KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
FACULTY OF RENEWABLE NATURAL RESOURCES
DEPARTMENT OF AGROFORESTRY

THE IMPACT OF AGROFORESTRY ON THE LIVELIHOOD OF RURAL FARMING HOUSEHOLDS: A CASE STUDY OF SELECTED COMMUNITIES OF OFFINSO, AFIGYA SEKYERE AND ATWIMA DISTRICTS

By

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APRIL, 2008

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A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE MASTER OF SCIENCE DEGREE IN AGROFORESTRY

BY

ISAAC BOATENG BSC (HONS) AGRICULTURE DEP.ED (UCC)

APRIL, 2008

DECLARATION

I do hereby declare that, except for references to other peoples work which have been duly cited, this work submitted as a thesis to the Department of Agroforestry, Faculty of Renewable Natural Resources, Kwame Nkrumah University of Science and Technology, Kumasi, for the degree of Master of Science in Agroforestry, is the result of my own investigation.

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ISAAC BOATENG STUDENT

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DR. K. TWUM AMPOFO SUPERVISOR/ HEAD, DEPARTMENT OF AGROFORESTRY DEDICATION

This work is dedicated to my wife and children.

ABSTRACT

This study was to evaluate the impact of agroforestry on the livelihood of rural farming households, in selected communities of Offinso, Afigya Sekyere and Atwima Districts. Ten rural communities namely, Nyamebekyere (Kwadwo Forjourkrom), Abofour, Kyebi, Kona, Tano Odumasi, Adankwame, Esaso, Kumi, Maban and Barekese, were selected for the study. The specific objectives involved the identification of the socio-economic characteristics of the farmers, description of the land use systems, determination of the existing problems of agroforestry adoption in the study area and the determination of the impact of agroforestry on the livelihood of rural farming households.

In this study 70-agroforestry practitioners, 20 non-agroforestry practitioners (to serve as control) and officers of the Ministry of Food and Agriculture, Ministry of Lands, Forestry and Mines, Community/Development office in the Districts were contacted. Both structured and unstructured interview questionnaires were used to obtain information from individual farmers in the households, Foresters and Extension agents/Agricultural Officers, Community/Development Planning Officers. Data collected were described statistically and the responses given by the farmers were tabulated.

The study revealed a high level of literacy rate among agroforestry practitioners, which is likely to increase technical efficiency and decrease conservatism. A greater proportion of agroforestry practitioners (63%) used family labour plus hired labour since the tending of both tree crops and food crops influenced the labour requirements. It was found that family labour was negatively related to adoption while hired labour was positively related to adoption. Age and education were negatively related to sources of labour. Age and sex were significantly related to sources of labour. Many agroforestry techniques require intensive labour use, which contrast greatly with the limited amount of labour expended in the traditional farming system and that small-holder farmers must hire expensive labour to implement the technologies. Also, it can be said that as the farmer ages his/her ability to provide labour physically decreases and therefore resort to hired labour. The study shows that most of the agroforestry practitioners finance their farming activities from their personal savings. The dominant energy type in the rural household was fuelwood. The study revealed that practitioners of agroforestry in the study area have been obtaining increased income levels, improved upon the household food security, a greater proportion are to a larger extent able to afford fees and learning materials for their children and wards, clothes and medical treatment for individuals in the household after adoption of agroforestry. About a third of practitioners have succeeded in building their own houses from the sales of the tree crops/products and food crops. Others have succeeded in buying building plots in Kumasi.

The economic, legal and political arrangement governing the ownership and management of agricultural land in the study area should be restructured. To achieve success, government should institute land tenure policies, which

provide farmers access and permanent rights to land. This would reduce the problems associated with land ownership, acquisition and utilization. Gender sensitivity, to a large extent has enormous influence on agroforestry adoption, with the females being in the minority. Mechanisms should therefore be put in place to plan a sustainable education programme for women on agroforestry practices and also give support to women organizations interested in agroforestry.

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To GOD ALMIGHTY be the glory, honour and power forever more.

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CHAPTER ONE INTRODUCTION

In the past soil fertility maintenance under the subsistence smallholder farmers level in West Africa was long-term bush fallow, which allows regrowth of vegetation, resulted in accumulation of organic matter and plant nutrients (Steiner, 1982). However, the explosive growth of human population has forced farmers to reduce the length of fallow periods resulting in severe soil erosion, reducing yields and rapid destruction of the natural assets of their communities. For example, the World Resources Institute sets the global human population at 8.5 billion in 2025 and by 2050 the population is expected to hit 10 billion (Mackenzie, 1994). Considering high population growth rates, increasing poverty levels and scarcity of land, the need for technologies that would boost food production including crops and animals, forest and wood products as well as sustaining the use of land cannot be over emphasized (Young, 1987).

International concern is to find alternative farming systems that are ecologically and economically sustainable as well as culturally acceptable to farmers.

Agroforestry, which is a collective name for all land-use systems and practices where woody perennial plants are deliberately grown on the same land management unit as agricultural crops and/or animals, either in spatial mixture or in temporal sequence (Lungren, 1987) has been suggested by several development experts as a new solution to rural development needs (Rocheleau *et al*, 1989). The combination of several types of products in agroforestry, which are both subsistence and income generating helps farmers to meet their basic needs and minimizes the risk of the production system's total failure (ICRAF, 1993). Agroforestry can help mitigate deforestation because it addresses in general, the issues of tree planting, can combat land depletion because of its potential for soil conservation and as a result contribute to the alleviation of rural poverty (ICRAF, 1993). Given the immense agricultural and environmental potential of agroforestry it is no wonder that it is being promoted for adoption among farmers in most developing countries especially in sahara and sub-sahara Africa where productivity is low and more marginal lands are increasingly being brought under cultivation.

In Ghana, there is a national concern to combat environmental degradation and those emanating from poor agricultural practices (deforestation, soil erosion) have received a lot of attention. Agroforestry has been suggested as one of the solutions (Nabilla, 1984; Owusu, 1990). Agroforestry technologies were introduced in several parts of the country in 1989 by the then Agroforestry unit of Ministry of Food and Agriculture and other individuals. Examples of the introduced technologies are alley cropping, woodlot, shelterbelt and windbreaks, fruit trees on cropland. However, technology transfer and adoption has not been very easy in the country as a result of several existing barriers, which have not yet been fully overcome. Some of the barriers that militate against agroforestry adoption include illiteracy, in-adequate credit facilities, non-availability of farm inputs and sociocultural factors (Lele, 1989; Tripp, 1993).

Adaptive trials and demonstration farms were established in some rural communities of Atwima, Offinso and Afigya Sekyere Districts of the Ashanti Region, all in a bid to promote agroforestry adoption. Also nurseries including tree species such as *Leucaena leucocephala, Gliricidia sepium, Senna siamea, Mangifera indica*, *Anacardium occidentale*, *Tectona grandis, Citrus sinensis* were established in several communities all in the Ashanti Region (Agbleze *et al*, 2002) The problem is that no research has been conducted specifically to ascertain the impact of these introduced technologies on the livelihood of rural farming households.The study aims at obtaining information on the impact of agroforestry on the livelihood of rural farming households.

The specific objectives of the research are to:

- Identify the socio-economic characteristics of the farmers in the study districts and to describe the land use systems.
- Describe the existing problems of agroforestry adoption in the study area.
- Determine the impact of agroforestry on the livelihood of rural farming households.

This information will allow the Ministry of Food and Agriculture (MOFA) and other bodies and Non-governmental organizations (NGO'S) involved with transfer of these technologies to be acquainted with the performance of these technologies as regards the objectives of the introduction of these innovations in these areas or Communities. The research would therefore serve as a useful case study and a reference point for future research in adoption and impact of Agroforestry on the livelihood of rural farming households.

CHAPTER TWO LITERATURE REVIEW

2.1 Definition and Concepts of Agroforestry

Agroforestry is "*a collective name for all land-use systems and practices where woody perennial plants are deliberately grown on the same land management unit* *as agricultural crops and/or animals, either in spatial mixture or in temporal sequence*" (Lundgren, 1987). Lungren stated that there must be significant ecological and economic interactions between the woody and non-woody components. The word and concept attained a fair level of acceptability in international land use in a rather short time, but not without some difficulty as most of the writings on agroforestry during the late 1970s and early 1980s contained at least one definition, and often some imaginative and fascinating interpretations, of agroforestry. The situation was reviewed in an editorial, titled, 'What is Agroforestry,' in which inaugural issue of Agroforestry systems (Vol. 1, No. 1. pp. 7-12; 1982), which contains a selection of 'definitions' of agroforestry, proposed by various authors (Nair, 1993).

Lundgren(1982) of International Centre for Research in Agroforestry (ICRAF) stated that:

A strictly scientific definition of agroforestry should stress two characteristics common to all forms of land use, namely:

- the deliberate growing of woody perennials on the same unit of land as agricultural crops and/or animals either in some form of spatial mixture or sequence.
- there must be a significant interaction (positive and/or negative) between the woody and non woody components of the system either ecological and/or economical. What this mean is that an agroforestry system generally speaking combines at least two of the following components: trees, crops and animals in an optimum fashion. The components influence each other

and the wider environment. The interactions can be beneficial within the system or create competition for space, water, light and nutrients. Competition can be minimized by selecting the appropriate tree species and managing it so that competition is reduced. When promoting agroforestry, one should then stress the potential of it to achieve certain aims, not only by making theoretical and qualitative remarks about the benefits of trees, but also, more importantly, by providing quantitative information (Lundgren, 1982).

These ideas were later refined through 'in-house' discussion at ICRAF, and the following

definition of agroforestry was suggested:

Agroforestry is a collective name for land use systems and technologies where woody perennials (trees, shrubs, palms, bamboos etc.) are deliberately used on the same land management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components (Lundgren and Raintree, 1982).

This definition implies that:

- Agroforestry normally involves two or more species of plants (or plants and animals), at least one of which is a woody perennial;
- An agroforestry system always has two or more outputs;
- The cycle of an agroforestry system is always more than one year; and

- Even the simplest agroforestry system is more complex, ecologically (structurally and functionally). This definition, though not 'perfect' in all respects, was increasingly used in ICRAF publications and thus achieved wide acceptability.

Leakey(1996) also defined agroforestry as "*a dynamic, ecologically based, natural resource management system that through the integration of trees in farm-and rangeland, diversifies and sustains small holder production for increased social, economic and environmental benefits*". He stated that if the above concepts are accepted, then agroforestry researchers and extension workers have a new challenge to start the process of integrating a number of agroforestry practices into productive and sustainable land use systems that alleviate poverty.

Agroforestry is practiced for a variety of objectives and represents an interface between agriculture and forestry and encompasses mixed land use practices (Nair, 1993). These practices have been developed primarily in response to the special needs and conditions of tropical developing countries that have not been satisfactorily addressed by advances in conventional agriculture or forestry (Nair, 1993). Furthermore, he stated that, the term agroforestry is used to denote practices ranging from simple forms of shifting cultivation to complex hedgerow intercropping systems; systems including varying densities of tree stands ranging from widely-scattered *Faidherbia albida* trees in Sahelian millet fields, to the high-density multistoried home gardens of the humid tropics; and systems in which trees play a predominantly service role (e.g. windbreaks) to those in which they provide the main commercial product (e.g., intercropping with plantation crops). It needs to be re-emphasized that one concept is common to all these diverse agroforestry systems: the purposeful growing or deliberate retention of trees with crops and / or animals in interacting combinations for multiple products or benefits from the same management unit. This is the essence of agroforestry (Nair. 1993).

2.2 Classification of Agroforestry systems

An agroforestry system is a specific local example of a practice characterized by environment, plant species and their arrangement, management and socioeconomic functioning (Nair, 1991). The three major components of agroforestry systems are crops, trees and animals and depending upon the combination of these components, three major systems can be identified. These are Agrisilvicultural systems, Silvopastoral systems and Agrosilvopastoral systems (Nair,1991)

2.2.1 Agrisilvicultural Systems

Nair (1985), noted that the term agrisilviculture is used to denote the combination of trees and crops – including shrub/vine/tree crops. An example of such system is the cultivation of maize, cassava, or plantains grown between selected timber tree species or coconut or palm trees. Other examples include improved fallow, taungya, alley cropping (hedgerow inter-cropping), multipurpose trees on crop lands, plantation crop combinations, homegardens, trees in soil conservation and reclamation, shelterbelts and windbreaks, live hedges and fuelwood production.

2.2.2 Silvopastoral Systems

This system involves the combination of pasture and/or animals and trees on the same land management unit (Nair, 1985). Gholz (1987), said that in India silvopastoral systems involve lopping trees and grazing understory grasses and bushes in forests and plantations. He reported that one of the more outstanding examples of silvopastoralism is grazing in forest lands in Himalaya. Examples of silvopastoral systems include trees on rangelands or pastures, protein banks, plantation crops with pastures and animals.

2.2.3 Agrosilvopastoral Systems

This system involves the combination of trees, crops and pasture/animals on the same land management unit (Nair, 1985). Examples include homegardens involving animals, multipurpose woody hedgerows, apiculture with trees, aquaforestry, multipurpose woodlots.

Other agroforestry systems include aquaforestry, entomoforestry and various forms of shifting cultivation (Nair, 1989).

2.3 Agroforestry Practices

An agroforestry practice denotes a distinctive arrangement of components in space and time (Nair, 1993). Examples of agroforestry practices are Tree home gardens, Woodlot, Windbreaks/shelterbelts, Boundary planting, Live fences, Alley cropping, improved fallow, Taungya, Plantation crop combinations, silvopastoral practices, Agroforestry for fuelwood production, Intercropping under scattered or regularly planted trees, Agroforestry for reclamation of problem soils, Buffer – zone agroforestry etc.

2.3.1 Homegardens

According to the classification of agroforestry systems based on the nature and type of components, most homegardens are agrosilvopastoral systems consisting of herbaceous crops, woody perennials and animals and some are agrisilvicultural systems consisting only of the first two components (Nair, 1993). This is an agrosilvopastoral system under which a mixture of perennials, annuals and animals occur in combination very close to the homestead (Nair, 1993). Tropical homegardens consists of an assemblage of plants which may include trees, shrubs, vines, and herbaceous plants, growing in or adjacent to a homestead or home compound and these gardens are planted and maintained by members of the household (Nair, 1993). Homegardens are of economic importance to small farm families because they provide supplementary and continuous flow of products such as food for household consumption, medicine, poles, and offer a buffering capacity when the main crops fail (Soemarwoto and Conway, 1991; Torquebiau, 1992; Nair 1993); the gardens also have considerable ornamental value, and they provide shade to people and animals (Nair, 1993). Even though its structure is very complex a 3-layer storey may be recognized (Fernandes *et al*, 1984): The upper storey is made of tall tree species, which along contours to the upper side of barrier produce timbers, fuelwood and fodder. This layer may include tall oil palms ("*abetene*"), Mango and tamarind. The middle-storey is made up of small trees and shrubs that tolerate some amount of shade. This layer typically includes cocoa, coffee, banana and plantain, papaya and other types of fruits and spices. The understorey consists of low growing crops such as cassava, yam, beans, grasses, pineapple, and vegetables up to approximately 1.5 to 2.0m high. The above arrangement shows that the components are mixed or appear in an irregular manner.)

2.3.2 Woodlot

A woodlot is an agroforestry practice where multi-purpose woody perennials are planted and managed over time to produce fuelwood, poles, and stakes for climbing crops; food and animal components may be integrated into woodlots, especially during the initial establishment phase (Nair, 1993). Depending upon the nature of the land and the purpose for which the woodlot is being established the selected plot of land is marked, lined, and pegged at the recommended or required spacing and on marginal or degraded lands, a spacing of 1m x 1m is recommended to ensure early canopy closure, soil protection and weed suppression (Young, 1997). He reported that on cultivable or good fertile lands, 2m x 2m, 2m x 3m or 3m x 3m spacing is acceptable and these spacing allow for intercropping with food crops in the first year before canopy closes. It is best to have a mixture of 2-3 species within woodlot to reduce risks of insect infestation (Nair, 1993). Maintenance of the woodlot is essential especially during the first 36 months of establishment and this involves controlling weeds within the area around trees to reduce competition, pruning side shoots, and thinning of planted trees to maintain correct density (Young, 1997). He further reported that where food crops are integrated into woodlots, prunings from the trees should be spread on the ground to serve as mulch and green manure. Harvesting regime and frequency depends on the type of species, the rate of growth and the purpose to which harvested tree is going to be put (Nair, 1993).

2.3.3 Windbreaks/Shelterbelts

A windbreak is most often an agrisivicultural practice but can also be silvopastoral if the product derived from the tree is fodder (Torquebiau, 1994). Windbreaks are narrow strips of trees and shrubs planted to protect fields, homes, canals, and other areas from the adverse effects of high speed winds while shelterbelt, a type of windbreak, are long, multiple rows of trees and shrubs, usually along sea coasts to protect agricultural fields from inundation by tidal waves (Nair, 1993). Windbreaks usually consists of multi-story strips of trees and shrubs planted at least three rows deep and are placed on the windward side of the land to be protected and are most effective when oriented at right angles to the prevailing winds (Nair, 1993). When properly designed and maintained, a windbreak reduces the velocity of the wind, and thus its ability to carry and deposit soil and sand, improve the microclimate in a given protected area by decreasing water evaporation from the soil and plants, protect crops from loss of flowers, reduce crop loss due to sand-shear of seedlings, in addition windbreaks can provide a wide range of useful products from poles and fuelwood to fruits, fodder, fiber, and mulch (Nair, 1993; Torquebiau, 1994) Species for windbreaks should include tall trees (>15m), medium trees (5-15m) and shrubs (<10m) and these should be wind resistant, have a small canopy, well-developed rooting system, coppicing ability and preferably multipurpose (Reid and Wilson, 1985). *Tectona grandis, Gmelina arborea, Senna siamea, Eucalyptus camaldulensis, Gliricidia sepium* and *Leucaena leucocephala* are recommended species for windbreaks /shelterbelts (Vandenbeldt, 1990, Nair, 1993).

2.3.4 Boundary Planting

Boundary planting is an agrosilvicultural technology and the components are spatial zoned (Torquebiau, 1994). It involves planting of trees (including fruit trees), shrubs and grasses in single or multiple lines to define boundaries or spaces dividing separate land-use units and it is mainly used along boundaries of farms, home compounds, pastures or scattered cropland (Torquebiau, 1994; Young, 1997). It is preferred to use tree species that provide useful products which could be sold to generate additional income while at the same time delineating the boundaries (Nair, 1993). Timber trees planted along boundaries may be spaced at 6m x 6m or 5m x 5m to reduce excessive shading of food crops, while for fruits trees 4m x 4m is ideal and trees for fuelwood can be planted at 3m x 3m (Nair, 1993). Fruit trees like mangoes, avocadoes, citrus, oil palm, coconut, or timber trees: *Cedrela odorata*, *Terminalia superba*, and other multipurpose species like *Newbouldia laevis, Gliricidia sepium and Cajanus cajan* are good species for boundary planting (Nair, 1993). Moreover, Nair (1993) reported that planting trees on boundaries will affect more than one land user and crops on neighbouring farms could be affected through shading at some time of the day. This could lead to conflicts between farmers and in practice, it is important that all land owners and users agree on its establishment.

2.3.5 Live Fencing

Live fences are permanent lines of trees or shrubs planted to define areas where general access is prevented such as around a compound homestead gardens/farms, pasture plots, or animal enclosures and they serve mainly as field boundaries to keep animals on the farm and off adjacent crop fields or farm areas (Nair, 1993; Torquebiau, 1994). There are two types of live fences: those that have non-living materials such as bamboo interwoven between the growing trees to maintain the barrier and those made up entirely of living plants (Nair, 1993). Species used for live fences should be fast growing, thorny and unpalatable to livestock, and should be able to withstand drought and they can be established either by planting vigorously sprouting vegetative material (Cuttings) or from seed/seedlings (Nair, 1993). In general, sturdy, small trees or shrubs with multiple stems or low dense branches are the best plants to use; however, fodder plants may be planted in bounded space to provide feed for animals (Nair, 1993). They reported that species that may be used for live fences include *Pithecelobium dulce, Jatropha curcas, Gliricidia sepium, Newbouldia laevis, Senna siamea ,Erythrina spp and Acacia nilotica.*

2.3.6 Alley Cropping

Alley cropping is an agrisilvicultural practice and the components are spatial zoned (Torquebiau, 1994). This entails growing food crops between hedgerows of planted shrubs and trees, preferably leguminous species and the hedges are pruned periodically during the crop's growth to provide biomass which, when returned to the soil, enhances its nutrient status and physical properties and prevents shading of the growing crops (Nair, 1993). Single or multiple hedgerows spaced between 3-15m depending on the slope of the land could be established from seeds, seedlings or stakes during the rainy season and the hedgerows should be positioned in an east-west direction to maximize absorption and utilization of sunlight during the day

(Huxley, 1986; Torquebiau, 1994). Trees within the hedgerows are usually spaced at least 1.0m apart and species that could be used include *Gliricidia sepium, Leucaena Leucocephala, Acacia* spp, *Senna siamea* and other fast growing leguminous tree species (Nair, 1993; Young, 1997). Alley cropping combines the regenerative properties of a bush fallow system with food crop production and the underlying scientific principle of this technology is that, by continually retaining fast-growing, preferably nitrogen-fixing, trees and shrubs on crop producing fields, their soil improving attributes such as recycling nutrients, suppressing weeds, and controlling erosion on sloping land will create soil conditions similar to those in the fallow phase of shifting cultivation (Nair, 1993). The principal benefit from alley cropping is the crop harvest. There is often a secondary harvest from the hedges, of fodder, fuelwood or both, and this can make a significant contribution to the economics of the system and to diversify farm production (Young, 1997). A study conducted by ICRAF (1993) in Yaoundé, Cameroun where over 4 years showed an upward trend in crop yield

(2.1, 3.7, 4.8 and 5.0 tha^{-1}). Under a humid climate in Indonesia, yield ratios for soybean and maize rose markedly with time, from 0.7 in year 1 to 1.3 – 1.5 in years 3 (Sitompul *et al*., 1992). In the Cote d'lvoire, alley cropping of *Gliricidium sepium* reduced evapotranspiration in the alleys during most of the cropping season (Schroth *et al*.,1995). In Costa Rica, after a 9-year trial soil moisture, soil carbon and nitrogen were higher under alley cropping systems (Mazzarino *et al*., 1993). A study conducted by Rippin *et al* (1994) revealed that a layer of surface prunnings can reduce weed biomass by more than 50%, with consequent benefits for crops. In Malawi, after 3 years of intercropping with four hedge species, soil properties related to organic matter were much improved as compared with controls (Khonje, 1989).Despite its obvious benefits, hedgerow intercropping is labour intensive and in most cases this becomes a disincentive to small farmers and this system is therefore recommended only in situations where the benefits outweigh the extra costs incurred in hiring labour for pruning and spreading mulch, as is the case when contour aligned hedgerows are established for erosion control on slopes (Nair, 1993; Young, 1997).

2.3.7 Improved Fallow

Improved fallow is an agrisilvicultural practice and the components are arranged sequentially (Torquebiau, 1994). It is a rotational fallow system where trees, usually fast growing leguminous trees or shrubs are introduced into fallow systems for the restoration of soil fertility (Nair, 1993; Young, 1997). The purpose is to shorten fallow period and increase fertility of the soil by introducing high biomass yielding species in rotation with annual crops (Nair, 1993; Young, 1997). Species that can be used include *Sesbania sesban, Cajanus cajan, Gliricidia sepium, Senna siamea,* and *Leucaena leucocephala* and any other fast growing species and such species should be deep rooted to ensure pumping up of leached nutrients from the sub horizon to the soil surface and have good coppicing ability (Nair, 1993). They found out that improved fallow species can be interplanted with herbaceous legumes like Mucuna, Centrosema, and Pueraria and depending on the species; spacing of seedlings and stakes could be 1m x 1m to 3m x 3m. An improved fallow should be established on an old farm, which is about to be left fallow for natural regeneration or at various stages of an existing poorly established fallow (Nair, 1993; Young, 1997).

2.3.8 Taungya

The taungya system consists of growing annual agricultural crops along with forestry species during the early years of establishment of the forestry plantation (Nair, 1993). The land belongs to the Forestry Departments or their large scale lessees, who allow the subsistence farmers to raise their crops and to tend the forestry seedlings and, in return, retain a part or all of the agricultural produce (Nair, 1993). This agreement lasts for two or three years, during which time the forestry species would grow and expand its canopy, the soil fertility declines, some soil is lost to erosion and weeds infest the area, making crop production non-remurative (Nair, 1993). He reported that taungya system can be considered as another step in the process of transformation from shifting cultivation to agroforestry. While shifting cultivation is a sequential system of growing woody species and agricultural crops, taungya consists of the simultaneous combination of the two components during the early stages of forest plantation establishment and although wood production is the ultimate objective in the taungya system, the immediate motivation for practicing it, as in shifting cultivation is food production. Although the taungya system is often cited as a popular and mostly successful agroforestry approach to establishing forest plantations, it has also been criticized as labour-exploitative as it capitalizes on the poor forest farmer's need for food and his willingness often out of helplessness to offer labour for plantation establishment free of cost in return for the right to raise the much needed food crops for even a short span of time (Nair, 1993).

2.3.9 Plantation Crop Combinations

A Plantation crop combinations is generally agrisilvicultural and the components are spatially mixed. This involves intensive plantations in association with multipurpose trees (Torquebiau, 1994). Smallholder farmers are often limited by major production functions, land and capital and the farmer's objective is not maximization of a single commodity (Nair, 1993). In many such cases, especially in densely populated areas, farmers usually integrate annual crops and animal production with perennial crops, primarily to meet their food requirements. It is for these innumerable smallholder areas that perennial crop associations and integrated land use practices are becoming increasingly important. Contrary to popular belief a substantial proportion of tropical plantation crops is grown by smallholders as reviewed by Ruthenberg (1980), Nair (1983; 1989) and Watson (1983). Most of the cocoa production in Ghana and Nigeria, for example, comes from smallholdings and it is usually grown in association with a specific crop, such as maize, cassava, banana, cucumber, and sweet potato, especially during the first four years. The size of the holding varies from one farmer to another. A widespread system in Latin America consists of combinations of coffee or cacao with species of *Erythrina*, *Inga* and *Cordia*, most commonly, *Erythrina poeppigiana*, *Inga jinicuil* and *Cordia alliodora*. Erythrina is usually pruned regularly and the prunings are left for soil improvement, a role recognized by farmers; Cordia is allowed to grow into a mature tree and harvested for timber (Beer, 1987). Plantation crop combinations form a sustainable use of steep valley sides in the Philippines and Sri Lanka, for example, and are a common system in many countries of West Africa (Young, 1997). The growing of rubber or oil-palm with a herbaceous legume cover crop is a standard management practice, helping to check erosion, add organic matter, shade the soil and fix nitrogen (Jayasinghe, 1991). In the Cote d'lvoire, *Acacia mangium* and *Acacia auriculiformis* were interplanted in a coconut plantation and pruned every 4 years; both species were effective in recycling potassium, magnesium and nitrogen and this led to a spectacular increase in coconut yield: 8000 nuts ha^{-1}, compared with 3500 nuts on coconut – only plots (Zakra *et al*., 1996).

Gliricidia sepium is sometimes seen as a shade tree above coffee or cacao, for example in the Solomon Islands and also forms straight poles, which can be either cut or used as live stakes for black pepper, yams and other climbing crops (Budelman, 1990). Besides providing straight stems, it produces abundant litter, giving a complete soil cover. Perennial crops encourage the farmer to take up a more sedentary lifestyle than of annual crops, and may also contribute to increased motivation for investment in permanent housing and agricultural improvement e.g., irrigation systems (Nair, 1993). Perennial crops are often considered the basis of a family's wealth and security and in addition, the relative constancy of yield and a seasonality of production of some of the perennial crops for example, coconut and rubber have made them a reasonable insurance against the risk of total crop failure, which is common for rainfed, seasonal crops in the tropics (Nair, 1993). Cropping systems consisting of perennial plant associations offer improved chances for conserving the soil and soil fertility due to the presence of a permanent plant cover and addition of litter (Nair, 1993). He reported that disincentives of perennial crop cultivation include the relatively long time-lag between planting and profitable production, land is committed to a crop for several years or even decades, the high initial investment in capital and labour costs, the processing requirements of some crops and the special management skills and diverse maintenance operations that are usually needed.

2.3.10 Silvopastoral Practices

Silvopastoral practices are land-use systems in which trees or shrubs are combined with livestock and pasture production on the same unit of land (Nair, 1993). Nair found out that within this broad category, several types of practices can be identified depending on the role of the tree / shrub component. These include the following:

Intensively managed

- Cut and carry systems (or protein bank): The tree/shrub species are grown in block configurations or along plot boundaries or other designated places; the foliage is lopped periodically and fed to animals that are kept in stalls.
- Live-fence posts: The fodder trees are left to grow to develop sufficient wood so that they serve as fence posts around grazing units or other plots; the trees are lopped periodically for fodder and for poles and posts as in the cut-and-carry system.

Extensively managed

- Browsing: Foliage (especially tender twigs, stems, and leaves) and sometimes fruits and pods of standing trees/shrub are consumed.
- Grazing: Animals graze on the plants, usually herbaceous species. Only those grazing systems in which trees are present and play an interactive role in animal production (for example, by providing shade to animals, promoting grass growth, and providing tree fodder or other tree products) can be considered as silvopastoral systems.

2.3.11 Agroforestry For Fuelwood Production

It is universally accepted that fuelwood shortage is a very serious problem affecting not only individual households, but also national and international resource conservation, and several measures have been recommended to address the problem, the most significant being the promotion of tree-planting for fuelwood production (Nair,1993). Several substantial tree-planting programmes initiated in the late 1970s to the early 1980s, especially in the dry tropics, included fuelwood 1990).Since several of these programmes involved tree planting by farmers on their own farms or communally or publicly-owned lands, they are generally known as agroforestry or social forestry projects for fuelwood production (Nair, 1993). A large number of tree species have been identified as fuelwood production as one of the major objectives (Kerkhof, 1990). Since several of these programmes involved tree planting by farmers on their own farms or communally-or publicly-owned lands, they are generally known as agroforestry or social forestry projects for fuelwood production (Nair, 1993). A large number of tree species have been identified as fuelwood crops and agroforestry programmes have been designed using a number of these fuelwood species (Nair, 1993). Since the largest share of fuelwood demand is associated with rural households, some observers (example, Gregerson *et al*., 1989) believe the key to solving the fuelwood problem is encouraging farm families to grow sufficient trees to meet their own requirements and to generate surpluses for sale. Care must be taken to ensure that the species chosen for fuelwood production are locally desirable and saleable and for example, in city fuelwood markets in Niger, wood from *combretum* species is preferred; wood of species such as neem and eucalyptus that have been extensively promoted in the Sahel for more than 20 years is still not popular (Nair, 1993). Similarly, fuelwood markets in India are dominated by wood of *Acacia nilotica*, *Tamarindus indica*, *Prosopis* and other local species, in spite of the large scale tree-planting efforts for fuelwood production by state agencies using exotics such as Leucaena, Casuarina and eucalyptus (Vandenbelt, 1990).

2.3.12 Intercropping Under Scattered or Regularly Planted Trees Various forms of intercropping under trees are often cited as common examples of agroforestry systems, and consist of growing agricultural crops under scattered or systematically-planted trees on farmlands, the farmer being far more extensive and common under small holder farming conditions (Nair, 1993). He stated that large part of the agricultural landscape under subsistence farming conditions in the tropics (as in Africa), is characterized by dispersed trees. The parklands (Savanna) in the Sahelian and Sudanese zones of Africa are characterized by the deliberate retention of trees on cultivated or recently fallowed land (Kessler, 1992). Kessler (1992) reported that approximately 20 different species are common in these parklands, and are well known for their multiple products such as fodder, fruits, medicine, wood, etc. Scientific studies on the interaction between such trees and intercropped agricultural crops have been few. Those that have been conducted are limited to a few tree species, such as *Faidherbia albida* in West Africa (Vandenbelt, 1992) and *Prosopis cineraria* in the Indian desert (Mann and Saxena, 1980). In both of these cases, crops yields under the trees are generally reported to be higher than in the open field and this has been attributed to various factors that contribute to microsited enrichment by the trees (Nair, 1993).

2.3.13 Agroforestry For Reclamation of Problem Soils

Physical and Chemical constraints to plant growth severely limit the productivity of vast areas of land in the world (Nair, 1993). Waterlogging, acidity, salinity and alkalinity, and the presence of excessive amount of clay, sand, or gravel are some of the major constraints and in addition to these naturally occurring conditions that constitute wastelands, flawed agricultural and other land-management practices result in the creation of more and more wastelands every year (Lal,1989). Agroforestry techniques involving planting multipurpose trees that are tolerant of these adverse soil conditions have been suggested as a management option for reclamation of such areas and several genera of economically useful trees have been identified as capable of growing in Saline-alkaline conditions, including *Tamarix* (Tomar and Gupta, 1985), *Atriplex* (Le Houerou, 1992), *Casuarina* (NAS, 1984), and *Prosopis* (Ormazabel, 1991). Acid-tolerant trees and shrubs useful for agroforestry include *Gmelina arborea* (Sanchez *et al*. 1985), *Erythrina* spp; and *Inga* spp. (Szott el al, 1991). Some success has been accomplished by tree planting and subsequent soil amelioration in the salt-affected soils of Northwestern India (Ahmed, 1991). The species utilized were *Acacia nilotica, Acacia tortilis, Prosopis juliflora, Butea monosperma* and *Eucalyptus* spp.

2.3.14 Buffer-zone Agroforestry

The introduction of agroforestry practices into buffer zones around protected forest areas has been suggested as a technology option which may not only reduce pressures on forest resources but which also can improve the living standards of the rural population living around these protected areas (van Orsdol, 1987). The buffer-zone system, first conceptualized by UNESCO (1984), consists of a series of concentric areas around a protected core; usually, this core area has been designated as a national park, wilderness area, or forest reserve, and its biological diversity is maintained through careful management.

Surrounding this core area is a primary buffer zone in which research, training, education and tourism are the main activities and this primary buffer zone is encircled by secondary or transitional buffer zones, in which sustainable use of resources by the local community is permitted (Nair, 1993). He reported that it is in these transitional zones that great possibilities exist for agroforestry innovations. There are several possible agroforestry strategies for buffer zone management. van Orsdol (1987) reported that mixed plantations, or woodlots of mixed indigenous tree species can provide less hostile environments for forest animals. Taungya systems could be used to gradually expand small forest tracts while minimizing the social and economic hardships to the surrounding population and that the concept of buffer zone agroforestry was successfully implemented in a number of projects including the Bururi Forest Project in Burundi (USAID, 1987), the Ugandan Village Forest Project (Care, 1986) and the conservation of Oku Mountain Project in Cameroon (van Orsdol, 1987). In all these projects, an important consideration is the inclusion of useful indigenous trees in the system designs.

2.3.15 Other Agroforestry Practices

Other Agroforestry practices include entomoforestry and aquaforestry.

Entomoforestry

Entomoforestry refers to insect rearing and well known examples are apiculture (beekeeping), sericulture (silk worms rearing) – (Torquebiau, 1994). Apiculture is considered to be an agroforestry technology directly, once the hives are set up in the trees, or indirectly, when the bees gather nectar from tree flowers (Torquebiau, 1994). He stated that apiculture is practiced in most tropical and temperate regions and can be a very profitable enterprise as found in the lesser Suunda islands in Eastern Indonesia where honey gathering is successful because the sap- producing lontar stands support large bee populations and due to the abundant supply of sugar foods, the islanders usually sell honey as a valuable export commodity. Sericulture is a very important farm enterprise in several regions of the world, specially India and China where silk worms feed on the mulberry tree (*Morus alba***)**, and therefore the tree becomes part of the breeding system, hence making it typical agroforestry (Torquebiau, 1994). Lac culture is a peculiar agroforestry technology where scale insects are grown on twigs of trees on which they exudate a substance known as lac, used in varnishes and paints (shellac) and other applications (e.g. jewellery) for its insulating and coating properties (Torquebiau, 1994). He reported that different trees are used for this, for example, *Ziziphus mauritiana***,** in countries like India, Bangladesh or China. The technologies used are silvopastoral and the components may be mixed, but rows of mulberry trees are common, on for example, field boundaries or along roads, scattered, single or multistrata depending upon the type of canopy from which the bees gather their nectar (Torquebiau, 1994). Mulberry trees and trees used for Lac are usually in a single strata arrangement.

Aquaforestry

Aquaforestry refers to the rearing of aquatic animals in association with trees (Torquebiau, 1994). Fish, shrimp, or oyster breeding in association with woody perennials is done in mangroves in certain parts of Southeast Asia and this is a typical agroforestry association, because the animals are species that are strictly adapted to mangroves and, therefore depend on trees for their survival (Torquebiau, 1994). Examples of fish ponds are known in a great many farming systems and once the fish feeds on tree biomass the system becomes an agroforestry one, as would be the case with any other type of animal (Torquebiau, 1994). He reported that in Siaya, in Western Kenya, fish bred in a basin feed partially on fodder from Leucaena used in alley cropping. The technologies used in aquaforestry are generally silvopastoral unless a herbaceous component is also grown with trees as fish fodder, in which case the system becomes agrosilvopastoral; the term agrosilvofishery is used and the components are mixed, scattered, single strata, except in the case of certain developed mangroves which can be multistrata or simultaneous (Torquebiau, 1994).

2.4 Importance of Agroforestry

Agroforestry combines production and service roles. Agroforestry leads to the production of some economic products such as food, fodder, fuelwood, medicinal substances, gums and resins, tannins, essential oils, fibres and waxes (Rehm and Espig, 1991). Oram (1993) reported that agrofoestry provides a wider range of products, more secure subsistence or more cash income from wood products to enable the farmer to buy food. Nair (1993) indicated that the combination of several types of products which are both subsistence and income generating, helps farmers to meet their basic needs and minimizes the risk of the production system's total failure. In the some countries, e.g. Indonesia, agroforestry home gardens play an essential role in the agricultural economy, producing foodstuffs or other subsistence or commercial products and also meeting most of the requirements for sustainability (Torquebiau, 1992). Similar situations exist in the "Chagga" forest gardens on the slopes of Kilimanjaro in Tanzania; in the Kandy region of Sri Lanka, in Bangladesh and in the homegardens or backyards gardens of West Africa (Okafor and Fernandez, 1987).Nair (1993) found that in tree home gardens, the production is for home consumption, but any marketable surplus can provide a safe guard against future crop failures and security for interval between the harvests (e.g. rice in Java and Sri Lanka, coffee and maize in Tanzania, coconut and rice in South Western India). Soemarwoto and Conway (1991) reported that compared with the rice fields of Java, the homegarden has a greater diversity of production and usually produces a higher net income; in West Java, fish production in homegarden ponds is common, with an income of 2 to 2.5 times that of rice fields in the same area.

Torquebiau (1994) found in Sumatra, for example, some people plant trees as a source of food, as well as rubber trees in their fallow fields. In Bornea, some people, plant rattan canes in rice fields during the last rice season and that rattan, a very aggressive vine, will use the trees as supports. He stated that rattan is a very profitable cash crop and can be harvested after 8 – 10 years.

The potential of the hardy Neem tree (*Azadirachta indica*), a native of the India sub – continent where it is reserved for its many pharmacological and other beneficial properties for agriculture and rural development in less developed countries is mentioned by Ahmed (1985). He points out that pest control materials which can be produced from the Neem tree at village level can be used effectively to reduce dependence on imported synthetic pesticides and to generate income for the rural poor. Traditionally, Indo – Pakistan farmers simply mixed 2 – 5kg of dried neem leaves/100kg of grain in order to control stored – grain pests (Ahmed and Koppel, 1985). Oil from the seeds of certain agroforestry trees can be used as a substitute for paraffin in hurricane lamps (FAO, 1986).

According to Rehm and Espig (1991), *Rauwolfia serpentina* was well known in ancient Asiantic medicine and contains the alkaloid reserpine which cures hypertension and calms down mad people. Ayensu (1983) pointed out that folk medicinal uses of the leaves, bark and roots of Rauwolfia species are extensive particularly for their aphrodisiac, emetic, purgative, abortive and insecticidal properties in India and other tropical countries.

Some important service roles of agroforestry are: soil conservation, either erosion control (presence of a permanent soil cover, barrier effect against run-off), soil fertility maintenance (incorporation of organic matter into the soil, nutrient pumping from the deep layers of the soil through the tree's roots, these nutrients then improve the crops through litter and mulch, nitrogen fixation) or soil physical properties maintenance (Young, 1989). He indicated that the creation of a microclimate, which can be beneficial to certain plants or animals, for example modifications of light, temperature, humidity or wind, and can also help fight weed proliferation. Maintenance or increase of organic matter has been proven and widely demonstrated, and is quantitatively known through studies of organic matter cycling under agroforest; a widely – quoted, now – classic, study is that of Nye and Greenland (1960). Afforestation has been used successfully to reclaim saline and alkaline soils. For example, under *Acacia nilotica* and *Eucalyptus tereticornis* in the Karnal region in India, a reduction of topsoil pH from 10.5 to 9.5 over five years has been reported with tree establishment assisted by additions of gypsum and manure (Singh et al; 1988). Sanchez (1987), in a review of this topic, cited encouraging results from experiments conducted to assess the nutrients cycling potential of agroforestry systems on Alfisols and Andepts of moderate to high fertility. Studies on the use of *Erythrina poeppigiana* as shade trees in *Coffea Arabica* plantations in Costa Rica have also yielded promising results (Glover and Beer, 1986; Imbach *et al*., 1989). *Coriana arborea* is known to be a valuable component in agroforestry where when grown as an understory species in plantations of *Pinus radiata* in New Zealand, is reported to fix up to 192kg Nha^{-1} yr^{-1} (Silvester, 1983). There is a large agroforestry project in Haiti, where farmers are motivated to plant hedgerows of Leucaena and other multipurpose trees and shrubs specifically for erosion control (Bannister and Nair, 1990; Pelleck 1992). In Australia, the high water uptake of Eucalyptus has been put to good use. Replacement of natural woodlands by pastures led to rising water – tables and salinity in valley floors. Trials showed that evapotranspiration from two fodder trees and seven out of nine *Eucalyptus* species was higher than from pastures by 70 – 80mm or 20%, drawing up water from beneath the root zones of the trees (Eastham *et al*,. 1994). This method has been successfully used to lower the water – table with associated reduction in salinity (Bari and Schofield, 1992). Agroforestry therefore helps to mitigate deforestation, combat land depletion, and as a result, can contribute to the alleviation of rural poverty (ICRAF, 1993). Bird *et al* (1992) found out that government – aided establishment of windbreaks to check soil erosion took place in the USA during the 'dust – bowl' drought period of 1930s. Vandenbeldt (1990) also reported that windbreaks have been planted on projects to check desertification in the Sahel zone of Africa. In China, shelter – belt systems, in some cases as broad as woodland belts; have been planted for integrated purposes of protection from wind, soil conservation and production (Moore and

Russel, 1990). In Niger, shelterbelts of Neem interplanted with other species reduced windspeeds up to 65% (National Academy of Sciences, 1980).

2.5 The Concept of Adoption

Adams (1982) conceptualized that adoption of innovation by the individual innovator is of five stages: Awareness – the individual first hears about or becomes aware of the innovation, but is not yet motivated to seek further information.

Interest stage – he feels that the innovation may be relevant to his needs he becomes interested and seeks additional information about it.

Evaluation stage: Weigh up the advantages and disadvantages of using it. Trial Stage: If his evaluation is favourable, he may decide to give the innovation a trial, by applying it on a small scale to determine its utility under his condition. Adoption – in the light of his experience during the trial stage, the individual may decide to apply the innovation fully, thus, on a relatively large scale and continuous use of the idea and personal satisfaction of it. It does not necessarily mean the constant use of the idea but that the idea has been accepted and the individual intends to include it in his practice. According to Ahmed (1991) a farmer is considered to have adopted a technology if he uses it to any extent on his farm.

From the concept put forward by Adams (1982) it may be decided that adoption of new innovations is not immediate and the final decision is usually the result of a series of influences operating through time. It might also be important to distinguish between adoption and diffusion. Agyemang (1991) gave a theoretical distinction between diffusion and adoption as: - Diffusion begins at a point in time when technology is ready for use. How the technology is made available to the potential user is the main focus of diffusion. Adoption considers the behaviour of individuals in relation to the use of the technology, more particularly the reasons of adoption at a point in time are of primary interest.

The concept of adoption has often attracted considerable attention as a result of the infrequent success in achieving high adoption rates in developing countries (Feder *et al,* 1985). Some of the underlying factors for low adoption rates can be found in the proposition by Rogers and Shoemaker (1971). According to them the adoption rate usually is a function of: - The relative advantage of the innovation as perceived by the farmer; the compatibility of the innovation in the context of the farming systems; the complexity, that is the degree to which the innovation is perceived as difficult to understand and use; the degree to which it can be subjected to simple and non – consequential trial on the farm; and the observability of the innovation and its effect. These propositions have been the core of much research on adoption. For example, Burch (1992) analyzing evidence from 100 studies found that innovations that permit a trial run have strongest initial local support. The perceived advantage and compatibility, he concluded, does not seem to be a great consideration in adoption.

2.6 Factors that affect adoption of agroforestry

Generally, the factors that affect adoption of agroforestry technologies may not be much different from the adoption of agricultural innovations. Agroforestry systems, however, can often be more complex than existing crop and other farming practices (Arnold, 1987). Thus there is the need to isolate factors that might specifically affect the adoption of agroforestry technologies. This is even more important because sometimes where trees are especially scarce, rural people may be unwilling to grow them. It is unlikely that the reason for this is ignorance of the benefits of trees or of the technologies used in cultivating them; it is far more likely that there is other real constrains (FAO, 1986).

Burley (1982) as quoted by FAO (1986) has suggested that the major conditions which must be satisfied before rural people will plant trees are economic, social/cultural and environmental.

Economic: - There must be sufficient land, capital and labour resources available to make tree growing possible and to cover the expenses of planting, cultivating, harvesting and marketing trees and their products. The benefits of tree cultivation and management, both in economic and financial terms, must exceed the net benefits from alternative resources and agricultural management, strategies as well as costs of production.

Social/ Cultural: -Changes in productive relationships and in the pattern of resource ownership which might be brought about by tree cultivation must fall within culturally accepted strategies for resource distribution. Further, appropriate and culturally sensitive technical expertise must be available.

Environmental: - Interventions or adaptive strategies must be responsive to the availability of water, to temperature regimes, to soil types and to other characteristics of the natural environment. In contrast to the broad categorization of factors that influence tree growing above, Agyemang (1991) concludes that the specific factors that should receive prominent attention of farmer adoption of agroforestry technologies are: land tenure and tree ownership, institutional support systems, labour requirement, management complexity for traditional farmers, long term nature of benefits and social security and equity.

Also an analysis on farmer adoption of agroforestry technologies by Mercer and Hyde (1992) draws a direct relationship between empirical studies on adoption of green revolution in developing countries and that of agroforestry and lists the following as the major factors that influence adoption of agroforestry technologies: risk and uncertainty, farm size, human capital, labour availability, credit and land tenure.

2.6.1 Socio-economic factors that affect adoption of agroforestry Technologies

Socio-economic considerations are increasingly becoming important in technology diffusion and adoption processes. This is more so for agricultural, forestry, agroforestry and related innovations, which are meant for the diverse environments and circumstances of rural people (Rocheleau and Raintree, 1986). The need to examine socio-economic factors in the adoption of agroforestry technologies has been highlighted by Raintree (1991) in his evaluation of the storm over Eucalyptus in social forestry programmes in India. Among his findings he stated that: "On closer examination of the issues, it appears that while most of the debate has been couched on ecological terms, many of the underlying issues are social and economic in nature. The debate demonstrated how important the socio-economic context of the intended user can be in determining whether or not he or she will be able to make effective use of a particular tree planting practice.

Again, Hoskin (1987) gives a partial list of socio-economic issues that must be taken into consideration if farm families are to adopt agroforestry technologies as: local uses and knowledge of trees, tenure, organization, conservation, landlessness, enterprises and marketing, labour, nutrition and gender/age. In his analysis on socio-economic context and development strategy for tree growing Raintree (1991) pointed out that factors that are relevant to consider under the broad heading of socio-economics will vary from place to place. Among the most important are: - degree of local socio-economic stratification (by wealth, land holding size, gender, ethnic group etc.); access to resources (land and tenure); overall economic development strategy; general approach to tree planting programmes, opportunity for relocation of resources; access to credit; processing technology and marketing assistance etc. It could be seen from the above discourse that the socio-economic factors that affect the adoption of agroforestry are many and varied and differ form place to place and it is time specific. In spite of these variations the major socio-economic factors that are necessary in the adoption of agroforestry by individuals are land tenure and ownership issues, socio-economic stratification, labour requirements, capital, markets and institutions;

2.6.1.1 Land tenure and Tree ownership Issues

One of the critical factors that have been given consideration in determining the potential acceptability and viability of agroforestry is land tenure systems and tree ownership. Francis (1987) gave the assertion that patterns of technology adoption will be shaped by the structure of opportunities and constraints presented by the rules of tenure. In the study of “Agroforestry adoption and risk perception by farmers in Senegal", Caveness and Kurtz (1993) found out that land ownership was one of the two predominant factors (the other was labour) affecting the adoption of agroforestry practices. Raintree (1991) has also found that if a would be user does not have security over the intended planting location, adoption of the tree planting innovation may be quite out of question. Kolade (1984) also noted that in vast agricultural lands of Tropical Africa, agroforestry has yet to make a break through. The reason is largely due to the flexible system of land tenure as well as its attendant insecurity.

Land tenure reforms in Ghana has been advocated by Benneh (1976) on the grounds that the old system does not provide security of tenure; that it discourages the investment of natural resources and does not encourage investments which bring about development in the land. Miniature farm sizes and the manner in which they are fragmented and scattered, he argues, constitute an obstacle to farm improvement for they do not enable farmers to take advantage of economies of scale in production. The old system, he claims prevent the use of farmland as collateral for credit, also it discourages the adoption of innovations and individual initiative in farming.

Governments in many African countries are aware of the need for tenure reformation. For example in Ghana the Rent Stabilization Act 109 of 1960 as amended the same year by Rents (Cocoa Farms Amendment) Regulation among others prohibited ejection of tenants without ministerial approval (Arhin, 1985). Okyere *et al* (1993) pointed out that many government interventions at tenure reformation have given rise to clashes between landowners and tenants. They pointed out that despite attempts by government to intervene by legislature; the bulk of statutory law relating to rural land has remained migratory. Most land matters are handed by linage elders and local chiefs in accordance with their interpretation of indigenous land laws.

Leach and Mearns (1988), asserted that tenure issues in agroforestry do not relate to land tenure only but also to tree tenure. The distinction between land and tree tenure is crucial to the participation of rural communities in projects involving tree growing. Fortmann (1985) has listed four major categories of rights that make the bundle, which comprises tree tenure: - the right to plant, the right to use, the right to dispose and the right to own or inherit. Each of these categories or combinations of any, Fortmann emphasizes, have restrictions on community participation in agroforestry projects in several African countries. He also points out that tree tenure issues in the community intended for the project needs careful examination to avoid problems like the loss of rights, particularly to other uses of land or the trees on it and loss of gathering rights among others. The complexity of tenure issues is believed to have discouraged many tenants from growing trees. Francis (1987) said that in areas where land pressure is more intense and other terms of tenancy are more definite, permanent tenants, many of whom grow food crops under tenancy leases, may be disallowed from planting tree.

2.6.1.2 Socio-economic stratification

Raintree (1991) pointed out that the degree of socio-economic stratification, which exists within a locality, is important in determining the adoption of a new technology particularly if it is highly attached to factors, which govern access to resources. The stratification of a community can be on the basis of wealth, landholding size, gender, age, ethnicity, religion, education etc. For example, results of studies by Akorhe (1981) and Nweke (1981) as quoted by Njoku (1991) indicated that the level of technology adoption on smallholder farms is influenced by the farmers' age, literacy rate, access to material inputs of technology and food security needs.

Eckman (1992) deduced from his studies that individuals within a household may have different rights depending on gender, birth or intrafamily status. He found also that in some African countries, for example, women plant and tend firewood or fruit trees but do not have right to harvest fruits or wood; these may be sold or appropriated by male members. Fortmann (1985) has also pointed that group rights which alienate "strangers" and deny them use rights of trees and discourage their participation in agroforestry projects. Socio-economic stratification has been found to be important in extension work. Johnson (1987) has concluded that to be effective in encouraging adoption of innovations, extension workers must work with rather homogenous categories of farmers i.e. Based on their access to land, water, labour inputs, markets, credit and information.

2.6.1.3 Labour requirements

One of the major factors influencing farmers' adoption of agroforestry is labour requirement (Arnold, 1987). He stated that a farmer's decision to grow trees can be influenced by two main factors: one is the high cost of labour and capital and the other is the potential of income to be generated from tree as distinct from food production in farmers production objectives. Njoku (1991) in his studies on adoption of improved oil palm production found that a major constraint was high cost of labour. He concluded that many new technologies require intense labour use, which contrasts greatly with the limited amount of labour expended in the traditional wild oil palm groves and that smallholder farmers must hire expensive labour to implement the improved technologies. The strong competition for household labour with other activities in the farming system particularly during critical periods in the agricultural season would obviously influence farmers' decision about adopting agroforestry. This has been found for example to be true of alley farming (Kang and Wilson, 1987).

2.6.1.4 Capital

One of the captivating arguments about capital requirements and adoption of agroforestry products has been put forward by Arnold (1987) as; "*It is widely argued that the lengthy production period and the incidence of most of the costs at the time of establishment, create financial problems for farmers in adopting practices involving tree growing*". It is this argument that underlies the widespread provision of planting stock, either free or at subsidized prices in programmes to support tree growing. However, the evidence that tree systems are favoured by farmers when capital is scarce because trees require less investment than alternative crops and/ or provide substitutes for purchased inputs example fertilizer and herbicides suggests that improved access to capital would not necessarily increase adoption of agroforestry practices. In support of Arnold argument, Hyman (1983) in his investigation on pulpwood production in the Philippines concluded that capital could be an impediment to investment in larger rotation timber species grown as cash crops. In this situation however, the constraint seems to be not the capital cost of establishment but lengthy period that elapses before there is any return. Schutjer and Van der Veen (1977) argued that adoption of scale-neutral innovations are not necessarily inhibited by credit constraints. They stated that the profitability of innovations often induces smallscale farmers to find the cash required for adoption from their relatively meager resources.

Contrary to the above discourse, capital in the form of savings and credit is required in order to form many agricultural and agroforestry innovations. Therefore differential access to capital is frequently cited as a major factor determining adoption rates (Mercer and Hyde, 1992). For example, Owusu Sekyere (1991) concluded that participating farmers in an agroforestry project complained that they needed credit in the form of cash to pay for extra labour required to maintain their agroforestry plots and that without attending to farmers cash needs project implementation can be very slow.

2.6.1.5 Markets

Marketing of products could serve as a great incentive or disincentive to virtually all productive ventures. According to Hedge (1990), the important criteria for farmers to grow any new tree species, depend among others on assured demand for the produce and really market outlets, minimum support price, at which tree growing is profitable; and generation of cash surplus as the most powerful incentive for most farmers. The important role of markets in tree growing is further highlighted by an observation of a participant in a farm forestry project in Gujarat, India and quoted by FAO (1989):

"*Having invested heavily in planting and maintaining the trees we waited patiently for four years. Now it is the end of 1986 and we have not been able to sell the trees. There are no buyers the Lokhariti workers are hiding away from us and the Forest Department Official who used to visit us has been transferred to another place, so we have nobody to turn to. We see this business of farm forestry as a disaster for our people*". The scenario above depict the frustrations farmers go through if they cannot market their tree products and also it underscores the risk aversion tendencies of farmers in adopting tree planting practices. It is only with a co-ordinated effort to market the forest produce at a remurative price that afforestation programmes can be implemented successfully with the active participation of the rural people (Hedge, 1990).

2.6.1.6 Institutions

Policy analysis define institutions as rules, norms and values that shape our behaviour. Sometimes known as the 'rules of the game; institutions can be:

- Both formal (example, laws that govern land tenure, market transactions or civil rights) and informal (example, social customs and conventions);
- Created (example, as a result of deliberate political or policy decisions) or may evolve overtime;
- Present at local, organizational, national, and international levels. In many developing countries, policies and institutions discriminate against those

with few assets and disadvantage poor people. Such discriminatory policies and institutions undermine development efforts to eradicate poverty. It is now generally accepted that significant and sustainable gains in poverty reduction cannot be achieved unless accompanied by pro-poor reforms to domestic and international policies and institutions (Ashley and Carney, 1999).

2.7 Promotion of Agroforestry Technologies: Gender Consideration

Gender considerations in the promotion of agroforestry have been highlighted partly because of the varying gender perceptions of tree resources, their different roles in production activities and access to resources. For example women and men have different views of the importance of various forest resources. A woman's first concern may be to find enough trees and forest products to satisfy the immediate family needs. Men's first concern may be forest products that are primarily sources of cash (FAO, 1989). Identification and incorporation of these different objectives into agroforestry promotional activities greatly enhances their success.

Leach and Mearns (1988) have also emphasized division between men and women in access to natural resources and their management system. They concluded that: Forestry development initiatives must therefore not just "consider" women but aim at giving them equality with men in control over resources, and in empowerment to evolve self-directed problem solving strategies. For this reasons, projects aimed specifically at women have often been unsuccessful, as they tend to ignore the broader social reasons why women are second to men in these concerns. More promising are efforts that emphasize involvement of all family members with explicit focus on women.

The emphasis on women in promotional activities has been given credence by several authors (Davidson and Dankelman, 1988; Shiva 1988). They all invariably point out that women are commonly collectors of water, fuel, and medical herbs etc. and that they are directly affected by environmental degradation and in their decision making they place higher value on taking care of the environmental than the male family members do.

2.8 The sustainability of livelihoods

A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living (Chambers and Conway, 1992).

Livelihoods are sustainable when they:

- are resilient in the face of external shocks and stresses;
- are not dependent upon external support (or if they are, this support itself should be economically and institutionally sustainable).
- maintain the long term productivity of natural resources; and
- do not undermine the livelihoods of, or compromise the livelihood options open to other (Chambers and Conway, 1992).

2.8.1 Sustainable livelihoods Framework

The framework for livelihoods analysis and its contribution to the design and management of intervention as given by Ashley and Carney (1999), is shown in the figure 2.1.

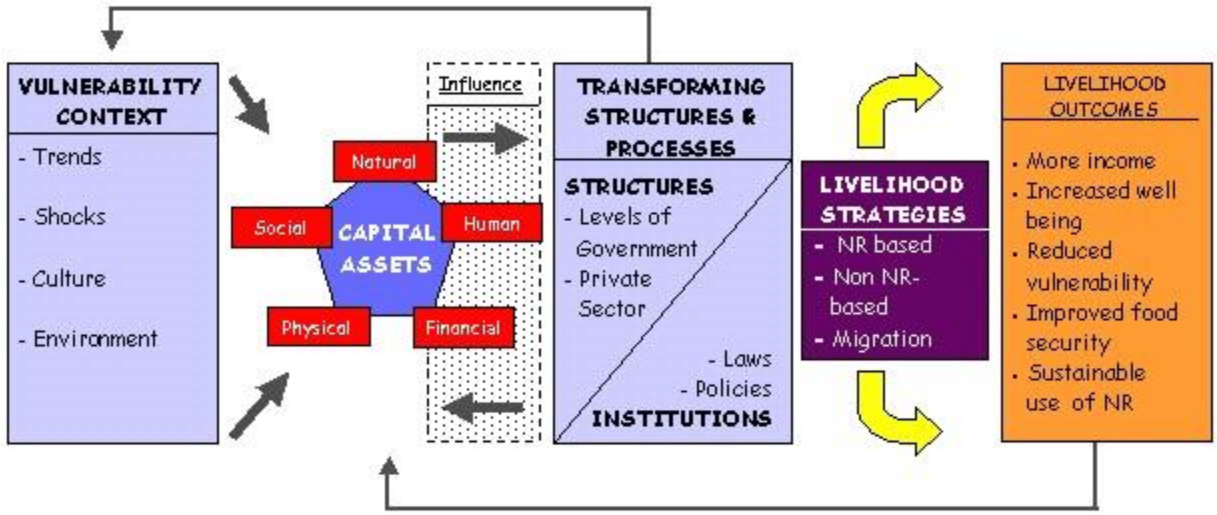


Fig 2.1 Sustainable Livelihood Framework

The various components of the framework is discussed as below:

The vulnerability context may include population trends, resource trends (including conflict), national/international economic trends, trends in governance (including politics), technological trends, human health shocks, natural shocks, and economic shocks, conflict, crop/ livestock health shocks, and seasonality of prices, production health and employment opportunities.

Human capital represents the skills, knowledge, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives. At a household level human capital is a factor of the amount and quality of labour available; this varies according to household size, skill levels, leadership potential and health status.

Social Capital is taken to mean the social resources upon which people draw in pursuit of their livelihood objectives. These are developed through: networks and connectedness, membership of more formalized groups, and relationships of trust, reciprocity and exchanges that facilitate co-operation, reduce transaction costs and may provide the basis for informal safety nets amongst the poor.

Natural Capital is the term used for the natural resources stocks from which resources flow and services (e.g. Nutrient cycling, erosion protection) useful for livelihoods are derived. There is a wide variation in the resources that make up natural capital, from intangible public goods such as the atmosphere and biodiversity including divisible assets used directly for production (trees, land).

Physical Capital comprises the basic infrastructure and producer goods needed to support livelihood. Producer goods are the tools and equipment that people use to function more productively. Infrastructure consists of change to the physical environment that helps people to meet their basic needs and to be more productive. The following components of infrastructure are usually essential for sustainable livelihoods: affordable transport, secure shelter and buildings; adequate water supply and sanitation, affordable energy and access to information (communication)

Financial Capital denotes the financial resources that people need to achieve their livelihood objectives. There are two main sources of financial capital; available stock which can be held in several forms such as cash, bank deposit, liquid assets such as livestock and jewellery, or resources obtained through credit – providing institutions; and regular inflow of money, including earned income, pension, other transfers from the state and remittances.

Transforming structure and processes are the institutions, organizations, policies and legislation that shape livelihoods. They operate at all levels, from the household to the international arena, and in all spheres, from the private to the most public. Structures are the organizations, both private and public, that set and implements policies and legislations, deliver services, purchase, trade and perform all manner of other functions that affect livelihoods. Processes determine the way in which structures and individuals operate and interact. They include macro, sectorial, redistributive and regulatory policies, international agreements, and domestic legislation, market culture, societal norms and believe, and power relations associated with age, gender, caste or class.

Livelihood strategies are the range and combination of activities and choices that people make/undertake in order to achieve their livelihood goals (including productive activities, investment strategies and reproductive choices). This is a dynamic process in which people combine activities to meet their various needs at different times. Links between urban and rural centers will need to be explored, as will the implications for the decisions – making and asset usage of split families. It is important to recognize that people compete for jobs, markets, securing better prices. There is no solution to this problem. However its existence does underscore the importance of intending choices and opportunity for the poor and building up their ability to take advantage of this opportunities and thinking about safety nets for those who remain unable to achieve their livelihood objectives in what will always be a competitive environment.

Livelihood Outcomes are the achievements or output of livelihood strategies. We should not assume that people are entirely dedicated to maximizing their income. It is hard to weigh up the relative values of increased well – being as oppose to increase income, but this is the type of decision that people must make everyday when deciding which strategies to adopt. There may also be conflict between livelihood outcomes. Examples are when increased incomes for a particular group is achieved through practice that are detrimental to the natural resources base or when different family members prioritize different livelihood objectives – some seeking to reduce vulnerability, while others seek to maximize income streams. There is a close relationship between livelihood outcome and livelihood assets, the two being linked through livelihood strategies.

2.9 Rural poverty in developing countries

Poverty in developing countries is a reality that we live with on a daily basis .

One does not need to venture far to see naked poverty in Africa.

2.9.1 Rural poverty

Ashley and Carney (1999) gave the concept of poverty and it evolution over the decade as follows:

- Before 1970 poverty was largely defined in economic terms as a lack of income or gross national product per capital.
- In the 1970s the concept of basic need evolved. Basic needs included access to certain consumer goods as well as to collective goods (such as education and health services), and broader element of well – being.
- In the 1980s the basic needs approach was partially abandoned and more general interpretation of well – being gained ground. People's ability to perform various functions and to develop and deploy their capabilities was considered to be a critical dimension of poverty. New thinking emerged both "entitlements" to resources and vulnerability of poor people to change in their ecological, economic and political environment. It was recognize that poverty is a relative concept that is intimately connected with political, moral and cultural values in a given society and the condition of 'social exclusion' relate to all these.
- In the 1990s poverty and the processes that leads to poverty are conceived as multi – dimensional (economic, political, social, ecological, cultural) and highly context – specific. The poor are no longer considered to be a homogenous group. Poverty assessment has evolved, moving beyond the characterization of poverty and towards the analysis of processes that cause poverty at various levels.

Sharp *et al* (1990) also looked at poverty as a relationship between minimum food budget and the cost of the food budget. They defined the threshold of poverty as the minimum amount of money that families need to purchase nutritional adequate diet, assuming they use one – third of their income on food [cost of basic needs (CBN) definition of poverty].

Cepal (1997) defined poverty line as that level of income beneath which a person cannot meet daily nutritional requirements and other basic needs (hygiene, clothing, education and transport). The absolute poverty line was defined by Cepal (1997) in terms of income insufficient to meet the minimum daily nutritional requirements. Poverty indicators include those living below the absolute poverty line. He also discovered that rural poor face three fundamental problems: few opportunities for productive employment in agricultural or nonagricultural activities, inadequate nutrition, poor health services and absence of educational opportunities and lack of sufficient levels of organization needed to lobby effectively for rural interests. About one-fifth of the world's population is afflicted by poverty. Poverty is not only a state of existence but also a process with many dimensions and complexities. Usually it is characterized by deprivation, vulnerability (high risk and low capacity to cope), and powerlessness (Lipton and Ravillion, 1995; Sen, 1999). These characteristics impair people's sense of well being. Poverty can be chronic or transient, but transient poverty, if acute, can trap succeeding generations. The poor adopt all kinds of strategies to mitigate and cope with their poverty.

To understand poverty, it is essential to examine the economic and social context, including institutions of the state, markets, communities, and households (families). Poverty differences cut across gender, ethnicity, age, residence (rural versus urban), and income source. In households, children and women often suffer more than men. In the community, minority ethnic or religious groups suffer more than majority groups, and the rural poor, more than the urban poor; among the rural poor, landless wageworkers suffer than small landowners or tenants. These differences among the poor reflect highly complex interactions of cultures, markets, and public policies (Khan, 2000).

Khan (2000), also said that the links among poverty, economic growth, and income distribution have been studied quite extensively in recent literature on economic development. Absolute poverty, he said can be alleviated if at least two conditions are met. First, economic growth must occur- or mean income must rise- on a sustained basis. Second, economic growth must be neutral with respect to income distribution or reduced income inequality. Generally, poverty cannot be reduced if economic growth does not occur. Ravallion and Datt (1999), said that persistent poverty of a substantial portion of the population could dampen the prospects for economic growth. Also, the initial distribution of income) and wealth), they said, can greatly affect the prospects for growth and alleviation of mass poverty. Khan (2000), said that there is substantial evidence that a very unequal distribution of income is not conducive to either economic growth or poverty reduction. Current experience of economic growth has shown that if countries put in place incentive structures and complementary investments to ensure that better health and education lead to higher incomes, the poor will benefit doubly through increased current consumption and higher future incomes.

The pattern and stability of economic growth also matter. On the one hand, traditional capital-intensive, import-sustainability, and urban-biased growthinduced by government policies on pricing, trade, and public expenditure-has generally not been good for alleviating poverty. On the other hand, agricultural growth-where there is low concentration of land ownership and labour-intensive technologies are used has almost always helped to alleviate poverty (Gaiha, 1993; Datt and Ravallion, 1998). Finally, they also said that sharp drops in growth resulting from shocks and adjustments may increase the incidence of poverty; and even when growth resumes, its incidence may not decrease if inequality has been increased by the crisis.

Khan (2000), asserted that rural poverty accounts for nearly 63 percent of poverty worldwide, reaching 90 percent in China and Bangladesh and between 65 and 90 percent in Sub-Saharan Africa. (Exceptions to this pattern are seen in several Latin American countries in which poverty is concentrated in urban areas). In almost all countries, he said, the conditions in terms of personal consumption and access to education, health care, potable water and sanitation, housing, transport, and communications-faced by the rural poor are far worse than those faced by the urban poor. Khan (2000), again found that persistently high levels of rural poverty, with or without overall economic growth, have contributed to rapid population growth and migration to urban areas. In fact, much urban poverty is created by the rural poor's efforts to get out of poverty by moving to cities. Distorted government policies, such as penalizing the agriculture sector and neglecting rural (social and physical) infrastructure, have been major contributors to both rural and urban poverty.

2.9.2 Rural Poor's links to the Economy

Khan (2000), found that the rural poor depend largely on agriculture, fishing and forestry, and related small-scale industries and services. To understand how poverty affects these individuals and households and to delineate the policy options for poverty reduction, one needs to know first who the rural poor are. They are not a homogenous group. He said that one important criterion for classifying the rural poor into groups is their access to agricultural land: cultivators have access to land as small landowners and tenants, and noncultivators are landless, unskilled workers. There is, however, much functional overlap between these groups, reflecting the poverty-mitigating strategies of the poor in response to changes in the economy and society. He explained that cultivators, who form bulk of the rural poor in developing countries, are directly engaged in producing and managing crops and livestock.

Since these households cannot sustain themselves on the small parcels of land they own or cultivate, they provide labour to others for both farm and nonfarm activities inside and outside their villages. Some members of these households migrate to towns or cities on either a rotational or a long-term basis. In many countries, both small landowners and tenants are under increasing pressure to get out of the agriculture sector altogether. Underlying this process of "depeasantization" are market forces and policies affecting landholdings, rents, prices, credit, inputs and public investment in the social and physical infrastructure.

Khan (2000), found that non-cultivators are perhaps the poorest among the rural poor. Their numbers have been rising rapidly because of the natural increase in population and depeasantization. These workers depend on seasonal demand for labour in agriculture and in rural informal, small-scale industries and services. The landless rural workers are vulnerable to fluctuations in the demand for labour, wage rates, and food prices. He continued to say that, they find it even more difficult than small landowners and tenants to gain access to public infrastructure and services. In addition, unlike their counterparts in urban areas, they are often excluded from public sector safety nets (food rations, for example).

Rural women tend to suffer far more than rural men. Their poverty and low social status in most societies is one of the most important reasons for chronic poverty. Substantial evidence from numerous countries shows that focusing on the needs and empowerment of women is one of the keys to human development. Khan (2000), found that to understand poverty creation in rural areas and its effects on different groups, we should look at the assets that the poor own or to which they have access, and their links to the economy. He said that the economic conditions faced by the rural poor are affected by a variety of assets (and the returns on them) held at the household, community, and supra-community levels. The poor's physical assets include natural capital (private and common property rights in land, pastures, forest, and water), machines and tools and structures, stocks of domestic animals and food, and financial capital (jewelry, insurance, savings, and access to credit). Their human assets are the labour pools-comprising workers of varying ages, genders, skills, and health- in the households and communities. Their infrastructural assets are publicly and privately provided transport and communications, access to schools and health centers, storage, potable water, and sanitation.

Their institutional assets include their legally protected rights and freedoms and the extent of their participation in decision making in households and communities, as well as at the supra-community level. The first two categories of assets, he said, are largely regulated through formal and informal networks among individuals and communities. Most rural people, particularly women and those in landless households, are greatly handicapped by their dearth of assets and the low and volatile returns on these.

Khan (2000) again found that the differences among the rural poor are more clearly reflected in their links to the economy which determine how they use their assets and participate in production. All the rural poor are engaged in production of both tradable and non-tradable goods and services. He said that artisans and unskilled workers provide many nontradeable services and some nontradeable products (such as staple foods) that small cultivators also produce. Only cultivators, however, have access to small parcels of land through ownership or (sharecropping) tenancy. They are also the only groups of poor people who own or rent physical capital such as tools, implements, and machinery. Artisans and small-scale farmers have only limited amounts of physical capital. They have only limited access to financial capital and acquire it largely through informal agents or institutions, except for tenants, who can use their landlords as conduits to formal credit. Borrowed capital is often costly and is used to maintain consumption during hard times or to buy supplies and equipment needed for farming. Households' labour is used both within the family-for work done by unpaid family members- and to earn the wages paid to landless, unskilled workers in farm and nonfarm activities. Khan (2000), asserted that all groups of the rural poor are vulnerable to serious risk owing to changes in weather, health, markets, investment, and public policy. The resulting fluctuations in the prices and quantities of their assets and of what they produce can either deepen their poverty or give them opportunities to escape from it. The main reason is that the rural poor are ill equipped to absorb shocks. In addition, economic crises and natural disasters can bring about sharp increases in poverty and make it more difficult for the poor to escape it.

2.9.3 Causes of Rural Poverty

Numerous characteristics of a country's economy and society, as well as some external influences, create and perpetuate rural poverty (Jazairy *et al*, 1992; Gaiha, 1993): These include:

- Political instability and civil strife;
- Systematic discrimination on the basis of gender, race, ethnicity, religion, or caste;
- Ill-defined poverty rights or unfair enforcement of rights to agricultural land and other natural resources;

- High concentration of land ownership and asymmetrical tenancy arrangements;
- Corrupt politicians and rent-seeking public bureaucracies;
- Economic policies that discriminate against or exclude the rural poor from the development process and accentuate the effects of their povertycreating process;
- Largely and rapidly growing families with high dependence ratios;
- Market imperfections owing to the high concentration of land and other assets and distortionary public policies; and
- External shock stemming from natural causes (for example, climate changes) and changes in the international economy.

2.9.4 Policies for reducing Rural Poverty

Boosting agricultural growth by applying new technologies is one of the most important ways to reduce rural poverty. However, the impact of such efforts on the rural poor depends on initial conditions, the structure of relevant institutions, and incentives. It is known that agricultural stagnation has harmed the rural poor in Sub-Saharan Africa by creating their ability to buy food and find work. Conversely, experience with the Green Revolution showed that rapid agricultural progress made a big difference in reducing rural poverty in parts of South Asia (Khan 2000).

Datt and Ravallion (1998) reported that higher crop yields reduce both the number of rural poor and the severity of rural poverty. But these effects are strong only if certain conditions are met.

Since the rural poor are quite varied, we need to understand how macroeconomic changes and policies can affect them. The three major ways in which policies affect the rural poor are through markets, infrastructure (including public services), and transfers (Behrman, 1993). The markets, in which the rural poor participate, he said, are those for products, inputs (labour and non-labour), and finance (from formal and informal sources). Several important features of these markets can affect conditions in the rural areas. The infrastructure that directly affects the rural sector's productivity and the rural poor's quality of life includes the economic (transport, communications, extension services, irrigation) and the social (education, health care, water, and sanitation). Given that most elements of a community's infrastructure are provided through public funding, the level of spending, cost effectiveness, quality of service, and access of the rural poor to infrastructure and public services have important impacts on human capital and productivity in rural areas. Behrman (1993) said that transfers, which are both private and public, provide some insurance against anticipated and unanticipated shocks. Most of the rural poor depend on private transfers among households, extended families, and other kinship groups. Public transfers can take the form of redistribution of assets like land, employment on public works projects, and targeted subsidies for inputs and some consumer products. These transfers, he said, supplement or displace private transfers, depending on the policy instrument and how it is used. An important point is that these channelsmarkets, infrastructure and transfers-do not work in the same way for all of the rural poor because each group has quite different links to the economy.

Behrman (1993) said that policy focus should be on four major groups of the poor: small landowners, who cultivate their land; landless tenants who cultivate other people's land; landless labourers who depend on casual or long-term employment in the farm and non-farm sectors; and women, who could also be part of any of the three preceding groups. All of these groups will benefit from good macro-economic management-which helps keep inflation in check and maintains unsubsidized prices-because it facilitates sustained economic growth through private investment and competitive markets. Needless to say, unfair laws or poor enforcement of exciting laws, exclusion of the poor from decision-making, and pervasive corruption in the public sector are no less detrimental to the well being of the poor than they are to the country's overall economic growth.

Lipton (1998) has identified several policy components for national strategiesinvolving the government, the private (for-profit) sector, and civil society-to reduce rural poverty:

- The right to adequate land and water is the key importance in reducing rural poverty in many developing countries. A broad-based land reform programme- including land titling, land redistribution, and fair and enforceable tenancy contracts- can make small (marginal) landowners and tenants more efficient producers and raise their standard of living.

- The rural poor need to build and strengthen their human capital so they can get out of poverty and contribute more to the economy and society.
- Basic health care (immunization, provision of clean water, and family planning and education (literacy, schooling, and technical training)- particularly for women and children- are essential building blocks and should be accessible at reasonable cost. The rural poor cannot, however, make the best use of their resources, including human capital, if either the quantity or the quality of some of the key parts of the country's physical infrastructure (irrigation, transport, and communications) and support services (research and extension) is inadequate. The social and physical infrastructure and services can be funded and maintained best- that is, they will be cost-effective and of reasonable quality-if the target groups are involved in designing, implementing, and monitoring them, as well as in ensuring accountability of the government officials responsible for them.
- Informal and formal sources of credit often are too costly for, or unavailable to, the rural poor. Targeted public sector rural credit programmes, especially if they are subsidized, benefit the non-poor far more than the poor. The poor want credit that is available on accepted terms and when they need it. Recent experiments with community-based credit programmes, in which the poor actively participate in the

making of lending decisions and that are subject to peer accountability, have been successful in reaching target groups at reasonable cost.

- A large and increasing proportion of the rural poor depends on wage labour, because they have either no asset other than raw labour or very few assets: limited quantities of land and domestic animals. A flexible public works programme can greatly help the near landless and the landless to smooth out household consumption and avoid transient poverty. If used on a sustained basis, such a programme can also strengthen the bargaining power of the poor in rural areas.
- Some of the rural poor, both individuals and households, suffer from inadequate nutrition most of the time. They need different kinds of support, depending on their circumstances. These may include food supplement programmes; food assistance provided through schools, health care clinics, and community centers; and cash transfers. Decentralized and targeted programmes seem to work best.

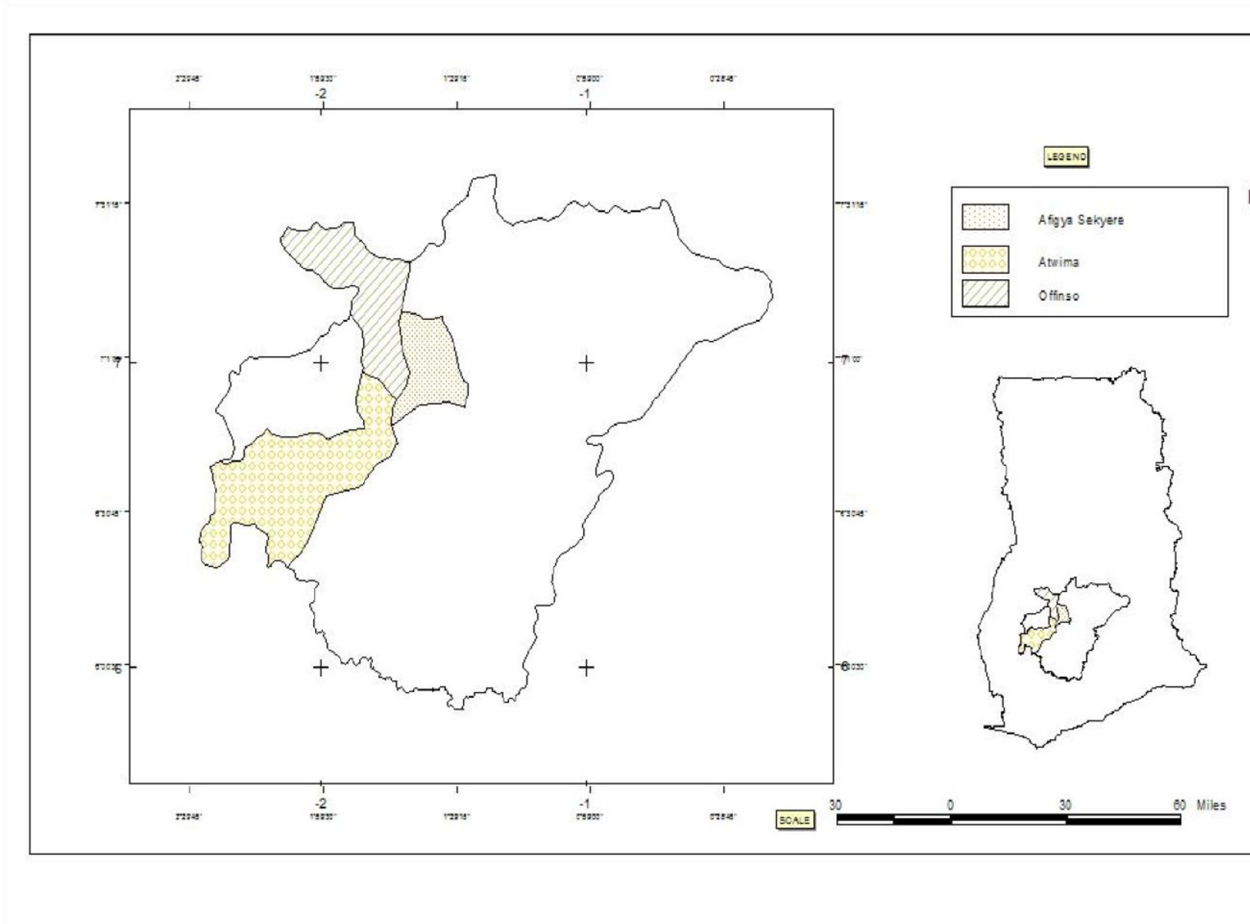
2.10 Conclusion

The ultimate feasibility of agroforestry will depend on actual impact that it has on farmer economic and physical well-being. No matter how convincingly that biological scientists argue in favour of agroforestry in terms of long-term organic matter maintenance and nutrient recycling, such attributes will remain largely invisible to farmers, extension agents, international donors, and others in agricultural development until they can be translated into tangible lower costs of production and increased output. This will entail numerous challenges in the years ahead. Both macro and microeconomic stability, competitive markets, and public investment in physical and social infrastructure are widely recognized as important requirements for achieving sustained economic growth and a reduction in rural poverty. These will provide conducive socio-economic environment for the adoption of agroforestry technologies and subsequent impact on the economic and well being of the rural farmer. In addition, because the rural poor's links to the economy vary considerably, public policy should focus on issues of their access to land and credit, education and health care, support services through well-designed public work programmes and other transfer mechanisms. Also ongoing agroforestry enterprises can be modified and improved through a realistic assessment of social acceptability, financial feasibility and changing market opportunities.

CHAPTER THREE MATERIALS AND METHODS

3.1 Study Area

The study was carried out in the Offinso, Afigya Sekyere and Atwima Districts all in the Ashanti Region of Ghana (fig. 3.1). The study area lies roughly within Latitudes 6º 21'N and 6º 75'N and longitude 1º 65 W and 2º 23'W. The three districts where the sites are located share boundaries with Ejura Sekyedumase to the North, Sekyere West and Sekyere East to the East, Kumasi Metropolitan Assembly, Kwabre and Bosomtwi-Kwanwoma to the South East, Amansie West to the South and Ahafo-Ano North and Ahafo-Ano South to the West.The total land area is 2391.47 square kilometres forming about 0.56% of the total land area of the region which is 434,390 square kilometers. The communities in the Districts selected for the study includes Nyamebekyere (Kwadwo Forjourkrom), Abofour, Kyebi, Kona, Tano Odumasi, Adankwame, Esaso, Kumi, Mabanand Barekese(fig.3.2). The reason for selecting these communities was that they have been introduced to Agroforestry technologies since 1983. Specifically, windbreaks/shelterbelt were introduced to Tano Odumasi and Kona in 1983 while taungya, alley cropping and woodlot were introduced to the remaining communities



in 1989. These communities therefore have one of the largest concentrations of farmers practicing various agroforestry technologies in the country.

Maps of the selected district and communities are presented in fig. 3.1 and fig. 3.2 respectively.

Fig 3.1 Map of Ashanti Region of Ghana showing Afigya Sekyere, Offinso and Atwima districts

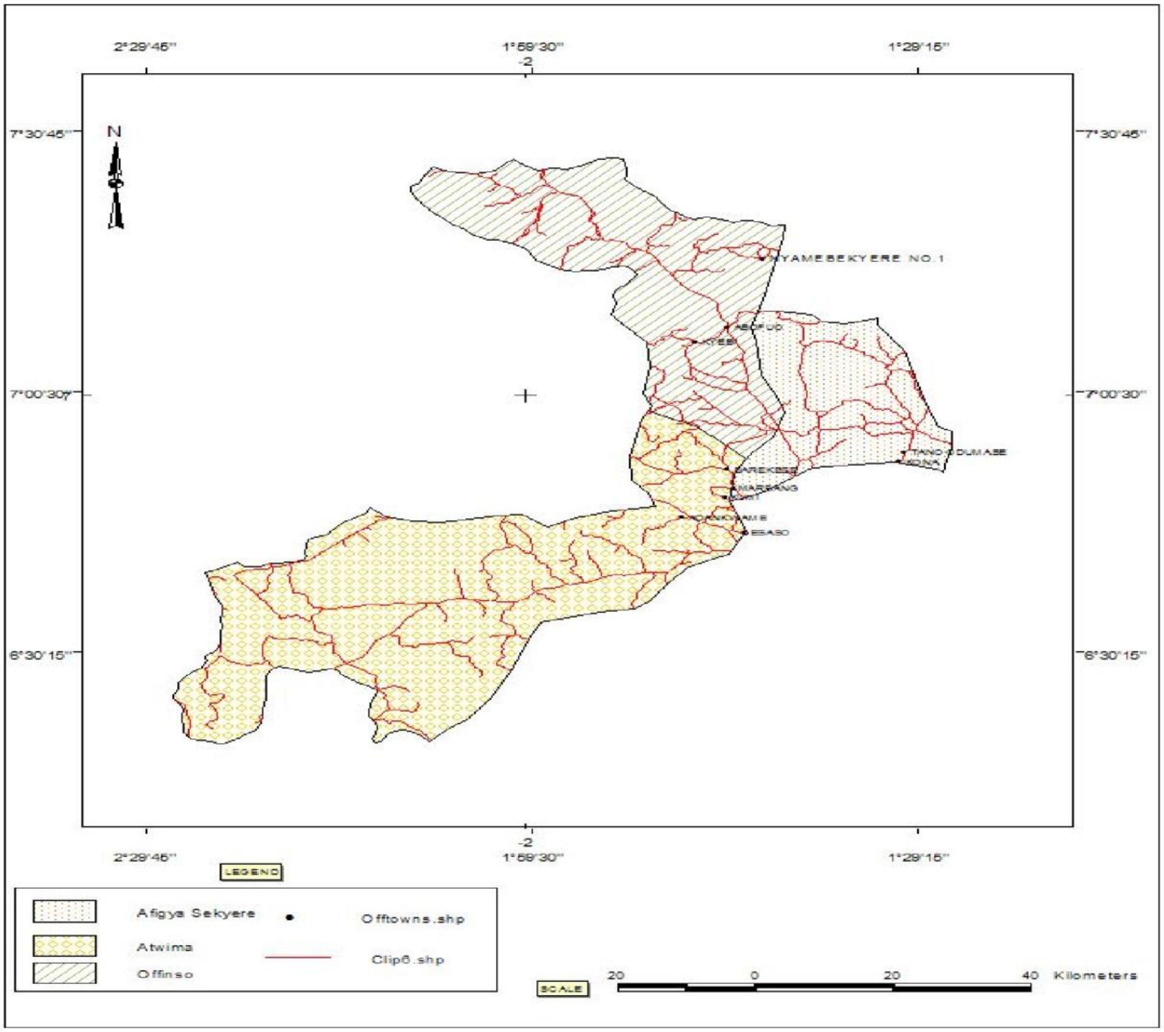


Fig 3.2 Communities for the survey within Afigya Sekyere, Atwima and Offinso districts.

3.2 Biophysical Characteristics of the Study Area

3.2.1 Relief and Drainage

Greater parts of the Afigya-Sekyere district fall within a disserted plateau with heights reaching 800m to 1200m above sea level. The plateau forms part of the Mampong-Gambaga scarp. Many years of erosion has reduced the area to uniformly low height between 480m and 600m above sea level. The district is drained by many rivers and streams. Notably among them are Offin, Oyon and Abankro rivers. The Offinso District also forms part of the Mampong-Gambaga scarp and drained mainly by the river Offin. The Atwima district has an undulating topography. It is dissected by pene plains and slopes and has an average height of about 77m above sea level. The area has gentle to steep slopes. The surface area of the district is mainly drained by the Offin, Owabi and Tano rivers. Other minor rivers that drain the area include Kobi and Dwehen. Two major dams, Owabi and Barekese have been constructed across the Owabi and Offin rivers respectively. These dams supply pipe-borne water to the residents of Kumasi and its immediate environs. (Districts Development plan, 2004).

3.2.2 Vegetation

The study area lies within the semi – deciduous forest. The vegetation type has largely been disturbed by man's activities changing it gradually from primary forest to a secondary forest depriving the area of its valuable tree species and other forests products. Tree species found in the forest include wawa, mahogany, odum, sapele among others. Also large area of forest reserves exist which include Tano-sura

Extension Forest Reserves, Asamanyo Forest Reserve, Owabi Water Works Forest Reserve (Districts Development plan, 2004).

3.2.3 Soils

There are two geological formations in the Afigya-Sekyere district namely; the Voltaian and Dahomeyan formations. The soil here is ideal for the cultivation of tree crops such as cocoa, citrus, coffee and oil palm. It also supports the cultivation of crops such as pear, cola, plantain, banana, cocoyam, maize, cassava, beans, groundnuts, ginger and all kinds of vegetables. The soils in the Offinso district are developed from different parent materials. Soils developed from granite are deep, well drained and permeable. They are suitable for the cultivation of crops such as yam, cassava, maize, tobacco and vegetables. The Birimian rock types are well drained and support the cultivation of food crops and trees. The soils in the Atwima District are very shallow, excessively rocky and are susceptible to erosion. It is suitable for the cultivation of tree crops such as cocoa, coffee, cola, citrus and oil palm and food crops such as cassava, maize, cocoyam, plantain and vegetables. (Districts Development plan, 2004).

3.2.4 Climate

The study area experiences semi-equatorial conventional climate. It has double rainfall maxima regimes with the major season occurring between March and July. The minor rainfall season occurs between September and November.

Average annual rainfall ranges between 855mm and 1500mm. Relative humidity is high during the major rainy season, reaching its peak of 90% between May and

June. The months December to March are dry. A maximum temperature of 30ºC is experienced between March and April. Mean monthly temperature is about 27ºC. (Districts Development plan, 2004)

3.3 Socio-Economic Characteristics of the Study Area

3.3.1 Population

The population of the Afigya Sekyere District according to the 2000 population census is 119,093 with the 1984 population of 72,125; the population of the district is growing at a rate of 3.1% with a density of 162.6 persons per sq. km. The rural population constitutes 64.4% of the total population (Districts Development plan, 2004). The population of the Offinso district is 138,190 comparing 68,713 males and 69,477 females. The population density is 63,5 persons/km^2. There are about 125 settlements in the district. Out of these settlements, (five) 5 could be described as urban. This means the remaining 121 settlements are rural. The population of the Atwima district stood at 237,610 made up of 122,298 males and 115,312 females. The projected population of the district with annual growth rate of 2.8% is estimated to be 243,550 (Districts Development plan, 2004).

3.3.2 Ethnicity and Religion

The study area is quite homogenous. It is peopled mainly by the Asantes with pockets of other tribes mainly of the northern extraction. There are also Ewes, Gas and Fantis.

The main religions in the district are Christianity, Islam and Traditional African Religions. The Christians forms about 80% of the population. All these groups live in harmony and could be used to disseminate information, education and mobilize the people for development purposes (Districts Development plan, 2004).

3.3.3 Physical infrastructure (Roads)

The Afigya Sekyere district has a total of 180,2km length of road network. Over 90% of roads in the district are untarred. Among the few tarred roads in the districts are the Kumasi-Mampong trunk road, Kumasi-Offinso trunk road, about 2km of Agona-Wiamoase road and parts of the Ahenkro-Kwamang road. Generally communities in the district are interconnected by a network of feeder roads. The Kumasi-Techiman road is the only tarred road in the Offinso district. Two trunk roads within the Atwima district are Abuakwa-Bibiani road and 5 km stretch of Abuakwa-Mfensi road. (Districts Development plan, 2004).

3.3.4 Economic Activities

Agriculture especially food-crop farming is the main economic activity in the study area. Over 70% of the active populations are farmers. This type of agriculture takes place through the traditional system of land rotation and bushfallowing, in which the land is left to fallow for three to five years in order to regenerate its fertility after a period of cultivation. The increased demand for land has led to shortening of fallow period and consequently severe degradation of farm sites. A limited number of livestock such as fowls, goats and sheep are kept usually on a free-range basis (Districts Development plan, 2004).

3.4 Data Collection

Data used in this study was obtained from primary and secondary sources. The primary source involved field survey whiles the secondary sources include a review of existing literature on the study area in relation to the districts, region and nation as a whole.

The study was conducted using three main approaches: exploratory/ familiarization visit, reconnaissance survey and socio-economic survey.

Exploratory/ Familiarization Visit

A visit was undertaken to each of the districts (Afigya-Sekyere, Atwima and Offinso districts) to familiarize with the District Directors of Agriculture and Forest Services Division and to hold discussion with them on the research, which was to be carried out in their area of jurisdiction. Field officers and forestry range supervisors assigned to each community were also contacted.

Reconnaissance Survey

Ten days were spent to carry out a reconnaissance survey in the study area. The objectives of the survey were four fold: to establish rapport/contact with farmers in the villages where the actual survey was to be carried out, to identify possible households from which a random sample was to be taken for the actual survey, to pretest questionnaire to be used in the actual survey and to rapidly appraise some of the main biophysical and socio-economic features in the area.

The survey was conducted in 10 communities where agroforestry practitioners were dominant. With the help of the field/technical officers of the Ministry of Food and Agriculture and a forestry range supervisor, a contact farmer chosen for each community was taken through a pre-test of a drafted questionnaire for the actual survey.

Key biophysical (nature of soils, important trees, rainfall) and socio-economic (major ethnic groups and their composition, tenurial arrangements, religion) features of the study area were rapidly appraised through the use of discussions, direct observation. Visits were also made to some Ministries/Departments (Agriculture, Forestry, Statistics and Development Planning) at the districts and regional capital for the collection of general information on the study area.

3.5 Socio-economic Survey

Population and Sample

Ten communities in the study area were selected for the entire survey. The communities were selected based on their involvement in agroforestry. An effort was made to sample at least 20 non-agroforestry practitioners in the study area to serve as a control. Again, officers of the Ministry of Food and Agriculture, Ministry of Lands, Forestry and Mines, Community/Development office in the Afigya Sekyere, Atwima and Offinso in the districts were interviewed. Seventy (70) of the sample farmers (Agroforestry practitioners) were interviewed.

Instrumentation

Both structured and unstructured interview questionnaires were used to obtain information from individual farmers in the households, Foresters, Extension agents/Agricultural Officers and Community/Development Planning Officers. The survey instrument for the farmers, developed after the reconnaissance survey, considered questions under farmers' background (personal and household characteristics), land tenure, land use systems and agroforestry technologies, input and financial support, household energy, level of income and expenditure of the farmer and household needs before and after adoption of the technology.

The survey instrument for forest officers/range supervisors, District officer/ extension agent of Ministry of Food and Agriculture, Community/Development Planning Officers considered questions such as activities of the establishment, failures and successes, constraints of programme of activities and steps taken to overcome them, agroforestry technologies dominant in the district, perceived impact of agroforestry problems facing technology adoption and recommendations from officers to solve problems in technology adoption. A copy of the survey instrument is presented in Appendix II and III.

3.6 Data Analysis

The responses to the questionnaire for the household survey were analysed both qualitatively and quantitatively. Frequency Distribution and simple ranking procedures were used for the data analysis to summarize farmer's characteristics, farm level and specific characteristics and factors that influence the adoption of agroforestry and its subsequent impact. The Multiple Logistic Regression Model was used in the second part of the data to examine the inter-relationships between factors that influence adoption.

The logistic regression model is easily extended to more than one independent variable. In fact, several independent variables are usually required with logistic regression to obtain adequate description and useful predictions.

The multiple logistic regression model can be stated as follows:

Y, are independent Bernoulli random variable with expected values

$E\{Y_1\} = \pi_1,$ where

$$E\{Y_1\} = \pi = \frac{\exp(ß^1 X_1)}{1 + \exp(ß^1 X_1)}$$

Again, the X observations are considered to be known constants. Alternatively, if the X variables are random, $E\{Y_1\}$ is viewed as a conditional means, given the values of $X_{1 \ldots} X_1$. p-1.

The X variables may be different independent variables, or they may represent curvature or interaction effects. Also, the independent variables may be quantitative, or they may be qualitative and represented by indicator variables. This flexibility makes the multiple logistic regression models very attractive. Standard statistical software programmes specifically designed for logistic regression was used to obtain the numerical solutions to the logistic regression equation above.

CHAPTER FOUR RESULTS AND DISCUSSION

4.1 Farmers' Characteristics

4.1.1 Age of Farmers

The ages of the farmers' ranged from 22 years to 78 years and majority of the farmers (77.2%) were between 30 and 59 years (Table 4.1)

Table 4.1: Age distribution of Farmers

Age group	Number of Farmers	Percentage of Farmers
20-29	2	2.9
30-39	7	10.0 34.3
40-49	24	32.9
50-59	23	12.9
60-69	9	7.1
70-79	5	
Total	**70**	**100.0**

It is important to note that the middle age group in the context of the respondents (40-59) forms the bulk of agroforestry practitioners indicating the potential of this group as the most important clientele who could be involved in the dissemination of agroforestry practices and technologies. The age range 40-49 years constitute the majority of respondents (34.3 percent), which shows that younger farmers are more likely to adopt a new technology because they had more schooling than the older generation and could reap the benefits of tree crops in their life time. According to Tripp (1993), younger farmers are more likely to adopt a new technology, since they have had more schooling than the older generation or perhaps have been exposed to new ideas as migrant labourers.

4.1.2 Gender of Farmer

About 75.7% of the agroforestry practitioners were males while 24.3% were females. In contrast, 29.4% of non-practitioners of agroforestry were males while 70.6% were females (Table 4.2).

Table 4.2: Gender of Farmer

Gender	AF Practitioners		Non - AF Practitioners		Total of all farmers	
	No. of Farmers	**% of Farmers**	**No. of Farmers**	**% of Farmers**	**No. of Farmers**	**% of Farmer**
Male	53	75.7	5	29.4	58	52.5 47.5
Female	17	24.3	12	70.6	29	
Total	**70**	**100.0**	**17**	**100.0**	**87**	**100.0**

The gender of farmers indicates poor involvement of women in agroforestry. Many of the agroforestry practices like woodlot, cashew/arable intercrop, planting of shelterbelts and windbreaks, as well as fruit trees on cropland in the study area involved strenuous activities, which are done manually. The fact that women constitute about one-quarter of agroforestry practitioners shows that women are also into agroforestry. However it can be said that women are mostly interested in planting and cultivating food crops to meet household consumption needs rather than tree crops. Eckman (1992) deduced from his studies that individuals within a household may have different rights depending on gender. He found that in some African Countries, for example, women plant and tend fire-wood or fruit trees but do not have right to harvest fruits or wood; these may be sold or appropriated by male members. Leach and Mearns (1988) have emphasized division between men and women in access to natural resources and their management and use as common in African land management system. They concluded that forestry development initiatives must therefore not just "consider" women but aim at giving them equality with men in control over resources, in decision making over resource production and use, and empowerment to evolve self – directed problem solving strategies.

Again, the emphasis on women in promotional activities has been given credence by several authors (Davidson and Dankelman, 1988; Shiva 1988). They all invariably point out that women are commonly collectors of water, fuelwood, foodstuffs and medicinal herbs and that they are directly affected by environmental degradation. In their decision making, women place higher value on taking care of the environment than the male family members do.

4.1.3 Years of Experience in Farming

The majority (34%) of farmers interviewed had between 20-29 years of experience in farming while a few (2.9%) had between 50 and 59 years of experience in farming (Table 4.3)

Table 4.3: Years of Experience in Farming

Years of Experience	No. of Farmers	Percentage of Farmers
0-9	6	8.6
10-19	13	18.6 34.0
20-29	24	30.0
30-39	21	5.7
40-49	4	2.9
50-59	2	
Total	**70**	**100.0**

From the results in table 4.3, it can be deduced that since the factors that affect the adoption of agroforestry technologies may not be very different from those of general adoption of agricultural technologies, the rich experience of farmers can be used to improve agroforestry using indigenous technical knowledge to bring about the desire results. Rist (1991) found that revitalizing local knowledge in projects make communities act and effectively implement their own development programmes which consists of ensuring their livelihood in harmony with their own nationality. Saravia (1992), also concludes that the cause of many of the ecological, social, cultural and economic problems of farmers is the abandonment and erosion of the farmers know-how and technologies in favour of modern solutions**.**

4.1.4 Level of Education of Farmers

The level of education among agroforestry practitioners was generally high. Over 65% of respondents had formal education to the basic/elementary (MSLC) level while 17.1% were illiterates. The total number of Agroforestry practitioners who were literate constituted 82.9 percent. (Table 4.4)

Table 4.4: Level of Education of Farmers

Education Level	No. of Farmers	Percentage of Farmers
Illiterate	12	17.1
Basic/Elementary	46	65.7
Secondary	5	7.1 5.7
Vocational/Technical	4	4.3
Tertiary	3	
Total	**70**	**100.0**

The high level of literacy rate would result in increase of technical efficiency and decreased conservationism among farmers. This would also contribute to the acceptance of agroforestry innovations (Sarfo Mensah, 1994). According to Tripp

(1993), education is an important socio-economic variable that may make a farmer more receptive to advice from an extension agency or more able to deal with technical recommendations that require a certain level of numeracy or literacy.

4.1.5 Religion of Farmers

Over 92% of the agroforestry practitioners interviewed were Christians while 1.4% were Muslims. About 4% of the respondents indicated that they do not belong to any religion (Table 4.5).

Table 4.5: Religion of Farmers

Religion	No. of Farmers	Percentage of Farmers
Christian	65	92.9
Muslim	1	1.4 1.4
Traditional	1	4.3
None	3	
Total	**70**	**100.0**

The larger Christian population makes the church a possible forum for information dissemination in agroforestry as church leaders are held in high esteem and their views highly respected. This agrees with Sarfo Mensah (1994), who found out in his survey that Christians formed the largest proportion of the surveyed farmers. He concluded that the larger Christian population makes the church a possible forum for information dissemination as church leaders are held in high esteem and their views highly respected. He also concluded that Islam could be used as a tool for conservation because of the strong cohesion among Muslims as observed during his survey at Korkormu where more than 75 percent of the people were Muslims.

4.1.6 Household Size

About 63% of households had between 5-10 members, while 25.7% had more than 11 members (Table 4.6).

Table 4.6: Household Size

Household Size	**No. of Farmers**	**Percentage of Farmers**
Small size (1-4 members)	8	11.4 62.9
Medium size (5-10 members)	44	25.7
Large size (11+ members)	18	
Total	**70**	**100.0**

The large family size may be due to other extended family members being catered for. Also, the reasonably high household sizes probably indicate that farmers were youthful and highly reproductive. The large family size of the bulk of farmers (88.6%) could provide labour which is an incentive to agroforestry adoption. However, the consequences of large family size are increased pressure on the ecosystem, land fragmentation and tree ownership problems. According to Akinsami (1988) excessive land fragmentation may leave a farmer several small land holdings scattered over an area, and therefore very difficult and uneconomical for working.

4.2 Land Tenure and Agricultural Production System

4.2.1 Mode of Land Acquisition

Forty nine percent of farmers indicated that their lands were communally owned while twenty percent (20%) worked on state owned land as taungya farmers. About 17 percent said that the land belonged to them personally (freehold) and could therefore use it for any purpose they deemed fit (Table 4.7):

Table 4.7: Mode of Land Acquisition

Land acquisition	No. of Farmers	Percentage of Farmers
Freehold	12	17.1
Tenancy (share cropping)	4	5.7
Communally owned	34	48.6
State owned	14	20.0
Through purchase	4	5.7
Others (e.g. gifts)	2	2.9
Total	**70**	**100.0**

A greater proportion of practitioners owned land communally. Communal land cannot be pledged for money or used as collateral in securing loans from financial institutions like banks. It is very difficult to plant perennial crops (tree crops) on communal land since the land belongs to the community or family. Most practitioners particularly those who had planted woodlot (*Tectona grandis*) and those who had intercropped food crops with citrus reported that other members of their families are concerned about the fact that the land may become theirs (practitioners) permanently, which may deny other family members access to the use of the land. Many also said the use of land for woodlot, cashew/ arable intercrop and citrus/arable intercrop which were all agroforestry practices would help them raise their income levels through the sale of tree products but deny them food which they needed for household consumption in the future, particularly when the canopy closes. These scenarios may discourage many from using their land for agroforestry purposes. The first and second scenarios agrees with Adegbola *et al* (1976) who found that communal land cannot be used as security if the farmer is trying to get a loan from a bank. They also concluded that, to the farmer as long as his crops remain on the land and again because perennial crops are permanent on the land, the community is unable to re-allocate that piece of land. Seventy one percent of farmers said they would find problems in acquiring land in the future while only 29 percent said they have enough land for farming. This indicates that the transfer and large-scale adoption of agroforestry technologies in the study areas are likely to face problems due to land ownership and acquisition problems.

4.2.2 Farm Size and Factors Limiting Farm Size

Seventeen percent of the farmers had farms with sizes < 1 acre. Eleven percent of the farmers had farms of 11+ acres (Fig 4.1). The average farm size is 4.8 acres. Farmers who had land size above 10 acres were mostly those involved in citrus/arable intercrop. The average farm size of 4.8 acres indicates that farmers were mostly small holder ones. The small farm sizes constitute an obstacle to farm improvement. For example, it will be difficult for smallholder farmers to expand their farms. This finding supports Benneh(1976) who argued that miniature farm sizes and the manner in which they are fragmented and scattered, constitute an obstacle to farm improvement since they do not enable farmers to take advantage of economies of scale of production.

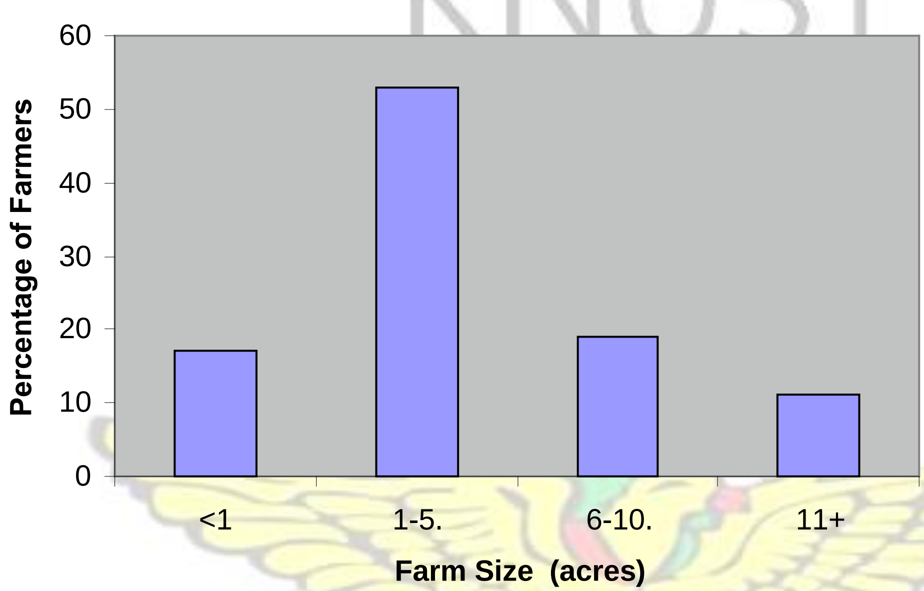


fig 4.1. Sizes of farm in the study area

The factors which influenced farm size in the study area include land, labour and capital. Inadequate capital limited the farm sizes of 70% of farmers while unavailability of land and capital limited the farm size of 16% of farmers (Table 4.8).

Table 4.8: Factors Limiting Farm Size

Factor	No. of Farmers	Percentage of Farmers

Land	6	8.6
Labour	1	1.4
Capital	49	70.0
Land + Capital	11	15.7
Land + Labour + Capital	3	4.3
Total	**70**	**100.0**

In this study capital is a significant factor in limiting farm size. According to many of the farmers they needed money to hire-labourers to undertake one farm operation or the other and also to expand the farm. Others also needed money to buy herbicides, pesticides and other agrochemicals. This means capital is required in order to finance many agroforestry innovations. The poor capital outlay of farmers in the study area can wane their interest in agroforestry adoption and its subsequent impact on their livelihood. This agrees with Morris (1991) who found that most technical recommendations were both capital and labour intensive. Lele (1989) also observed that resource poor farmers are slow to adopt new technologies.

4.2.3 Land use systems and the type of crops cultivated in the study area

The land use systems in the study area include crop production and animal production systems. Agroforestry practices undertaken by farmers in the study area include Woodlot, Taungya, Alley cropping, Windbreaks/Shelterbelts and Citrus/arable intercrop. Ninety percent of farmers intercropped food crops and tree crops (Table 4.9). The food crops cultivated in the land use system included maize (*Zea mays*), Yam (*Dioscorea spp*), Plantain (*Musa paradisiaca*), cassava (*Manihot esculenta*), cocoyam (*Xanthosoma sagithifolium*). The tree crops in the land use system included *citrus* sp, cashew (Anar*cadium occidentale*), Oil palm (*Elaeis* *guineensis*) and cocoa (*Theobroma cocoa*).Food crops were grown to provide food for household consumption and farmers wanted to increase income by incorporating tree/cash crops. Farmers also cultivated pepper (*Capsicum frutecens*), ginger (*Zingiber officinale*), cabbage (*Brassica oleracea* var capital), groundnut (*Arachis hypogea*), Soyabean (*Glycine max*) and cowpea (*Vigna unguiculata*) as additional source of income.

Table 4.9: Type of Crop(s) Grown in the Study Area

Type of crop(s)	No. of Farmers	Percentage of Farmers
Food crops	4	5.7
Tree crops	3	4.3
Food crops + Tree crops	63	90
Total	**70**	**100**

Most farmers had the desire to grow food crops in order to provide food for household consumption. They also wanted to increase income by incorporating tree crops. This shows that agencies involved in agroforestry technology transfer and other innovations should first study and know the priorities of rural farmers in order to design a locally adapted one which can easily fit into the existing land use system.

4.2.4 Trend of Crop Production

Trend of crop production for the last three years are presented in Table 4.10.

Over twenty four percent of farmers had increased food production for the last three (3) years while 35.7% experienced a decrease in food production. In contrast, 67.1% had an increase in tree crop production for the last three (3) years as against only 4.3% of farmers who experienced a decrease in the production of tree products. Over thirty eight percent of farmers had the canopies of their tree crops closed for the past three (3) years and therefore no food was being obtained from their agroforestry farms and hence no visible trend could be observed in terms of food production. On the other hand, 27.1% of practitioners could not give any significant trend of tree production. These were either taungya farmers or farmers who had planted windbreaks to avert wind damage to buildings.

Table 4.10: Trend of Production

Trend of Production	Food Crop		Tree Crop		Total	
	No. of Farmers	**%**	**No. of Farmers**	**%**	**No. of Farmers**	**%**
Increasing	17	24.3	47	67.1	32	45.7
Decreasing	25	35.7	3	4.3	14	20.0
About the Same	1	1.4	1	1.4	1	1.4
None	27	38.6	19	27.1	23	32.9
Total	**70**	**100.0**	**70**	**100.0**	**70**	**100.0**

Farmers (practitioners of agroforestry) gave various reasons for either the increases or decreases in food crop and/ or tree crop production. Food production increased initially when the canopy of the trees was not closed. Some farmers also used manure and the land was also fertile. However, the decrease in food production could be attributed to enlargement of the canopies of the tree crops shading off the food crops which decreased their photosynthetic ability. General climatic problems like erratic rainfall was also one major cause. Tree products or production increased due to increase in the size of canopy. Also, regular weeding and application of manure facilitated the bearing of citrus and cashew. The yield of citrus decreased frequently due to pest and disease infestation. Most farmers initially did not know how to manage tree crops and food crops simultaneously and this caused the food crops to outgrow the tree crops which led to a decrease in yield of the tree crops. Others also asserted that as the tree ages (citrus and cashew), the yield decreases. The decline in yield in citrus due to diseases infestation was resolved through extension education.

4.2.5 Animal Production System

The animals reared by farmers included sheep, goats, poultry (chicken, turkey, ducks, guinea fowl) and pigs. Snail farming, bee-keeping and Rabbitery were on a small-scale. Majority of respondents (58%) were involved in poultry farming while 22% were involved in sheep rearing (Table 4.11).

Table 4.11: Types of animal reared

Type of animal	N of households raising animals	Percentage of households raising animal	Flock size	
			Minimum flock size	Maximum flock size
Sheep	15	22.0	2	50
Goat	5	8.0	1	30
Poultry	39	58.0	2	200
Pigs	6	9.0	3	15
Others(beekeeping, Rabbitery etc)	2	3.0	5	170

With regards to the management system, all the poultry were kept on free-range basis. The farmer occasionally fed the birds with grains of dried maize. Farmers with very large flock of poultry (example, 200) were those who stayed within their own farms in cottages. The birds could therefore find most of their food in the form of insects, herbage and seeds. Simple shelters constructed with bamboo were the only housing provided.

Sheep and goats were kept in a backyard where they were fed on household waste such as cassava peels, plantain peels and other discarded portions. Farmers in the study area also fed them with Guinea grass (*Panicum maximum*), and other local fodder plants. Feed could be obtained adequately during the rainy season but during the dry season it was difficult to come by and farmers resorted to household waste as the main source of food for animals. The animals contribute to the household in diverse ways. Animals provide source of food for the farmers and their household and also income to meet certain household needs eg. buying of soap, clothes and payment of fees amongst others. During festivities like Easter, Ramadan and Christmas animals were given to friends and relatives as gifts. Animals were also used to pacify others in order to settle disputes socially.

4.3 Sources of Farm Labour and Maintenance

4.3.1 Source of Farm Labour

Family labour plus hired labour is used mainly by farmers and these constitute about 63 percent of farmers while 23% of farmers only use hired labour. Fourteen percent of farmers use only family labour in their operations. The tending of both tree crops and food crops at different periods influenced the labour requirements.

This scenario may serve as a disincentive to the adoption of agroforestry and its subsequent impact in the study area. The hiring of labour in addition to family labour agrees with Njoku (1991) who concluded that many new technologies require intensive labour use which contrasts greatly with the limited amount of labour expended in the traditional farming system and that small-holder farmers must hire expensive labour to implement the improved technologies.

Affordability and Accessibility of Labour for farm Operations

Weeding which included initial clearing and weeding around crops was very expensive since farmers had to hire labourers. The cost of hired labour per day ("by day") ranged between ¢13,000 and ¢15,000 depending on whether the farmers would provide food or not. Pruning was somewhat affordable since most of the farmers performed the operation themselves. Harvesting was very affordable as perceived by farmers and that 69% of them ranked harvesting as such (Table 4.12). Teak and citrus were harvested by the buyers. Farmers easily got access to labourers to perform all the labour operations. Farmers easy access to labourers and their ability to afford cost of labour would serve as an incentive to agroforestry adoption in the study areas.

Table 4.12: Affordability and Accessibility of labour operations

	Weeding	Pruning	Harvesting

Affordability and accessibility of labour operations	No. of Farmers	%	No. of Farmers	%	No. of Farmers	%
Very affordable	18	25.7	2	2.9 7.1	48	68.6
Somewhat affordable	6	8.7	5	2.9	12	17.1
Not very affordable	5	7.1	2	2.9	2	2.9
Not affordable	41	58.6	2		8	11.4
Total	**70**	**100.0**	**11**	**15.8**	**70**	**100.0**
Very accessible	62	88.6	11	15.7	66	94.3
Somewhat accessible	2	2.9 1.4	0	0.0 0.0	1	1.4 1.4
Not very accessible	1	7.1	0	0.0	1	2.9
Not accessible	5		0		2	
Total	**70**	**100.0**	**11**	**15.7**	**70**	**100.0**

4.4 Input, Financial, Marketing and Institutional Support

4.4.1 Source of Planting Materials and its Sufficiency

Over twenty five percent of farmers obtained planting materials such as maize (*Zea mays*), Yam (*Dioscorea sp*.), Plantain (*Musa paradisiaca*), Cassava (*Manihot esculenta*), Cocoyam (*Xanthosoma sagithifolium*), Pepper (*Capsicum frutescens*), ginger (*Zingerber officinale*), tomato (*Lycorpersicon esculentum*), Garden eggs (*Solanum melongena*) from the market (Table 4.13). Seven percent of farmers obtained it from their own previous harvest. However, 60% of farmers obtained planting materials for food crops from more than one source. Over 45% of farmers obtained planting materials for tree crops from either extension agents or N.G.O. while 37.1% obtained it from the market. Over 97% of farmers received sufficient planting materials for food crops while 94.3% of farmers received sufficient planting materials for tree crops.

Table 4.13: Source of Planting Materials

Source of planting materials	Food crops		Tree crops	
	No. of Farmers	**%**	**No. of Farmers**	**%**
Extension agents or NGO	1	1.4	32	45.7
Market	18	25.7	26	37.1
From other farmers	4	5.7	3	4.3
One's own previous harvest	5	7.1	7	10.0
"More than one source"	42	60.0	2	2.9
Total	**70**	**100.0**	**70**	**100.0**

The findings reveal that the most credible sources for planting materials for food crops are the Market and "More than one source" while the most credible sources for planting materials for tree crops are Extension agents/NGO's and market in the study area. From the above discourse, it can be said that some farmers buy planting materials for both food crops and tree crops from the market. Farmers in the study area therefore need to be fully resourced since inadequate resources may serve as a disincentive to agroforestry adoption and reduce its subsequent impact. This scenario agrees with Lele (1989) who observed that resource poor farmers are slow to adopt new technology since they lack access to inputs, cash and their preferences conflict with the technology. Wealthier farmers have access to inputs and have ability to take risk.

4.4.2 Financing of Farming Activities

Over ninety one percent of the farmers had their source of finance from their own personal savings. Only 2.9% used bank loan to finance their farming activities (Table 4.14).

Table 4.14: Financing of Farming Activities

Source of Finance	No. of Farmers	Percentage of Farmers
Bank loan	2	2.9
Money lenders	1	1.4
Personal savings	64	91.4
Family members support	3	4.3
Co-operative	-	-
Total	**70**	**100.0**

Inadequate sources of finance such as Bank loans, money lenders, family member support may hamper agroforestry adoption. The above observation agrees with Anaman (1988), who reported that, the most important and reliable source of capital funds for running the farm business is the farmer's own savings which come out from the profit of the farm business and this is used to invest in the farm. It can therefore be concluded that the most reliable source of finance for agroforestry in the study area is the farmer's personal savings

Almost all the farmers expressed interest in loans either directly from the government or the banks in the area. However, problems that prevented the use of loans for farming activities in the study area were that, the government being a credible source had not taken up the responsibility of granting loans and at certain times failed to do so after promising farmers. The financial institutions wanted farmers to organize themselves into groups before they could grant them loans. In addition, they needed a certain number of farmers within a group and these farmers should be existing customers in order to qualify for a loan.

Farmers were afraid to collect loans from the bank since they believed that in situations of crop failure, they would be made to repay in full with the interest. Some farmers were also afraid of repayment since they had small land size. The financial institutions were also not ready to give loans to farmers since farmers who collected loans defaulted in the payment. To some farmers, it was extremely difficult in getting loans for the farm business and others had no idea of any credible sources. This scenario may serve as a disincentive in the adoption of agroforestry technologies and reduction in its impact. This finding supports Lipton (1998) who found that informal and formal sources of credit often are too costly, or unavailable to, the rural poor. He asserted that targeted public sector rural credit programmes, especially if they are subsidized, benefit the wealthy farmers more than the poor. The poor want credit that is available on acceptable terms and when they need it.

4.4.3 Government and Non Governmental Organization input Support.

Input in the form of fertilizers, seeds and agrochemicals were given to farmers by both government and non governmental organizations. Only 24.3% and 17% of farmers received input support from the government and non governmental organizations respectively. Inputs in the form of fertilizers, seeds and agrochemicals were not adequately supplied by both government and non government organizations in the study area. Inadequate input support may serve as a disincentive to agroforestry adoption and reduce its subsequent impact in the study area. This finding agrees with Hoffmann and Hoffmann (1989), who reported that, if finance-intensive innovations are offered without input/credit, it is impossible for small-scale farmers to adopt them.

4.4.4 Off-Farm Activities

Forty four percent of agroforestry farmers were engaged in off-farm activities. These activities gave farmers additional substantial income. However, a greater proportion (55.7%) of farmers did not engage in any off-farm activities (Table 4.15).

Table 4.15: Off-Farm Activities

Off-Farm Activities	No. of Farmers	Percentage of Farmers
Service	11	15.7
Artisans	4	5.7
Business	16	22.9
None	39	55.7
Total	**70**	**100.0**

Service as an off-farm activity include revenue collection, "by-day", teaching, susu collection and health attendance. Business as an off-farm activity include cloth selling, kenkey making, selling of secondhand clothing, seedling production, selling of rubber buckets and sacks, selling of foodstuffs and operating a shop. Artisans includes carpenters, wood calvers, kente weavers and masons. Therefore the significant economic activities in the study area include petty trading in cloth and secondhand cloth, selling of kenkey , selling of foodstuffs; cottage industries like carpentry, wood calving and kente weaving.

The substantial additional income obtained from the off-farm activities could be used to finance farming activities. This is an incentive to agroforestry adoption and its subsequent impact on the living standards of rural farming households.

4.4.5 Marketing of Crops

The majority of farmers (96.4%) sold their crops at the local market while 3.6% transported their crops to urban centres for sale. Examples of food crops sold at the market include plantain, cassava, cocoyam, pepper, ginger, cowpea, and soybean. Buyers exploited and cheated the rural farmers by buying the food crops, tree crops and tree products at a cheaper price and on many occasions failed to pay the full cost of these items. This gives an indication of the frustration farmers go through in marketing their products. Since buyers exploit and cheat farmers by buying the food crops, tree crops and tree products at a cheaper price this situation may serve as a disincentive to agroforestry adoption and its subsequent impact on the livelihood of farmers in the study area. This finding agrees with Hedge (1990), who reports that, it is only with a coordinated effort to market the forest produce at a remurative price that afforestation programmes can be implemented successfully with the active participation of the rural people.

4.4.6 Extension Support from Government/NGO

Majority of the farmers (57%) indicated that they did not have access to extension services of any kind. However, 43% of farmers had contact with extension agents. The non-governmental organizations, which complemented the efforts of government extension services, were TechnoServe and Adventist Development and Relief Agency (ADRA). Farmers received extension education on improved cultural practises. This is an incentive to agroforestry adoption and its subsequent impact on the livelihood of farmers in the study area. This agrees with Adams (1982) who concluded that techniques or innovations normally provide the means of achieving sustained increases in farm productivity and income and that it is the extension workers job to encourage farmers to adopt innovations of proven value.

Group extension was an appropriate communication method for 54% of farmers while 41% of farmers considered individual extension as an appropriate method of communication (Table 4.16).

Table 4.16: Mode of technology transfer

Communication method	No. of farmers	Percentage of Farmers
Individual extension	29	41.4
Group extension	38	54.3
Individual+Group extension	1	1.4
Mass media	2	2.9
Total	**70**	**100.0**

It was found that group extension gave the farmers opportunity to learn from each other certain unknown skills and also solve certain common problems encountered in their productive ventures. Again individual extension facilitated interaction between the agent and the farmer and this helped farmers to find solutions to the problems they were confronted with. The above trend was observed in that, according to Volker and Waltraud (1989), individual extension is not very effective way of promoting the cause of the mass of small farmers, but it plays an important role in complementing group and mass extension methods.

4.5 Problems of Agroforestry Adoption by Farmers

The problems farmers encountered in the adoption of agroforestry included the following:

Money was not available to hire labour to weed around the farm and to purchase chemicals for spraying. Some of the agrochemicals were fake, particularly weedicides and there was no money for the expansion of the farm. Loans given were in small amounts, and could not be used for any meaningful farm venture for the desired results.

Fruits were stolen from tree crops such as citrus. Taungya farmers under the National Forest Plantation Development Programme were not quiet sure of the government promise of 40% share from the proceeds when the trees were matured. Land was unavailable since family members thought that the trees would occupy the land permanently denying other members access to use the land. Farmers had problems of marketing their produce. Farmers involved in citrus/arable intercrop experienced seasonal infestation of pests and diseases, which decreased production. The infestation occurred around March at the beginning of the rains. This reduced the output of citrus fruits every year. However, farmers particularly those integrating food crops with citrus had to spend huge sums of money in purchasing weedicides and other agrochemicals to manage their farms. Integrating tree crops in the farming system was labourintensive since both tree crops and food crops were managed con-currently. Farmers asserted that resource poor and exclusively lazy farmers would be reluctant to adopt agroforestry technologies since it is labour intensive. Some farmers were old and could not use larger portion of their land for agroforestry since it was labour-intensive.

4.6 Impact of Agroforestry on livelihood of Households

4.6.1 Household Energy

A greater proportion of farmers (69%) used fuelwood as their only source of household energy whiles 23% used both fuelwood and charcoal. Only 8.6% of farmers used charcoal as household energy. This agrees with Sayer *et al* (1992) who concluded that fuelwood and charcoal account for over 75% of the total energy consumption in Ghana. Ardayfio – Schandorf (1993) also found that in Ghana, people, particularly the rural folk are forced to walk up to 10km to collect fuelwood which is the major source of energy for households. None of the respondents used liquefied Petroleum gas (LPG). The rural poor would not be able to afford the cost involved in buying liquefied Petroleum gas and its accessories. These findings indicate that the dominant energy type in rural households is fuelwood and therefore the need to integrate trees in the land use system.

Sixty four percent of farmers obtained fuelwood from their own farm while 20% got their energy needs partly from their own farm and partly through purchase. Ten percent of farmers obtained fuelwood through purchase. Only 6% of the farmers obtained their household energy (fuelwood) from the forest.

Since most or greater proportion of farmers got their fuelwood from their own farm there is the need to integrate trees with food crops in the land use system. Farmers who integrated teak with food crops sold the branches of the teak after harvesting as fuelwood. This increased the income levels of farmers and had positive impact on their living standards. This supports the findings of Gregerson *et al* (1989), who concluded that the key to solving the fuelwood problem is encouraging farm families to grow sufficient trees to meet their own requirements and to generate surpluses for sale. Tree species used as fuelwood in the study area are presented in table 4.17

Table 4.17: Tree species used as fuelwood.

Local/Common Name	Scientific Name

Kyenkyen	*Antiaris toxicaria*
Ofram	*Terminalia superba*
Esa	*Celtis mildbraedii*
Kakapenpen	*Rauvolfia vormitoria*
Okoro	*Albizia zygia*
Pepea	*Margaritaria discoidea*
Akyee	*Blighia sapida*
Neem	*Azadiracta indica A. juss*
Teak	*Tectona grandis*
Tanuro	*Trichilia monadelpha*
Gyama	*Alchornea cordifolia*
Wawa	*Triplochiton screleroxylon*
Wama	*Ricinodendron heudelotii Macaranga*
Opam	*spp.*
Fruntum	*Funtumia elastica*
Sesea	*Trema orientalis*
Onyina	*Ceiba pentandra*
Konkroma	*Morinda lucida*
Odwuma	*Musaga cecropiodes*

4.6.3 Household Incomes

The change in income before and after adoption of agroforestry is presented in table 4.18. The incomes involve the money that accrued from the sales of both food crops and tree crops/products

Table 4.18: Change in income before and after adoption of Agroforestry

Change in income	No. of farmers	Percentage of farmers
Increased	52	74.3
Decreased	15	21.4
About the same	3	4.3
Total	**70**	**100.0**

A greater proportion of farmers (74.3%) had increase change in income levels. The increased level of income could help farmers meet certain household needs like affording medical bills and paying fees. This indicates a significant impact on the livelihood of the farmers' households.

The income level of 40% of farmers was between 1-10 million cedis while 62.9% of the farmers' income level after adoption was between 1-10 million cedis after adoption (Table 4.19). Thirty percent of the farmers could not supply figures of income and expenditure of their farm operations before adoption of the technology. Since they did not keep records and the long time lapse, had made them to forget completely about it.

Table 4.19: Level of income before and after adoption per year (¢ Million)

Level of income (¢ Million)	Before Adoption		After Adoption	
	No. Farmers	of Percentage of Farmers	No. of Farmers	Percentage of Farmers
< 1	20	28.6	16	22.9 62.9
1-10	28	40.0	44	14.3
11+	1	1.4	10	-
None	21	30.0	-	

Total	**70**	**100.0**	**70**	**100.0**

However, the poor farm records agrees with Anaman (1988), who asserted that lack of accurate data from the farm sector has contributed partly to poor performance of the economic predictions in many African countries, especially so because the farm sector is usually the largest sector of the economy. He emphasized, for example that pieces of sticks, marbles and pebbles have been used to count yields of crops and the number of animals. Special markings on walls have been used to record information such as monies owned by debtors, expenses and yields.

4.6.4 Households Food Security

A greater proportion of households (97%) had improved food security after adopting agroforestry. This was partly due to the fact that most farmers used money accruing from the sales of tree crops/products in purchasing food items to supplement food in the household. This agrees with Oram (1993) who concluded that agroforestry provide a wider range of products, more secure subsistence or more cash income from wood products to enable the farmer to buy in food.

4.6.5 Affordability of School Fees and Learning Materials, Clothes and Medical Treatment/Drugs in the household

A greater proportion of the farmers (91.4%) to a large extent were able to afford school fees and learning materials for their children and wards, clothes and medical treatment/drugs for the household from improved food production and tree crops production after adoption of agroforestry. Most farmers obtained income from the sales of surplus food crops and tree crops. The percentage change in the ability of farmers to afford school fees and learning materials, clothes and medical bills before and after adoption of agroforestry are 47.4%, 44.3% and 42.9% respectively (fig 4.2). It can be concluded that agroforestry adoption had a significant impact on the livelihood of most farmers and their households.

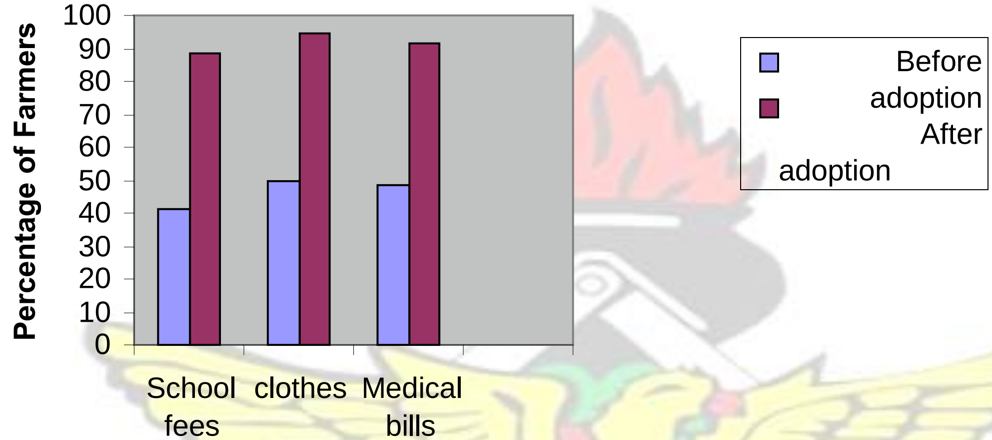


Fig. 4.2. Affordability of School fees and Leaing materials, Clothes and Medical Treatment/Drugsin the household.

4.6.6 Accommodation of Farmers Before and After Adoption of Agroforestry.

Majority of farmers (72.9%) lived in family houses before adopting agroforestry but this reduced drastically to 55.7% of farmers after adopting agroforestry. Thirty percent of farmers were able to built their own houses after adopting agroforestry compared to 5.7% of farmers who owned houses before adopting agroforestry (Table 4.20)

Table 4.20: Accommodation of farmers before and after adoption of agroforestry.

Accommodation	Before Adoption		After Adoption of	
farmers	No. of Farmers	percentage of Farners	No. of Farmers	percentage
Living in family house	51	72 . 9	39	55 . 7
Hired apartment	8	11 . 4	6	8 . 6
Own house	4	5 . 7	21	30 . 0
Others (huts, cottage etc)	7	10 . 0	4	5 . 7
Total	**70**	**100 . 0**	**70**	**100 . 0**

The results depict that about a third of the farmers had succeeded in building their own houses and bought building plots in Kumasi from the sales of the tree crops and food crops. This had a significant impact on the livelihood of such farmers and their households.

4.6.7 Impact of Windbreaks/shelterbelt on buildings and living standards of farmers

In Tano Odumasi and Kona in the Afigya Sekyere District, windbreaks and shelterbelts have been planted for integrated purposes of protection of buildings against rainstorms, soil conservation and production. Fruit trees used by farmers as windbreaks include *Mangifera indica* and *Anacardium occidentale.* Other trees used as windbreaks/shelterbelt include *Tectona grandis* and *Blighia sapida*. *Azadirachta indica* A.juss is valued for its medicinal properties. The windbreaks provide shade, fresh air and are places of relaxation and for village meetings. The windbreaks /shelterbelts has influenced the rainfall pattern of the area positively and reduced the rate of lodging of crops. This has substantially increased crop yield. The planting of windbreaks/shelterbelt has improved the standard of living of farmers since money that would have been used occasionally to buy building materials for damaged buildings could then be channeled into other ventures.

4.7 Estimation of the Associations and Relationships of Key Determinants of Agroforestry Technology Adoption

A combination of variables was used in the analysis to bring principal characteristics of farmers that could be used to predict adoption of agroforestry in the study area. The Multiple Logistic Regression model was used to estimate the impact that a set of personal and farm level characteristics have on the adoption of agroforestry technologies (See Appendix I).

4.7.1 Parameter Estimate of the Relationship between Mode of Land Acquisition and Farmer's Personal Characteristic

The regressional coefficient shows that communally owned land, state owned land and land obtained through purchase are positively related and highly significant in adoption of agroforestry technologies. It is difficult to plant tree crops on communal land since it belongs to families and clans. This indicates that the transfer and large-scale adoption of agroforestry technologies in the study area is likely to face land acquisition problems due to the fact that a greater proportion of the land is communally/family owned. However, state owned land and purchased land would favour the practice of agroforestry. Agroforestry can easily be promoted on communal land if members of families would agree to come together to practice it on their land and share the proceeds.

Again the regressional coefficient shows that years of experience in farming, age, religion are negatively related to mode of land acquisition whereas sex, education and marital status are positively related to land acquisition with sex and marital status being significantly related. An important reason for this is that resource allocation (land, choice of crops and production techniques) rested with men (Table 4.21)

Table 4.21: Parameter Estimates of the Relationship Between Mode of Land Acquisition and Farmer's Personal Characteristics.

Variable	**Coefficient**	**Std. Error**	**Wald**	**P-Value**
Land acquisition				
Freehold	2.842 3.226	1.977 1.979	2.066	0.151
Tenancy	5.716 7.422	2.064 2.145	2.658	0.103
Communally owned	8.607	2.237	7.668	0.006 * * 0.001
State owned			11.970	* *
Purchase	-0.009	0.029 0.263	14.806	0.000 * *
Personal characteristics	-0.266	0.612 0.253		
Yrs. Of experience	1.680	0.358	0.092	0.761
Age	0.345	0.776	1.018	0.313
Sex	-0.192		7.526	0.006 * *
Education	1.721		1.863	0.172
Religion			0.287	0.592
Marital Status			4.921	0.027 *

Note: **-** Indicate negative effect on adoption or negative relationship.

, * Indicate statistically significant effect at 5% and 1% respectively.

4.7.2 Parameter Estimates of the Relationship Between Sources of Farm labour and Farmers' Personal Characteristics.

The regressional coefficients show that family labour is negatively related to adoption while hired labour is positively related to adoption. However, years of experience, sex, religion and marital status are positively related to sources of labour while age and education are negatively related to sources of labour. Age and sex are significantly related to sources of labour. Many agroforestry technologies require intensive labour use which contrasts greatly with the limited amount of labour expended in the traditional farming system and that smallholder farmers must hire expensive labour to implement the technologies. Also, it can be said that as the farmer ages his/her ability to provide labour physically decreases and therefore resort to hired labour. Again, generally males are physically stronger than females and can comparatively provide more labour (Table 4.23).

Table 4.23: Parameter Estimates of the Relationship Between Sources of Farm Labour and Farmer's Personal Characteristics

Variable	Coefficient	Std Error	Wald	P-Value
Sources of labour				
Family/household	-0.684	2.556	0.072	0.789
Hired	0.858	2.547	0.113	0.736
Personal characteristics				
Yrs. of experience	0.021	0.032 0.301	0.432 7.173	0.511
Age	-0.807	0.922 0.259	4.796 0.054	0.007**
Sex	2.019	0.469	0.657	0.029*
Education	-0.059	0.981	0.386	0.817 0.417
Religion	0.380			0.534
Marital Status	0.609			

Note: - indicate negative effect on adoption or negative relationship

, * Indicate statistically significant effects at 5% and 1% respectively.

4.7.3 Parameter Estimates of the Relationship Between Size of Farm and Farmer's Personal Characteristics

The regressional coefficients showed that land size of < 1 acre and 1-5 acres were negatively and not significantly related to adoption of agroforestry. However, land size of between 6-10 acres was positively related to adoption. Large sized agroforestry farms were more likely to give maximum output, all things being equal compared to small sized agroforestry farms. Age, education and marital status were positively related to farm size while years of experience, sex and religion were negatively related to farm size. However, sex is significantly related to farm size. This is an indication that most of the females involved in agroforestry had smaller farm size compared to males. The research revealed that most of the agroforestry practitioners in the study area were males (Table 4.24).

Table 4.24: Parameter Estimates of the Relationship Between Size of Farm and Farmers Personal Characteristics.

Variable	Coefficient	Std. Error	Wald	P-Value
Size of Farm (acres)				
< 1 1-5	-3.183	2.085 2.005	2.331 0.020	0.127 0.889
6-10	-0.218	2.032	0.613	0.613
Personal characteristics	1.027			
Yrs. of experience		0.029 0.263	0.012 0.007	0.912
Age	-0.003	0.668 0.252	8.121 2.229	0.934
Sex	0.022	0.376	0.374	0.004**
Education	-1.903	0.764	0.115	0.135
Religion	0.377			0.541
Marital status	-0.230			0735
	0.259			

Note: - indicate effect on adoption or negative relationship.

, * Indicate statistically significant effects at 5% and 1% respectively.

4.7.4 Parameter Estimates of the Relationship Between Government Input Support and Farmers' Personal Characteristics.

The regression coefficient indicated that agroforestry practitioners who received one kind of input/credit or the other from the government were positively related and significant to adoption. Years of experience in farming, age and religion were positively related to government input support while sex, education and marital status were negatively related to government input/credit support in adoption of agroforestry technologies. Sex was however significantly related to government input/credit support (Table 4.25).

Table 4.25: Parameter Estimates of the Relationship Between Government Input Support and Farmers' Personal Characteristics

Variable	Coefficients	Std. Error	Wald	P-Value
Government input support				
Yes	6.888	3.100	4.939	0.026*
Personal characteristics				
Years of experience	0.013	0.046 0.460	0.083	0.774
Age	0.256	0.837 0.334	0.310	0.577
Sex	-2.883	0.000	11.851	0.001**
Education	-0.304	1.255	0.827	0.363
Religion	15.230			
Marital Status	-2.120		2.853	0.091

Note: - indicate negative effect on adoption or negative relationship. ***, **** Indicate statistically significant effects at 5% and 1% respectively.

4.7.5 Parameter Estimates of the relationship between NGO Input Support and Farmers' Personal Characteristics.

The regression coefficient indicated that agroforestry practitioners who received one kind of input or the other from an NGO were positively related and highly significant to adoption. This shows that the NGO's have an edge over the government as far as resources are concerned to promote the adoption of agroforestry technologies for the desired impact to be felt. The regression coefficient showed that age, education, religion and marital status were positively related to NGO input support while years of experience in farming and sex were negatively related to NGO input support in adoption of agroforestry technologies (Table 4.26).

Table 4.26 : Parameter Estimates of the Relationship between NGO Input Support and Farmers' Personal Characteristics

Variable	Coefficient	Std. Error	Wald	P-Value
NGO input support				
Yes	16.976	2.587	43.068	0.000**
Personal characteristics				
Years of experience	0.019	0.045 0.399	0.193 0.273	0.660 0.601
Age	0.209	0.761 0.587	0.144	0.704
Sex	-0.289	0.000	1.897	0.168
Education	0.809	0.897		
Religion	15.346		0.991	0.319
Marital Status	0.893			

Note: - indicate negative effect on adoption or negative relationship.

*, ** Indicate statistically significant effects at 5% and 1% respectively.

4.7.6 Relationship Between Level of Income of Farmers Before Adoption per year (¢Millions) and Level of Income of Farmers After Adoption per year

(¢Millions)

The relationship between level of income of farmers before adoption per year (¢Millions) and level of income of farmers after adoption per year (¢Millions) is presented in Table 4.27

Table 4.27: The Relationship Between Level of Income of Farmers Before Adoption per year (¢Millions) and Level of Income of Farmers After Adoption per year (¢ Millions)

	Test Value = 0				
	T	**Sig. (2-tailed)**	**Mean difference**	**Standard Deviation**	**Standard error mean**
Level of income Before adoption Per year (Millions)	12.151	0.000 **	3.04	2.095	0.250
Level of income After adoption Per year (Millions)	15.545	0.000 **	2.44	1.315	0.157

Note: - ****** Indicates statistically significant effect at 1%

Table 4.27 depict that there is extremely high significant difference between the level of income of farmers before adoption and the level of income of farmers after adoption. The study revealed that the level of income of greater proportion of agroforestry practitioners increased after adoption compared to before adoption.

CHAPTER FIVE CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This chapter provides conclusion of major findings as well as recommendations to enhance the adoption of agroforestry and its positive impact on the livelihood of farmers' households. The middle-aged group forms the bulk of agroforestry practitioners in the study area indicating its potential as the most important clientele (target group) who could be involved in dissemination of agroforestry.

The study shows poor involvement of women in agroforestry. Many of the agroforestry technologies like woodlot, cashew/arable intercrop planting of windbreaks/shelterbelt, citrus/arable intercrop in the study area involved strenuous activities, which were done manually and therefore by men. Women, however, are mostly interested in planting and cultivating food crops to meet household consumption than tree crops.

The study revealed high level of literacy rate among agroforestry practitioners, which is likely to increase technical efficiency and decrease conservatism. A greater proportion of agroforestry practitioners owned land communally. Other members of the community/family were afraid the land may be owned permanently by practitioners, which may deny them access to use the land because of the planting of tree crops. The transfer and large-scale adoption of agroforestry technologies in the study area is likely to face problems due to land ownership and acquisition problems.

According to many farmers capital limits their farm size. They needed money to hire labourers to undertake farm operations and to expand the farm. Those involved in citrus/arable intercrop needed money to buy weedicides, pesticides and other agrochemicals. The poor capital outlay of farmers in the study area can wane their interest in agroforestry and its subsequent impact on their livelihood.

A greater proportion of agroforestry practitioners use family labour plus hired labour. The tending of both tree crops and food crops influenced the labour requirement. This intensive labour use may serve as a disincentive to the adoption of agroforestry and reduce its subsequent impact on the livelihood of practitioners in the study area.

The study shows that most of the agroforestry practitioners finance their farming activities from their personal savings. Almost all practitioners expressed interest in loans either directly from the government or the banks in the study area. Farmers are being confronted with many problems that prevent them from receiving loans.

A greater proportion of the farmers' sell their farm produces thus food crops and tree crops at the local market/farm gate. The produce is bought at a cheaper price. Teaks were bought by individuals with certificate from Forestry Division. Buyers exploited and cheated the rural farmers by buying the crops at a cheaper price and on many occasions failed to pay the full cost of these items. The problems and price involved in marketing the produce may serve as a disincentive to adoption and its subsequent impact on the livelihood of farmers and their households.

Most agroforestry practitioners do not get contact with extension agents. The poor extension services could serve as a disincentive to agroforestry adoption and its subsequent impact on the livelihood of the farmers and their household. The study revealed that group extension gives opportunity for farmers to learn from each other certain unknown skills and also solve certain common problems encountered in their productive ventures. Individual extension, however, facilitate interaction between the agent and the farmer so that problems confronting the farmer in his farm business could be presented for specific solutions to be found to them.

The dominant energy type in the rural household is fuelwood. None of the agroforestry practitioners' use liquefied petroleum gas (LPG). There is therefore the need to integrate trees in the land use system. The rural poor would not be able to afford the cost involved in buying LPG and its accessories.

A greater proportion of the farmers obtained increased income levels after adoption of agroforestry. This had a positive impact on the livelihood of the farmer and his household. Also a greater proportion of households' food security has improved after adopting the technology. This is partly due to the fact that farmers can now use money that accrue from the sale of tree crops to purchase food items to supplement food in the household. Again, a greater proportion of the farmers to a large extent are able to afford school fees and learning materials for their children and wards, clothes and medical treatment for individuals in the household. About a third of agroforestry practitioners have succeeded in building their own houses from the sales of tree crops/products and food crops and others have succeeded in buying building plots in Kumasi compared to only 5.7% of farmers who owned houses before adopting agroforestry. It can therefore be concluded that agroforestry adoption has had a significant impact on the livelihood of most farmers' households.

5.2 Recommendations

The economic, legal and political arrangement governing the ownership and management of agricultural land in the districts should be restructured. To achieve success, government should institute land tenure policies, which provide farmers access and permanent rights to lands. This would reduce the problems associated with land ownership, acquisition and utilization.

Formal financial institutions (Banks) in the study area should take the responsibility of granting loans/credit to farmers to reduce the financial problems encountered in their quest to adopt agroforestry. Gender sensitivity, to a larger extent has enormous influence on agroforestry adoption with the females being in the minority. Meanwhile, women play significant roles in farming activities. Mechanisms should therefore be put in place to plan a sustainable education programme for women on agroforestry practices and also give support to women organizations interested in agroforestry.

The indigenous technical knowledge of farmers should be purposefully included in the design of agroforestry interventions since this would promote farmer adoption of such interventions.

The continuous use of weedicides, pesticides and other agrochemicals by farmers involved in citrus/arable intercrop would have detrimental effect on the soil and its fertility in the near future. There is the need for the design of an agroforestry intervention, which would involve citrus tree-leguminous tree (example, Gliricidia, Leucaena etc) - Food crop interphase. The leguminous tree would increase the nutrient content of the soil through the fixation of atmospheric nitrogen, provide leaf mulch which creates favourable soil conditions for microorganisms that are beneficial for soil improvement and nutrient cycling. This can also reduce the growth of weed. Farmers should also increase the use of organic manure in their quest to improve the fertility of the soil. These interventions are likely to reduce the use of external inputs such as weedicides, pesticides and other agrochemicals and sustain the use of the land and to protect it from future destruction through soil erosion, which would lead to decline in soil fertility.

The government should buy both the food crops and tree crops directly from farmers at a reasonable price to avoid exploitative middlemen. Farmers should also constitute themselves into cooperatives so that food crops and tree crops could be bought at a fixed price determined by the cooperative society. Also those involved in fruit-canning industry such as Refresh and Kalyppo should be encouraged to buy their raw materials (citrus fruits) from farmers in the study area at reasonably attractive price.

The number of Technical Officers (TO's) of the Ministry of Food and Agricultural and Range Supervisors of the Forest Services Division should be increased so that these agents could work with a large section of the farming community. These personnel should be motivated enough by for example, providing them adequate transport allowances for them to perform effectively and efficiently. These agents should frequent their visits to give education to farmers on the management of both food crops and tree crops.

A larger proportion of agroforestry research is conducted on-station. The traditional tendency has been to fine-tune a methodology before testing it on-farm lest failure on-farm would result in a negative farmer's attitude, and prevent farmers from accepting and adopting the technology. There are still gaps in our knowledge of agroforestry which require further research. Considering the nature of agroforestry future efforts should be directed at participating on- farm research; this would involve farmers and researchers working together to identify research problems or disseminate research results. Once they are involved and consulted on matters affecting them, farmers will consider themselves partners in success or failure. This approach is likely to minimize the fear of failure by researchers and encourage them to conduct more on-farm research.

Dissemination of agroforestry is likely to be more effective through Nongovernmental organizations in the study area. These organizations have the resources for development work and access to a large number of farmers.

Biophysical analysis which would consider the organic matter accumulation, nutrient content of the soil in the study area should be undertaken as a further research. This would enable one to assess the nutrient build up after integrating tree crops in the land use system. Contributions, qualities and importance of indigenous trees should also form part of such a study since farmers have a rich knowledge about their trees and in the course of the centuries have developed technologies that maintain and use trees, integrating them with crops and animals.

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APPENDICES

Appendix I Variables used in the Analysis of the Determinants of Agroforestry Technology Adoption

Variable	Description

1. Independent		
a)	Age	Age of respondents: 20-29 = 1 30-39 = 2 40-49 = 3 50-59 = 4 60-69 = 5 70-79 = 6
b)	Sex	Sex of respondents: Male = 1, Female = 2
c)	Years of experience in farming	Years of experience in farming of respondents: 0-9 = 1 10-19 = 2 20-29 = 3 30-39 = 4 40-49 = 5 50-59 = 6
d)	Education	Education level of respondents: Illiterate = 1 Basic/Elementary = 2 Secondary = 3 Vocational/Technical = 4 Tertiary = 5

e) Religion	2. Dependent
	a) Land Acquisition
f) Material status	

Muslim = 2

Traditional = 3

b) Distance of farm

None = 4

Material status of respondents: Single = 1

Married = 2

c) Farm size

Land acquisition of respondents: Freehold = 1

Tenancy = 2

Communal = 3

State owned = 4

Purchased = 5

d) Source of labour

Distance of farm of respondents: 0-4 = 1

5-9 = 2

10-14 = 3

15-19 = 4

Farm size of respondents: < 1 = 1

1-5 = 2

6-10 = 3

e) Government monetary support

> 10 = 4

Sources of labour of respondents: Family/household = 1

Hired/wage = 2

Co-operative = 3

Family/household + hired = 4

Religion of respondents: Christian = 1

Government monetary support of farmers: Yes = 1

No = 2

---

f) NGO monetary support

NGO monetary support of farmers: Yes = 1

No = 2

g) Level of income before adoption	Level of income of farmers: (¢ Million) None	< 1 = 1 1-10 = 2 11-20 = 3 21-30 = 4 31-40 = 5 41-50 = 6 51-60 = 7

APPENDIX II

QUESTIONNAIRE FOR FARMERS

1. FARMERS BACKGROUND

a) Age ………………………. (Years)

b) Sex: Male/Female …………………………..

c) Name of Town/Village ……………………..

d) Years of experience in farming ……………. (Years)

e) Highest Education level

i) Illiterate ii) Basic/Elementary iii) Secondary iv) Vocational/Technical v) Tertiary

f) Religion

i) Christian ii) Muslim

iii) Traditional

iv) None

g) Household size

i) Small size (1 – 4) ii) Medium size (5 – 10)

iii) Larger size (11+)

h) Marital status single [ ]

married [ ]

Divorced [ ]

Widow [ ]

2. LAND TENURE

a) Does the land belong to you? Yes/ No

b) How did you acquire it?

i) Freehold ii)

Tenancy (Share

Cropping) iii)

Communally owned

iv) State owned

v) Through purchase

vi) Others

c) Are you likely to face land acquisition problems in the future? Yes/ No

Why?…………………………………………………………………………..

d) What would you most likely use your best land to grow?

i) Food crop ii) Cash

crop iii) Tree crop

iv) Others (Specify)

Explain………………………………………………………………………………

…………………………………………………………………………………………

……………

3. LAND USE SYSTEMS AND PRACTICES

CROP PRODUCTION SYSTEM

a) What type of crop(s) do you cultivate or what do you use the land for?

Food crop

Cash crop

Tree crop

Others (specify)

Why? ………………………………………………………………………………

C)

Type of Farm (practice)	Distance from Home (km)	Total land size under cultivation (acres)

i. Wood lot

ii. Windbreaks

iii. Fruit trees on cropland iv. Alley cropping v. Taungya
vi. Others

d) What limits farm size?

i) Land ii) Labour iii) Capital iv) Others (specify)

e) How do you prepare your land for cultivation?

i) Slash and burn ii) Set fire in the bush iii) Zero burning (Proka)

iv) Minimum tillage v) Tilling

vi) Others (specify)

f) What has been the trend of production over the last 3 years′

Crop	Trend	Reason
Tree crop		
Food crop		
Others (specify)		

Key of Trend: Increasing, decreasing, about the same If it is a windbreak, explain how it has helped in the protection of buildings and production of crops

g) If there is decline in yield, how are you trying to resolve the production problems?

………………………………………………………………………………………………
………

4. ANIMAL PRODUCTION SYSTEM

a) Indicate the type of management system(s) typical herd size of the following animals in the households.

Animal Type	Typical Herd Size	Management System Fr He Pd St Si
Cattle		
Sheep		
Goats		
Poultry		
Pigs		
Others		
None		

NB: Fr = Free range, He = Herding, Pd = Paddocking, St = Stall feeding, Si = Semi – intensive.

b) Type of Feed and when used

Indicate the type of feed and when used for the types of animals in a) above?

Type of Feed	When Used	Type of Animal

Tree/shrub fodder	DWA
Formulated/concentrate	DWA
Feed From mills	DWA
Household waste	DWA
Grassland (local)	DWA

NB: Dry Season, W = Wet Season, A = All year round

c) What is the contribution of the animals in the household?……………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

5. SOURCES OF FARM POWER/LABOUR

a) What type of implement do you use?

i) Cutlass ii) Tractor iii) Hoe iv) Others (specify)

6. What is/ are the sources of labour on your farm

i) Family/ household ii) Hired/ wage – per day/ contract iii) Nnoboa/ cooperative iv) Others

c) How affordable and accessible are the operations below with regards to labour?

	Weeding	Punning	Harvesting

i) Very affordable
ii) Somewhat
affordable iii) Not very
affordable iv) Very
expensive
i) Very accessible ii)
Somewhat accessible
iii) Not very accessible
iv) Not accessible

- Tick appropriately

d) What is the mode of weed control in your farm?

i) Manually
ii) Use of herbicides iii) Mechanically iv)
Others (specify)

6. INPUT, CAPITAL/ FINANCIAL, MARKETING AND INST
SUPPORT.

a) What is the source of your planting materials?

TIONAL

	Food crop	Tree crop
Extension office/ Gov't market		
From other farmers		
From one's own previous harvest Others		

- Tick appropriately

b) Do you obtain sufficient planting materials?

Food crops Yes/ No
Tree crops Yes/ No

c) How do you finance your farming activities/ source of loan / credit?

i) Bank

ii) Money lenders iii) Personal savings iv) Family member support v) Cooperatives

vi) Others (specify)

d) Have you been getting or already received any assistance from Government in terms of monetary support and/ or other inputs? Yes/ No

If Yes what kind?
………………………………………………………………………………………
………………………………………………………………………………………

g) Have you been getting or already received any assistance from a non-governmental organization in terms of monetary support and/ or other inputs?

Yes/ No …………………………………….

Name the NGO(s)

If Yes what kind?
………………………………………………………………………………

h) What do you do for a living other than farming (Off-farm activities)?

i) Service ii) Artisans iii) Business

iv) None

Where do you sell the Food crops and the tree crops?

Type of market	Food crop	Tree crop

Local Market
Urban Market
Foreign Market
None

j) If you are not satisfied with the marketing system, of the food crop and tree crops, what do you think can be done to improve it?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

k) Do you receive extension support from government agencies or non-governmental organizations in using the Agroforestry technology?

Yes/ No

If Yes, explain

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

l) How many average contacts have you had with extension agents?

i) 1 ii)

2 iii) 3

iv) 4

v) > 4

vi) No contact

m) Which of the following mode of technology transfer (communication method) do you consider appropriate in your case?

i) Individual extension ii) Group extension iii) Mass media

iv) Others (specify)

7. PERCEPTION, PROBLEMS AND SOLUTIONS TO AGROFORESTRY ADOPTION

i) What is your general view about Agroforestry (perception)?

…………………………………………………………………………………………

…………………………………………………………………………………………

ii) Explain the problems you encounter in your quest to adopt Agroforestry technologies.

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…………………………………………………………………………………………

iii) What suggestions can you make to help solve the problem(s) you have identified?

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8. IMPACT OF AGROFORESTRY ON LIVELIHOOOD OF HOUSEHOLDS.

(α) HOUSEHOLD ENERGY

a) What is the type of household energy?

Gas

Fuel wood

Charcoal

Others (specify)

b) What is the source of household energy?

i) Own farm ii) Forest
iii) Purchase iv) Others
(specify).

c) Name the tree species used as fuelwood

……………………………………………………………………………………………

……………………………………………………………………………………………

β. LEVEL OF INCOME AND EXPENDITURE OF THE FARMER BEFORE AND AFTER ADOPTION

PRE – ADOPTION

a) State your average income from the sale of crops before adoption.

Food crop/ Cash crop	Income/ year
Maize production	
Cassava production	
Plantain production	
Cocoa production	
Others (specify)	
Total	

b) **State your average expenditure in the following operations before adoption.**

Operation	Expenditure/ year
i) Pre-planting operations (cutting undergrowth, Felling of trees, etc.)	
ii) Planting operations (cost of seeds/ planting materials, labour etc)	
iii) Post planting operations (weeding, spraying, harvesting, etc)	
Total	

POST – ADOPTION

a) State your average income from the sale of food/ cash crops and tree crops.

Crop	Income/ year			
Food / Cash crop				
Tree crop	Fruits	Poles/timber	Fuelwood	Fodder
Total				

b) State your average expenditure in the following operations after adoption

Operation	Expenditure/ year
i) Pre-planting operations (Cutting undergrowth, Fellin g of trees, removal of stumps etc)	
Planting operations (cost of tree seedlings/ planting materials, labour etc)	
Post planting operations (weeding, pruning, harvesting etc)	
Total	

(γ) HOUSEHOLD NEEDS

PRE – ADOPTION

a) How was the food security situation in the household?

Very good

Somewhat good

Not very good

d) How affordable were the following needs?

Affordability	School Fees and learning materials	Clothes	Medical treatment
Very affordable			
Somewhat affordable			
Not very affordable			

c) What was your accommodation before adoption?

i) Family house ii)

Hiring iii) Own

house/ built

iv) Others (huts, cottage, etc)

POST ADOPTION

a) How is the general food security situation in the household?

i) Very good ii)

Somewhat good

iii) Not very good

b) How affordable are the following needs?

Affordability	School Fees and learning materials	Clothes	Medical treatment

Very affordable
Somewhat affordable
Not very affordable

c) What is your accommodation after adoption?

Family house

Hiring

Own house/ built

Others (huts, cottage, etc).

APPENDIX III

QUESTIONNAIRE

1.

a) Name of institution/Establishment

……………………………………………………………………………………

b) Location/ District.

……………………………………………………………………………………

c) Office of the respondent

……………………………………………………………………………………

d) What are the major activities of your establishment?

i)……………………………………………………………………………………………

ii)……………………………………………………………………………………………

iii)…………………………………………………………………………………………

e) What are some successes and failure of your programmes/ activities in (d) above?

Successes:

i) ……………………………………………………………………………………..

ii)……………………………………………………………………………………….

iii) ……………………………………………………………………………………

Failures:

i) ……………………………………………………………………………….

ii) ………………………………………………………………………………

iii)

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f) Enumerate the constraints and problems of your programme(s)/ Activities in (d) above.

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g) What steps has the institution taken to overcome the constraints and to solve the problems?

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2.

a) Which of the following agroforestry technologies is dominant or commonly practiced in your locality/ district?

i) Woodlot ii) Taungya

iii) Alley cropping

iv) Fruit trees on cropland

v) Others…………………………….

b) What is the impact of agroforestry on the livelihood of farmers' household as perceived by you? Explain with some evidence (if available).

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c) What are common problems you perceive to be hindrance to Agroforestry technology adoption? (Please, list them in order of seriousness).

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d) What would you recommend to the government so as to enhance technology transfer and subsequent adoption in the district?

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