FARMERS' PERCEPTION ON EUCALYPTUS TREE PLANTATION AS CROPLAND AGROFORESTRY: A CASE STUDY OF BOGURA DISTRICT

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TO

MY BELOVED

PARENTS AND

SISTER

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CERTIFICATE

This is to certify that the thesis entitled ***"FARMERS' PERCEPTION ON EUCALYPTUS TREE PLANTATION AS CROPLAND AGROFORESTRY: A CASE STUDY OF BOGURA DISTRICT"*** *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***Master of Science*** *in* ***Agroforestry and Environmental Science****, symbolizes the result of a piece of bona fide research work carried out by* ***Mahabuba Pervin****, Registration No. 11-04286 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged by the Author.

Dated: ……..
Place: Dhaka, Bangladesh

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The Author

Farmers' Perception on Eucalyptus Tree Plantation as Cropland Agroforestry: A Case Study of Bogura District

ABSTRACT

Eucalyptus is one of the most extensively planted trees in Bangladesh as well as in the world. The purpose of this study was to determine farmers perception about Eucalyptus tree cultivation as cropland agroforestry and explore the contribution of the selected characteristics of the farmers. The selected characteristics were age, education, family size, total land area, income sources, training exposure, duration of involvement with eucalyptus cultivation, land use pattern and farmer's opinion on prospect of eucalyptus tree cultivation. Data were gathered from randomly selected 60 farmers of fifteen villages of three upazilas named Bogura Sadar, Kahaloo and Sherpur upazila under Bogura District by using interview schedule. For harmonious representation from each village, 60 farmers were selected by using a standard formula. Respondents were selected by using stratified random sampling method. Stepwise Multiple Regression was used to examine the contribution of the selected characteristics of the farmers. The findings revealed that majority of the respondents (40%) of the farmers were felt in poorly favorable perception whereas 28.3 percent in moderately favorable perception and 31.7 percent in highly favorable perception towards eucalyptus tree cultivation. Hence, more than half (60%) of farmers had medium to high perception towards eucalyptus tree cultivation. Stepwise Multiple Regression exposed that farmer's opinion on prospect of eucalyptus tree cultivation, training exposure, total land area and education had significant contribution on farmer's perception about eucalyptus tree cultivation. The R2 value indicates the four independent variables collectively contribute (53.3 %) of the total variation on farmers' perception about eucalyptus tree cultivation. It may be concluded that farmers' perception about eucalyptus tree cultivation will be increased with the increase of training exposure and educational level of the respondents.

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ABBREVIATIONS AND ACRONYMS

BARC = Bangladesh Agricultural Research Council

DAE = Department of Agricultural Extension

DFO = Divisional Forest Officer

UAO = Upazila Agriculture Officer

AEO = Agriculture Extension Officer

SAAO = Sub-Assistant Agriculture Officer

FAO = Food and Agriculture Organization

BDT = Bangladesh Taka

GO = Government Organization

NGO = Non-Government Organization

SD = Standard Deviation

SPSS = Statistical Package For Social Science

SAU = Sher-e-Bangla Agricultural University

WUE = Water Use Efficiency

CHAPTER I

INTRODUCTION

1.1 General Background

Bangladesh being the most densely populated country having very low per capita cultivable land (0.06 ha) and forestland (0.02 ha), is struggling hard for meeting the demand of her agricultural and forest products. Introduction of high yielding varieties of cultivated crops shorten the gap between crop production and existence need, but still there remains a big gap between supply and demand of forest products. The situation of forestry in Bangladesh is sultry. Most of the large tracts of forestland become barren and degraded due to continous human pressure. Although 17% of the land areas are designated as forestland,the actual tree cover is only 9-10% of the country (Ahmed, 2001). The massive human obstruction and low productivity of forest are increasing the demand and supply gap of forest products. The demand for forest products has been continuously creating enormous pressure on reserve forests.On the other hand, the existing narrow forests of Bangladesh are not well alloted throughout the country. Most of the forests are situated in the south-eastern and south-western parts of the country and 35 districts out of 64 districts have no natural forest (Bhuiyan, 1994). The situation in the northern part of Bangladesh is worse although initiatives has been undertaken for tree plantation in the homesteads, roadside, boundary of crop fields and other areas by the GOs, NGOs and farmers as well.

Most of the available literature on fuel wood production in Bangladesh is mainly focused on extent of use of fuel wood by households rather than estimation of actual amount of fuel wood consumption. For example, in national level data, only the extent of use of fuel wood is available but there is no information on the amount of fuel wood consumption. The Population and Housing Census Report of Bangladesh (BBS 2011) provides information on the percentage of households using various kinds of cooking fuelwood.

From the private homestead forest, rural dewellers mostly get their fuel wood. Villagers usually plant fruit trees, bamboo, timber species, non-fruit trees and shurbs and most of which is used for fuel wood. According to FAO (1981) the major portion of fuel comes from non-traditional sources like cow dung, jute stick, rice hull and rice husk. The only probable way to compete with existing fuel wood shortage and the rising need for enhanced population in future is to establish fast growing species and short rotation (5-7 years) species, eucalyptus could be a good option for Bangladesh.

Eucalyptus (*Eucalyptus camaldulensis*) is one of the most extensively planted trees in Bangladesh as well as in the world. Because of its fast growing characterstics and outstanding physiological, genetic and silvicultural attributes (Davidson and Das, 1985), this tree is extensively used for afforestation and reforestation in more then 58 countries (FAO, 2005). Probably in the 1930s, the tea planters introduce eucalyptus in eastern Bangladesh as ornamental tree (Davidson and Das, 1985). Subsequently, this tree was expanded throughout the country in a chaotic manner by the botanists, foresters, gardeners and tree lovers. The potential of eucalyptus in Bangladesh is being capable to produce 3-4 times biomass and 6-8 times more stemwood on short rotations than the present forest species (Islam, 1986). Besides, this tree grows well on waned sites in public forest areas and village forest areas for fuelwood and agroforestry intendeds. The main part of eucalyptus in Bangladesh (i.e. stem) is used for multifarious uses such as: house construction, transmission pole, door, window, furniture (chair,table etc.), tool handles, railway sleeper, hardboard, pulp, paper, fuelwood etc. Besides its multiple uses, eucalyptus out-weights all other tree species in growth and yield; and brings more wood and money for the cultivators in the shorten time because of its cylindrical bole, small crown and light foliage, it casts least shade on the agricultural crops. Similarly, it also interferes least with other agricultural crops and ploughing operation as well, because of its straight and vertical root system.

Although the species has broad range of adaptibility, uses and benefits, there are strong debates on this species in Bangladesh, specially for more water use, soil nutrient depletion, allelopathic effect, influences on wildlife habitat and social and cultural heritage. Assuming its several negative effects on other resources, Government of Bangladesh has imposed restriction on new plantation in public lands. But most of the controversies came from mass media rather then the scientific world (Ahmed and Aktar, 1994). Water consumption of eucalyptus is even lower than many other popular species in Bangladesh such as: *Albizia lebeck, Acacia auriculiformis, Dalbergia sissoo* etc. (Chaturvedi, 1983). On the other hand, interception of precipitation by tree species showed that precipitation reaching the ground was 30-50% more in eucalyptus plantation than in the plantations of other broard leaved species such as *Shorea robusta, Tectona grandis, Alstonia scholaris, Acacia catechu* etc (Ghosh, et.al.1978). Despite its alleged controversies and restriction on new plantation, farmers particularly in the northern part of the country (largely in Rangpur, Bogura, Rajshahi and Dinajpur) have been cultivating huge eucalyptus trees along the boundaries of their crop fields, roadside, embankment, homestead, fallow land etc. considering its fast growth, low investment for plantation establishment and maintenance, quick return on a short rotation and diversified benefits. Among different areas, this tree is widely cultivating along the crop field boundary in the 3 upazilla under Bagura district.

Therefore, there are a lot of benefits of eucalyptus plantation and on the other hand, there are strong controversies as well. But information in these perspective of eucalyptus plantation is limited. In these circumstances, it is important to know the farmers' perceptions especially the growth performances and impact of eucalyptus tree on the cropland as well as uses for future promotion and development of eucalyptus based agroforestry system in Bangladesh.

1.2 Statement of the Problem

Though eucalyptus have become important industrial species in many countries, debate still remains about their effect on the environment; objection to large scale planting is very intense in India (Shiva and Bandyopadhyay, 1983; Karanth and Singh, 1983). However, the current expansion rate of eucalyptus around the world shows not all countries embarking in large scale plantations are convinced by concerns raised in India.

This controversy has resulted in confusion about the suitability of eucalyptus cultivations in Bangladesh. Research results suggest that some provenances of several species of the genus are suitable for the country in terms of growth and site adaptability. As a result the country has undertaken a large scale eucalypt planting program and to date 6,500 ha have been brought under plantations to supply domestic fuel wood. No specific research project has yet been undertaken to verify objections under Bangladesh conditions. In some cases, it is assumed that the effects in Bangladesh are the same as those in India; as a result, a confused/negative attitude towards eucalyptus cultivation has developed among policy makers, politicians and elites.

However the mass of farmer, who cultivate eucalyptus on their lands have shown less negative reaction to these environmental whims. These farmer participate in tree cultivation in small rural woodlots, agroforests and marginal land rural areas. An early return of a handsome volume of wood is very important to them. They are in crucial need of fuelwood, poles and posts for domestic uses. So a sharp divergence of opinion exists between different groups of farmers in society.

From the view point, the present study has been undertaken to answer the following research questions:

1. What is the farmers' perception about Eucalyptus tree cultivation as cropland agroforestry?

2. What are the farmers' selected characteristics that are related to their perception about Eucalyptus tree cultivation?
3. Is there any contribution between selected characteristics of farmers with the perception about Eucalyptus tree cultivation?

1.3 Specific Objectives

In order to find proper direction of the present study, the following specific objectives were formulated:

1) To describe some selected characteristics of the farmers which are related to eucalyptus plantation. The characteristics are :
    i) Age
    ii) Education
    iii) Family size
    iv) Total land area
    v) Income sources
    vi) Training exposure
    vii) Duration of involvement with eucalyptus cultivation
    viii) Land use pattern
    ix) Farmers opinion on prospect of eucalyptus tree
2) To assess the farmers' perception on Eucalyptus tree plantation
3) To explore the contribution of selected characteristics of the farmers to their extent of perception on Eucalyptus tree plantation.

1.4 Justification of the Study

Nevertheless the eucalyptus have great potential for wood production as well as for the provision of some services, which could be increased plantations. Plantation programs could be promoted through the use of incentives, as has happened elsewhere in Bangladesh.

No development programs with eucalyptus species or any other species can succeed, however, without awareness of the political processes necessary for success including reliable information, participation in decision-making and management by farmers and careful planning and evaluation of the social consequences of environmental and economic effect.

The development of the agroforestry sector has brought substantial benefits, not only for the farmers who have cultivated eucalyptus tree as a large scale and consequently realized a combined increase in income in this sector but also for the government.

It is therefore, urgently necessary to devise ways and means to increase production by identifying the problems and by minimizing the problems.

So the findings may however, be useful to the eucalyptus research personnel, government policy maker and development workers for further study about eucalyptus tree cultivation in Bangladesh.

1.5 Assumptions

An assumption has been defined as "the supposition that an apparent fact or principle is true in light of the available evidence" (Goode, 1945). An assumption is taken as a fact or belief to be true without proof. So the following assumptions were in mind of the researcher while carrying out this study:

i) The respondents included in the sample were capable of furnishing proper responses to the questions of the interview schedule.

ii) Views and opinions furnished by the respondents were the representative views and opinions of the whole population of the study.

iii) The responses furnished by the respondents were reliable and they truly

expressed their opinions on the perception about Eucalyptus tree cultivation.

iv) The data collected by the researcher were free from bias.

v) The researcher who acted as the interviewer was well adjusted to the social and cultural environment of the study area. Hence, the respondents furnished their correct opinions without any hesitation.

vi) The respondents had almost similar background and seemed to be homogenous to a great extent.

vii) The information sought by the researcher revealed to the real situation

viii) The findings were useful in choosing the clients as well as for planning execution and evaluation the agroforestry programme.

1.6 Scope and Limitations of the Study

The present study was undertaken to have an understanding of the perception of the farmers on the eucalyptus tree plantation and contribution with selected characteristics of the farmers. The findings of the study will help for eucalyptus cultivated areas of Bangladesh where physical, socio-economic, cultural and geographic condition do not differ much from those of the study area. Thus, the findings are expected to be useful to students, researchers, government foresters, and particularly for planners for evaluating the importance of the research and further study of eucalyptus plantation. The findings may also be helpful to the agroforestry researcher, because there are potential opportunities that would arise in the future for improving the livelihoods of poor people in the region by providing income generating means.

Considering the usual problem of conveyance, time, physical facilities and co-operation of respondents, any scientific investigation undertaken by a student face and to make the study manageable and meaningful, it became necessary to impose certain limitations as mentioned bellow:

i. The study was confined to only three upazila namely Sadar upazila, Khaloo Upazila and Sherpur Upazila of Bogura district which may fail

to represent the actual picture of the whole situation as people develop their strategies according to the concrete situation they face.

ii. It is difficult to get exact information from the farmers as many of them are not enough educated.

iii. There were awkwardness situations at the data collection time. So, the researcher had to form proper rapport with the interviewees to collect accurate responses.

iv. Few scales, methods and statistical tests have been used in this study over a relatively short period of time.

v. The population for the study was kept confined to the heads of the family who regularly cultivated their land.

vi. There were many characteristics of the farmers but in the study only nine of them were selected for investigation due to the fewness of research time.

vii. For information about the study, the researcher depended on the data furnished by the selected respondents during their interview with her.

viii. Major information, facts and figures supplied by the respondents were applicable to the situation prevailing in the locality during the year 2018.

Thus, the findings are expected to be useful to students, researcher and particularly the government for formulating future plan about eucalyptus tree cultivation.

1.7 Definition of Various Terms

For clarity of understanding, certain terms frequently used throughout the study are defined and interpreted as follows:

Age: Age of a farmer refers to the period of time from his/her birth to the time of interview.

Education: Education of an individual farmer was defined as the formal education received up to a certain level from an educational institute (e.g. school, college and university) at the time of interview.

Family Size: Family Size refers to the total number of members including the respondent himself/herself, spouse, children and other dependents, who live and eat together in a family unit.

Annual family income: It refers to the total annual earning of all the family members of a respondent from agricultural and other non-agricultural sources (Services, business, daily labour etc.) during a year. It was expressed in Taka.

Land area: Land area refers to the total area on which a farmer's family carries on farming operations, the area being estimated in terms of full benefit to the farmer's family.

Training exposure: It refers to the total number of days attended by the farmers in his/her life to the various agriculture related subject matter.

CHAPTER II
REVIEW OF LITERATURE

The present study deals with farmers' perception about eucalyptus tree cultivation as cropland agroforestry. The purpose of this chapter is to review previous studies, opinions and observations of experts having relevance to this research. A systematic and comprehensive review supports a strong base for conducting any scientific research.

2.1 Concept of Perception

According to Webster's (1931) New-International Dictionary perception is any act or process of knowing objects, facts or truths whether sense experiences or by thoughts. It is also the references of sensation to an external object.

Conland (1968) defined perception as the content of sensory experience. He made a distinction between perception and sensation on the assumption that - sensation refers to the action by a receptor when it is stimulated and perception refers to the meaning given to the sensation. Sensation is the mosaic of stimulated receptors within the retina. Perception is the cognition or supposition added to the mosaic.

Ruch (1953) stated perception as the process of organizing and interpreting sensory data by combining them with the results of previous experience. It is a response, which in turn furnishes stimuli that elicit and steer further responses. Perception enables an individual to know how he stands in relation to the objects and conditions of the world about him and to act accordingly.

According to Iqbal (1963), perception is the process by which we observe the world of objects and other people. Perceiving is the activity of an organism. The individual brings along with him the influences of his experiences and his present needs and wishes as he faces the world. No one sees the world exactly as it is and an individual's perception depends partly on what he himself is.

Royee and Jones (1961) defined perception as the total sensory awareness of a material object present to the sense organs. It is a function of the central sense plus one or more of the special senses and usually also shows influence of the imagination and the other internal senses. In practice, it is impossible to know how much intellectual influence might also be there, but at least the term always refers to our total impression of a sensed object.

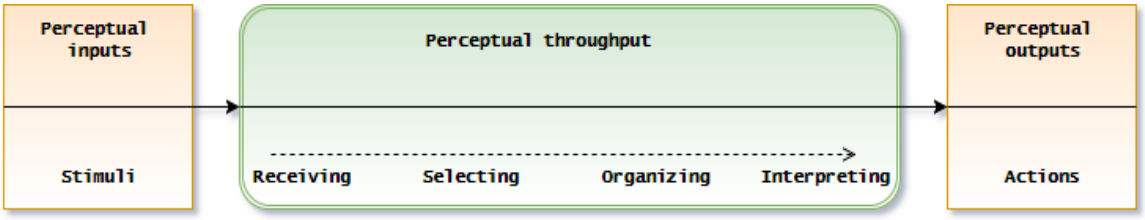
Vandalen (1973) stated that observation is sensation plus perception sensation is the immediate result of a stimulus to the sense organs. This information is not useful unless it is interpreted. Perception is the art of linking what is sensed with some past experience to give the sensation meaning. Meanings are in men's minds rather in the objects themselves. Hence, when looking at tile same objects, not everyone sees the same thing. Perceptions may be relatively simple or highly complex. They may involve a single sense organ or several senses.

Review of the concepts of different authors about perception indicates that perception reflects to the understanding of an individual about an object or a thing. Perception is influenced by several factors such as sensation, previous experience, needs and investigation. Perception may be relatively simple or highly complex. They may involve the single sense organ or several senses.

2.2 Perception Process

Perceptional Process

Perception is a process consisting of several sub processes. We can take an input –through output approach to understand the dynamics of the perceptual process. This approach emphasizes that there is input which is processed and gives output. The stimuli in the environment-objects, events, or people-can be considered as the perceptual inputs. The actual transformation of these inputs through the perceptual mechanism of selection, organization, and interpretation can be treated as the throughputs, and the resultant opinions, feelings, attitudes etc. which ultimately influence our behavior, can be viewed as the perceptual outputs. This simplified process of perception (Sarkar, 2017) in fig: 2.1

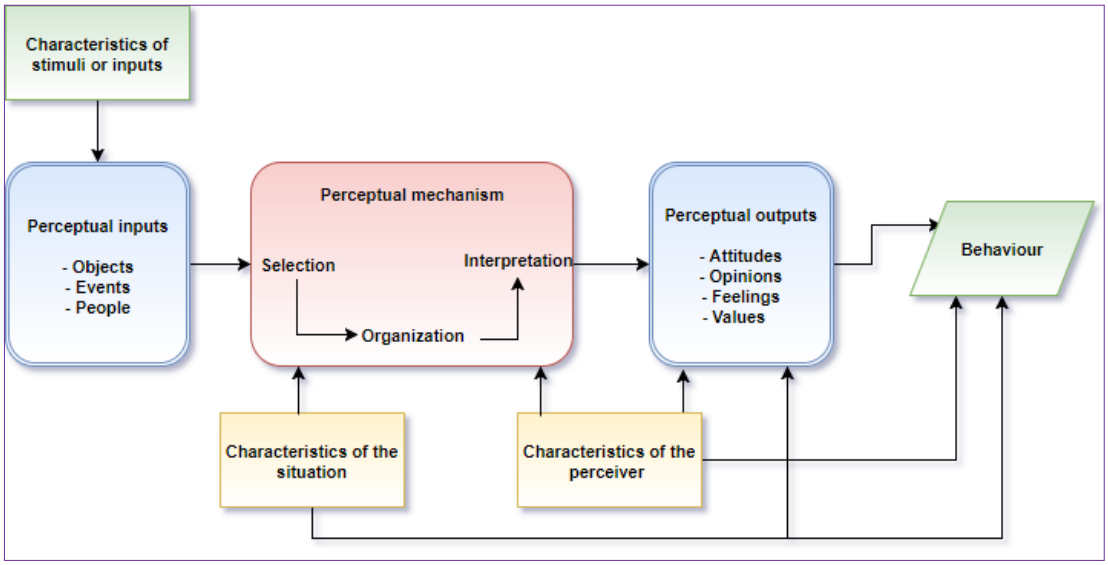


Simplified process of perception

Source: (Sarkar, 2017).

Figure 2.1 Simplified version of perceptual process

It does not present the whole factors which go in input-through output process of perception. Figure 2.1 presents a comprehensive view of process of perception.



Source: (Sarker, 2017).

Figure 2.2 Perceptual process presents three basic sub processes or elements of perception.

These are existence of stimuli, perceptual mechanism, and perceptual outputs. Perceptual outputs along with other determinants of human behavior affect and shape behavior. Let us we discuss how perceptual process works in terms of its three basic elements.

Perceptual Inputs

Strictly speaking, perceptual inputs in the form of stimuli are not part of actual perceptual process through these are necessary for the occurrence of perception. Stimuli may be in the form of objects, events, or people. Thus everything in the setting where events occur, or which contributes to the occurrence of events, can be termed as perceptual input. Further the characteristics of stimuli are important as these affect the extent to which the perceiver is attracted to these which affects the selection of stimuli for perception along with other variables affecting selection of stimuli like perceiver's characteristics and situational variables. When the perceiver interacts with a stimulus, sensation takes place which, we have seen earlier starts perceptual process.

Perceptual Mechanism

Perceptual mechanism involves three elements- selection of stimuli, organization of stimuli, and interpretation of stimuli.

Selection of Stimuli

After receiving the stimuli from the environment, some are selected for further processing while others are screened out because it is possible for a person to select all stimuli which he sees in the environment. There are two types of factors which affect selection of stimuli. These are external and related to stimuli and internal related to the perceiver. These external and internal factors are of several types. We shall discuss these factors and their impact on the selection of stimuli in the subsequent section of this chapter dealing with perceptual selectivity.

Organization of Stimuli

After the stimuli are received, these are organized in some form in order to make sense out of that. The various forms of organizing stimuli are figure-ground perceptual grouping, simplification, and closer.

Interpretation of Stimuli

The perceptual inputs that have been organized will have to be interpreted by the perceiver so that he can sense and extract some meaning of what is going on in the situation. People interpret the meaning of what they have selectively perceived and organized in terms of their own assumptions of people, things and situation. They also become judgmental as well and tend to interpret the thing as good/bad, beautiful/ugly and so on which are quite relative terms. In such a process, there are chances of misinterpretation. Interpretation of stimuli is affected by characteristics of stimuli, situations under which perception takes place, and characteristics of the perceiver. These factors also affect the total perceptual process.

Perceptual Outputs

Based on perceptual mechanism which ends with interpretation of stimuli, perceptual outputs emerge. These outputs may be in the form of covert actions development of attitudes, opinions, beliefs, impression about the stimuli under consideration. These outputs along with other factors affecting human behavior may result in overt behavior. For overt behavior to occur, perception is not the sole decider though it is important.

2.3 History of Eucalyptus in Bangladesh

In the 1930's *Eucalyptus citriodora* Hood was haphazardly introduced into eastern Bangladesh by tea estates as an ornamental (Davidson and Das, 1985; Zabala, 1990). The species was spread widely by botanists, foresters and gardeners but no plantation was established. First interest on other species of eucalypt was recorded in 1963 when germination tests of three species *E. citriodora, E. tereticornis* and *E. botryoides* were made in the silvicultural research stations at Mymensingh and Chittagong (Davidson and Das, 1985). From then on until 1984 about 37 species were introduced and tried (Islam and Neven, 1989). After five years of experimentation, the Bangladesh Forest Research Institute in Chittagong arrived at the conclusion that *E. camaldulensis Dehnh, E. tereticornis, E. brassiana* S.T. Blake, could be profitably grown in

the soil and climatic conditions of Bangladesh (Das, 1984). Since then small scale planting on degraded lands and roadside have been initiated. Initially spacing was 3m x 3m, later reduced to 1m x 1m to maximize production. Actually eucalypt were introduced in this subcontinent much earlier than Bangladesh, for instance, in 1867 in Pakistan, in 1919 in India (Chaturvedi, 1983). At present eucalypt planting around the world extends to about 80 countries and another 50 countries are in trial phases.

2.4 Need for Eucalyptus

Bangladesh, with more than 110 million population over an area of 14.3 million (mil.) ha is highly populated, 764 persons per square km. About 83% of the total population live in rural areas. The country is mostly composed of flood plains except some hilly areas along the eastern and north eastern boundaries and upland terraces on the central and north western regions. Of the total land area 0.93 mil. ha are waterways, 8.5 mil. ha cropped area, 2.67 mil. ha uncultivated land and 2.2 mil. ha declared Forest Land. However, only 0.93 mil. ha (6.5%) is under tree cover, some 40% of the Government controlled forests (UNDP/FAO, Global Environmental Monitoring System 1983-84; Huq and Banik, 1992). The remaining 60% Government forest includes denuded grasslands, scrub and encroached lands. The forests are unevenly distributed and of low productivity types because of their heterogeneous character.

The homestead village woodlots currently supply 53% of annual consumption of timber, fuelwood and bamboo in Bangladesh (FMP, 1992). Dependence for this produce on the village woodlots is almost 100% in non-forested areas (FMP, 1992). As a result, a substantial decline in tree cover is also common in rural areas. Though there are several causes of forest decline, over exploitation to meet industrial and domestic demand is the most important. A large tract of forest land, Unclassed State Forests (USF) of Chittagong Hill Tracts, has become barren and degraded due to shifting cultivation and over exploitation. Reserve Forests of Rangkheong, Chittagong were depleted by 61% between the years 1963 to 1983 (Chowdhury and Hossain, 1989) promoting further

deterioration of the environment. As eucalypts have adaptation potential to degraded areas and grow faster than many native species, the country has been raising eucalypt plantations largely on degraded sites.

2.5 Present Status of Eucalyptus

Three species, *E. camaldulensis, E. tereticornis* and *E. brassiana* have proved superior to over 30 others tried in the country (Davidson, 1985). With these species Petford, Mt. Garnet and Coen provenances respectively are the best ones. After 5 years of growth, mean annual increment per ha ranged from 11.7 to 95.6 m3 for Petford, 4.9 to 66.6 m3 for Mt. Garnet and 7.3 to 34.2 m3 for Coen (Davidson *et al.* , 1985).Three species, *E. camaldulensis*, *E. tereticornis* and *E. brassiana* have proved superior to over 30 others tried in the country (Davidson, 1985). With these species Petford, Mt. Garnet and Coen provenances respectively are the best ones. After 5 years of growth, mean annual increment per ha ranged from 11.7 to 95.6 m3 for Petford, 4.9 to 66.6 m3 for Mt. Garnet and 7.3 to 34.2 m3 for Coen (Davidson et al. , 1985). The Petford provenance of *E. camaldulensis* has been planted widely in Bangladesh to supply fuelwood at a rotation of 6 years and, poles and posts at a rotation age of 12-18 years. Block plantations with eucalyptus currently cover an area of 6,500 ha (Latif, 1993). These plantations were established mainly on accessible lands of three hill Districts of Chittagong, Chittagong Hill Tracts and Sylhet in the east.

Seed for plantations are collected from provenance and growth trials of the Bangladesh Forest Research Institute. Keen interest is shown in raising eucalyptus along roadsides, homestead afforestation and rural marginal lands (TANDP). The Forest Department, NGOs and rural population are mainly involved in these plantings. About 10,000 ha of land are in agroforests, mostly eucalypt and acacias (TANDP). The proportion of eucalypts in these plantings is unknown but it may be assumed to be not less than 60% of the planted area.

In the hill Districts of Bangladesh of Chittagong, Coxs Bazar and Sylhet, where most of the forest areas are located, some eucalypt plantations have been established; areas established from 1985-92 (Latif, 1993).

2.6 Prospects for Expansion

Eucalyptus cultivation objectives are restricted to production of fuel wood, poles and posts only. The species have potential for the production of raw materials for industries, pulp wood industries; plenty of land is still available for tree planting.

The central and the NW regions contain 50,181 ha of tree cover though the total notified forest areas in these regions are estimated as 113,654 ha (Chowdhury, 1993). These forest areas are scattered, small patches and they are under heavy exploitation pressure. As a result the areas are ecologically fragile and need restocking and proper management to balance extraction with planting. Cultivation on these areas alone will not lessen the pressure on natural tree cover; cultivation in marginal lands is also important and some 31,573 km of road and highways are still available for strip plantations in 61 non forested Districts in Bangladesh (Chowdhury, 1993).

These marginal lands are suitable for eucalyptus cultivation. Marginal lands in some cases can be planted in multiple rows whereas feeder roads cannot be planted by more than one row. Karim (1991) has calculated that Bangladesh can establish energy plantings along highway and feeder roads which are equivalent to 988,000 ha and thereby produce energy which is roughly 20 times more than crude oil imported annually. Moreover, 140,000 ha of land are available for energy plantations in the unclassed state forests of the south east.

Richards and Hassan (1989) studied the suitability of Bangladesh soil for growing eucalypt on land capability classes. About 456,000 ha were found suitable for eucalyptus cultivation (Richards and Hassan, 1989). These areas could produce 3-4 times more biomass and 6-8 times more stem wood on short rotations with eucalypt than the present forest crops (Munshi, 1986). Chowdhury (1993) studied growth potential of *E. camaldulensis*, *Acacia*

auriculiformis and *A. mangium* by a site index method of growth and showed eucalypt better than acacias (Chowdhury, 1993).

2.7 Farmers' Attitudes to Eucalyptus

The future of eucalypts in Bangladesh depends on their acceptability in society among different groups of farmers. To indicate the degree of acceptability, it is relevant to understand how farmer react with participatory forestry practices specially in woodlot and agroforestry plantations where eucalyptus are the major components of the systems. Farmers' participation is so far, encouraging in such plantation activity. The average participants in woodlot and agroforestry plantations are about one family per ha and farmers' participation is increasing day by day (TANDP).

Social surveys can also be an indicator of social acceptance of eucalyptus cultivation. Chowdhury (1993) interviewed people living in and near the forest and plantation areas to understand their preference in choosing species. Among the interviewee, 80% favored short rotation species, 15% favored combination of short and medium rotation species, whereas less than 2% respondents favored long rotation species; the rest did not have any choice or they did not understand about the choice. However, none mentioned fuelwood as the first priority but the majority advocated cash returns. It was found the majority prefer *E. camaldulensis to A. auriculiformis*.

The Swiss Development Corporation has been conducting research from 1986 on tree growing in the 'khet' (abandoned area) and has the experience of farmers favoring *E. camaldulensis*. In the D & D (Diagnosis and Design) survey, conducted by BARI, BRAC and ICRAF in 1991, it was reported that the tendency was to give lowest priority to trees in terms of resource allocation and management inputs, as farmers have little knowledge of production potential and management of trees. However, if they are motivated and provided with technology, they would prefer eucalyptus as their first priority species in agroforestry because of its better crown architecture suitable to their agricultural crops.

A third approach could be users' preference. With the increase in alternative uses of eucalyptus, acceptability will increase. For instance, cottage industry where about 75% of total industrial labour forces are employed (Chowdhury, 1993), depends on local timber species, bamboo, canes, and murta. Exotic species like acacias and eucalyptus are yet to be exploited in this sector. Though eucalyptus can be used in many secondary timber based industries as pulp, veneer, hardboard, particle board, matches and furniture it are not used for such purposes in Bangladesh. If the uses of eucalyptus are fully explored, and management techniques to increase production rate per unit land area are adopted, their acceptability will increase further in society.

2.7 Criticism of Eucalyptus

Eucalyptus planting is a controversial issue in some countries where it has been planted extensively. Critics assert that: i) it has deleterious effect on the hydrological balance; ii) it depletes the soil nutrients; iii) it has an allelopathic effect leading to inhibition of growth of other plants; and iv) it has a deleterious effect on native animals. This may be disputed by the reasoning that it is highly unlikely that a genus with outstanding evolutionary adaptation to infertile soils and a dry climate of Australia will use excessive water and nutrients.

Eucalypt as a single entity failed to take account of the great climatic and edaphic diversity of the Australian continent. There are more than 600 eucalyptus species differing in inherent growth rates, environmental adaptation to low nutrient soils, and dry climates. Within the Australian forests site factors exert a strong control on species composition, stand structure, leaf area index and productivity. As each unit of forest in Australia is in balance with the particular characteristics of the site, the eucalyptus are not making excessive demands on the resources of that site.

Where a eucalyptus is planted in countries other than Australia, it is removed from it is regulated environmental context, and the checks and balances imposed by site no longer apply. For example, *E. camaldulensis* occurs naturally as a woodland in dry areas over most of the Australian continent

where the rate of water use is hardly an issue in the Australian circumstances (Florence, 1992), it could become an issue where it is established elsewhere as a forest on moderately fertile soil with good rooting depth and access to a water table.

2.8 Attributes of Introduced Eucalyptus

It is important to understand the attributes of eucalyptus cultivation in Bangladesh to understand their environmental consequences. The most outstanding eucalyptus introduced are *E. tereticornis* and *E. camaldulensis*. These species, including others introduced elsewhere as exotics, as *E. grandis* and *E. urophylla* in the Indo-Malaya region, tend to have a number of characteristics in common:

(a) They belong predominantly to the subgenus Symphyomyrtus - individual members of which may be characterized by a wider environmental tolerance than members of other subgenera.

(b) They are the more successful species capable of responding more positively to better soil conditions - particularly higher soil fertility.

(c) They are capable of rapid root development, particularly in depth. This may be a general attribute of eucalyptus growing, or capable of growing, away from moist regions.

(d) The species usually reach early and strong peaks in current annual volume increment (CAI). This peak may be as early as 4 years in *E. tereticornis*, 6-7 years in *E. grandis* and 12-15 years in *E. globulus*. By the time the peak is reached wood volume production on high quality sites may be in the range of 24 m3/ha/yr for *E. tereticornis* to 50 m3/ha/yr for *E. globulus* (Florence, 1992).

The controversial effects of eucalyptus on environment should be seen with respect to its attributes, and high productivity within a short duration.

2.9 Allelopathy and Eucalyptus

It is widely held in some countries, notably India, that eucalyptus are strongly allelopathic; that they produce foliar and root exudates directly toxic to other plants. This may not be true in all cases. It is more likely that the effect of eucalyptus on understory plants or adjacent crops are the result of the very great capacity of eucalyptus to compete for short supply soil resources (nutrients and water). Where soil resources are not in short supply the understory vegetation may be maintained under a vigorous tree canopy.

In India Dabral *et al* (1987) found an undergrowth vegetation of *Lantana spp*., *Murraya koenigii, Carissa karonda, Jasminum officinale, Mallotus philippensis* and *Syzygium cumini* under 16 year old Eucalyptus hybrid plantation, at spacing 2m x 2m, at an experimental site near Dehra Dun Forest Research Station. In our forest conditions undergrowth develops, especially if spacing is more than 1m (Bhuiyan, 1986). It has been observed undergrowth under eucalyptus plantings at 1.8m x 1.8m spacing but the diversity is less than of native forest types. The composition observed could have been disturbed by weeding, ground fire and shrub collection of local people and a confirmation study of the diversity of undergrowth need to be made under suitably undisturbed eucalyptus plantation.

Lisa and Michelsen (1993) reported in Ethiopia that eucalyptus leaf exudates have some inhibitory effect on germination, and on reduction of shoot dry weight of four crops tested; they state an allelopathic potential rating from lower to higher as *Cupressus lusitanica* < *E. globulus* < *E. saligna* < *E. camaldulensis*. This type of exudate allelopathy may be controlled by management techniques under rainfall conditions of Bangladesh.

2.10 Nutrient Depletion by Eucalyptus

During the rapid biomass accumulation phase, fast growing eucalyptus will accumulate a store of nutrients in the phloem and sapwood (7-10 years of growth). This nutrient is withdrawn very efficiently from the cells at heartwood formation and maintained in a mobile phloem - sapwood pool (Banks, 1992).

As there is a very low residual concentration of nutrients in the heartwood, the mature stand in the natural environment manages on a much smaller biomass nutrient pool than in a forest of comparable productivity elsewhere. A large tree will have a thin shell of relatively nutrient rich active tissue surrounding an inert bole wood mass. The tree can be felled and removed at low nutrient cost to the site, i.e. a small amount of nutrient is exported per unit weight of wood. Alternatively where the stand is grown in well stocked plantations and harvested on short rotations (e.g. 6-10 years), there may be a substantial nutrient cost to the site. Pande *et al* (1987) reported harvesting of utilizable biomass (bole, bark and branch) at age 10 years in Kerala Forest Division, India, results in the removal of 52% nitrogen (N), 70% phosphorus (P), 66% potassium (K), 78% calcium (Ca), and 67% magnesium (Mg); the removal of N, P, K, Ca and Mg will be 42%, 55%, 54%, 61% and 56% respectively in the Madhalli Afforestation Center at the age of 7 years. A major depletion of site nutrient is caused by early removal of the crop, rather than to deleterious effect of eucalyptus plantations. The site nutrient depletion by early biomass removal may also vary from site to site and species to species at a particular age of harvest. Yet, scientific opinion is, that such cost may still be no greater than what of other fast growing tree species.

The nutrient accumulation is generally greater in species with a comparatively larger crown biomass relative to stem size. The ranges of nutrient accumulation in E. camaldulensis was established by Hopmans et al (1990) . A considerable amount of N accumulated in the leaves and twigs of eucalyptus can be left in the forest environment, and would compensate for the loss to some extent but in case of other macro nutrients some corrective measures may have to be taken. This is very important, especially in the case of eucalyptus, because nutrient content in the litter of eucalyptus is lower than other species as they usually absorb nutrients before the shedding of litter (Banks, 1992). Sing et al (1989) state that the litter of Populus deltoides contains 1.3 times more N and 1.5 times P and K than of E. hybrid. Additions of N, P and K to the soil through

litter decomposition was respectively 36.6%, 91.6% and 69.9% more in P. deltoides than the E. hybrid. Moreover, litter fall was 5 kg per tree per year for P. deltoides whereas for E. hybrid it was only 1.5 kg. Bahuguna (1991) reported that litter decomposition is faster under eucalyptus than under 'Sal'. In Bangladesh the loss of soil nutrient may be more severe as the litter layer and the leftover debris on the forest floor are regularly harvested. If we consider these human factors and the early harvesting of eucalyptus, the depletion of soil nutrients by the deleterious effects of eucalyptus is not an established fact under the social conditions of Bangladesh.

2.11 Water Use by Eucalyptus

Claims are made that eucalyptus use excessive amounts of ground water by developing a deep root system. In dry areas, though eucalyptus develop long deep tap root in moist areas, they mostly develop fibrous roots (Zimmer and Grose, 1958). Dabral *et al* (1987) observed that the fibrous root of eucalyptus extend up to 18 m within a soil depth of 30 to 60 cm in moist areas. When moisture content varies at different localities of a site, eucalypts may try to maintain growth by extending root systems in drier areas. An observation on height growth of *E. camaldulensis* at top hill and valley shows that first year growth was significantly different from the top to the valley but from the second year height growth was not significantly different (Anon, 1992). This adjustment could have taken place by differential expansion of the root system by eucalyptus for enough moisture. A supportive statement to this effect is noted by Pal and Raturi (1991). They studied the dry biomass production of E. hybrid in a semiarid environment under rainfed condition. The stand was divided into three classes according to the height growth of the species and found that at the age of three, the lowest class produced 31.8% root biomass whereas the highest class and the middle class root biomass was 21.0% and 26.7% of the total biomass respectively. The higher root development of suppressed trees may be to capture more moisture from the soil to maintain the physiological need and hence growth potential to compete with the dominant

trees. However, the following points can be made against the statement of excessive water use:

(a) Florence (1992) mentions that in a regrowth forest of *E. regnans*, a strong early peak in CAI (current annual increment) water yield declined for some 25 years before beginning to rise again. The pattern is closely related to the pattern of volume production for this species, that is, a peak in CAI occurs around 20 years.

(b) Some eucalyptus which are widely planted as exotics, have even faster early growth rates than *E. regnans,* and a strong early peak in CAI, e.g. *E. tereticornis, E. grandis, and E. camaldulensis*. Where these species are planted on high quality sites with access to a good soil water resource, high rates of water use might be anticipated at an early age.This is expressed, for example in the rapid decline in stream flow as early as 6 years on an *E. grandis* catchment in South Africa (Florence, 1992).

(c) It is possible that where one of the more opportunistic of the faster growing eucalyptus (e.g. *E. camaldulensis*) has access to a substantial water resource (e.g. a water table at 1 to 2 m), and where there is a prolonged dry period with high vapor pressure deficits, large amounts of water may be transpired. In this case, water use efficiency may be low. This may explain why *E. camaldulensis* has sometimes been planted to help drain or control swamps (Florence, 1992).

2.12 Management Strategy of Eucalyptus

Appropriate management techniques could improve the social and environmental consequences of the use of eucalypts in Bangladesh. For example, thinning a stand will reduce water use and increase stream flow at least temporarily. Thinning may remove those trees which are more inefficient user of water (e.g. transpiring but producing little wood). Indeed, in the jarrah forest of Western Australia, a heavy thinning to retain the better trees resulted in both increased wood production and increased stream flow (Florence, 1992).

In our condition one option might be to thin early for fire wood production and maintain the residual trees over a longer rotation of pulpwood production. For fast growing eucalypts, it is surprising how small the stocking may be, yet, produce maximum site volume production.

Eastham (1990) studied the relationship between stem density and water use efficiency with 2,150, 304 and 82 stems per ha to relate transpiration with biomass production. Tree density modified biomass production and water use of trees, with both being consistently lower at the higher densities throughout the study. Values varied both with season and with year. This means that selection of a suitable stem density in a stand may help in water management for efficient use.

Crop improvement may be another strategy to minimize the consequences. In Bangladesh, though there were some provenance trials for selection, no seed orchard has been established. Local and rural nurseries use seed from provenance trial plots and distribute these for planting. As a result projected yields from the planting are not available in the field from these inbred seedlings, and lead to social disparities. A seed orchard designed to hybrid production, and clonal propagation from selections may improve the yield and protect land race formation.

The hybrids and clones can be planted in small patches with native species forming a mosaic of mixed stands may solve the problems of allelopathy and wildlife diversity, while at the same time, productivity can be maintained. Appropriate research should be taken on this line

2.13 Multiple Uses

Small scale farmers consider eucalyptus as a Nature’s gift; as a contribution to retirement owing to the different benefits it provides assisting in their daily livelihoods expenses. As FAO (2002) reported, eucalyptus is preferred by small holder farmers particularly on account of the following basic services;

- It is used for fuel woods for developing countries like, Ethiopia where the other energy source is not available or affordable (even if it is there like electricity not affordable for each poor households).
- Its uses as construction material, such as: as poles and stakes for construction of house, fencing, transmission pole, It can be used for making farm utilities (equipment).
- It generates income with a comparatively good cash-flow since it produces yield with a short period of time. Therefore, it is used as a cash crops by farmers to cover some of their daily overheads (costs).
- It can be used for production of charcoal.
- Farmers also suggests that planting of eucalyptus is the management strategy to prevent soil from being eroded or as an erosion controlling mechanism.
- Eucalyptus is also used as, shelter belt and wind break (Selamyihun, 2009; Lemenih, 2004).

Because of its fast growing characteristics, farmers prefer eucalyptus to solve the growing demand for wood and wood products. For the reason of its various benefits farmers started to change even their fertile farm land to eucalyptus plantation currently to generate income and address the ever-increasing shortage of wood products (Nyssen, 2004; Dessie, 2011). With a proper planning for management and a good access of local market eucalyptus has comparatively good capacity to increase the income level of small scale farmers in addition to its role for alleviating farmers' constraints of fuel wood, construction materials and farm equipment. From dense plantation and increased density after coppicing, small-scale farmers used to plan thinning programs that give wood for construction and fire wood before the final felling (Selamyihun, 2009).

In addition eucalyptus has a social value as its widespread use create employment opportunity for women and youths in rural areas where there are few other opportunities. Kelemu and Taddesse (2010) discovered that planting

of eucalyptus create job opportunities for females (about 60%) compared to males starting from seed collection up to the final logging. For example, raising seedlings digging holes, weeding, carrying logs and collection of remains of logs like branches, leaves, barks, etc is mostly done by females. Hence, smallholders in Ethiopia prefer to plant eucalyptus due to its positive influence on their livelihood, and the contribution to job opportunities for all ages and particularly for women. There is no other exotic tree species that can play such a vital role for farmers benefit at such a large scale (Gamachu, 1977; Whitesell, 1992; Bone, 1997; Yirdaw and Luukkanen, 2003; Jagger and Pender, 2003; Selamyihun, 2009).

2.14 Eucalyptus Decrease Biodiversity in the under Growth

Even if eucalyptus has an allelopathic effect there is no concrete evidence and agreement that prove its detrimental effect on the undergrowth species. On the contrary some studies show that regeneration of undergrowth species is better under eucalyptus than other exotic tree species and natural forest (*C. lustinica, and P. patula*. On the other hand Lemenih (2005) study the undergrowth of different species of eucalyptus plantation and natural forest and found that the condition for under growth is more conducive in natural forest for shade tolerant plant species (52 species) compared to eucalyptus (46 species); the density of understory growth in eucalyptus was 3282 stem per ha and that of natural forest 4122 stem/ha. This difference is too small compared with the livelihood benefit eucalyptus gives to smallholders and to justify a ban of eucalyptus.

The species growing under eucalyptus plantation at its younger stages are mainly grasses (Loumeto and Huttel, 1997) but when older (more than 10 years) the under growth include different woody species, shrubs and herbs. In relation to water consumption Poore and Fries (1985) reported that eucalyptus are not a good biological conservation methods both for soil and water since the ground cover of under storey plant species is suppressed by the roots of

eucalyptus. On the contrary Tesfaye (2009) argue that if eucalyptus is planted in a wider space it favor the under growth , allowing the entrance of light to the surface that almost all plant species needs to grow, therefore it helps to protect soil erosion (runoff) if planted at the right spacing. Michelsen and Lisanework (1993) analysed the impact of eucalyptus species (*E. camaldulensis* and *E. Saligna*) and *C. lustinica* on different crops showing a negative impact on the germination and growth of wheat, teff, chick pea, and maize attributed to the allelopathic effect the eucalyptus leaves. The toxicity proved higher in eucalyptus leaf compared to *C. lustinica*. Similarly, Jagger and Pender (2000) stated that eucalyptus have a negative impact on agriculture production (result reduction of crop yield) also attributed to allelochemicals production. In Congo, Loumetto and Huttel (1997) found that until the age of 10 years eucalyptus have allelopathic impacts, especially on the regeneration of woody species. However, this effect did not prove significant beyond ten years. On the contrary, in Brazil eucalyptus could not reveal any negative impact (colonization) on the understory regeneration of plant species (Loumetto and Huttel, 1997). In Ethiopia, *E. grandis* used as shades in coffee plantation (Alem and Weldemariyam, 2010) had a density of coffee stems nearly similar to that of the natural forest (1022 stems per ha in eucalyptus plantation and 1042 stems per ha in natural forest). Proper land use and planning is used to protect the allellopathic effect of eucalyptus including other exotic tree species particularly in areas with poor rainfall and unfertile soil that limit growth and in turn increase its competitiveness with the crops (Malik and Fries, 1985). Several studies approves that there is no special factors that makes eucalyptus different from other exotic and endogenous tree species in relation to the undergrowth of various species like shrubs, climbers, herbs and other tree species. Comparatively better under storey is found under eucalyptus compared to that under other tree species (especially from exotic once) giving increasing evidence to conclude that eucalyptus has no particular negative impact on the under storey growth (Loumetto and Huttel, 1997). In some other studies

understory regeneration is by far better in terms of diversity and richness in natural forest compared to that of eucalyptus.

Small scale farmers are aware about the negative impact of eucalyptus specially if it is planted as a boundary around the farm land close to the cultivated fields. The distance between the crops and tree should be more than 12 meter; if it is less the crop yield will be negatively affected due to chemicals released from the eucalyptus leaves. Even if there is compensation from eucalyptus production it will not make up for the loss in crop yield (Lisanewerk and Michelsen 1993). To improve the biodiversity under eucalyptus plantation it is vital to take the management into consideration.

2.15 Conceptual Framework

In view of the prime theme of the study, the researcher constructed a conceptual framework which is self- explanatory and is presented in Figure 2.3.

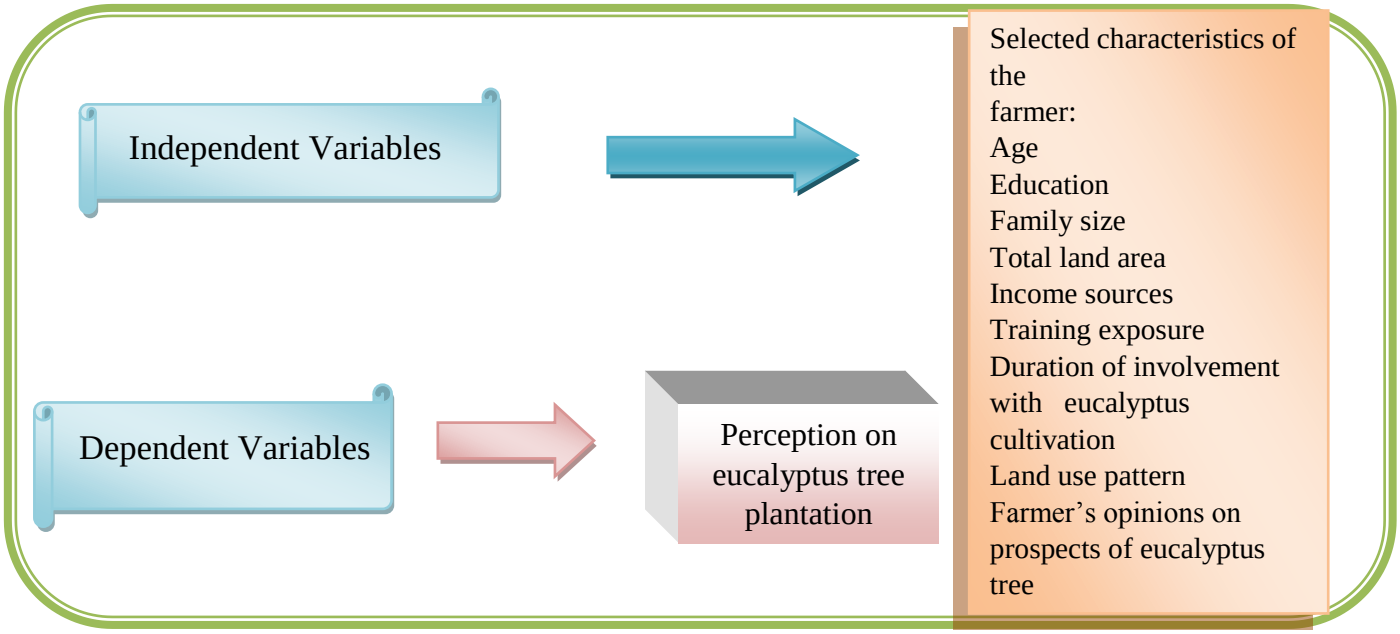


Figure 2.3 Conceptual framework of the study

CHAPTER III

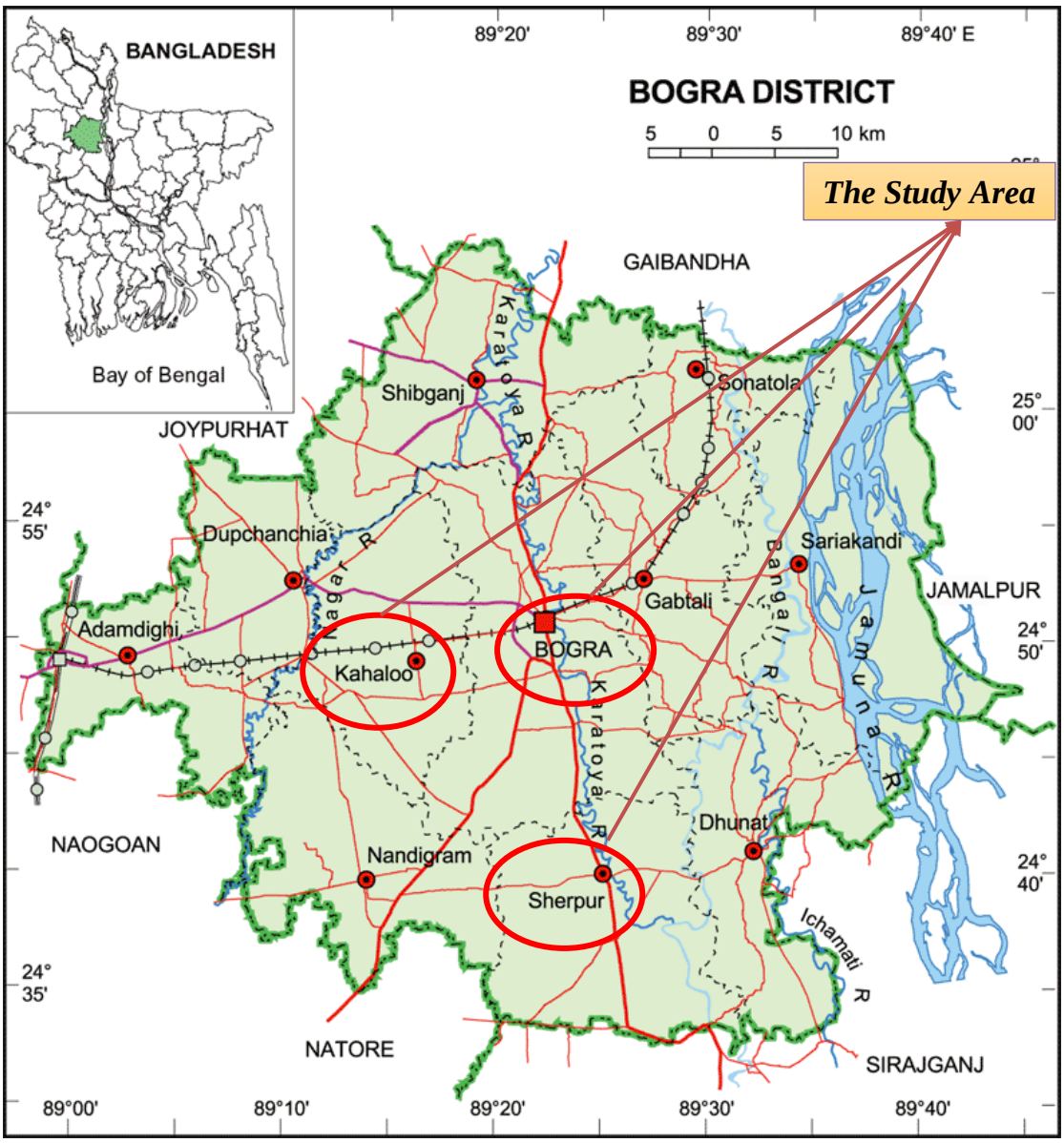
MATERIALS AND METHODS

Materials and methods have an important role in a scientific research. A researcher should be very careful for formulating methods and procedures in conducting the research for the fulfillment of the objectives. Research methodology is a structured set of guidelines or activities to generate valid and reliable research results. This Chapter describes the research methodology and procedures used to collect and analyze the data and attaining the purposes of the research. A chronological description of the materials and methods followed in conducting the research work has been presented in the succeeding part of this chapter:

3.1 Locale of the Study

Bogura is a northern district of Bangladesh, in the Rajshahi Division. It is called the gateway to North Bengal. Bogura district was a part of the ancient Pundravardhana territory and the ruins of Mahasthangarh, the ancient capital of Pundravardhan, are located north of Bogura. The present study was conducted in Bogura district which is divided into 12 upazilas. Mainly considering the farm families engaged in eucalyptus tree cultivation, the study was conducted in three (3) upazilas named Bogura Sadar, Kahaloo and Sherpur upazila under Bogura District, which were considered as the study area. The site was purposively selected as locale of the study. Five (5) villages (Fapore, Patitapara, Karal, Belghari, Shohordighi) of Bogura Sadar upazila, Five (5) villages (Dorgarhat, Bishnopur, Bakra, Joytul, Girail) of Kahaloo upazila and Five (5) villages (Vobanipur, Ambail, Aramsham, Jamail, Krishnopur) of Sherpur upazila were randomly selected for conducting this research.

The map of the Bogura district has been presented and showing the study area Bagura Sadar, Kahaloo and Sherpur upazila in Figure 3.1.



Source: (Banglapedia)

Figure 3.1 Map of Bogura district showing the study area.

3.2 Population and Sample of the Study

3.2.1 Population

People who engaged in eucalyptus tree plantation and permanently reside in the selected villages of Bogura Sadar, Kahaloo and Sherpur upazila constituted the active population of this study. Updated lists of all farm families were prepared with the help of SAAO, ideal farmer, personnel of social forest office (Bogura district) and local leader. As all population of the study area could not possible to measure, head of the farm families of eucalyptus tree cultivator of the selected villages were the population of the study. The total number of eucalyptus tree cultivator in selected fifteen villages was 404 which constituted population of the study.

3.2.2 Determination of sample size

The population size was 404.

Respondents were randomly selected as the sample of the study by using random number table. The sampling size was determined by using a standard formula. In calculating sample size 12% marginal error was chosen from the following formula (Moral, 2011). Thus the sample size is 60.

$$n = \frac{N}{1+Ne^2}$$

Where, n (sampling size) = 60

N (Population size) = 404

e (margin of error) = 12%

3.2.3 Distribution of the population, sample size and reserve list

The respondents comprised of 60 eucalyptus tree cultivators. A reserve list of 15 respondents was also prepared so that the eucalyptus tree cultivators of this list could be used for interview if respondents included in the original sample were not available at the time of interview. However, representative sample from the population were taken for collection of data following proportionate random sampling technique. The distribution of the population, the number of

sample size and number of respondents along with the reserve list are given in the following Table 3.2.

Table 3.2 Distribution of the respondents according to population, sample size and reserve list

Selected district	Selected upazila	Selected villages	Population	Sample size	Reserve list
Bogura	Bogura Sadar	Fapore	26	4	1
		Patitapara	24	3	1
		Karal	35	5	1
		Belghari	25	4	1
		Shohordighi	30	5	1
	Kahaloo	Dorgarhat	25	4	1
		Joytul	20	3	1
		Bishnopur	27	4	1
		Bakra	32	5	1
		Girail	26	4	1
	Sherpur	Vobanipur	24	3	1
		Ambail	22	3	1
		Aramsham	26	4	1
		Krishnopur	34	5	1
		Jamail	28	4	1
Total			404	60	15

3.3 Data Collecting Instruments and Procedure

3.3.1 Data collecting instruments

In order to collect valid and reliable data from the respondent farmer, an interview schedule (questionnaire) in English version was designed keeping the objectives in mind. The English version of interview schedule has been enclosed in Appendix-I.

For obtaining information, simple and direct questions and different scales were used. Both open and closed form questionnaire was included in interview schedule to obtain information. From the study area, the interview schedule was pre-tested with 10 sample respondents. Questions were asked systematically and explanations were made according to necessary. The interview session was conducted at the leisure time of the respondent by using local language to the extent possible so that they can give accurate information in a cool brain.

3.3.2 Procedure of data collection

The researcher collected data through personal interview schedule from the sampled eucalyptus tree cultivators of the selected villages. The researcher met the respective Divisional Forest Officer (DFO), Upazila Agriculture Officer (UAO), Agriculture Extension Officer (AEO) and the concerned SAAO before starting collection of data. The researcher also discussed the objectives of the present study with the respondents and above mentioned officers and requested them to provide actual information. A rapport was established with the respondents so that they feel easy to answer the questions. Very good cooperation was obtained from the field extension workers and the local leaders. The interviews were made individually in the houses of respondents. Questions were asked in different ways so that the respondents could easily understand the questions. Whenever a respondent faced difficulty in understanding any questions, care was taken to explain the same clearly with a view to enabling him to answer it properly.

Before going to the respondent's home for interviewing they were informed verbally to ensure their availability at home as per schedule date and time. In case of failure to collect information from the respondents due to their other business, revisit was made with prior to appointments. If any respondent failed to understand any question, the researcher took great care to explain the issue. If the respondents could not clear about what was wanted to know then

supplementary questions were asked for further clarification. The researcher received full cooperation from the respondents during the time of interview. Data were collected from 10 January, 2018 to 20 March, 2018.

3.4 Variables and their measurement techniques

The variable is a characteristic, which can assume varying, or different values in successive individual cases. A variable is any characteristics which can assume varying or different values are successive individuals' cases (Ezekiel and Fox 1959). In the scientific research, the selection and measurement of variable constitute a significant task. Following this conception, the researcher reviewed literature to widen this understanding about the natures and scopes of the variables relevant to this research. The variables were selected which include age, level of education, family size, effective farm size, annual family income, experience in eucalyptus cultivation, training exposure, extension media contact, level of aspiration in life, organizational participation, knowledge on eucalyptus cultivation technologies. The methods and procedures in measuring the variables of this study are presented below:

3.4.1 Age

Age of the farmers was measured in terms of actual years from their birth to the time of the interview, which was found on the basis of the verbal response of the farmers. A score of one (1) was assigned for each year of one's age. This variable appears in item number 1 in the interview schedule as presented in Appendix-I.

3.4.2 Education

Education was measured by assigning score against successful years of schooling by a farmer. One score was given for passing each level in an educational institution. For example, if a farmer passed the final examination of class five or equivalent examination, his/her education score has given five (5). A farmer who can't read & write has given a score of zero (0). A person not knowing reading or writing but being able to sign only has given a score of

0.5. If a farmer did not go to school but took non-formal education, his educational status was determined as the equivalent to a formal school student. This variable appears in item number 2 in the interview schedule as presented in Appendix-I.

3.4.3 Family size

Family size of a farmer was determined by the total number of members in his/her family including him/her, children and other dependents. The scoring was made by the actual number of family members expressed by the farmers. For example, if a farmer had five members in his/her family, his/her score was given as 5. This variable appears in item number 3 in the interview schedule as presented in Appendix-I.

3.4.4 Total Land Area

Total Land Area of a farmer referred to the total area of land on which his/her family carried out the farming operation, the area being in terms of full benefit to the family. The data was first recorded in terms of local measurement unit i.e. kani or decimal and then converted into hectare. The total area, thus, obtained is considered as their total land area (assigning a score of one for each hectare of land). This variable appears in item number 4 in the interview schedule as presented in Appendix-I.

3.4.5 Income sources

The term other income source and income refers to the annual gross income of farmer and the members of their family from different sources. It was expressed in thousands taka. In measuring this variable, previous year total earning of an individual farmer was converted into score. A score of one was given for every one thousand taka was calculated. This variable appears in item number 5 in the interview schedule as presented in Appendix-I.

3.4.6 Training exposure

Training exposure of a farmer was determined by the total number of days agricultural training received in his/her life. A score of one (1) was assigned for each day of training attended. This variable appears in item number 6 in the interview schedule as presented in Appendix-I.

3.4.7 Duration of involvement with Eucalyptus tree cultivation

Duration of involvement with Eucalyptus cultivation of the farmer was determined by the total number of year involved in Eucalyptus cultivation. A score of one (1) was assigned for each year involvement with eucalyptus cultivation. Motivate for the first time in eucalyptus plantation and purposes of eucalyptus plantation are also measured in this section. This variable appears in item number 7 in the interview schedule as presented in Appendix-I.

3.4.8 Land use pattern

The respondents were asked to mention their response regarding to land use pattern at the time of eucalyptus cultivation. This variable appears in item number 8 in the interview schedule as presented in Appendix-I.

3.4.9 Farmer's opinions on prospects of Eucalyptus tree plantation

To determine this criterion, a number of 10 statements were randomly presented before the interviewees. A five-point scale was used to measure the prospects of Eucalyptus tree plantation of the beneficiaries. This scoring was done in the following manner: a score of 5, 4, 3, 2 and 1 was given for responses strongly agree, agree, neutral, disagree and strongly disagree, respectively and summed up and the final score was determined. The range of final score is ten (10) to fifty (50) where ten (10) indicate poor prospects and fifty (50) indicate the highest or favorable prospects of Eucalyptus tree plantation of the beneficiaries. This variable appears in item number 9 in the interview schedule as presented in Appendix-I.

3.4.10 Perception on Eucalyptus tree plantation

Perception about Eucalyptus tree plantation as cropland agroforestry of a respondent implies to his beliefs, outlook, and action tendencies. To determine this criterion, a number of 12 statements (6 positive and 6 negative) were randomly presented before the interviewees. A five-point scale was used to measure the perception of the beneficiaries. This scoring was done in the following manner: For positive statements a score of 5, 4, 3, 2 and 1 was given for responses strongly agree, agree, neutral, disagree and strongly disagree respectively. For negative statement, the opposite process was followed. All the scores for positive and negative statements were summed up and the final score was determined. The range of final score is twelve (12) to sixty (60) where twelve (12) indicate poor attitude and sixty (60) indicate highest or favorable attitude of the farmers towards Eucalyptus tree cultivation. This variable appears in item number 10 in the interview schedule as presented in Appendix-I.

3.5 Statement of the Hypotheses

As defined by Goode and Hatt (1952) a hypothesis is "a proposition which can be put to test to determine its validity. It may seem contrary to, or in accord with common sense. It may prove to be correct or incorrect. In any event, however, it leads to an empirical test."

3.5.1 Research hypotheses

In the light of the objectives of the study and variables selected, the following research hypotheses were formulated to test them in. The research hypotheses were stated in positive form, the hypotheses were as follows:

"Each of the selected characteristics of the farmers had contribution to the perception on eucalyptus tree plantation."

3.5.2 Null hypotheses

In order to conduct statistical tests, the research hypotheses were converted to null form. Hence, the null hypotheses were as follows:

"Each of the selected characteristics of the farmers had no significant contribution to the perception on eucalyptus tree plantation."

3.6 Data Processing

Data processing is an on-going part of data collection. After completion of field survey, all the data were coded, compiled and tabulated according to the objectives of the study. Local units were converted into standard units. All the individual responses to questions of the interview schedule were transferred in to a master sheet to facilitate tabulation, categorization and organization. In case of qualitative data, appropriate scoring technique was followed to convert the data into quantitative form.

3.6.1 Editing

The collected raw data were examined thoroughly to detect errors and omissions. As a matter of fact the researcher made a careful scrutiny of the completed interview schedule to make sure that necessary data were entered as complete as possible and well arranged to facilitate coding and tabulation. Very minor mistakes were detected by doing this, which were corrected promptly.

3.6.2 Coding and tabulation

Having consulted with the research supervisor and co-supervisor, the investigator prepared a detailed coding plan. In case of qualitative data, suitable scoring techniques were followed by putting proper weight age against each of the traits to transform the data into quantitative forms. These were then tabulated in accordance with the objective of the study.

3.6.3 Categorization of data

Following coding operation, the collected raw data as well as the respondents were classified into various categories to facilitate the description of the independent and dependent variables. These categories were developed for each of the variables by considering the nature of distribution of the data and extensive literature review. The procedures for categorization have been discussed while describing the variables under consideration in chapter IV.

3.7 Statistical Analysis

Data collected from the respondents were analyzed and interpreted in accordance with the objectives of the study. The analysis of data was performed using statistical treatment with SPSS (Statistical Package for Social Sciences) computer program, version 20. Statistical measures as a number, range, mean, standard deviation were used in describing the variables whenever applicable. Tables were also used in presenting data for clarity of understanding. Initially, Pearson Product Moment correlation was run to determine the relationship between the selected characteristics of the farmers with the perception about eucalyptus tree cultivation. To find out the contribution of selected characteristics of the farmers with the perception about eucalyptus tree cultivation, step-wise multiple regressions were used. Five percent (0.05) level of probability was used as the basis for rejection of a null hypothesis throughout the study. Co-efficient values significant at 0.05 level is indicated by one asterisk (*), and that at 0.01 level by two asterisks (**) and at 0.001 level or above by three asterisks (***).

CHAPTER IV

RESULTS AND DISCUSSION

The findings of the study and their interpretation have been presented in this chapter. These are presented in three sections according to the objective of the study.

4.1.1 Age

The age of the farmers has been varied from 27 to 61 years with a mean and standard deviation of 42.02 and of 8.74 respectively. Considering the recorded age, farmers were classified into three categories as presented in Table 4.1.

Table 4.1 Distribution of the farmers according to their age

Categories	Observed range	Number	Percent	Mean	SD
Young aged (≤ 35)	27-61	15	25	42.02	8.47
Middle aged (36-50)		31	51.7		
Old aged (> 50)		14	23.3		
Total		60	100.0		

Table 4.1 reveals that the middle-aged farmers comprised the highest proportion (51.7 %) followed by old aged category (23.3 %) and young aged category (25 %). Moreover, data also revealed that 76.7 % of the respondents in the study area were young to middle aged. This is because they are likely to be involved Eucalyptus tree plantation who are comparatively more energetic, prompt, enthusiastic and innovative than the older people in our community. The extension services like DAE, BRAC, PROSHIKA and others use young and middle aged farmers in technology diffusion and income generating activities.

4.1.2 Education

The educational scores of the farmers ranged from 0 to 12 with a mean and standard deviation of 5.27 and of 3.45 respectively. Based on the educational scores, the farmers were classified into five categories as presented in Table 4.2.

Table 4.2 Distribution of the farmers according to their level of education

Categories	Observed range	Number	Percent	Mean	SD
Can't read and sign (0)	0-12	3	5	5.27	3.45
Can sign only (0.5)		5	8.3		
Primary education (1-5)		23	38.4		
Secondary education (6-10)		26	43.3		
Above secondary (>10)		3	5		
Total		60	100.0		

Table 4.2 shows that farmers under secondary education category constitute the highest proportion (43.3 %) followed by primary education (38.4 %). On the other hand, the lowest 5% was in both can't read and sign and above secondary level. 8.3 % was in can sign only category. Education helps the farmers to face the adverse condition and adjust with unfavorable condition through reading leaflets, booklets, books and other printed materials in this case. Hence, it is expected that education is one of the important factors in Eucalyptus tree cultivation. Comparatively educated person is relatively more responsive to the technology and new innovation.

4.1.3 Family size

Family size of the farmers ranged from 3 to 8 with the mean and standard deviation of 5.62 and of 1.29 respectively. According to family size the farmers were classified into three categories as presented in Table 4.3.

Table 4.3 Distribution of the farmers according to their family size

Categories	Observed range	Number	Percent	Mean	SD
Small size (3-4)	3-8	14	23.3	5.62	1.29
Medium size (5-6)		32	53.4		
Large size (> 6)		14	23.3		
Total		60	100.0		

Table 4.3 indicates that the medium size family constituted the highest proportion (53.4 %) followed by the large size family and small size family (23.3 %). Hence, most of the village families are medium to large in size. Such finding is quite normal as per the situation of Bangladesh. The findings also indicate that average family size of the study area was bigger than the national average which is 4.85 (BBS, 2014).

4.1.4 Total land area

The total land area of the farmers ranged from 0.45 ha to 4.30 ha with a mean and standard deviation of 1.30 and 0.90, respectively. Based on their total land area, the farmers were classified into five categories following the categorization according to DAE. The distribution of the farmers according to their total land area is presented in Table 4.4.

Table 4.4 Distribution of the farmers according to their total land area

Categories	Observed range	Number	Percent	Mean	SD
Landless (≤ 0.02)	0.45-4.30	-	-	1.30	0.90
Marginal (0.021-0.20)		-	-		
Small (0.21-1.00)		29	48.3		
Medium (1.01-3.0)		28	46.7		
Large (> 3)		3	5.0		
Total		60	100.0		

Table 4.4 indicates that the small land area holder constituted the highest proportion (48.3 %) followed by medium land holder (46.7 %) and the only 5.0 percent were in large category land area. In Bangladesh, population is being increased day by day. But agricultural land does not increase with the increase of population. So, individual possess limited amount of cultivable land.

4.1.5 Annual income from eucalyptus plantation

The score of annual income from eucalyptus cultivation ranged from 105 to 720 thousand (BDT) with a mean and standard deviation of 2.2130 and 122.21, respectively. On the basis of annual income from eucalyptus plantation, the eucalyptus cultivators were classified into three categories as presented in Table 4.5.

Table 4.5 Distribution of the farmers according to their annual income from eucalyptus cultivation

Categories	Observed range	Number	Percent	Mean	SD
Low income (≤ 205)	105-720	31	51.7	2.2130	122.2
Medium income (206-410)		25	41.6		
High income (> 410)		04	6.7		
Total		60	100.0		

Table 4.5 revealed that the eucalyptus cultivators having low annual income constituted the highest proportion (51.7 %), while 41.6 percent farmers had medium income and 6.7 percent had high income. As a result, the most 93.3 percent of the respondents in the study area had low to medium annual income. Here, standard deviation is high because of the difference between the highest and lowest annual income.

4.1.6 Training exposure

Training exposure score of the eucalyptus cultivators ranged from 2 to 21 with a mean and standard deviation of 10.66 and of 5.03, respectively. Based on the training exposure score, the eucalyptus farmers were classified into three categories (Mean ± 0.5 Standard Deviation) as presented in Table 4.6.

Table 4.6 Distribution of the farmers according to their training exposure

Categories	Observed range	Number	Percent	Mean	SD
Low training (≤ 8)	2-21	27	45	10.66	5.03
Medium training (9-13)		15	25		
High training (> 13)		18	30		
Total		60	100.0		

Table 4.6 indicates that the highest proportion (45 %) of the eucalyptus farmers had low training exposure followed by 25 percent had medium training exposure and 30 percent had high training exposure. Findings show that majority (55 %) of the farmers possessed medium to high level of training on various aspects of eucalyptus tree plantation. The probable reason for this may be due to disseminate new technology more rapidly within the community. For eucalyptus tree plantation, farmers are encouraged to share their knowledge and experiences with other farmers within their local village and community organizations. Training helps the farmers about fertilizer management, soil management and crop management.

4.1.7 Duration of involvement with eucalyptus tree plantation

Duration of involvement with eucalyptus tree plantation scores of the farmers ranged from 3 to 24 with a mean and standard deviation of 9.70 and of 3.59 respectively. On the basis of duration of involvement with eucalyptus plantation scores, the eucalyptus cultivators were classified into three categories (Mean ± 0.5 Standard Deviation) as shown in Table 4.7.

Table 4.7 Distribution of the farmers according to their duration of involvement with eucalyptus tree plantation

Categories	Observed range	Number	Percent	Mean	SD
Low duration (≤ 8)	3-24	25	41.7	9.70	3.59
Medium duration (9-12)		23	38.3		
High duration (> 12)		12	20		
Total		60	100.0		

Table 4.7 reveals that the majority (41.7 %) of the eucalyptus cultivator fell in low duration of involvement with eucalyptus plantation category, whereas 38.3 percent in medium duration category followed by 20 percent in high duration of involvement with eucalyptus tree plantation category.

4.1.8 Land use pattern

Land use pattern with eucalyptus tree plantation scores of the farmers ranged from 2 to 3 with a mean and standard deviation of 2.66 and of 0.47, respectively. On the basis of land use pattern the eucalyptus tree cultivators were classified into three categories.

Table 4.8 Distribution of the farmers according to their land use pattern with eucalyptus tree plantation

Categories	Observed range	Number	Percent	Mean	SD
Low land use pattern (≤ 2)	2-3	20	33.3	2.66	0.47
Medium land use pattern (>2)		40	66.7		
High land use pattern		0	0		
Total		60	100.0		

Table 4.8 reveals that the majority (66.7 %) of the eucalyptus cultivator fell in medium land use pattern and 33.3 percent had low land use pattern.

4.1.9 Farmer's opinions on prospects of eucalyptus tree plantation

Scores of prospect of eucalyptus tree plantation of the farmers ranged from 31 to 43 with mean and standard deviation of 36.68 and 3.72, respectively. On the basis of prospect towards eucalyptus tree plantation scores, the farmers were classified into three categories namely 'low prospects', 'medium prospects' and 'high prospects' towards eucalyptus tree plantation. The distribution of the farmers according to their prospect towards eucalyptus plantation is given in Table 4.9 .

Table 4.9 Distribution of farmers according to their prospects of eucalyptus tree plantation

Categories	Observed range	Number	Percent	Mean	SD
Low prospects (≤ 35)	31-43	26	43.3	**36.68**	**3.72**
Medium prospects (36-39)		15	25		
High prospects (> 39)		19	31.7		
Total		**60**	**100.0**		

Table 4.9 reveals that the majority (43.3%) of the farmers were felt in low prospects towards eucalyptus tree plantation category, whereas 25 percent in medium prospects towards eucalyptus tree plantation and 31.7 percent in high prospects towards eucalyptus tree plantation category.

4.1.10 Perception on eucalyptus tree plantation

Score of perception about eucalyptus tree plantation of the farmers ranged from 28 to 48 with mean and standard deviation of 37.65 and 5.41 respectively. On the basis of perception towards eucalyptus tree plantation scores, the farmers were classified into three categories namely ‘poorly favorable’, ‘moderately favorable’ and ‘highly favorable’ perception towards eucalyptus tree plantation. The distribution of the farmers according to their perception towards eucalyptus tree plantation is given in Table 4.8.

Table 4.10 Distribution of farmers according to their perception on eucalyptus tree plantation

Categories	Observed range	Number	Percent	Mean	SD
Poorly favorable perception (≤ 35)	28-48	24	40	**37.65**	**5.41**
Moderately favorable perception (36-40)		17	28.3		
Highly favorable perception (> 40)		19	31.7		
Total		**60**	**100.0**		

Table 4.10 reveals that the majority (40%) of the farmers were felt in poorly favorable perception towards eucalyptus tree plantation category, whereas 28.3 percent in moderately favorable perception towards eucalyptus tree plantation and the 31.7 percent in highly favorable perception towards eucalyptus tree plantation category.

4.2 Contribution of the Selected Characteristics of the Respondents and their perception on eucalyptus tree plantation

For this study nine characteristics of the respondent were selected and each of the characteristics was treated as independent variables. The selected characteristics include age (x_1), education (x_2), family size (x_3), total land area (x_4), income sources (x_5), training exposure (x_6), duration of involvement with eucalyptus cultivation (x_7), land use pattern (x_8) and farmer's opinion on prospect of eucalyptus tree (x_9). Farmer's perception on eucalyptus tree plantation (Y) was the only dependent variable of this study. Before exploring contribution of the selected characteristic of the farmers and their perception on eucalyptus tree plantation, Pearson Product Moment Correlation was run to find out the relation between the selected characteristics of the farmers and

their perception on eucalyptus tree plantation. From this correlation test, it was found that education, land area, income sources, training exposure and farmer's opinion on prospect of eucalyptus tree had significant positive relationship with farmers' perception on eucalyptus tree plantation. Beside these five characteristics, rest four characteristics of the farmers (age, family size, duration of involvement with eucalyptus tree plantation and land use pattern) had no significant relationship with farmers' perception on eucalyptus tree plantation.

The result of co-efficient of correlation between the independent and dependent variables were presented in the Table 4.11. However, the results of interrelationships among different independent and dependent variables are presented in Appendix-II.

Table 4.11 Co-efficient of correlation showing relationships between the selected characteristics of the farmers and their perception on eucalyptus tree plantation (N = 60)

Selected characteristics (independent variables)	**Correlation co-efficient (r) (farmers perception on eucalyptus tree plantation)**
1. Age	-0.187 ^{NS}
2. Education	0.419**
3. Family size	-0.117 ^{NS}
4. Total land area	0.411**
5. Income sources	0.366**
6. Training exposure	0.468**
7. Duration of involvement with eucalyptus cultivation	-0.150 ^{NS}
8. Land use pattern	-0.106 ^{NS}
9. Farmer's opinion on prospect of eucalyptus tree	0.450**

NS = Not significant
* = Significant at 0.05 level
** = Significant at 0.01 level

Then full model regression analysis was run with selected 09 independent variables. But it was observed that the full model regression results were misleading due to the existence of interrelationships among the independent variables. Therefore, in order to avoid the misleading results and to determine the best explanatory variables, the method of step-wise multiple regressions was administrated and 09 independent variables were fitted together in step wise multiple regression analysis. Table 4.12 shows the summarized results of step-wise multiple regression with 09 independent variables of the farmers' perception on eucalyptus tree plantation. It was observed that out of 09 variable 4 independent variables namely training exposure, farmer's opinion on prospect of eucalyptus tree, total land area and education were entered into the regression equation. Other five variables were not entered into the regression equation. The regression equation so obtained is presented below:

$$\mathbf{Y= 32.286 + 0.372\ X_6 + 0.316\ X_9 + 0.302\ X_4 + 0.295\ X_2}$$

Table 4.12 Summary of stepwise multiple regression analysis showing the contribution of selected characteristics of the farmers to their perception on eucalyptus tree plantation

Variable entered	Standardize partial 'b' coefficient	Value of t (with probability level)	R^2	Adjusted R^2	Increase in R^2	Variation explained in %
Training exposure	0.372	3.83 (0.00)	0.219	0.206	0.206	20.6
Farmer's opinion on prospect of eucalyptus tree	0.316	3.01 (0.004)	0.433	0.413	0.207	20.7
Total land area	0.302	3.12 (0.003)	0.502	0.476	0.063	6.3
Education	0.295	2.79 (0.007)	0.564	0.533	0.057	5.7
Total					0.533	53.3

Multiple R = 0.751
R-square = 0.564
Adjusted R- square = 0.533
F-ratio = 7.811
Standard error of estimate = 3.695
Constant = 32.286

The multiple R and R^2 values were found 0.751 and 0.564 respectively and the corresponding F-ratio was 7.81 which were significant at 0.000 levels. For determining unique contribution on farmers' perception on eucalyptus tree plantation each of the four variables the increase in R^2 value was determined. These four variables combined explained 53.3 % of the total contribution on farmers' perception on eucalyptus tree plantation. Farmer's opinion on prospect of eucalyptus tree plantation had the highest contribution (20.7 % of the variation) followed by training exposure 20.6 %, total land area 6.3 % and education had 5.7 % on farmers' perception on eucalyptus tree plantation.

Table 4.12 showed that farmer's opinion on prospect of eucalyptus tree plantation, training exposure, total land area and education had significant contribution on farmers' perception on eucalyptus tree plantation. i.e. the farmer who had higher education, more knowledge were found to have good perception about eucalyptus tree cultivation and in this connection, some predictive importance has been briefly discussed below:

4.2.1 Training exposure

Stepwise multiple regressions found that training of the respondents had contribution (20.6%) to the farmers' perception on eucalyptus tree plantation. Correlation matrix also showed that training of the respondents had significant positive relationship with the farmers' perception on eucalyptus tree plantation. (Appendix- II and Table 4.11) The contribution indicated that the farmers having more training had favorable perception on eucalyptus tree plantation. Eucalyptus tree cultivating farmers are encouraged to share their knowledge and experiences with other farmers within their local village and community organizations. Training helps the farmers about fertilizer management, soil management and crop management.

4.2.2 Farmer's opinion on prospect of eucalyptus tree

Stepwise multiple regressions found that farmer's opinion on prospect of eucalyptus tree had contribution (20.7%) to the farmers' perception on

eucalyptus tree plantation. Correlation matrix also showed that prospect of eucalyptus tree had significant positive relationship with the farmer's perception on eucalyptus tree plantation (Appendix- II and Table 4.11).

4.2.3 Total land area

Stepwise multiple regressions found that total land area had contribution (6.3%) to the farmers' perception on eucalyptus tree plantation. Correlation matrix also showed that total land area had significant positive relationship with the farmers' perception on eucalyptus tree plantation (Appendix- II and Table 4.11).

4.2.4. Education

Stepwise multiple regressions revealed that education of the respondents had contribution (5.7%) to the farmers' perception on eucalyptus tree plantation. Correlation matrix also showed that education of respondents had significant positive relationship with farmers' perception on eucalyptus tree plantation (Appendix-II and Table 4.11). Education develops mental and psychological ability of average person to understand, decide and adopt new practices and technology. Hence, it is expected that education is one of the important factors in determining the farmers' perception on eucalyptus tree plantation. Education helps the farmers to broaden their outlook and mental horizon by helping them to develop proper attitude and correct perception to decrease knowledge gap about production technology of the tree. An educated man is more responsive to the technology and new innovation. The farmers who have no education, s/he is supposed to face a great difficulty in adjusting with the unfavorable condition regarding knowledge gap for eucalyptus tree cultivation. Such condition indicates the need for improving literacy level among the farmers for having the knowledge on eucalyptus tree cultivation.

CHAPTER V
SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Findings

5.1.1 Selected characteristics of the farmers (Independent variable)

Age

The highest proportion (51.7%) of the eucalyptus cultivators belonged to middle aged category while 23.3 percent belonged to old aged category and only 25 percent were young aged category.

Education

The highest proportion (43.3 %) of the eucalyptus cultivators had secondary level education, while 38.4 percent had primary education level. On the other hand, the lowest 5 percent had in both can't read and sign and above secondary level. 8.3 percent had can sign only category.

Family size

The medium size family constituted the highest proportion (53.4 %) followed by the large size family and small size family (23.3 %).

Total land area

The small land area holder constituted the highest proportion (48.3 %) followed by medium land holder (46.7 %) and the only 5.0 percent were in large category land area.

Annual income from eucalyptus cultivation

The eucalyptus cultivators having low annual income constituted the highest proportion (51.7 %), while 41.6 percent farmers had medium income and 6.7 percent had high income.

Training exposure

The highest proportion (45 %) of the eucalyptus farmers had low training exposure while 25 percent had medium training exposure and 30 percent had high training exposure.

Duration of involvement with eucalyptus cultivation

The majority (41.7 %) of the eucalyptus cultivator fell under low duration of involvement with eucalyptus cultivation category, whereas 38.3 percent in medium duration category and only 20 percent in high duration of involvement with eucalyptus tree plantation category.

Land use pattern

The majority (66.7 %) of the eucalyptus cultivator fell under medium land use pattern and only 33.3 had low land use pattern.

Farmer's opinions on prospects of eucalyptus trees cultivation

The majority (43.3%) of the farmers were felt in low prospects towards eucalyptus tree plantation category, while 25 percent in medium prospects towards eucalyptus tree plantation and only 31.7 percent in high prospects towards eucalyptus tree plantation category.

5.1.2 Dependent variable

Perception about eucalyptus tree cultivation

The majority (40%) of the farmers were felt under poorly favorable perception towards eucalyptus tree plantation category, whereas 28.3 percent in moderately favorable perception towards eucalyptus tree plantation and the 31.7 percent were in highly favorable perception towards eucalyptus tree plantation category.

5.1.3 Contribution of the Selected Characteristics of the Respondents and Perception on eucalyptus tree plantation

Out of nine variables four independent variables namely training exposure, farmer's opinion on prospect of eucalyptus tree, total land area and education had significant contribution on perception on eucalyptus tree plantation. These four variables combined explained (53.3%) of the total contribution.

5.2 Conclusions

Based on the findings and its logical interpretation the following conclusions have been drawn:

The findings revealed that majority of the respondents (40%) had poorly favorable perception towards eucalyptus tree plantation. So there is a scope to increase the perception towards eucalyptus tree plantation by providing training, result demonstration, method demonstration and other extension services to increase the perception towards eucalyptus tree plantation.

Overwhelming majority (86.7 %) of the respondents were literate. Stepwise multiple regressions revealed that education of the respondent had the contribution to the perception towards eucalyptus tree plantation. Correlation matrix also showed that education of respondents had significant positive relationship to the perception towards eucalyptus tree plantation. So, it may be concluded that education is an important factor to the perception towards eucalyptus tree plantation.

The findings of the study revealed that (45%) of the farmers had low training exposure towards eucalyptus tree plantation. Stepwise multiple regressions found that training exposure of the respondents had contribution to the perception towards eucalyptus tree plantation. Correlation matrix also showed that training exposure had significant positive relationship towards eucalyptus tree plantation. Therefore, it may be concluded that there is necessity to increase the training exposure of the farmers.

5.3 Recommendations

With the consideration of present findings the following recommendations are suggested:

1. A detail in-depth study should be undertaken covering all regions where eucalyptus has been widely planting.
2. Fundamental research particularly on below and above ground resource use and precise assessment of ecological aspects of eucalyptus in Bangladesh condition should be undertaken to resolve the so-called controversy about eucalyptus plantation.
3. Research should also be undertaken to standardize the production packages of eucalyptus plantation for the different ecological zones of the country.

5.3.1 Recommendations for further study

A small piece of study as has been conducted can not provide all information for the proper understanding of the perception towards eucalyptus tree plantation. On the basis of scope and limitations of the present study following suggestions are being put forward for further research:

1. The study was conducted at Bogura district. Findings of this study need verification by similar research in other parts of the country.

2. The present study was conducted taking 09 characteristics of the farmers. Further study may be conducted considering other characteristics of the farmers.

3. In the present study age, family size, duration of involvement with eucalyptus plantation and land use pattern had no significant relationship with the perception towards eucalyptus tree plantation. In this connection, further verification is necessary.

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ENGLISH VERSION OF THE INTERVIEW SCHEDULE

Department of Agroforestry and Environmental Science
Sher-e-Bangla Agricultural University, Dhaka-1207

An Interview Schedule for a Research Study Entitled

Farmers' Perception about Eucalyptus Tree Cultivation as Cropland Agroforestry: A Case Study of Bogura District

Serial no: ..... Date: .....

Name of respondent: .....

Village: ..... Union: .....Thana: .....

(Please answer the following questions. Give tick (√) marks if necessary. Information given by you will be kept secret and only be used for research work)

1. Age

How old are you?
.....year(s)

2. Education

Please mention your educational status

a) Illiterate

b) Can sign only

c) Studied up to class ……...

3. Family Size

Please mention the number of your family members in the following groups:

a) Male member …….. person(s)

b) Female member ……. person(s)

c) Total member ……. person(s)

d) Family member involve in agriculture …….. person(s)

4. Total Land Area

Please mention the area of your land possession:

Sl. No.	Types of land ownership	Land Area	
		Local unit	Hectare
1.	Homestead area (Including pond)		
2.	Own land under own cultivation		
3.	Land given to others as shared crop		
4.	Land taken from others as shared crop		
5.	Land given to others as lease		
6.	Land taken from others as lease		
7.	Fallow land		
	Total		

5.Income Sources

Please mention the amount of-income from the following sources during last year:

SL. No.	Name of income items	Production (Kg or Maund)	Income/Unit (Tk)	Total Income (Tk)
1.	Rice			
2.	Eucalyptus			
3.	Pulse crop			
4.	Vegetables			
5.	Fruits			
6.	Livestock			
7.	Poultry			
8.	Fish resources			
9.	Service			
10.	Business			
Total				

6. Training Exposure

Do you attend any training on agriculture during last 5 years? Yes ☐ No ☐

If yes, Please mention the training courses you have attended so far

Subject	Place	Duration(day)	Organization

7.Duration of Involvement with Eucalyptus Cultivation

How many years have you been involved with Eucalyptus plantation? ……years

8.Land Use Pattern

What type of land use pattern do you follow at the time of Eucalyptus cultivation?

a) Single cropped area b) Double cropped area c) Triple cropped area

9.Farmer's opinions on prospects of Eucalyptus trees [Put (√)marks]

Sl. No.	Farmers opinion on	**Extent of contact**				
		Strongly agree (5)	Agree (4)	No opinion (3)	Disagree (2)	Strongly disagree (1)
1.	Possible to increase Eucalyptus trees plantation area					
2.	Possible to increase Eucalyptus trees plantation even in existing situation					
3.	Government facilities can be provided for commercial purpose					
4.	Possible to grow Eucalyptus trees within a short period					
5.	Possible to grow at diverse and adverse environmental conditions					
6.	Manufacture of high quality furniture is possible					
7.	It is ideal for pulp and paper, rail ties and other domestic usage					
8.	Possible to use the Eucalyptus trees at railway ties,					
9.	Possible to use the Eucalyptus trees at sports goods and plywood industry,					
10.	Possible to use the Eucalyptus trees at particle-boards industry, shuttering and scaffoldings,					

10. Perception about Eucalyptus Tree Cultivation as Cropland Agroforestry

Sl. No.	Statements	Extent of opinion				
		Strongly agree (5)	Agree (4)	No opinion (3)	Disagree (2)	Strongly disagree (1)
1. (+)	Eucalyptus trees contribute to the moisture content of the soil in cropland					
2. (-)	Eucalyptus tree shade can reduce leaf temperature experienced by crops					
3. (+)	Eucalyptus trees helps to prevent air pollution					
4. (-)	Eucalyptus tree shade can reduce evaporative demand experienced by crops					
5. (+)	Eucalyptus trees protect the crops from wind					
6. (-)	Eucalyptus tree compete for water with other crops					
7. (+)	Eucalyptus trees increase air humidity					
8. (-)	Shadow of Eucalyptus trees inhibit the crops growth					
9. (+)	Microclimate in shelter of the Eucalyptus tree contributes to increase bee activity, and can result in improved fruit set and earlier maturity of the crops					
10. (-)	Eucalyptus trees compete for nutrients with crops					
11. (+)	Eucalyptus trees can reduce weed populations towards less aggressive species.					

Thanks for your co-operation

.....

Date:..... Signature of Interviewer

Appendix -II. Correlation Matrix of the Dependent and Independent Variables (n=60)

Variables	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	Y
X_1	1.000									
X_2	-0.361**	1.000								
X_3	0.171	-0.256	1.000							
X_4	0.305*	-0.084	0.178	1.000						
X_5	0.301*	-0.048	0.168	0.894**	1.000					
X_6	0.006	-0.054	0.095	0.398**	0.462**	1.000				
X_7	0.228	-0.057	0.241	0.178	0.240	-0.097	1.000			
X_8	-0.095	-0.031	0.175	-0.046	-0.089	-0.154	0.030	1.000		
X_9	-0.277*	0.534*	-0.181	-0.046	0.027	-0.027	-0.149	-0.137	1.000	
Y	-0.187 ^{NS}	0.419**	-0.117 ^{NS}	0.411**	0.366**	0.468**	-0.150 ^{NS}	-0.106 ^{NS}	0.450**	1.000

Notes: ** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

X_1 = Age
X_2 = Education
X_3 = Family size
X_4 = Land area
X_5 = Income sources
X_6 = Training exposure
X_7 = Duration of eucalyptus cultivation
X_8 = Land use pattern
X_9 = Farmer's opinions on prospect
Y = Perception about eucalyptus tree cultivation