

Tewari (2007) calculated economics of bund plantation model i.e. BCR was 3.31, NPV Rs190241/ha and IRR 68.1% at 15% discount factor. In the earlier study by Dwivedi (2007) BCR found to be 2.84 at 10% discount rate. Some similar type of study were conducted in (Green gram+*Acacia auriculiformis*) model of Bund plantation where BCR was found 1.51,Annual Report Of All India Coordinated Research Project On Agroforestry, OUAT, 2020.

Table 4.11 Costs incurred(Rs) in agri silvi horti (Bamboo based agroforestry system)

Sl.No	Particulars	Unit	Quantity	Year wise expenditure (Rs)							
				1	2	3	4	5	6	7	Total
1	Site preparation	MD	50 MD initial yr then 20MD/yr@ Rs315/MD	15,750	6,300	6,300	6,300	6,300	6,300	6,300	53,550
2	Initial ploughing by tractor	HR	5hr/ha@Rs.400/hr	2,000	800	800	800	800	_	_	5,200
3	Bamboo culm , turmeric rhizome and banana suckers planting	MD	60 MD initial yr then 20MD/yr@ Rs315/MD	18,900	6,300	6,300	6,300	6,300	6,300	6,300	56,100
4a	Cost of fertilizer turmeric(DOSE 100:50:50::N:P: K kg/ha)	kg/ha	N=Rs18/kg P=Rs25/kg K=15Rs/kg Total cost=3800	3,800	3,800	3,800	3,800	3,800	3,800	_	22,800
4b	Banana(DOSE 200:50:300::N:P K g/plant)	g/plant Total plant=750 / ha	N=Rs18/kg P=Rs25/kg K=15Rs/kg Total cost=7013	7,013	_	7,013	_	7,013	_	_	21,039
4c	Bamboo(DOSE 30:15:15::N:P: K kg/ha)	Kg/ha	N=Rs18/kg P=Rs25/kg K=15Rs/kg Total cost=1140	1,140	_	1,140	_	1,140	_	_	3,420
5	Cost of insecticide / Fungicides including	lt/ha	16 lt/ha @125/lt	2,000	2,000	_	2,000	_	2,,000	_	8,000

	applications											
6	Cost of seedlings	a.Banana sucker	No.	Rs.15/sucker@750*15=11,250	11,250	_	_	_	_	_	_	31,250
		b.Turmeri c rhizome		5 QTL@Rs 2000/qtl	2,000	2,000	2,000	2,000	2,000	2,000	2,00 0	
		c.Bambo o culm		100 clump	5,000	500	500	_	_	_	_	
7	Weeding and tending operation		MD	315/MD 20 MD/yr	6,300	6,300	6,300	6,300	6,300	6,300	6,30 0	44,100
8	Water management cost		MD	40 MD initial yr then 30MD/yr@ Rs315/MD	12,600	9,450	9,450	9,450	9,450	9,450	9,45 0	69,300
10.A	Harvesting of rhizome		MD	Rs.315/MD 5MD Initially then 20MD/yr	1,575	6,300	6,300	6,300	6,300	6,300	6,30 0	33,075
10. B	Harvesting of banana		MD	Rs.315/MD 30MD/yr	9,450	9,450	9,450	9,450	9,450	9,450	9,45 0	66,150
10. C	Harvesting of Bamboo		MD	Rs.315/MD 25 MD/3yr	_	_	7,875	_	_	7,875	_	15,750
11.	maintenance and miscellaneous		MD	Rs.315/MD 25MD/yr	7,875	7,875	7,875	7,875	7,875	7,875	7,87 5	55,125
Total					**1,08,653**	**61,075**	**75,103**	**60,575**	**66,728**	**65,650**	**51,975**	**4,89,759**

Here in table 4.11 for Bamboo based agroforestry where main bamboo culm : banana : turmeric land ratio were 50:25:25, sum of Rs 53,550 / ha was required for site preparation where initially for first year 50 MDS and there after 20 MDS uniformly for next 5 years. Initial ploughing by tractor 5 hr/ha/yr for first year after that 2 hr/ha/yr for next 4 years and expends a calculated sum of Rs 5,200/ha. For planting there was a cost of Rs 56,100/ha was required where cost of fertilizer dose for fruit trees and intercrops were combinely Rs 22,800 / ha and cost of insecticides and fungicides were Rs. 8,000 /ha and cost of seedlings and seed were Rs 31,250 / ha. An amount of Rs. 44,100/ha was required for weeding and tending operation whereas for

irrigation Rs 69,300/ ha was required. Finally for harvesting of rhizome, banana ,bamboo there was a cost of Rs. 33,075 / ha,Rs 66150 and Rs. 15,750 / ha required respectively and maintenance cost was Rs 55,125 / ha.

Table 4.12 CBA of agri silvi horti(Bamboo based agroforestry system)

Year	Total Cost of cultivation(Rs)	Total Returns(Rs)	Annual B:C Ratio	Discounted Total Cost(Rs)	Discounted Total Return(Rs)	NPV(Rs)
1	1,08,653	75,000	0.69	95,615	66,000	-29,615
2	61,075	77,000	1.26	53,746	67,760	14,014
3	75,103	80,879	1.08	66,091	71,174	5,083
4	60,575	98,879	1.63	53,306	87,014	33,708
5	66,728	80,644	1.21	58,721	70,967	12,246
6	65,650	81,289	1.24	57,772	71,534	13,762
7	51,975	92,172	1.77	45,738	81,111	35,373
Total	4,89,759	5,85,863	8.88	4,30,988	5,15,559	84,572
Avg	6,99,66	83,694.71	1.27			
IRR	48.75%					

Table 4.13 Cash flow (Rs) and benefits from Agrisilvihorti (Bamboo based agroforestry) system

Cash flow (Rs) and benefits from Agrisilvihorti (Bamboo based agroforestry)system								
Years	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
Cost of cultivation(Rs)	1,08,653	61,075	75,103	60,575	66,728	65,650	51,975	4,89,759
Income from banana sucker(Rs)	40,000	41,000	42,138	42,958	43,140	43,463	35,172	2,87,871
Income from rhizome(Rs)	35,000	36,000	36,741	37,000	37,504	37,826	32,000	2,52,071
Income from woods(Rs)	–	–	20,000	–	–	–	25,000	45000
Net income(Rs)	–	–	–	–	–	–	–	95,183
NPV	-29615	14,014	5,083	33,708	12,246	13,762	35,373	84,572
BCR	0.69	1.26	1.08	1.63	1.21	1.24	1.77	1.27
IRR	48.75%							

Economic cash flow and benefits from (agri silvi horti**)** system were presented in table no 4.13 where returns from tree species and intercrops and NPV, BCR, IRR also shown here.

Data analyzed form the table 4.12 during 1st year the annual B:C ratio was 0.69 inclined that there was net loss against investment in agrihortisilviculture model. In 2nd year it showed a positive growth in B:C ratio but in 4th year it showed a remarkable growth of B:C ratio 1.63 which is due to decrease in cost of cultivation. For totals 7 years period the annualized B:C ratio was worked out to be 1.27. The calculated discounted cost returns in BCR, NPV, IRR, has been given in table 4.12. To neutralize impact of inflation the discounted rate was assumed 12%. The total discounted cost for model of 7 years was found to be Rs 4,30,988/ha and the discounted total returns was found to be Rs 5,15,559/ha. The NPV of model was found Rs 84,572/ha. The IRR was found as 48.75% which was sufficiently above the rate of interest 12%. Thus, the model was suitable for small hold farmers.

Singh *et al*. (2001) found that cashew nut in paddy field made the agri silvi horti model more profitable. Some similar type of study were conducted in (*Acia auriculiformis*+Jack fruit+Black gram) model of agri silvi horti system where B:C ratio was found 1.37, Annual Report Of All India Coordinated Research Project On Agroforestry, OUAT, 2020.

Table 4.14 Costs incurred(Rs) in Agri silviculture(Acacia+Ragi) system

Sl.N o	Particulars	Unit	Quantity	Year wise expenditure (Rs)								
				1	2	3	4	5	6	7	8	Total
1	Site preparation	MD	RS 315/MD 45 MD initial yr then 20MD/yr@ Rs315/MD	14,175	6,300	6,300	6,300	6,300	6,300	6,300	6,300	58,275
2	Initial ploughing by tractor	HR	6hrs/ha initial yrs then after 4hrs/ha @Rs.400/hr	2,400	1,600	1,600	1,600	1,600	1,600	1,600	1,600	13,600
3	Seed sowing and seedling planting	MD	25 MD/ha initial yrs then after 5 MD/year RS 315/MD	7,875	1,575	1,575	1,575	1,575	1,575	1,575	1575	18,900
4	Cost of fertilizer(DOS E 20:10:10::N:P: K kg/ha) Initial year additional fertilizer dose for silvi trees 10:5:5::N:P:K kg/ha	kg/ha	N=Rs18/kg P=Rs25/kg K=15Rs/kg	1,290	760	760	760	760	760	760	760	6,610
5	Cost of insecticide / Fungicides including applications	lt/ha	8 lt/ha @125/lt	1,000	1000	1000	1000	1000	1000	1000	1000	8000

6	Cost of seedlings	No.	850 plants/ha @Rs10/plant	8,500	850	850	_	_	_	_	_	10,200
7	Cost of intercrop seed	Qtl.	15kg@Rs 80/kg of seed	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	9,600
8	Weeding and tending operation	MD	315/MD 20 MD/yr	6,300	6,300	6,300	6,300	6,300	6,300	6,300	6,300	50,400
9	Water management operation	MD	5 MD/Yr @RS.315/MD	1575	1,575	1,575	1,575	1,575	1,575	1,575	1,575	12,600
10.A	Harvesting of intercrops	MD	10 MD/Yr @RS.315/MD	3150	3,150	3,150	3,150	3,150	3,150	3,150	3,150	25,200
10. B	Harvesting of wood	MD	65MD/Yr @RS.315/MD	_	_	_	_	_		_	20,4 75	20,47 5
11.	maintenance and miscellaneous	MD	10 MD/Yr @RS.315/MD	3150	3,150	3,150	3,150	3,150	3,150	3,150	3,150	25,200
Total(Rs)				**50,615**	**27,460**	**27,460**	**26,6 10**	**26,6 10**	**26,6 10**	**26,6 10**	**47,085**	**2,59, 060**

Here in table 4.14 for agri-silviculture system where Mango trees were grown along with turmeric with land ratio of 0.5:0.5 ha. Total sum of Rs 58,275 / ha was required for site preparation where initially for first year 45 MDS and there after 20 MDS for next 7 years onwards required. For seed sowing and seedling planting there was a cost of 18,900/ha was required where cost of fertilizer dose for tree and intercrop were combinely Rs 6,610 /ha and cost of insecticides and fungicides were Rs. 8,000 / ha and cost of seedlings and intercrop seeds were Rs19,800 / ha. An amount of Rs. 50,400 /ha was required for weeding and tending operation where as for water management cost Rs 12,600 / ha was required. There was requirement of Rs. 25,200 / ha harvesting of intercrop, Rs. 20,475 / ha for harvesting of woods and Rs 25,200 / ha for maintenance .

Table 4.15 CBA of Agri silviculture (Acacia+Ragi) system

Year	Total Cost of cultivation(Rs)	Total Returns(Rs)	Annual B:C Ratio	Discounted Total Cost(Rs)	DiscountedTotal Return(Rs)	NPV(Rs)
1	50,615	24,000	0.47	44,541	21,120	-23,421
2	27,460	26,000	0.95	24,165	22,880	-1,285
3	27,460	30,500	1.11	24,165	26,840	2,675
4	26,610	32,000	1.20	23,417	28,160	4,743
5	26,610	33,845	1.27	23,417	29,784	6,367
6	26,610	35,643	1.34	23,417	31,366	7,949
7	26,610	37,754	1.42	23,417	33,224	9,807
8	47,085	4,03,877	8.58	41,435	3,55,412	3,13,977
Total(Rs)	2,59,060	6,23,619	16.34	2,27,973	5,48,785	3,20,812
Avg	32,383	77952.38	2.04			
IRR	49.86%					

Table 4.16 Cash flow (Rs) and benefits from Agri silviculture (Acacia+Ragi) system

Cash flow (Rs) and benefits from Agri silviculture (Acacia+Ragi) system									
Years	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
Cost of cultivation(Rs)	50,615	27,460	27,460	26,610	26,610	26,610	26,610	47,085	2,59,060
Income from agricultural intercrop(Rs)	24,000	28,300	30,500	32,000	33,845	35,643	37,754	40,000	2,62,042
Income from woods	_	_	_	_	_	_	_	3,63,877	3,63,877
Net income(Rs)	_	_	_	_	_	_	_	_	3,66,859
NPV	-23,421	-1285	2,675	4,743	6,367	7,949	9,807	3,13,977	3,20,812
BCR	0.47	0.95	1.11	1.20	1.27	1.34	1.42	8.58	2.04
IRR	49.86%								

Economic cash flow and benefits from Agri silviculture system were presented in table 4.16 where returns from tree species and intercrops and NPV, BCR, IRR also shown here.

Benefit-cost analysis has been presented in table 4.15 It showed that during first year, the annual B:C ratio was 0.47 was indicating that there was a loss against investment in Agrisilviculture system. In 2nd year the B:C ratio was 0.95. Gradually there is increase in B:C ratio and in 8th year B:C ratio was 8.58 due to addition of returns of wood value in harvesting year. Summary of discounted cost, returns and B:C ratio, NPV, IRR, has been given in table. To neutralize the impact of inflation, the discounted rate was assumed as 12%. The discounted cost for model of 8 year was found to be Rs.2,27,973/ha. And discounted returns was found as Rs 5,48,785/ha. The average B:C ratio was found to be 2.04 for model. The NPV of model was found Rs 3,20,812/ha. The IRR is rate of returns or profit from the model the IRR was found as 49.86% which was sufficiently above rate of interest of 12%.

Himshika(2017) conducted a study related to economics of agri silvicultural system where she found BCR to be more than that is 2.60 and IRR was 50.85% and NPV was 3.33 lakh/ha. Hemrom and Nema (2015) in Bastar region reported that agrisilviculture is practiced with the combination of *Shorea robusta, Tectona grandis, Acacia* species and in *Agrisilvipastoral system combination with Albizia species, Leucaena* leucocephala, *Ficus racemosa*. Some similar type of study were conducted e in (*G. arborea*+Arhar) model of agrisilvicultural system where B:C ratio was found 1.69, Annual Report Of All India Coordinated Research Project On Agroforestry, OUAT, 2020.

Table 4.17 Costs incurred(Rs) in Homestead Agroforestry System

Sl. No	Particulars	Unit	Quantity	Year Wise Expenditure (Rs)					
				1	2	3	4	5	Total
1.	Site preparation	MD	Initially 95 MD then 50MD/yr @315/MD	29,925	15,750	15,750	15,750	15,750	78,750
2.	Seasonal Vegetable cropping (Tomato,Brinjal,Chilli,Cabbage,Cauliflower,cucurbitaceaous crops)	MD	115 MD/Year RS 315/MD	36,225	36,225	36,225	36,225	36,225	1,81,125
3.	Perennial fruit crops(mango,jack fruit,Litchi,Cashew,Sapota,Custardapple,Banana, Papaya,Ber,Guava,Lime, Lemon,Pineapple etc)	MD	90MD/Yr RS 315/MD	28,350	28,350	28,350	28,350	28,350	1,41,750
4.	Forest tree spp.(Neem,Bamboo,Gambhar,Sisoo,Teak,Acacia, Eucalyptus ,Samanea saman,Tamarind,Arjun etc)	MD	65MD/Yr RS 315/MD	20,475	20,475	20,475	20,475	20,475	1,02,375
5.	Spices(Ginger,Turmeric, capsicum,onion,garlic,Black pepper,Bay leaf etc)	MD	MD/Yr RS 315/MD	15750	15750	15750	15750	15750	15,750
6.	Cost of fertilizer DOSE 200:150:150::N:P:K kg/year)		N=Rs18/kg P=Rs25/kg K=15Rs/kg	9,600	9,600	9,600	9,600	9,600	48,000
7.	Cost of organic manure	8 ton/yr	1 ton@2500	20,000	20,000	20,000	20,000	20,000	1,00,000
8.	Cost of multi micro nutrient	5kg/yr	1 kg@1000	5,000	5,000	5,000	5,000	5,000	25,000
9.	Cost of insecticide / Fungicides including applications	lt/ha	30lt/yr @125/lt	3,750	3,750	3,750	3,750	3,750	18,750
10.	Cost of seed material(seed,seedlings,saplings,cutting,Rhizomes)	Rs	Rs/plant	50,000	25,000	25,000	15,000	15,000	1,30,000
11.	Hoeing,Weeding and tending operation	MD	120 MDS/yr@315/MD	37800	37800	37800	37800	37800	1,89,000

12.	Water management cost	MD	15 MD/Yr @RS.315/ MD	9,450	9,450	9,450	9,450	9,450	47,250
13.	Harvesting and value addition of Seasonal Vegetable cropping	MD	60MD/Yr @RS.315/ MD	18,900	18,900	18,900	18,900	18,900	94,500
14.	Harvesting and value addition of Perennial fruit crops	MD	45 MD/Yr @RS.315/ MD	14,175	14,175	14,175	14,175	14,175	70,875
15.	Harvesting and value addition of Forest tree spp	MD	20MD/Yr @RS.315/ MD	–	–	–	–	6,300	6,300
16	Harvesting and value addition of Spices	MD	45 MD/Yr @RS.315/ MD	14,175	14,175	14,175	14,175	14,175	70,875
17.	maintenance and miscellaneous	MD	10MD/Yr @RS.315/ MD	3,150	3,150	3,150	3,150	3,150	15,750
Total				**316725**	**277550**	**277550**	**267550**	**273850**	**14,13,225**

Here in table 4.17 cost incurred in homestead agroforestry system where different fruits crops, horticultural crops, tree crops and vegetables were grown. Total sum of Rs 78,750 / ha was required for site preparation where initially for first 5 years . For seed sowing and seedling planting there was a cost of Rs 50,000/ha was required for 1st year and thereafter Rs 25,000/ha for next 2 years and there after Rs 15,000/ha for next 2 years were needed. Cost of organic manure was Rs 1,00,000/ha and cost of multi micro nutrient was Rs25,000/ha where cost of fertilizer dose for tree and other crops were combinedly Rs 48,000/ ha and cost of insecticides and fungicides were Rs. 18,750 / ha.

An amount of Rs. 1,89,000 /ha was required for weeding and tending operation where as for water management cost Rs 47,250/ ha was required. Finally for harvesting of seasonal vegetable cropping perennial fruit Forest tree spp. were Rs.94,500/ha, Rs. 70,875 /ha, Rs. 6,300/ha respectively.For harvesting and value addition of spices Rs 70,875/ha were required maintenance and miscellaneous cost were Rs 15,750/ha.

Table 4.18 CBA of Homestead Agroforestry System

Year	Total Cost of cultivation (Rs)	Total Returns (Rs)	Annual B:C Ratio	Discounted Total Cost (Rs)	Discounted Total Return (Rs)	NPV (Rs)
1	3,16,725	1,05,000	0.33	2,78,718	92,400	-1,86,318
2	2,77,550	3,25,000	1.17	2,44,244	2,86,000	41,756
3	2,77,550	5,25,000	1.89	2,44,244	4,62,000	2,17,756
4	2,67,550	6,40,540	2.39	2,35,444	5,63,675	3,28,231
5	2,73,850	10,40,000	3.80	2,40,988	9,15,200	6,74,212
Total	14,13,225	26,35,540	9.58	12,43,638	23,19,275	10,75,637
Avg	2,82,645	5,27,108.00	1.92			
IRR	84.32%					

Economic cash flow and benefits from Agri silviculture system were presented in table 4.19 where returns from tree species and intercrops and NPV,BCR ,IRR also shown here

Table 4.19 Cash flow(Rs) and benefits from Homestead agroforestry system

Cash flow(Rs) and benefits from Homestead agroforestry system						
Years	1	2	3	4	5	Total
Cost of cultivation(Rs)	3,16,725	2,77,550	2,77,550	2,67,550	2,73,850	14,13,225
Income from seasonal vegetable(Rs)	24,000	50,000	80000	120540	150000	4,40,540
Income from fruit crops(Rs)	25000	90000	150000	185000	200000	6,70,000
Income from forest tree(Rs)	_	_	_	_	4,09,985	4,09,985
Income from spices(Rs)	42,000	1,30,000	1,60,000	2,00,000	2,20,000	8,30,000
Income from mushroom cultivation and vermicomposting(Rs)	14,000	1,15,000	1,35,000	1,40,000	1,45,000	5,35,000
Total year wise income	1,05,000	3,85,000	5,25,000	6,40,540	10,40,000	26,35,540
Net income(Rs)	_	_	_	_	_	12,22,315
NPV(Rs)	-186318	41756	217756	328231	674212	10,75,637
BCR	0.33	1.17	1.89	2.39	3.80	9.58

Benefit-cost analysis has been presented in table 4.18. It showed that during first year, the annual B:C ratio was 0.33 was indicating that there was a loss against investment in silvi-horticulture system. In 2nd year the B:C ratio increases significantly and reached up to 3.80 in 5 th year of plantation Summary of discounted cost, returns and B:C ratio, NPV, IRR, has been given in table 4.18. To neutralize the impact of inflation, the discounted rate was assumed as 12%. The discounted cost for model of 5 year was found to be Rs.12,43,638/ha. And discounted returns was found as Rs 23,19,275/ha. The discounted B:C ratio was found to be 1.92 for this model. The NPV of model was found Rs 10,75,637/ha.

In homegarden, various trees/shrubs, bamboo spp., shade loving crops, minor forest produce, pisciculture and livestock are integrated. This particular system has been found ecologically and economically most viable for the region (Bhatt et al., 2001; Bujarbaruah and Bhatt, 2005).

Table 4.20 Costs incurred in Block plantation for (*Acacia* spp)

Sl.No	Particulars	unit	Quantity	Year wise expenditure (Rs)						
				1	2	3	4	5	6	Total
1	Site preparation	MD	65MD initial yr then 24MD/yr@ Rs 315/MD=Rs.	20,47 5	7,560	7,560	7,560	7,560	7,560	58,275
2	Initial ploughing by tractor	HR	5hr/ha@Rs.40 0/ hr	2,000	2,000	2,000	_	_	_	6,000
3	Seed sowing	MD	20 MD/ha RS 315/MD	6,300	6,300	6,300	6,300	6,300	6,300	37,800
4	Cost of fertilizer(DOSE 60:60:60::N:P:K g/plant)	kg/h a	N=Rs18/kg P=Rs25/kg K=15Rs/kg Total cost=1960	3,480	3,480	3,480	_	_	_	10,440
5	Cost of insecticide / Fungicides including applications	lt/ha	16 lt/ha @125/ lt	2,000	2,000	2,000	2,000	2,000	2,000	12,000
6	Cost of seedlings including mortality replacement	No.	Rs10/plant	25,00 0	2,500	_	_	_	_	27,500
8	Weeding and tending operation and round the clock watching	MD	28 MD/yr@ Rs 315/MD	8,820	8,820	8,820	8,820	8,820	8,820	52,920
9	Water management cost	MD	21 MD/yr@ Rs 315/MD=Rs.3 1 50	6,615	6,615	6,615	6,615	6,615	6,615	39,690
10.	Harvesting of wood	MD	25MD@ Rs 315/MD=Rs.	_	_	_	_	_	7,875	7,875
11.	maintenance and miscellaneous	MD	15 MD/yr@ Rs 315/MD=1575	4,725	4,725	4,725	4,725	4,725	4,725	28,350
Total				**79,41 5**	**44,00 0**	**41,500**	**36,020**	**36,020**	**43,895**	**2,80,850**

Here in table 4.20 for Block plantation where *Acacia mangium* trees were grown Total sum of Rs 58,275 / ha was required for site preparation where initially for first year 65 MDS and there after 24 MDS for next 5 years onwards required. For seed sowing and seedling planting there was a cost of Rs 37800/ha was required where cost of fertilizer dose for tree and intercrop were

combinely Rs 10,440 / ha and cost of insecticides and fungicides were Rs. 12,000/ ha and cost of seedlings and intercrop seeds were Rs 27,500 / ha. An amount of Rs. 52,920 /ha was required for weeding and tending operation where as for water management and maintenance cost incurred was Rs 39,690 / ha and Rs28,350 / ha respectively.

Table 4.21 CBA of Block plantation for (*Acacia* spp)

Year	Total Cost Cultivation (Rs)	Total Returns (Rs)	Annual B:C Ratio	Discounted Total Cost (Rs)	Discounted Total Return (Rs)	NPV (Rs)
1	79,415	0	0.00	69,885	0	-69,885
2	44,000	0	0.00	38,720	0	-38,720
3	41,500	0	0.00	36,520	0	-36,520
4	36,020	0	0.00	31,698	0	-31,698
5	36,020	0	0.00	31,698	0	-31698
6	43,895	14,16,092	32.26	38,628	12,46,161	12,07,533
Total	2,80,850	14,16,092	32.26	2,47,148	12,46,161	9,99,013
Avg	46,808	236015.33	5.38			
IRR	58.15%					

Table 4.22 Cash flow(Rs) and benefits from Block plantation

Cash flow(Rs) and benefits from Block plantation							
Years	**1**	**2**	**3**	**4**	**5**	**6**	**Total(Rs)**
Cost of cultivation(Rs)	79,415	44,000	41,500	36,020	36,020	43,895	2,80,850
Income from woods(Rs)	_	_	_	_	_	14,16,092	14,16,092
Net income(Rs)	_	_	_	_	_	_	11,35,242
NPV	-69,885	-38,720	-36,520	-31,698	-31,698	12,07,533	9,99,013
BCR	-	-	-	-	-	32.26	5.38
IRR	58.15%						

Economic cash flow and benefits from Block plantation were presented in table no 4.22 where returns from tree species and intercrops and NPV,BCR ,IRR also shown here.

Data analyzed form the table 4.21 and we got that during First 5 years the annual B:C ratio remains 0 reported that there was net loss against investment in Block plantation. In 6th year it

showed a aggressive growth of B:C ratio 32.26 because as we know we got tree yield in harvesting year only . For totals 6 years period the annualized B:C ratio was stand out to be 5.38.

Summary of discounted cost returns in B:C ratio, NPV, IRR, has been given in table 4.21. To neutralize impact of inflation the discounted rate was assumed 12%. The total discounted cost for model of 6 years was found to be Rs2,47,148/ha and the discounted total returns was found to be Rs 12,46,161/ha. The NPV of model was found Rs. 9,99,013/ha. The IRR was found as 58.15% which was below rate of interest.

Results of growing Poplar and Eucalyptus have been found to be profitable in Block plantation as well as single rows as earlier mentioned by Singh(1990) and Singh *et al*.(1991).

Table 4.23 Economic Assessment of Different Agroforesty Models /ha

Sl No.	Systems	Production cost (Rs)	Gross returns (Rs)	Net returns(Rs)	NPV (Rs)	IRR %	BCR	Rank
1	Silvihorti	6,56,310	11,36,700	4,80,390	2,64,959	49.02	1.48	5
2	Agrihorti	13,53,504	19,03,000	5,40,546	5,46,080	45.00	1.40	6
3	Silviagri	2,54,335	6,25,919	3,66,859	3,20,812	49.86	2.04	2
4	Bund plantation	2,06,730	4,81,414	2,74,684	2,04,413	61.76	2.01	3
5	Agr silvi horti	4,89,759	5,84,942	95,183	84,572	48.75	1.27	7
6	Homestead	14,13,225	26,35,540	12,22,315	10,75,637	84.32	1.92	4
7	Block plantation	2,75,810	14,16,092	11,35,242	9,99,013	58.15	5.38	1

*Ranking on the basis B : C Ratio

From the table 4.23, it was concluded that among the selected agroforestry systems, it had been found that Blockplantation system was most profitable having BCR of 5.38 followed by > Agrisilviculture (2.04) > Bund Plantation (2.01) >Homestead (1.92) > Silvihorti (1.48) >Agri Horti (1.40) > Agri Silvi Horti (1.27). The study also revealed that the highest economic benefit, as well as resource conservation was possible when tree crops are in monoculture or with associated with different crop species along with NPV of Homestead (Rs10,75,637/-) morethan Blockplantation (Rs 9,99,013/-) followed

by AgriHorti (Rs5,46,080/-), Agrisilviculture (Rs 3,20,812/-), Silvihorti (Rs2,64,959/-), Bund Plantation(Rs 2,04,413/-) and AgriSilvi Horti (Rs84,572/-).

The IRR of different systems were calculated maximum for Homestead (84.32%) followed by Bund plantation (61.76%) > Block plantation (58.15%) > Agri silvi (49.86%) > Agri silvi horti(48.75%) > Silvi horti (48.52%) and least for Agri horti (45%). The similar result was found in Socio economic analysis of AF systems, Nayagarh (Das S, 2020) where it had been found that bund plantation system was most profitable having BCR of 3.77 followed by homestead (3.51) > agrisilviculture(3.29) > block plantation(2.66) > silvihorti(2.60) > others(2.44) > aquaforestry(2.29) > silvipasture(2.18) .

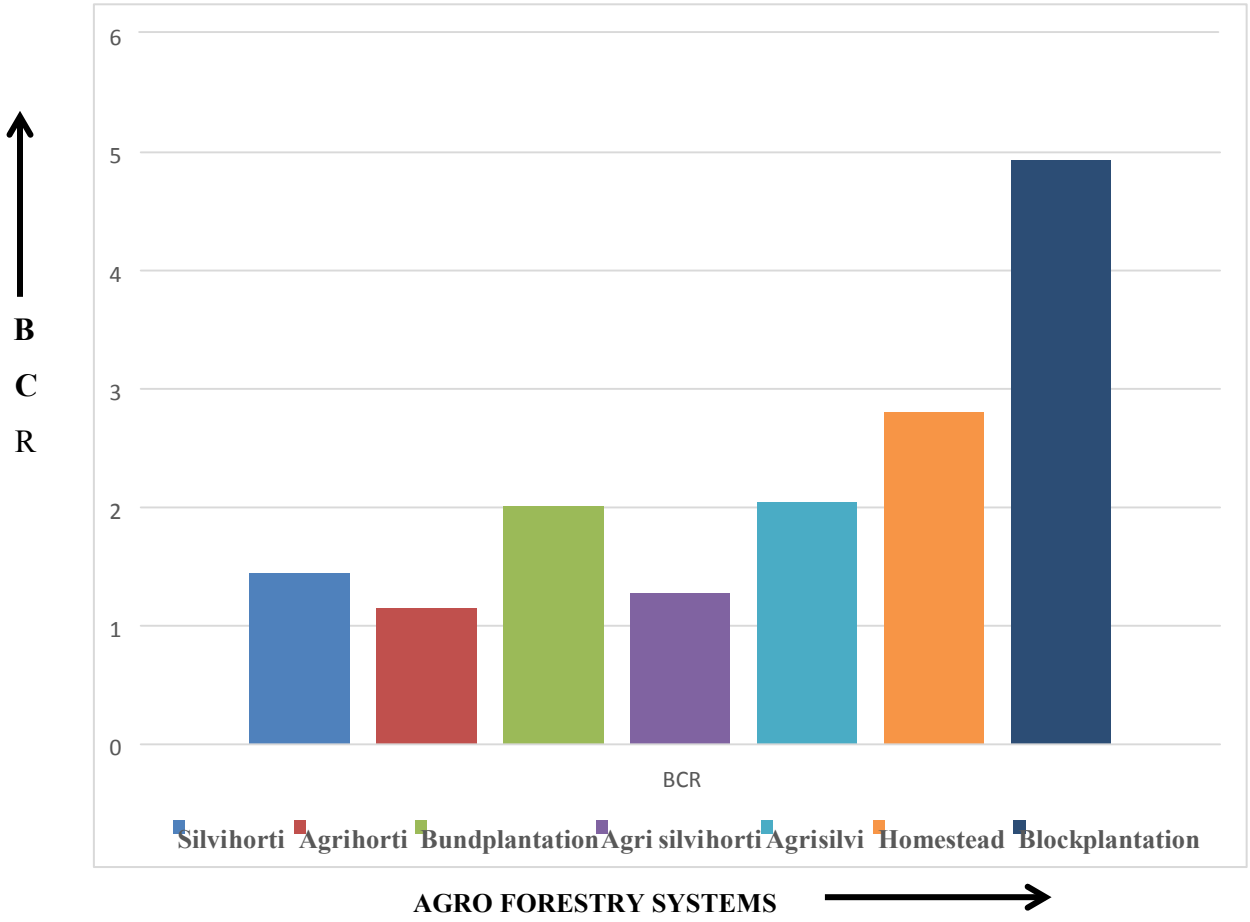

Fig 4.1 B :C Ratio of different Agroforestry Systems

4.2. To study different Agroforestry systems adopted by villagers

In earlier research, many scientists and intellectuals have claimed that different types of agroforestry exist in India. The thesis is on agroforestry practises that are prevalent in the Mayurbhanj area of Odisha, India. The main varieties of agroforestry in the region have been classified based on their architecture. The emphasis is on the shape of the components and how they are arranged in the performance. The following are the outcomes of several agroforestry activities:

4.2.1. Distribution of different agroforestry practice

In the study region, there is a potential history of framers keeping trees on their property. According to Pinto *et al.* (2005), farmers understand why they preserve diverse tree species on their farm and can discriminate between tree species that are ideal for agroforestry and those that are not.

Farmers used a variety of agroforestry types, including Bund plantation, Block plantation, Homestead, Agri horti, Agrisilviculture, Silvihorti, Agri silvi horti, according to the study. Table 4.24 shows a list of the many plants and crops that are cultivated throughout the seasons.

Table 4.24 Different Agroforestry Systems followed by farmers

Sl. No	Systems	Category	Household No.				
			Kishandahi	Valki	Chelia	Singtia	Total
1	Bund Plantation	Area(ha)	6	4	3.5	5	18.5
		Crop	9	7	7	8	31
		Tree	9	7	6	8	30
		Fruit Plant	6	5	4	7	22
		Any Other	–	–	–	–	–
2	Block Plantation	Area(ha)	4.2	3.7	2.8	3.9	14.6
		Crop	–	–	–	–	–
		Tree	8	7	6	8	29
		Fruit Plant	6	5	6	7	24
		Any Other	–	–	–	–	–
3	Homestead	Area(ha)	5.6	4.3	3.8	5.4	19.1
		Crop	7	8	6	9	30
		Tree	11	7	8	10	36
		Fruit Plant	13	11	10	12	46
		Any Other	3	2	1	1	7

4	Agri silvi horti	Area(ha)	5.7	3.4	2.7	5.3	16.1
		Crop	4	3	2	5	14
		Tree	6	4	3	6	19
		Fruit plant	7	5	4	7	23
		Any Other	_	_	_	2	2
5	Agrisilviculture	Area(ha)	10	6	5	6	27
		Crop	9	8	5	7	29
		Tree	8	7	6	8	29
		Fruit Plant	_	_	_	_	_
		Any Other	_	_	_	_	_
6	Silvihorti	Area(ha)	11	7	8	9	35
		Crop	_	_	_	_	_
		Tree	10	9	8	7	34
		Fruit Plant	9	8	8	9	_
		Any other	_	_	_	_	_
7	Agri-horti	Area(ha)	12	8	9	11	40
		Crop	12	10	9	11	42
		Tree	_	_	_	_	_
		Fruit Plant	11	9	8	10	38
		Any Other	_	_	_	_	_

4.2.2 Land distribution under different agroforestry practices

When we demonstrated the extent of the adoption of agroforestry practices, land distribution under it, was significant as it showed the enthusiasm of farmers to widen different AF practises in their sector. Table 4.24 showed land distribution under recorded different agroforestry practices in different villages of the study region.

Table 4.25 Land distribution under different Agroforestry Systems

Agroforestry systems	Land (ha) under Agroforestry	Land cover (%)	Rank
Bund Plantation	18.5	15.12	3
Block Plantation	14.6	11.93	7
Homestead	19.1	15.61	2
Agri silvi horti	16.1	13.16	5
Agrisilviculture	17	13.90	4
Silvihorti	15	12.26	6
Agrihorti	22	17.98	1
Total	**122.3**	**100**	

It was cleared from the above table 4.25, that maximum land had been utilized under Agrihorticulture 22 ha (17.98%), followed by 19.1 ha(15.61%) in homestead practices and 18.5 ha(15.12%) in Bund plantation and rest of the land had been distributed in Agrisilviculture 17 ha (13.90%), Agri silvi horticulture 16.1 ha(13.16%), Silvi horti 15 ha (12.26%), Block plantation 14.6ha (11.93%).

The similar kind of result obtained from the study entitled Socioeconomic analysis of different Agroforestry models, Nayagrh, Odisha by Das S (2020) where it was observed that maximum land had been utilized under Bund plantation (23.11%) followed by Agrisilviculture (22.47%) then Homestead practices (20.93%).

4.3 Determination of the socioeconomic characteristics of farmers

The socioeconomic status of a farmer is made up of numerous characteristics that can be divided into two categories like social and economic characteristics. In the view of agroforestry. various factors that are directly or indirectly related to socioeconomic status of a farmer, his desire to adopt agroforestry and vice versa in order to associate himself.

In order to understand Farmers reaction to (accept or reject) agroforestry practices, its important to know perceptions of farmers to agroforestry and the effect of all these characteristics on their decisions because we know that farmers in the same society will have different preferences and livelihood activities, and thus respond differently to the same management practices as agroforestry. A list of qualities that are projected to be associated with farmers' adoption of agroforestry activities.

4.3.1 Occupational profile of households

The household's occupation profile was divided according to the livelihood dependency into three categories: primary, secondary, and tertiary. Agriculture, agroforestry, labour, cattle rearing, private service, government service, business, and other occupations have been classified as other occupations, including family, employment, and others. A review of table no. 4.24 revealed that practically all families in all localities have agriculture as their principal occupation, and they are all involved in it. According to the statistics, farmers' major occupation was agroforestry (59%), and secondary occupation was agriculture (22%), and farmers with a tertiary occupation (19%).

One of the most important parts of work was rearing cattle, which was the main job of 56% of farmers, a secondary job for 28% of farmers, and a third job for 16% of farmers. Among others, primary professions are government service (4%), labour, and private service. Business and family occupations are basically non-existent.

According to Sood (2005), wealth status is one of the factors affecting the probability of implementation of any innovation, and overall yearly family income is one of the farmer's wealth indices. Higher household income is projected to improve the risk- bearing potential of decision-making by smallholder farmers and the ability to wait for long-term investment returns, such as trees (Sood, 2006). Households with a greater social position and more wealth may more easily bear the cost of innovation, and so do innovators or early adopters (Kragten *et al.* 2001). As a result, farmers are more likely to plant more trees per home if they have more money in their homes.

Farmers with higher incomes are more prone to use risky technology than farmers with lower incomes (Kivlin and Filegel, 1966). There has been an increase in the number of trees on farms among households with greater on-farm and overall earnings.

Table 4.26 Occupation of the respondents

Sl no	Occupation	Category	Household Number				Total
			Kishandahi	Valkl	Chelia	Singhitia	
1.	Agriculture	Primary	34	26	24	32	116
		Secondary	0	0	0	0	0
		Tertiary	0	0	0	0	0
2.	Agroforestry	Primary	26	14	12	17	69
		Secondary	9	7	3	6	25
		Tertiary	8	5	3	6	22
3.	Labour	Primary	0	0	0	0	0
		Secondary	15	11	8	10	44
		Tertiary	29	13	10	20	76
4.	Cattle rearing	Primary	16	12	14	18	60
		Secondary	11	8	7	10	36
		Tertiary	7	4	3	6	20
5.	Private Service	Primary	0	0	0	0	0
		Secondary	2	0	0	1	3
		Tertiary	2	1	2	3	8
6.	Govt. Service	Primary	1	0	1	1	3
		Secondary	0	0	0	0	0
		Tertiary	0	0	0	0	0
7.	Business	Primary	0	0	0	0	0
		Secondary	0	0	0	0	0
		Tertiary	0	0	0	0	0
8.	Family Occupation	Primary	0	0	0	0	0
		Secondary	0	0	0	0	0
		Tertiary	0	0	0	0	0
9.	Unemployed	Primary	28	14	18	25	85
		Secondary	8	5	4	5	22
		Tertiary	3	2	2	2	9
10.	Any other	Primary	0	0	0	0	0
		Secondary	0	0	0	0	0
		Tertiary	0	0	0	0	0

Table 4.27 Socio-economic traits of the study site

Sl no.	Socio-economic characteristics		Household Nos				
			Kishandahi	Valki	Chelia	Singhitia	Total
1	Age (yrs)	20-30	5	7	4	7	23
		30-40	14	8	10	12	44
		40-50	8	7	7	9	31
		>50	7	4	3	4	18
2	Gender	Male	22	16	13	23	74
		Female	12	8	11	11	42
3	Caste	SC	3	2	2	2	9
		ST	17	16	15	20	68
		OBC	8	5	4	6	23
		GEN	6	3	3	4	16
4	Marital Status	Single	3	4	2	2	10
		Married	31	21	21	28	102
		Widow	0	1	0	1	2
		Divorce	0	0	1	1	2
5	Literacy	Illiterate	24	20	16	23	83
		Primary	6	4	6	2	18
		Intermediate	1	2	2	5	10
		Graduate and other	1	0	0	1	2
		Any other(Vocational/ITI)	2	0	0	1	3
6	Types of Family	Nuclear	5	4	5	8	22
		Joint	29	22	19	24	94
7	Family Member	Upto 4 member	10	9	9	11	39
		4-8 Members	15	12	9	13	49
		8-12 Members	7	2	4	5	18
		>12 Member	2	3	2	3	10

8	Land holding	Landless	5	2	1	3	11
		Marginal(<1 Ha)	11	7	8	7	33
		Small (1-2 Ha)	11	9	8	13	41
		Medium (2-4 Ha)	5	4	5	6	20
		Large (>4 Ha)	2	4	2	3	11
9	Types of Ownership of land	Owner	27	22	21	3	73
		Leased in	5	2	2	1	10
		Leased out	1	0	0	2	3
		Owner and Leased out	1	2	1	26	3 0
10	Types of Land	Irrigated	34	26	24	32	116
		Non- irrigated	0	0	0	0	0
11	Types of Household	Pucca	3	2	2	2	9
		Semi-puccca	4	2	2	5	1 3
		Kutcha	9	7	8	9	33
		Thatched House	18	1 5	12	16	61
12	Employment Status	Full time	3	1	1	1	6
		Part time	5	2	1	4	12
		Self	10	1 0	9	10	39
		Unemployed	16	13	13	17	59
		Others	0	0	0	0	0
13	Annual income (Rs)	<10,000	2	2	1	3	8
		10,000-25,000	3	3	2	3	11
		25,000-50,000	9	7	8	8	32
		50,000-1,00,000	11	8	7	10	36
		>1,00,000	9	6	6	8	29

4.3.2 Research on individual and societal variables that influence adoption

4.3.2.1 Age

As seen in Table 4.28, the majority of respondents were between the ages of 30 and 40(37.9%) followed by the age category of 40 to 50 years (26.7%) and the age group of 20 to 30 years (19.8%) .The age group of over 50 years had the lowest percentage of respondents (15.6%).

Table 4.28 Age(yr) of the respondents

Sl No.	Age(yr)	Frequency	Percent
1.	20-30	23	19.8
2.	31-40	44	37.9
3.	41-50	31	26.7
4.	>50	18	15.6
To tal		116	100.0

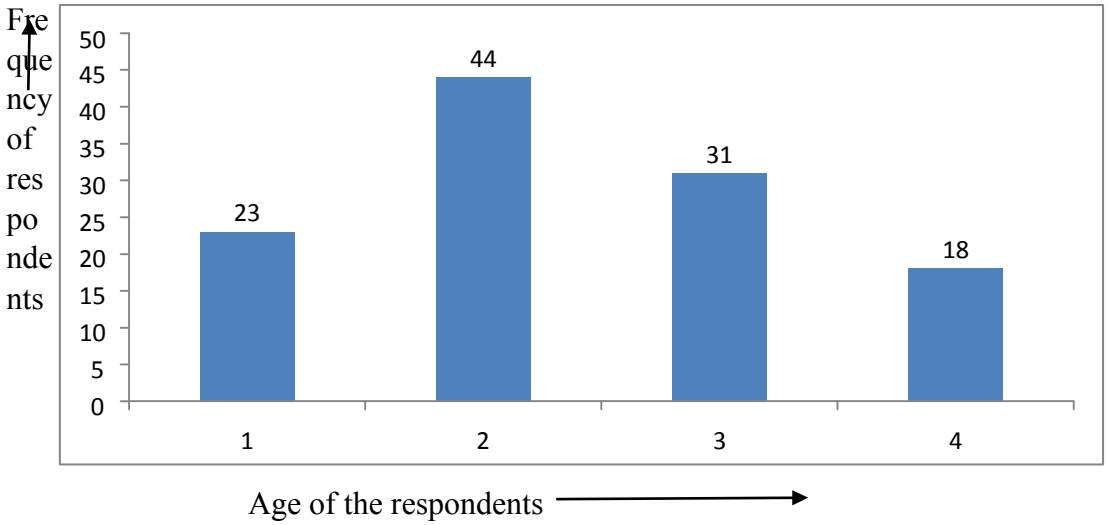

Fig.4.2. Age range of respondents

The findings revealed that younger farmers were more willing to adopt contemporary technology since they were more educated than their elders and would benefit from tree crops if they used modern techniques throughout their lives. According to Tripp (1993), younger farmers were more inclined to embrace developing technology because they had greater exposure than older farmers or had been exposed to new ideas as migrant workers..

4.3.2.2 Gender

It was discovered by analysing the table 4.29 that the percentage of male farmers (63.8%) was followed by female farmers (36.2%) in the research region.

Table 4.29 Gender of the respondents

Sl No.	Gender	Frequency	Percent
1.	Male	74	63.8
2.	Female	42	36.2
Total		116	100.0

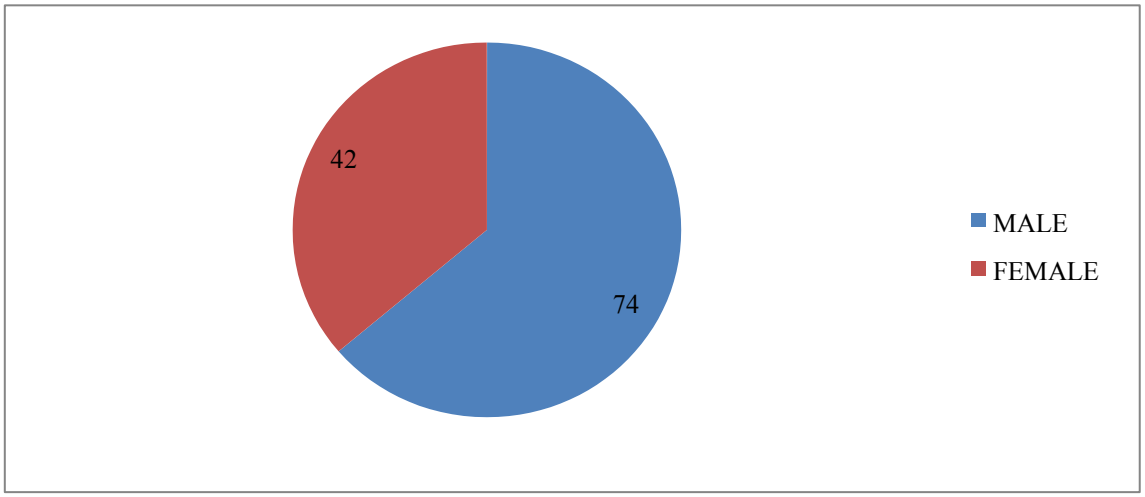

Figure 4.3 Gender of Respondents

In the past, there had been more male farmers than female farmers. It's possible that this is because males in the village lacked sufficient income-generating opportunities and relied heavily on agriculture for survival. According to Boateng (2008), age and sex are significantly linked to labour sources .

4.3.2.2.3 Caste

Table 4.30 shows that the majority of households in the study region (57.8%) are in the ST group followed by (19.8%) in the OBC category, 14.6% in the General category and a minimum of 7.8% in the SC category.

Table 4.30 Caste status of the respondents

Sl No.	Caste	Frequency	Percent
1.	SC	9	7.8
2.	ST	67	57.8
3.	OBC	23	19.8
4.	GENERAL	17	14.6
Total		116	100.0

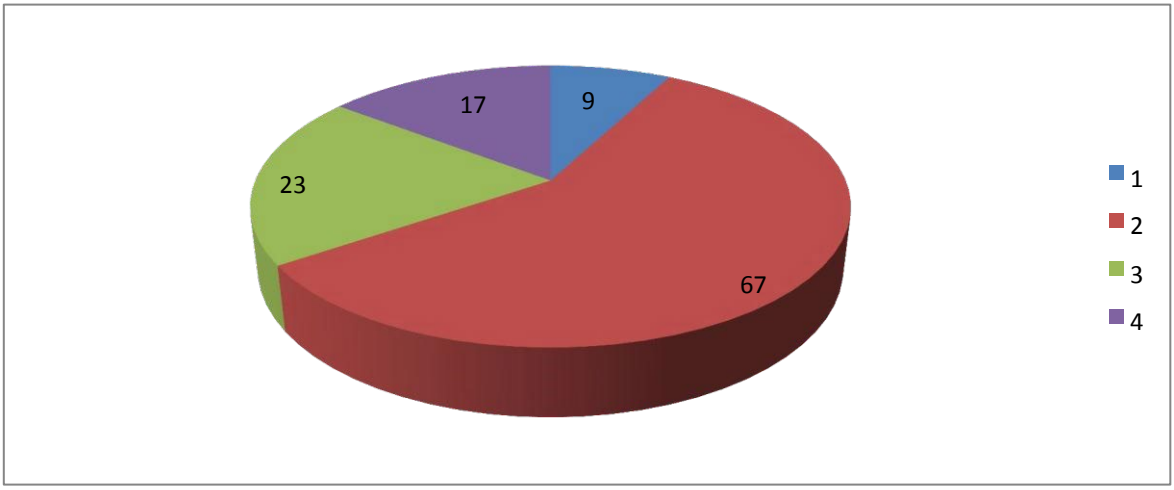

Figure 4.4 Caste status of respondents

The majority of farmers who engage in agroforestry operations belong to the ST group; it was found from the analysis that majority population practicing agroforestry belongs to ST group. This is may be due to poverty and lack of education and they don't

have any private and government services. Nayak (2021) conducted a similar type of study and get a citation that majority of farmers practicing agroforestry in nayagarh district belongs to ST group around 40% of the total population, illiteracy and poverty among tribal population is high and social disparities and injustice prevailed.

4.3.2.4 Marital status

From a perusal of table 4.31, it was revealed that married farmers were the most frequently reported (87.1 %). Unmarried farmers, widows and divorce were all recorded at 9.5%, 1.7% and 1.7% respectively.

Table 4.31 Marital status of the respondents

Sl No.	Marital status	Frequency	Percent
1.	Single	11	9.5
2.	Married	101	87.1
3.	Widowed	2	1.7
4.	Divorced	2	1.7
Total		116	100.0

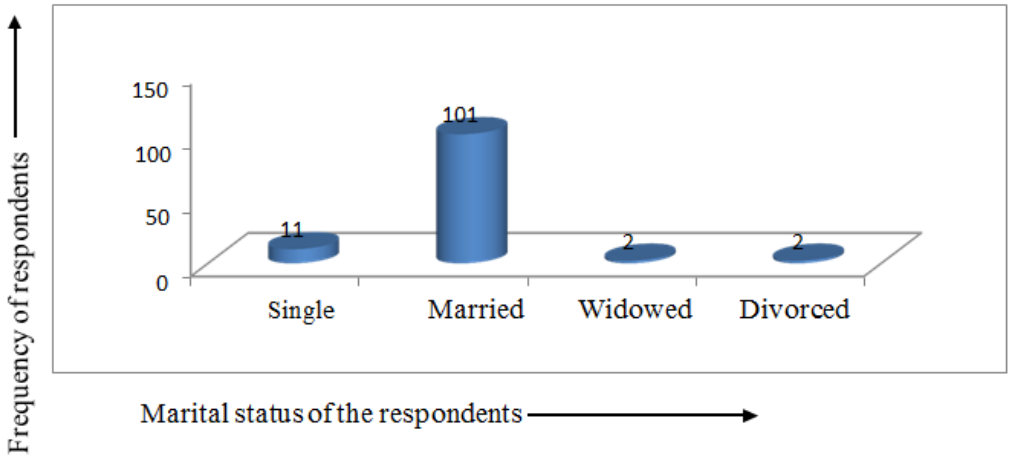

Figure 4.5 Marital Status of respondents

The study found that married people are more reliant on agroforestry activities than single people, because the married person is responsible for the family. The respondents' marital status, both husband and wife were interested in a variety of subsistence practices in the majority of the family.

4.3.2.5 Literacy

A closer analysis of the data in table 4.32. revealed that 71.6% of families were illiterate. In the literate category, 15.5% of families were educated at the elementary level, while 8.6% were educated at the intermediate level. Households with a high degree of education, such as graduate level, accounted for just 1.7% of the total, whereas households with any other type of education, such as vocational/ITI, accounted for 2.6%.

Rahman *et al.* (2008) did a similar study to address the common problem of agroforestry adoption in North Bangladesh and found that both agroforestry and non-agroforestry farmers require inspiration to adopt. Agroforestry is linked to education, at least at the primary level. Similarly, according to Gangadharappa *et al.* (2005), the majority of agroforestry farmers have education up to elementary school in Dharwad and Belgaun districts in Karnataka provide education up to elementary school.

Table 4.32 Literacy rate of the respondents

Sl No.	Literacy	Frequency	Percent
1.	Illiterate	83	71.6
2.	Primary	18	15.5
3.	High school and intermediate	10	8.6
4.	Graduate	2	1.7
5	Any other	3	2.6
Total		116	100.0

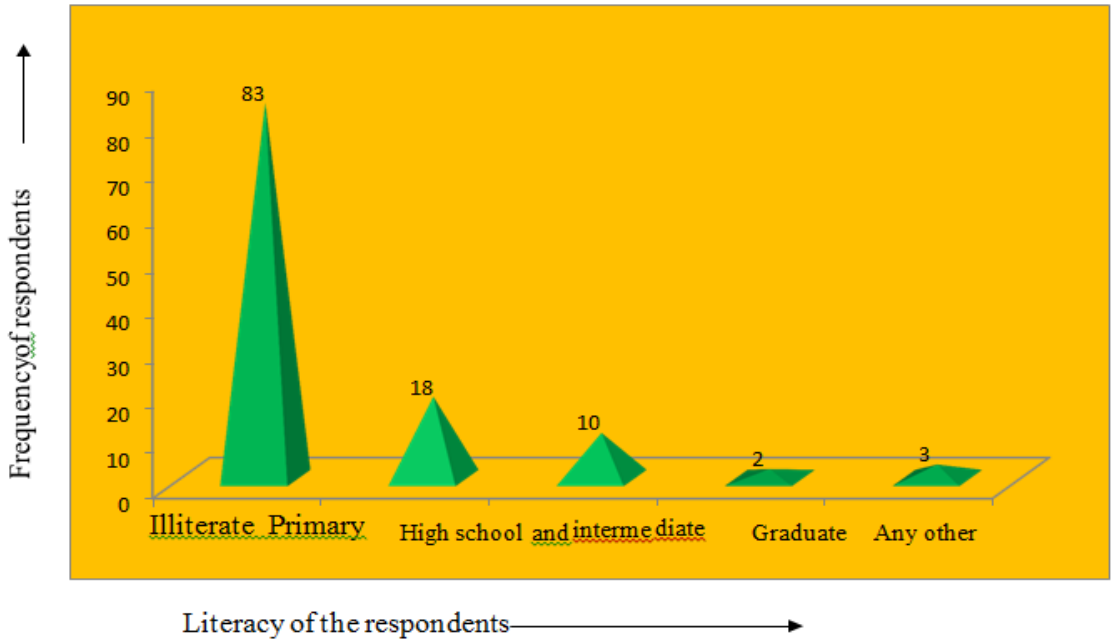

Figure 4.6 Literacy Rate of respondents

4.3.2.6 Family Type

A look at table 4.33 reveals that the nuclear family has the greatest percentage (79.2 %), while the joint family has the lowest (20.7%). Nkamleu and Manyong (2005) found that it might be because the joint family system is dissolving so that more and more nuclear families are being established.

Table 4.33 Family type of the respondents

Family type	Frequency	Percent
Nuclear	92	79.3
Joint	24	20.7
Total	116	100.0

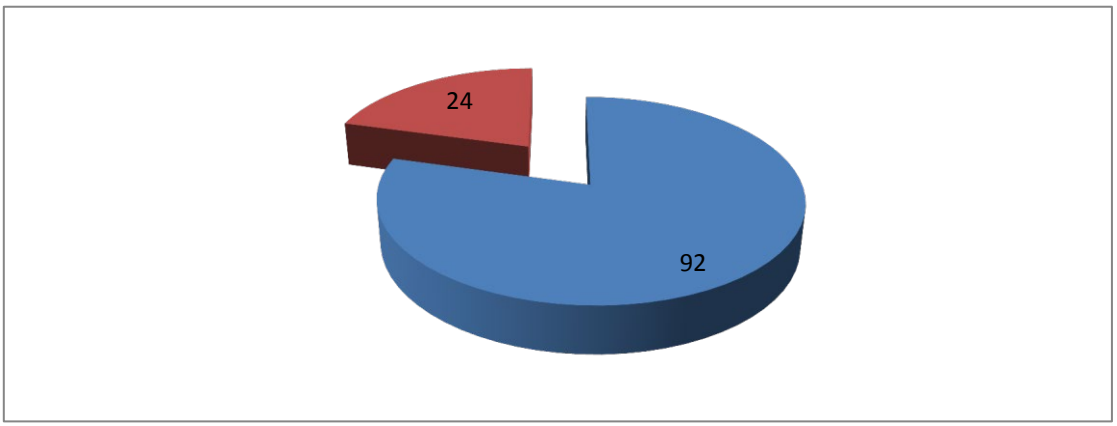

Fig.4.7. Family type of the respondents

The nuclear family accounted for the majority of the population (79.3%). This might be because tribal people tend to have a nuclear family after marriage owing to social and economic concerns. More land division, According to Akinsami (1988), more divided land will leave a farmer with numerous tiny land holdings distributed throughout a field, making operations difficult and uneconomical.

4.3.2.7 Family member

Here total number of family members in table 4.34. indicated that the majority of families had 4 to 8 family members (42.3 %) followed by up to four member (33.6 %) The percentage of households with 8 to 12 people is 15.5, while the percentage of households with more than 12 members is fairly low (8.6 %).

Table 4.34 Family member of the respondents

Sl No.	Family Member	Frequency	Percent
1.	Up to 4Members	39	33.6
2.	4-8 Members	49	42.3
3.	8-12 Members	18	15.5
4.	12-Members	10	8.6
Total		116	100.0

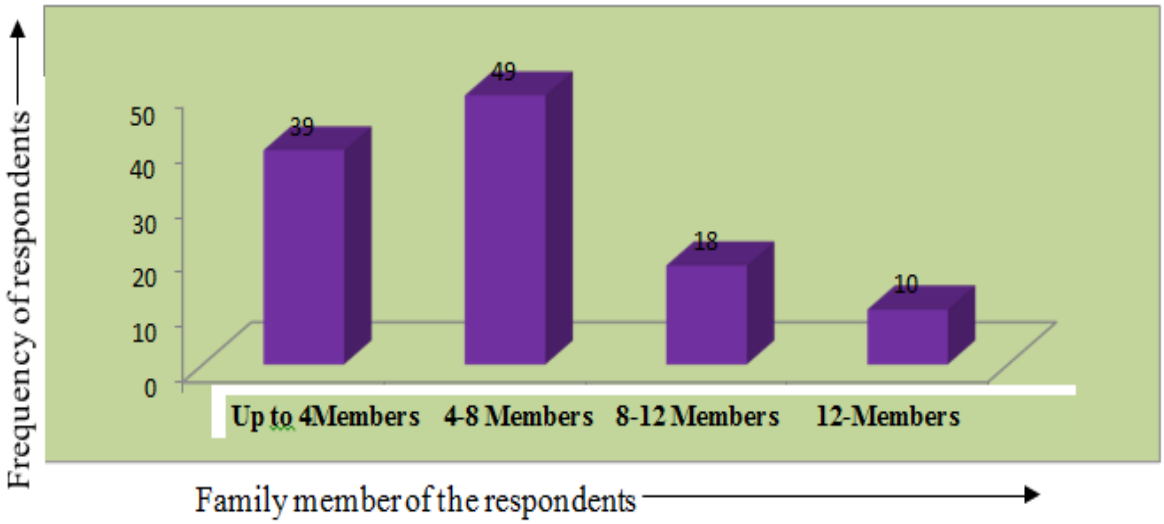

Fig.4.8. Distribution of respondents on family member

According to the data, the majority of respondents (42.3 %) had a family size of 4 to 8 persons. The rural shared family structure might explain the medium size of the families in the study area. This went on for two generations since the family members were separated from the founding family. Small families were preferred by persons on the survey site, as 33.6 percent of respondents still had households of up to four members.

It aligns with the conclusions of the Development Research Bureau (DRB) (2004) that there is a risk of high birth rates in protected area neighborhoods without access to an effective family planning service, which would be a major issue for agriculture and agroforestry.

4.3.2.8 Land holding

According to Table 4.35, landless farmers accounted for 9.5% of total land holdings, whereas farmers with marginal land holdings accounted for 27.6%, small land holdings accounted for 35.3%, medium land holdings accounted for 17.2%, and big land holdings accounted for 10.4% of total land holdings.

Table 4.35 Land holding of the respondents

Sl No.	Land Holding	Frequency	Percent
1.	Landless	11	9.5
2.	Marginal (<1ha)	32	27.6
3.	Small (1-2 ha)	41	35.3
4.	Medium (2-4 ha)	20	17.2
5.	Large (>4 ha)	12	10.4
Total		**116**	**100.0**

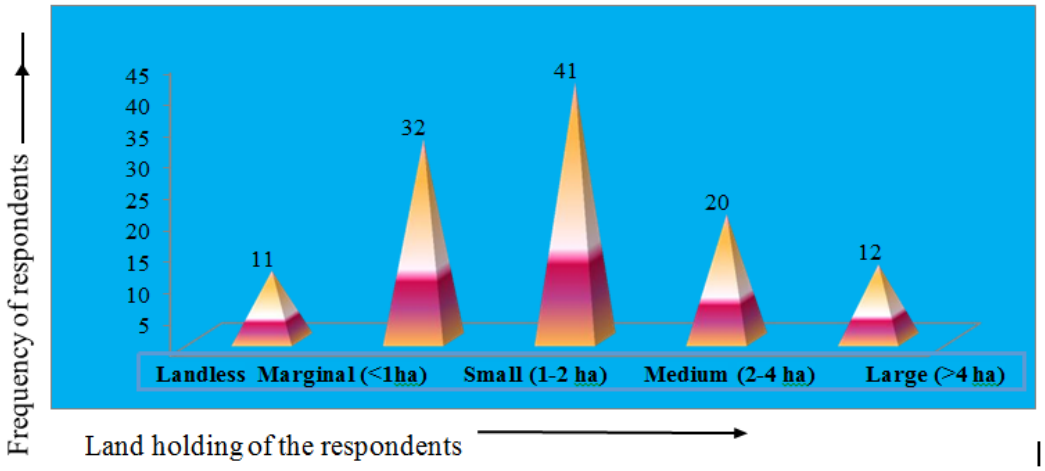

Fig.4.9. Distribution of respondents on the basis of land holding

Dwivedi *et al*. (2007) made similar findings when studying the overall land holding size of the sample farmers in Aligarh district. Similarly, Bharath (2010) found that among the forest-dwelling Siddi tribal population in Karnataka's Uttara Kannada district, the average total land holding of a household was 0.67 ha to 0.70 ha.

4.3.2.9 Types of Land Ownership

Figure 4.9 shows that the highest percentage of responses was ownership i.e. (82.8%), followed by rented in (10.3%). The percentage of total land holdings that are leased out is 1.7 % for both the owner and the leased out is 5.2 %.

Table 4.36 Ownership of the respondents

Sl No.	Ownership	Frequency	Percent
1.	Owner	96	82.8
2.	Leased in	12	10.3
3.	Leased out	2	1.7
4.	Owner and leased out	6	5.2
Total		116	100.0

Table 4.36 shown that the vast majority of respondents 82.8 %, owned their own land. The majority of respondents rely on their land for their livelihood. The smallest percentage of respondents (1.7%) had leased out their property; it's possible that the smallest percentage of respondents had leased out their own land in order to migrate out of the hamlet in search of work.

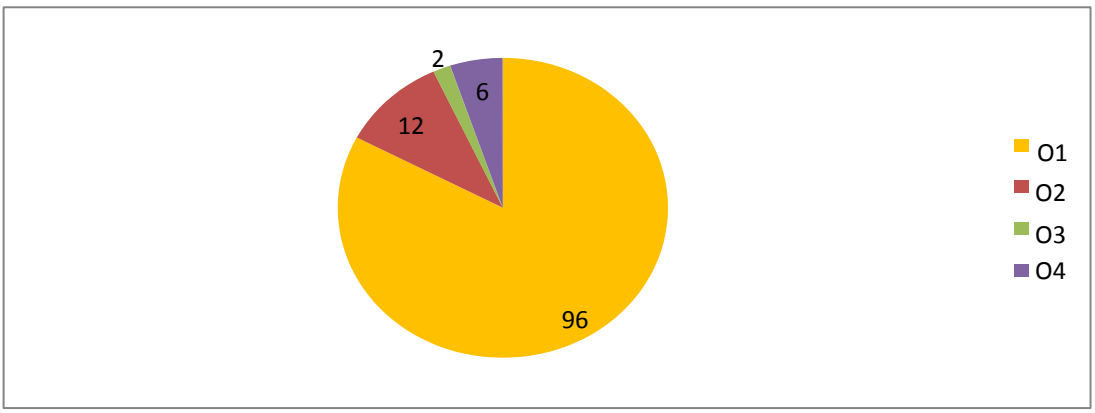

Fig.4.10. Distribution of respondents on the basis of ownership

4.3.2.10 Types of land

Among the many types of land such as irrigated and non-irrigated and total 100 % was irrigated presented in table 4.37.

Table 4.37 Types of land of the respondents

Sl No.	Types Of Land	Frequency	Percent
1.	Irrigated land	116	100.0

From the study it was found that all the farmers were depending on irrigation for their farming and 100% irrigation was found because of Govt. Scheme "Pradhan Mantri Jal Sinchai Yojana".

4.3.2.11 Types of Households

Farmers who had thatched homes were greater (52.6 %) than farmers who owned kutcha houses(28.4 %)., according to table 4.38 and Semi pucca and pucca farmers accounted for 11.2% and 7.8% of all farmers, respectively.

Table 4.38 Household type of the respondents

Sl No.	Household Type	Frequency	Percent
1.	Pucca	9	7.8
2.	Semipucca	13	11.2
3.	Kutcha House	33	28.4
4.	Thatched House	61	52.6
Total		116	100.0

Around 81% of households were discovered to reside in thatched and kutcha dwellings, which might be due to the respondents' poor socioeconomic status.

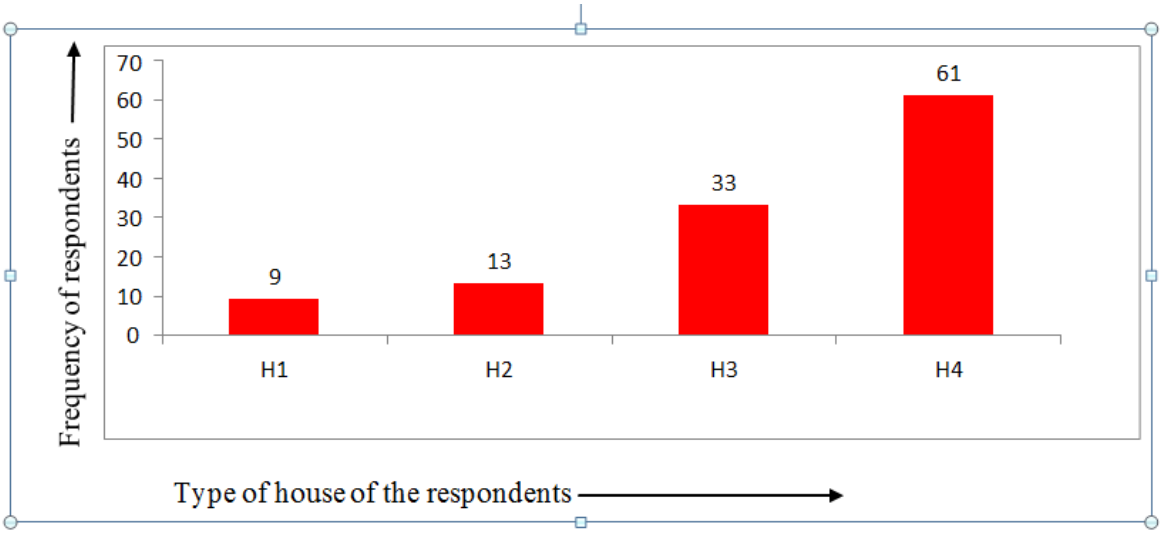

Fig.4.11. Distribution of respondents on the basis of type of house

4.3.2.12 Employment status

Table 4.39 shows that 5.2% of people were working full-time and 10.3% were worked part-time. The majority of the farmers were jobless (49.1%), and 34.5% were self-employed, it was implying that they rely on agricultural and agroforestry methods. 9% of farmers were classified as "others."

Table no 4.39 employment status of the respondents

Sl no.	Employment Status	Frequency	Percent
1.	Full time	6	5.2
2.	Part time	12	10.3
3.	Self	40	34.5
4.	Unemployed	57	49.1
5.	Others	1	.9
Total		116	100.0

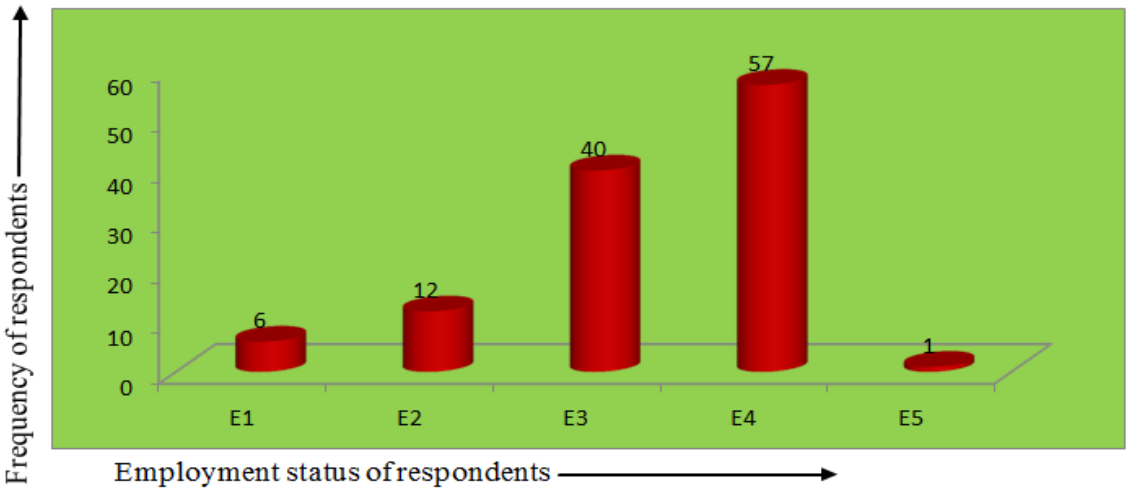

Fig.4.12. Employment status of the respondent

It was discovered that 34.5% of people were self-employed, implying that they were participating in their own subsistence and income-generating activities by investing in their own region. Due to bad conditions, the majority of the people became unemployed, indicating a lack of work prospects in the rural region. They were still not engaged in subsistence activities at any time. By increasing on-farm productivity, integrating agroforestry systems into the existing agricultural system would increase family earnings.

According to Salam *et al.* (2000), tree planting on farms raised average household income and reduced rural poverty.

4.3.2.13 Annual Income (Rs)

According to table 4.41, the majority of the households (31%) had an annual income of Rs. 50,000–1 lakh, followed by 27.6 % with Rs. 25,000–50,000, 25 % with more than 1 lakh, 9.5 % with Rs. 10,000–25,000 and the least i.e. 6.9 % with less than 10,000.

Grewal *et al*. (1992) investigated the agrisilvihorticulture system and found a net return of Rs. 17066 per year when compared to the double-planted agricultural system. According to Sood *et al.* (2006), tree planting, particularly homestead agroforestry, leads to an increase in overall household income and a reduction in rural poverty. According to Sood *et al.* (2008), total family income had a favourable and substantial impact on the uptake of tree cultivation in agroforestry systems. Nayak *et al.,* also found that majority of farmers who practiced agroforestry had income between 50k to 1 lakh and a sound family condition so that they were adopting agroforestry.

Table no 4.40 Annual income of the respondents

Sl no.	Income (Rs)	Frequency	Percent
1.	<10,000	8	6.9
2.	10-25,000	11	9.5
3.	25-50,000	32	27.6
4.	50,000-1 Lakh	36	31.0
5.	>1 Lakh	29	25.0
	Total	116	100.0

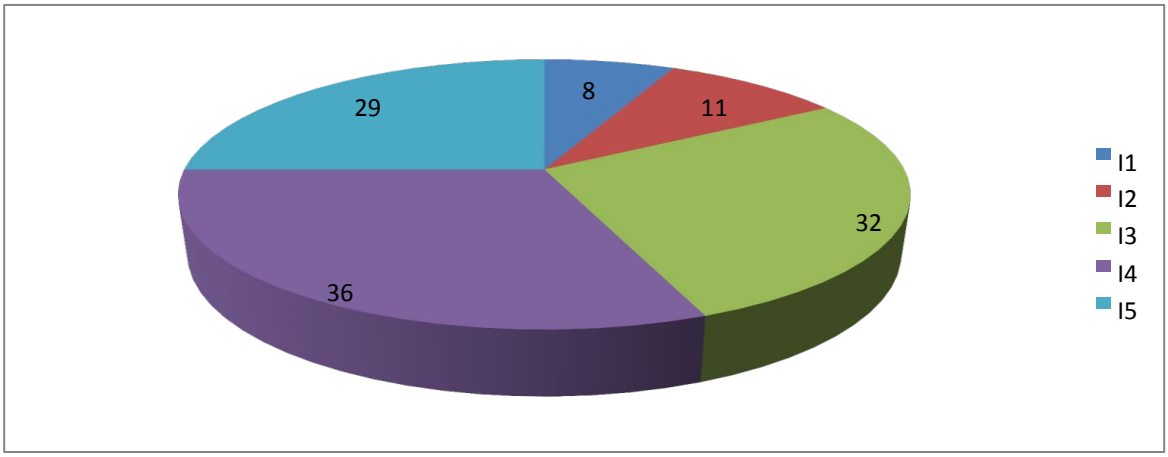

Figure 4.13 Annual income (Rs) of farmers

Households' status of livestock

The livestock industry is crucial to the livelihood development of rural populations. Farmers in the research region grow cattle, oxen, buffalos, goats, chickens, and ducks, as shown in Table 4.41. According to the statistics, 42 % of respondents had a cow, 27 % had an ox, 38 % had a goat, 98 % had a hen and 7 % buffalo was extremely high and extremely low, respectively.

Table 4.41 Livestock status of households

Sl.No	Livestock composition	HouseholdNo.				
		Kishandahi	Valki	Chelia	Singtia	Total
1	Cow	15	9	7	11	42
2	Ox	10	5	3	9	27
3	Buffalo	3	0	1	3	7
4	Goat	12	7	9	10	38
5	Hen	37	24	16	24	98
6	Duck	8	5	4	7	24
7	Any other	6	2	3	4	15

The animals make many contributions to the home. Animals provide farmers and their households with a food supply and are often reared for use on their own farms in agricultural agriculture as well as for hand out for income raise.

From the table 4.42, it is summarized that the different socioeconomic variables and descriptive statistics like mean, standard error, standard deviation

Table 4.42 Descriptive Statistics of socio-economic variables

Descriptive Statistics										
	N	Minimum	Maximum	Mean		Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	Statistic	Std. Error
age	116	1.00	4.00	2.3793	0.09052	0.97495	0.203	0.225	-0.921	0.446
gender	116	1.00	2.00	1.3621	0.04482	0.48268	0.582	0.225	-1.691	0.446
caste	116	1.00	4.00	2.4138	0.07751	0.83478	0.643	0.225	-0.283	0.446
marital status	116	1.00	4.00	1.9569	0.03947	0.42513	1.117	0.225	9.945	0.446
literacy	116	1.00	5.00	1.4828	0.08526	0.91825	2.177	0.225	4.629	0.446
types of family	116	1.00	2.00	1.2069	0.03777	0.40684	1.466	0.225	0.152	0.446
family member	116	1.00	4.00	1.9914	0.08527	0.91837	0.703	0.225	-0.258	0.446
land holding	116	1.00	5.00	2.9138	0.10359	1.11565	0.211	0.225	-0.566	0.446
ownership	116	1.00	4.00	1.2931	0.06928	0.74620	2.785	0.225	7.050	0.446
types of land	116	1.00	1.00	1.0000	0.00000	0.00000	.	.	.	.
Household type	116	1.00	4.00	3.2586	0.08755	0.94290	-1.112	0.225	0.228	0.446
employment status	116	1.00	5.00	3.3017	0.08050	0.86698	-1.038	0.225	0.570	0.446
income	116	1.00	5.00	3.5776	0.10824	1.16582	-0.559	0.225	0.379	0.446
Valid N (listwise)	116									

From table no. 4.42 it summarized the different socioeconomic variables and descriptive statistics like mean, standard deviation. standard error, skewness., and kurtosis. Highest skewness value was observed for Ownership, literacy and types of familysignified that less variance was observed there . House hold type, employment status and income are negatively skewed. As all the socioeconomic variable were numerically scored from 1-6.

Table no 4.43 Correlations studies of socio-economic variables

Parameters	Age	Gender	Caste	Marital Status	Literacy	Types of Family	Family Member	Land Holding	Ownership	Types of Land	Household Type	Employmet Status	Income
Age	1												
Gender	0.223*	1											
Caste	0.179	.013	1										
Marital Status	0.061	0.161	-0.096	1									
Literacy	0.182	0.152	0.089	0.277**	1								
TypesOf Family	**0**.064	0.279**	0.027	0.102	0.266**	1							
Family Member	0.159	-0.032	0.095	0.000	-0.129	0.051	1						
Land Holding	0.174	-0.119	0.225*	-0.008	-0.035	-0.075	-0.060	1					
Ownership	0.192*	0.041	0.208*	-0.179	0.147	0.000	0.029	0.156	1				
Types of Land	-	-	-	-	-	-	-	-	-	-			
Household Type	0.044	-0.036	0.073	0.006	-0.015	-0.050	-0.058	0.212*	0.015	-	1		
Employment Status	-0.065	0.173	-0.054	0.272**	0.176	0.019	-.117	0.189*	-0.057	-	0.436**	1	
Income	0.157	-0.050	0.172	-0.037	-0.043	0.076	.102	0.239**	-0.016	-	0.124	0.205*	1

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

The correlation study of different socio-economic variables of the respondents has been presented in table 4.43. It is evident from the table the as is statistically and positively correlated with gender and ownership where as rest of the characters are found to be not correlated with as, like wise gender is only statistically ($P<0.01$) and positively correlated with types of family. It is also observed from the table caste is correlated with land holding and ownership ($P<0.05$). Also, marital status is positively correlated with literacy as well as employment status and literacy is positively correlated with types of family. As evident from the table land holding is found to be significantly correlated with household types, employment status and income respectively and household type is only significantly correlated with employment status and employment status is also significantly correlated with income.

4.44 Multiple Regression analysis of socio-economic variables with income

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	Constant	1.700	0.838	-	2.029	0.045
	Age	0.209	0.120	0.175	1.741	0.085
	Gender	-0.302	0.243	-0.125	-1.243	0.217
	Caste	0.188	0.133	0.135	1.409	0.162
	Marital Status	-0.244	0.273	-0.089	-0.892	0.374
	Literacy	-0.128	0.131	-0.101	-0.978	0.330
	Types of family	0.376	0.277	0.131	1.359	0.177
	Family Member	0.100	0.119	0.079	0.842	0.402
	Land Holding	0.148	0.104	0.142	1.428	0.156
	Ownership	-0.128	0.150	-0.082	-0.850	0.397
	Household Type	-0.047	0.127	-0.038	-0.368	0.714
	Employment Status	0.374	0.149	0.278	2.509	0.014
a. Dependent Variable: income						

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	0.413[a]	0.170	0.083	1.11669
a. Predictors: (Constant), employment status, types of family, ownership, family member, caste, age, marital status, land holding, gender, Household type, literacy				

Multiple regression analysis of different socioeconomic variables with income is presented in table 4.44. However as evident from the above table, employment status is the only contributing variable for the income generation of the respondents and from the modern summary table which is presented below. It is evident there is only 17% contribution to the income generation of the respondents. The R square value i.e. 0.170 shown in the model summary table and it represented the overall contribution of socioeconomic variables to the annual income i.e. 17%

SUMMARY AND CONCLUSION

The present investigation, entitled "A Study on Socio-economic Analysis of" Agroforestry Systems in Mayurbhanj District, Odisha" was carried out through Independent experiments during 2020-21 in Shyamakhunta and Badasahi blocks of Mayurbhanj district of Odisha. The present investigation was conducted to analyse the economics of different agroforestry systems in Mayurbhanj district, to investigate various agroforestry systems used by villagers and to assess the socio-economic analysis of different agroforestry systems. For conducting the experiment, a total of 116 numbe of households from two blocks and ten villages (two villages from each selected from each gram panchayat of two blocks) were chosen through multistage sampling. Data was collected through the survey method, collecting information by interviewing members of the household. pretested and pre-structured questionnaires were designed for survey as well as group discussions with villagers and standard procedures for volume and biomass of various agroforestry systems were implemented in the systems.

5.1 Key Research Findings

From the study site the following observations were observed i.e.

The total cost of production under different systems was calculated per hectare. The total cost of production of different system/ha were given below Silvi Horti (Rs 6,56,310),Agrihorti(Rs13,62,454),Silviagri(Rs2,59,060),Bundplantation(Rs 2,06,730) ,A Grisilvihorti (Rs4,89,759),Homestead (Rs14,13,225) and Block Plantation (Rs2,75,810).

The gross return found highest in homestead (Rs26,35,540) followed by Agrihorti (Rs19,03,000), Blockplantation (Rs 14,16,092) then silvi horti (Rs 11,36,700), Siviagri (Rs 6,25,919), Agrisilvihorti (Rs 5,84,942) and least found for Bundplantation (Rs 4,81, 759).

The net return highest calculated in Homestead (Rs. 12, 22,315) followed by Block Plantation (Rs. 11,35,242) then Agri Horti (Rs 5,40,546), Silvi Horti(Rs4,80,390), Silvi Agri (Rs 3,66,859), Bund Plantation (Rs. 2,74,684) and least was for Agri Silvi Horti (Rs. 95,183).

Among the selected agroforestry systems, it had been found that Blockplantation system was most profitable having BCR of 5.38 followed by > Agrisilviculture (2.04) > Bund Plantation (2.01) >Homestead (1.92) > Silvihorti

(1.48) >Agri Horti (1.40) > Agri Silvi Horti (1.27). The study also revealed that the highest economic benefit, as well as resource conservation was possible when tree crops are in monoculture or with associated with different crop species along with NPV of Homestead (Rs10,75,637/-) morethan Blockplantation (Rs 9,99,013/-) followed by AgriHorti (Rs5,46,080/-), Agrisilviculture (Rs 3,20,812/-), Silvihorti (Rs2,64,959/-), Bund Plantation(Rs 2,04,413/-) and AgriSilvi Horti (Rs84,572/-).

The IRR of different systems were calculated maximum for Homestead (84.32%) followed by Bund plantation (61.76%) > Block plantation (58.15%) > Agri silvi (49.86%) > Agri silvi horti(48.75%) > Silvi horti (48.52%) and least for Agri horti (45%).

The most preferred forest tree species was *Acacia* sp, Teak (*Tectona grandis),* Subabul (*Leucaena leucocephala*) etc while the most preferred fruit tree species adopted by farmers were Mango (*Mangifera indica*), Guava (*Psidium guajava*), Banana (*Musa paradisiaca*), Papaya *(Carica papaya).* Various inter crops were grown mostly Cowpea, Ragi and horticultural crops like Turmeric, Ginger , Mango ginger , Garlic etc mostly preferred by farmers in the study area.

As far as land area under farming practices observed in the study field, around 22 ha under Agrihorti followed by Homestead (19.1 ha), Bund plantation (18.5 ha), agrisilviculture (17 ha), Agri silvi horti (16.1 ha), Silvihorti (15 ha) and Block plantation (14.6 ha) and it shown the adoption of different systems by the farmers in the study area.

The majority of farmers (59%) in the area practice agroforestry as primary on their farm, 15.5 % attend primary school and 8.6 % attend secondary school. The prevalent existence Agroforestry practices in the area were found to be silvi horticulture, block plantation, homestead, bund plantation, agrisilviculture, Agrisilvihorti, Agri horti and others. Many of the Respondents had more than one type of agroforestry practice on their farms

The results of the study revealed that the majority of families (63.8%) were headed by male member and the majority of households (37.9%) were between 31 and 40 years of age, showing a family can only have a certain number of young people. The

area is dominated by scheduled tribes (57.8%). More than half (71.6%) of households were illiterate. The majority of households (52.6%) had a thatched house.

In the study area, the majority of households (79.3%) had nuclear families. About half of the respondents (42.3%) had four to eight members in their families. More than half of the Households (49.1%) were unemployed, while respondents (34.5%) were self-employed.

The majority of households (98%) possessed hens, 42% possessed cows, and 38% possessed goats. 23% oxen, 24% ducks, 7% buffaloes, and 10% other animals such as pigs. This indicates Livestock rearing is also a means of livelihood and cash income. Around 35.3% of respondents owned 1-2 hectares of land, 27.6% owned less than one hectare, and 17% owned (2-4 ha). 9.5% were landless, while 10.4% owned more than 4 ha.

Conclusion

5.2 From the above study we concluded the following results

5.2.1 To analyse the economics of different agroforestry systems

1. This is about economic metrics, such as the fact that both the net benefit and the BCR are seen as good for the economy in the agroforestry models that have been studied.
2. The viability of agroforestry models that have been evaluated is highly reliant on investments such as labour participation and the market values of the manufactured commodities that have been gathered. Under the currently applicable cost structure, the price that can be achieved for tree and crop hybrid production is anticipated to provide farmers with significant benefits from the implementation of Block plantation models. Adding a monetary value to the products that trees produce, on the other hand, might make them more appealing.
3. The Block plantation of pure tree crop like Acacia, Homestead garden Silvi-agriculture model were the most popular with the farmers. Maximum investment is required for the bund plantation models of Acacia and Cowpea, Acacia and Ragi and Mango and Turmeric and mushrooms. (Mango + Turmeric) and Homesteads were the models that accounted for the most amount of expenditure in the plantation. This is due to the fact that these crops require additional processes for their administration and

operations in comparison to other crops. Because we know that the costs of a variety of cost variables, such as land planning, labour, irrigation, and tillage, are increasing at a high rate, this has an effect on the economic expenditure that is produced as well as the returns that are made from agroforestry models.

4. Block plantation, homestead, and agrisilviculture contributed the most to the overall success of the enterprise. Because there are so many trees packed into each acre, as well as robust agricultural production, market prices are high.

5. The models that generate the most amount of BCR are called "Block plantation," "homestead," and "agrisilviculture," respectively. It is because of the low demand for inputs in terms of management practices such as moderate tillage, minimal irrigation, and fodder crop labour requirements. These things further reduce the investment pressure that is placed on farmers, which leads to the conclusion that these agroforestry models are the most promising.

5.2.2 To study different Agroforestry systems adopted by villagers

1. This study came to the conclusion that agroforestry is a common method of land management that is embraced at the farm level. This is due to the fact that agroforestry is related to both traditional practices such as orchards that have been around for centuries and modern agricultural systems such as study area farm planting. Inquiries into the various facets of agroforestry led to the following discoveries: One significant agroforestry practice is prevalent in the region. These include bund plantation, block plantation, homestead, aquaforestry, agrisilviculture, silviculture, silvihorti, silvipasture, and others. The most common types of agroforestry procedures that are used include bund plantation, homesteading, and agrisilviculture. Some of the farmers have experimented with multiple agroforestry techniques, such as bund planting, aquaforestry, and others. These techniques have been shown to be successful. This has demonstrated that they favour monoculture over agroforestry. A number of different agroforestry activities are practised, the most common of which is the cultivation of teak trees by farmers, along with acacia and horticultural crops like mango.

2. It has been observed that Acacia, Subabul trees produce the greatest number of crop combinations.It is evident that cultivation of Bamboo through Bamboo based agroforestry also takes place. According to their participation in the majority of

activities, plantation habits, a substantial number of adopters, and maximum crop combinations, teak and acacia have proven to be the most prevalent tree species in agroforestry planting in the study field. Farmers who use agroforestry plant a wide variety of crops as the primary crops for agriculture. Some examples of these crops included. Cow pea, ragi and horticultural crop like Turmeric, Mango-ginger, Ginger, Garlic,Banana. The Pine Apple, the Guava are the three most important crops in horticulture, and the Marigold is the most important flower.

The benefits of various agroforestry models are the primary obstacle for farmers when it comes to accepting agroforestry. By employing cost benefit analysis, it has been determined that All of the models are reasonable. In particular, the Acacia based block plantation models have been deemed particularly reasonable because they have demonstrated bot h profitability and practicality for farmers. The anticipated economic intervention is positive, which demonstrates the economic compatibility of the agroforestry models concentrated on Acacia in this region. The results of the study indicate that, despite the fact that a variety of farmers, including small, marginal, medium, and large, practised agroforestry in the study area:

5.2.3 To asses socio economic character

1. There is a significant link between individual factors and social factors, such as age, gender, and race. factors such as education, occupation, annual income, household size, household size, family size, and land area, ownership, livestock properties, land use system, standard timber, tiny wood, fuel, and fuel sources agroforestry system adoption, among other things, as well as wood, fruit and vegetables, crops, and different socioeconomic aspects and characteristics.

2. The factors of old age, medium or large size are among the significant individual and social variables. possessing property, getting married, actively participating in training, and having an adequate level of knowledge and previous farming experience, growing either for testing or commercial objectives, a favourable farm record production has a beneficial effect, as does the selection of commercial tree species by producers implementing agroforestry principles on their own farms has a beneficial effect on the industry as a whole. by local farms.

3. Young and middle-aged adults, a more nationalistic perspective on forests, and negative production pertaining to agriculture, having either no experience or a very limited amount of professional knowledge of Agriculture appears to have a detrimental impact on the implementation of activities related to agriculture and forestry because of traditional reasons

4. Considerations of the economy, such as the level of annual income and the primary or secondary role played by agriculture additional sources of income, and the type of house they live in, which provides insight into their living conditions. ownership of land, the use of timber and prune wood as fuel, and income from farming are all factors. significant correlation has been found between the implementation of agroforestry practices and various studies. As a result, the approval of farmers is influenced by these economic factors.

5. A higher income, a good supply of labour services, agriculture as the main job, agriculture as a source of income, farmers' positive attitudes toward farm-based income, farmers' use of timber or prune wood as fuel, and strong income support from farm sales are all things that help people adopt agroforestry practices.

6. Other (rented or leased) land ownership, agriculture as a secondary occupation, and other job opportunities like government jobs, shop-keeping, and local work are all good things. However, agroforestry activities can be hard to do if there are negative things like low or limited farm production profits, no help with farm production income, and a low financial status.

So, we can say that there is a strong link between the socioeconomic factors that were looked at and the adoption of agroforestry. This also means that these socioeconomic factors play an important role in the adoption of agroforestry activities

5.3 Recommendation

The following recommendations were made on the basis of assumptions about the various agroforestry activities and their adoption

1. The National Agroforestry Strategy (NAF), which was developed in India for the purpose of expanding agroforestry, is currently in place. Farmers who are learning or are able to practice more than one type of agroforestry should be given special

attention to focus on the background of agroforestry practice in order to spread their knowledge to other farmers as well.

2. Instead of providing farmers with separate training programmes for different plantations, it is recommended that a joint curriculum be given to promote knowledge of the adoption and management of Subabul and Acacia in the various recorded agroforestry activities. This will allow farmers to learn more about the management and cultivation of Acacia in different trends at the same time within the time and resources that are available.

3. It is important to conduct a campaign with caution in order to raise the level of knowledge among farmers regarding the planting and production of agroforestry. In addition to this, farmers' knowledge and experience can be included in the planning stage of agroforestry projects as a potential resource.
4. Proper planning is essential for the successful implementation of agroforestry practices by farmers. In regions of the country where daily training programmes and extension facilities are not already available but where farmers are interested in learning about agroforestry and are able to participate in such programmes, the government should make recommendations for their establishment.

5. Relevant departments should make an effort to lessen the reliance that villagers have on forests in order to satisfy regular requirements, in particular for local forest browsing for fodder, fuelwood, and cattle. This will help ensure that regular requirements are met.

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APPENDIX

ODISHA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY

COLLEGE OF FORESTRY

BHUBANESWAR - 751003

This information is gathered for the purpose of research work of the Msc. Programme, College of Forestry

Respondent No---------- Date----------

Name of the Respondent ----------

Village----------

Age ----------

Gender----------

Block----------

District----------

Range----------

Division----------

DIFFERENT SOCIO-ECONOMIC PARAMETERS :

AGE

- 20- 30
- 30 – 40
- 40 – 50
- > 50

GENDER

- Male
- Female

CASTE

- SC
- ST
- OBC
- GENERAL

MARITAL STATUS

- Single
- Married
- Widow
- divorce

LITERACY

- Illiterate
- Primary
- High school and Intermediate (+2) and Above
- Graduate and above
- Any other (vocational/ITI)

TYPE OF FAMILY

- Nuclear family
- Joint family

FAMILY MEMBER

- Up to 4 members
- 4 to 8 members
- 8 to 12 members
- 12 members

LAND HOLDING

- Landless
- Marginal (< 1 ha)
- Small (1-2 ha)
- Medium (2-4 ha)
- Large (>4 ha)

TYPES OF OWNERSHIP OF LAND

- Owner
- Leased in
- Leased out
- Owner and leased out

TYPES OF LAND

- Irrigated
- Non irrigated

TYPES OF HOUSEHOLD

- Pucca
- Semi pucca
- Kutcha house
- Thatched house

EMPLOYMENT STATUS

- Full time employed
- Part time employed
- Self employed
- Unemployed
- Others

OCCUPATION:

Sl no	TYPES	PRIMARY	SECEONDARY	TERTIARY
1.	Agriculture			
2.	Agroforestry			
3.	Labour			
4.	Cattle rearing			
5.	Private service			
6.	Government service			
7.	Business			
8.	Family occupation			
9.	Unemployment			
10.	Any other			

ANNUAL INCOME:

SL NO	CATEGORY	NUMBERS
1	< 10,000	
2	10 -25,000	
3	25 – 50,000	
4	50,000 – 1 lakh	
5	>1lakh	

LIVESTOCK COMPOSITION:

SL NO	TYPES	NUMBERS
1	Cow	
2	Ox	
3	Buffalo	
4	Goat	
5	Pig	
6	Hen	
7	Duck	
8	Any other	

AGROFORESTRY SYSTEM:

Systems	Area	Crop	Tree	Fruit plants	Any other (Medicinal plants, animals, pasture etc)	Season
1. Bund plantation 2. Block plantation 3. Homestead 4. Aquaforestry 5. Agrisilviculture 6. Silvihorti 7. Silvipasture 8. Others						

Systems	Area	Tree spp	Crops		
			Kharif	Rabi	Summer
1					
2					

YIELD:

System	Arable crop yield (Qt/ha)	Trees sps	No.	Age of trees (yrs)	Ht (m)	DBH	Biomass			
							Vol /biomass	Pruned biomass (kg)		
								Small wood	fuelwood	fodder

FUEL WOOD:

Quantity consumed /day / household	No. of persons in that Households

FODDER CONSUMPTION:

Quantity consumed /day per household	no of cattle per household

ESTIMATION OF COST OF CULTIVATION OF CROP:

Sl. no	Particular	Input/ha	Rate (Rs)	Cost (Rs/ha)
1	a) land preparaton			
	-Harrowing by cultivator			
	-Disk harrow			
	-Planker			
2	b) Seed and Sowing			
	-Cost of seed			
	-Seed treatment			
	-Seed sowing			
3	c)Fertilizer			
	-Cost of fertilizer			

	-Application charges			
4	d)Irrigation			
5	e) Plant protection			
6	f) Weeding			
7	g) Harvesting			
8	h) Other misc.			
	Total			

RETURN FROM CROPS:

System	Crop	Yield (q)	Gross return (Rs.)	Cost of cultivation (Rs.)

ESTIMATION OF COST IN TREES:

Sl. No.	Particulars	Rate	Amount (Rs)
1	Cost of Seedling		
2	Digging pit, filling		
3	Tending		
4	Irrigation		
5	Misc.		
6	Expenditure till now		

RETURN FROM TREES:

System	Tree	Vol/Biomass(q)	Small wood/fuel wood/fodder (q/ha)	Rate (Rs/q)	Gross return (Rs.)	Cost of cultivation (Rs.)

ESTIMATION OF COST IN FRUIT CROPS:

Sl. No.	Particulars	Rate	Amount (Rs)
1	Cost of Seedling		
2	Digging pit, filling		
3	Tending		
4	Irrigation		
5	Misc.		
6	Expenditure till now		

RETURN FROM FRUIT TREES:

System	Tree	vol/Biomass (q/ha)	Rate (Rs/q)	Gross return (Rs.)	Cost of cultivation (Rs.)

ESTIMATION OF COST IN ANY OTHER (MEDICINAL PLANTS, ANIMALS, PASTURE ETC):

Sl. No.	Particulars	Rate	Amount (Rs)
1	Cost of Seedling		
2	Digging pit, filling		
3	Tending		
4	Irrigation		
5	Misc.		
6	Expenditure till now		

RETURN FROM (MEDICINAL PLANTS, ANIMALS, PASTURE ETC):

System	Tree	vol/Biomass (q/ha)	Rate (Rs/q)	Gross return (Rs.)	Cost of cultivation (Rs.)

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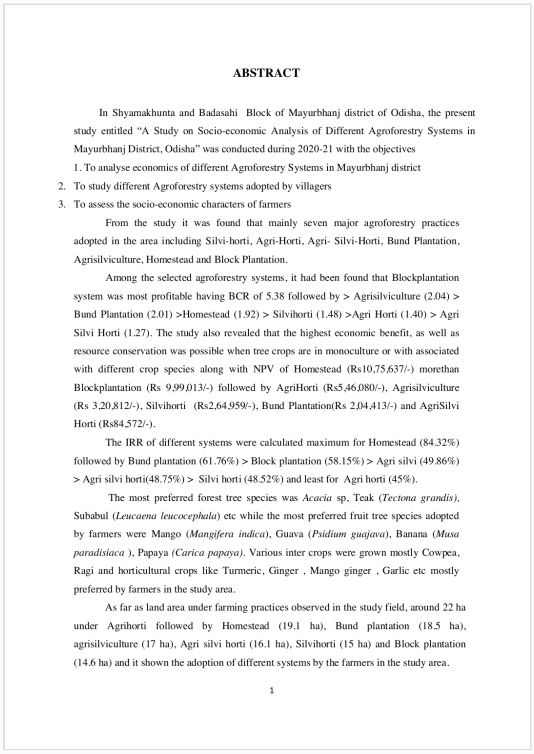

ABSTRACT

In Shyamakhunta and Badasahi Block of Mayurbhanj district of Odisha, the present study entitled "A Study on Socio-economic Analysis of Different Agroforestry Systems in Mayurbhanj District, Odisha" was conducted during 2020-21 with the objectives

1. To analyse economics of different Agroforestry Systems in Mayurbhanj district
2. To study different Agroforestry systems adopted by villagers
3. To assess the socio-economic characters of farmers

From the study it was found that mainly seven major agroforestry practices adopted in the area including Silvi-horti, Agri-Horti, Agri- Silvi-Horti, Bund Plantation, Agrisilviculture, Homestead and Block Plantation.

Among the selected agroforestry systems, it had been found that Blockplantation system was most profitable having BCR of 5.38 followed by > Agrisilviculture (2.04) > Bund Plantation (2.01) >Homestead (1.92) > Silvihorti (1.48) >Agri Horti (1.40) > Agri Silvi Horti (1.27). The study also revealed that the highest economic benefit, as well as resource conservation was possible when tree crops are in monoculture or with associated with different crop species along with NPV of Homestead (Rs10,75,637/-) morethan Blockplantation (Rs 9,99,013/-) followed by AgriHorti (Rs5,46,080/-), Agrisilviculture (Rs 3,20,812/-), Silvihorti (Rs2,64,959/-), Bund Plantation(Rs 2,04,413/-) and AgriSilvi Horti (Rs84,572/-).

The IRR of different systems were calculated maximum for Homestead (84.32%) followed by Bund plantation (61.76%) > Block plantation (58.15%) > Agri silvi (49.86%) > Agri silvi horti(48.75%) > Silvi horti (48.52%) and least for Agri horti (45%).

The most preferred forest tree species was *Acacia* sp, Teak (*Tectona grandis*), Subabul (*Leucaena leucocephala*) etc while the most preferred fruit tree species adopted by farmers were Mango (*Mangifera indica*), Guava (*Psidium guajava*), Banana (*Musa paradisiaca*), Papaya *(Carica papaya)*. Various inter crops were grown mostly Cowpea, Ragi and horticultural crops like Turmeric, Ginger , Mango ginger , Garlic etc mostly preferred by farmers in the study area.

As far as land area under farming practices observed in the study field, around 22 ha under Agrihorti followed by Homestead (19.1 ha), Bund plantation (18.5 ha), agrisilviculture (17 ha), Agri silvi horti (16.1 ha), Silvihorti (15 ha) and Block plantation (14.6 ha) and it shown the adoption of different systems by the farmers in the study area.

1

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