KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

FACULTY OF RENEWABLE NATURAL RESOURCES

DEPARTMENT OF AGROFORESTRY

FARMERS' PERCEPTION OF AGROFORESTRY ADOPTION IN THE ASUNAFO SOUTH DISTRICT IN THE BRONG AHAFO REGION OF GHANA

BY

PRINCE WIREKO (BSc. AGRIC. TECH. UDS)

JUNE, 2011

FARMERS' PERCEPTION OF AGROFORESTRY ADOPTION IN THE ASUNAFO SOUTH DISTRICT IN THE BRONG AHAFO REGION OF GHANA

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

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DECLARATION

I, Prince Wireko, hereby declare that this thesis, "Farmers' Perception of Agroforestry Adoption in the Asunafo South District in the Brong Ahafo Region of Ghana", consists entirely of my own work produced from research undertaken under supervision and that no part of it has been published or presented for another degree elsewhere, except for the permissible excepts/references from other sources, which have been duly acknowledged.

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Prince Wireko Date

(Candidate)

……………… ………………….

Dr. (Mrs) Olivia Agbenyega Date

(Supervisor)

……………. …………………..

Dr. K.Twum-Ampofo Date

(Head of Department)

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ABSTRACT

Farmers' perception of agroforestry adoption is important for the promotion of agroforestry which was the focus for this study conducted in the Asunafo South District in the Brong Ahafo Region of Ghana. Agroforestry is considered to have the potential to improve farming in the Asunafo South District. However, it has been observed that some problems are affecting the adoption of agroforestry in the district. The objectives of the study were to assess farmers' perceptions of adopting agroforestry technologies, assess farmers' preferences of indigenous trees suitable for agroforestry technologies and to identify the socio-economic factors that influence the adoption of agroforestry technologies in the district. The instruments used for collecting data from the 120 respondents were questionnaires, focus group discussions, and field observations. Data was analysed using Statistical Package for Social sciences (SPSS), version 16. Chi-square was used to test variables at 5% level of significance. Results indicated that 64.2% of the 120 respondents had knowledge of agroforestry whiles 35.8% had no knowledge. Some farmers (37.1%) practice agroforestry whiles a greater percentage of farmers (62.9%) are not practicing it. Indigenous trees identified by farmers that could be incorporated into agroforestry technologies are Onyina (*Ceiba pentandra*), Otie (*Pycnanthus angolensis*), Bese (*Cola nitida*), Essa fufuo (*Celtis mildbraedii*), Ofram (*Terminalia superba*), Onyamedua (*Alstonia boonei*), Nyankyerene (*Ficus exasperata*) and Emire (*Terminalia ivorensis*). The major socio-economic factors affecting farmers decision to adopt agroforestry technologies include land tenure (42.3%), risk and uncertainty (20.6%), low level of education (28.0%) and market availability (9.1%). The study recommends adequate education for farmers to promote adoption of agroforestry technologies. In addition, secure land rights when enforced would enhance adoption of agroforestry technologies in the district.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Agroforestry can be considered as one of the sustainable land management systems that increase production by combining agricultural crops, trees and/or animals on the same piece of land. Agroforestry is a dynamic, ecologically based natural resource management system that, through the integration of trees in farmland and cropland, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels (Leakey, 1996). Gold and Garrett (2009) also define agroforestry as an intensive land-use management practice, where trees and/or shrubs are deliberately combined with crops and/or livestock and incorporated into the agricultural landscape. Farmers can benefit from agroforestry technologies that give solutions to issues with soil productivity, environmental remediation, product diversification, and economic problems (Nair, 1996; Franzel and Scherr, 2002a). The economic benefits include an increase in farm revenue through the optimization of land production (Gold *et al.*, 2009). Agroforestry also produces important environmental benefits including control of wind erosion, reduction of run-off, stabilization of stream banks, improvements in internal drainage and infiltration, and enhancement of aquatic and terrestrial habitats (Gold and Garrett, 2009).

In spite of these benefits, the adoption of agroforestry technologies at the farmer level is low and therefore efforts to increase the adoption of these technologies should take into account the socio-economic issues as well as the method of extension (ICRAF, 1997). Individual factors that may influence attitudes regarding a technology and subsequent adoption include household preferences, resource endowments, market incentives, biophysical features, risk and uncertainty, as well as perceptions of the biophysical performance, profitability, acceptability and feasibility of the technology (Franzel *et al.*, 2002; Pattanayak *et al*., 2003). ICRAF (1997), states that the scientific potential of agroforestry technologies could be realised by recognising how and why farmers make long-term landuse decisions. Snapp *et al.*, (1998), reported that agricultural research in recent decades has focused on seeking solutions which rely on low-input organic matter technologies such as agroforestry. Agroforestry technologies can play a vital role in achieving sustainability in various farming systems. The technologies can increase agricultural productivity through nutrient recycling, reducing soil erosion, improving soil fertility and enhancing farm income compared with conventional crop production (Kang and Akinnifesi, 2000; Gold and Garrett, 2009). Furthermore, the technologies can also potentially reduce deforestation whiles increasing food, fodder, and fuelwood production (Young, 1997; Nair *et al*., 2004).

In recent times, it has become necessary to explore the most appropriate ways of promoting the adoption of agroforestry technologies in Ghana. This is because it has been reported by GPRS (2002), that there is annually a 2.8% decline in food production. However, due to the high cost and unavailability of inputs, farmers have not been able to increase production (Seini, 2002). Majority of farmers practice slash and burn, and slash and no-burn agriculture. These farming methods have forced farmers to seek more land to meet their food, fodder, and fuelwood needs. This process has resulted in substantial degradation of land, gradual disappearance of forest cover, and decline in soil fertility (Dykstra *et al*., 1996; Quansah *et al*., 2001).

In Ghana, agroforestry is an important landuse system which has been practiced, particularly by rural communities (Ofori *et al*., 1990). This practice gained prominence in Ghana in 1986 with the establishment of the Agroforestry Unit at the Ministry of Food and Agriculture. This was followed by a proposal for the formulation of the National Agroforestry Policy in Ghana (Terakawa, 2002). The overall objective of the policy was to promote agroforestry technologies for sustainable landuse (MOFA, 1986). Agroforestry development in Ghana in the late 1980s aimed at establishing tree seed nurseries to provide readily available seedlings for farmers interested in adopting agroforestry technologies. This was in line with the objectives of the National Agroforestry Policy, which was aimed at establishing and maintaining 350 demonstration centers, 400 nurseries and 30,000 hectares of agroforestry systems nationwide. As at 1992 the project had established 119 demonstration centres, 131 nurseries and 1,642 hectares of agroforestry systems, an achievement of 34, 33 and 5 percent respectively of the set targets (Terakawa, 2002).

Djarbeng and Ameyaw (2002) reviewed the work of some Non-Governmental Organisations (NGOs) that promote agroforestry technologies and their adoption in Ghana. They reported that, between 1991 and 1994, an NGO called Ghana Rural Reconstruction Movement (GhRRM) successfully introduced agroforestry to farmers in the Eastern Region. During this period, farmer constraints, adaptations, perceptions as well as training methodologies were evaluated. In 1997, an NGO, Adventist Development and Relief Agency (ADRA) initiated a five year food security programme covering the three regions in the North, Brong Ahafo, Volta, Greater Accra and Central Regions. The programme sought to promote availability, access, and utilization of food produced through agroforestry technologies. In 1998, another NGO, Conservation International (CI) in collaboration with government and farmer associations in Ghana contributed to sustainable cocoa farming through the promotion of cocoa-agroforestry. This was part of the conservation cocoa programme to promote cocoa-agroforestry as an integral landuse strategy to connect patches of the remaining forest fragments through conservation corridors in the south-western parts of the country (Ofori *et al*., 1990).

Perception of farmers about the adoption of agroforestry in the Asunafo South District is diverse. Generally, agroforestry is seen by the farmers to have the potential of solving their fuelwood needs, improve soil fertility, and provide favourable climate for crops. Farmers have indigenous knowledge on the use of trees in farming systems as well as some environmental benefits such as watershed protection and climate moderation (Owusu, 1993). Apart from the government giving land to farmers to practice agroforestry especially taungya system, some Non-Governmental Organisations such as Rural Development Youth Association (RUDEYA) and Tropenbos International Ghana (TBI-Ghana) have promoted agroforestry in the Asunafo South District. The Rural Development Youth Association (RUDEYA) provided tree seedlings to the farmers in the study area and also gave education on how to protect these trees against bush fire, illegal timber logging, and unsuitable farming practices in their various agroforestry systems. Tropenbos International Ghana (TBI-Ghana) on the other hand was mainly into research and testing of methods already used by farmers to improve their crop yields and sustain the introduced agroforestry technologies (Oduro, 2003).

1.2 Problem Statement

Agroforestry is considered to have the potential to improve farming in the Asunafo South District. However, it has been observed that some problems are affecting the adoption of agroforestry technologies in the district. These problems include; inadequate awareness on agroforestry, unavailability of land to practice the technologies, and inadequate education on agroforestry (Kwame Gyamfi, Personal Communication, 2011). This has consequently resulted in low adoption of agroforestry technologies in the district. Most farmers have very little or no knowledge about new agroforestry technologies because few agencies have introduced the technologies to the farmers in the district. Most farmers do not know what type of land to use to practice a specific type of agroforestry technology and therefore complain of inadequate land. This may be due to low level of education on the adoption of agroforestry technologies. These problems as a result have led to few farmers adopting agroforestry technologies in the district. It is therefore important to understand how and why farmers make adoption and land use decisions, and the factors that influence their adoption behaviour in order to enhance agroforestry adoption among farmers in the district.

1.3 Justification of Study

Over the last two decades, research and development organisations have made considerable efforts in promoting and disseminating agroforestry technologies to increase and sustain farm productivity, and improve environmental conservation (Raussen *et al*., 2001; Franzel and Scherr, 2002). However, the adoption levels of many of these technologies are less than satisfactory. Several studies have examined the determinants and constraints to the adoption of agroforestry technologies (Pattanayak *et al*., 2003; Franzel *et al*., 2004). The majority of these studies have concentrated on factors such as land tenure systems, farm size, education, age and extension. It is against this background that the research is conducted to determine farmers' perception of agroforestry adoption in the district. It is of the view that when this is achieved, farmers will acquire practical knowledge to help address their landuse problems as they benefit from the agroforestry technologies.

1.4 Aim and Specific Objectives

The main aim of this study was to identify and assess farmers' perceptions of adopting agroforestry technologies so as to provide guidelines to improve adoption and increase farm productivity in the district. The specific objectives of the study were:

1. To assess farmers' perceptions of adopting agroforestry technologies in the district.
2. To assess farmers' preferences for indigenous trees suitable for agroforestry technologies.
3. To identify the socio-economic factors that can influence the adoption of agroforestry technologies in the district.

From the specific objectives, the following research questions were proposed;

1. What do farmers know about agroforestry?
2. Which agroforestry technologies can be practiced on farms?
3. Which types of trees are managed on farm lands?
4. How do farmers decide on which trees to keep on their farms?
5. What problems are encountered in adopting agroforestry technologies?
6. What factors influence decisions in adopting agroforestry technologies?

CHAPTER TWO

LITERATURE REVIEW

2.1 Adoption of Agroforestry

Studies have been conducted on the adoption of agroforestry in different areas. Mercer and Miller (1998), report that economists have dominated agroforestry adoption research. These economists are involved in two separate and distinct lines, which include ex-ante and ex-post studies (Pattanayak *et al*., 2003). Ex-ante studies rely primarily on social and financial analyses of on-farm trials of agroforestry innovations to assess the adoption potential and to improve the effectiveness and efficiency of developing, modifying and disseminating new agroforestry technologies (Franzel and Scherr, 2002). In sub-Sahara African case studies, Franzel and Scherr (2002) have demonstrated the potential of agroforestry to increase farm incomes and solve difficult environmental problems. Pattanayak *et al*., (2003), state that ex-post studies of agroforestry have focused primarily on explaining how characteristics of farmers, farms, projects, and other demographic and socio-economic variables are correlated with past adoption behaviour.

Farmers make decision to adopt a practice that seems most consistent and appropriate to achieve their goals or interests (Barlas *et al*., 2001; Rob and Burton, 2004). Farmers make those decisions after assessing different farm internal resources such as household composition, farm size and external conditions like incentive policies, and market prices (Fuglie and Kascak, 2001). Internal and external conditions play a role in the adoption of agroforestry technologies. Pattanayak *et al*., (2003) found that demographic characteristics, intra-household homogeneity, resource assets, market incentives, biophysical factors, risk and uncertainty were determinants for agroforestry adoption. Flower (2004) found that attitudes, agroforestry knowledge and farm-structure attributes also determined the adoption of riparian buffers and forest farming. Similarly, Valdivia and Poulos (2009) established that physical properties of the landscape, such as bank stream erosion, influenced the adoption of riparian buffers. The influence of economic motivations, a commonly examined internal factor, is not conclusive in the adoption of agroforestry (Nair, 1996). Fregene (2007) proved that the economic benefits of agroforestry had a positive effect in adopting agroforestry while Valdivia and Poulos (2009) found that they were not a driving factor. Regarding external forces, the value of land for future development was found to be an important element in deciding whether to plant trees or grasses as riparian buffers (Lynch and Brown, 2000). It was therefore concluded that, there must be more studies to examine the full range of potential factors that may influence agroforestry adoption (Nair, 1996).

2.2 Review of some Agroforestry Technologies

The key agroforestry technologies that have been reviewed in this study include: taungya system, homegardens, alley cropping, improved tree fallows, and silvopastoral systems. The biophysical interactions among the trees, crops, and livestock occurring in these agroforestry technologies produce various physical, biological, ecological, economic and social benefits (Current and Scherr, 1995; Dobbs and Pretty, 2004). Tisdell (1999) mentioned that, there are normally both ecological and economic interactions between woody and non-woody components in agroforestry. As the links and interactions between climate change, biodiversity loss, land and water degradation and their effect on ecosystems and human beings are apparent, the potential of agroforestry technologies to mitigate and adapt to climate change, address land degradation and enhance biodiversity conservation. While protection of natural habitats remains the core of conservation strategies, agroforestry technologies designed to improve land quality and productivity also offer opportunities to create habitats for wild species in agricultural lands (Nair, 1998) The multifunctional nature of agroforestry technologies offer a range of opportunities sustaining ecosystem functions which includes the use of live fences to protect farms, woodlots to produce fuelwood, and nitrogen fixing trees to improve soil fertility, soil organic matter and physical conditions (Ajayi, 2007). Thus, by promoting agroforestry, the practice of integrating trees on farms can be more effectively aligned with biodiversity conservation, and this is considered as one of the approaches that can be very useful and effective in making progress towards balancing environment and development needs (World Agroforestry Centre, 2007). This is because of its ability to contribute to food security by restoring soil fertility for food crops, reduce soil erosion, reduce deforestation by providing fuelwood, reduce emissions and enhance sinks of green house gases, provide more diverse streams of income and reduce poverty. Nair (1998) also mentioned that many agroforestry technologies are associated with a more intensive use of land than shifting cultivation systems and can be used by smallholders with few resources. In addition, tree used in agroforestry technologies can act as insurance in the event of economic crises such as a complete failure of food crops as the trees can be harvested to provide cash.

2.2.1 Taungya System

Taungya system is a forestry system that involves planting trees with agricultural crops, particularly the local population's staple foods, and so serves to satisfy the farmer's quest for arable land (FAO, 1984). Farmers are expected to tend the trees to maturity and are also expected after three years to move to other lands, mostly in degraded state-owned or managed forest reserves, to repeat the process. Interactions between crops and trees under taungya systems are designed to achieve complementary rather than competitive effects (Vieira *et al*., 2009). The outcome of such interactions is influenced by factors related to species combinations and planting densities, the level of competition for growth resources, climatic and edaphic factors, including management regimes (Imo, 2009).

2.2.2 Homegardens

Homegardens are described as intimate, multistory combinations of various trees and crops, and sometimes in association with domestic animals around the homestead (Kumar and Nair, 2006). Homegardens are rich in plant diversity and have been ranked top among all man-made agro-ecosystems for their high biological diversity after natural forest (Swift and Anderson, 1993). Species diversity of tropical homegardens is quite variable depending on the geographical location, size of the garden, gardeners' socio-economic status, and managerial interventions (Kumar and Nair, 2004). The forest-like structure and composition of homegardens and the specific management practices tend to enhance nutrient cycling and increase soil organic matter (Mohan *et al*., 2007). Homegardens may ensure longer term stability of carbon storage in fluctuating environments apart from augmenting biomass production potential (Kumar, 2006).

2.2.3 Alley Cropping

Alley cropping involves growing food crops between hedgerows of planted shrubs and trees, preferably leguminous species. The hedges are pruned periodically during the crop's growth to provide biomass which enhances soil nutrient status and to prevent shading of the growing crops (Kang *et al*., 1990). The application of organic materials such as tree or shrub prunings with relatively high nutrient composition and fast decomposition properties have been recommended either as sole soil amendments or in combination with mineral fertilizers (Nziguheba *et al*., 2000; Quinkenstein *et al*., 2009). The addition of these tree or shrub prunings through alley cropping makes substantial contributions to the development of sustainable land-use systems in the tropics by providing a cost-effective mechanism for optimizing crop yields for efficient and stable crop production (Young, 1997). The periodic pruning and return of residues from hedgerow trees or shrubs through alley cropping contribute to recycling of plant nutrients, improvements in soil temperature, enhancement of soil structure, erosion control, maintenance of microbial activity and high soil nutrient status (Isaac *et al*., 2003; Wang *et al*., 2010).

2.2.4 Improved Tree Fallows

Long-term fallowing is no longer feasible and shorter natural fallows do not adequately replenish soil fertility. Researchers have therefore initiated research on the development of short-term improved fallows to allow for rapid replenishment of soil fertility (Rao *et al*., 1999). Improved fallow system is a technique for integrating leguminous tree and shrub species in rotation with crops to build up nutrients in farmers' fields (Kwesiga *et al*., 1999). Improved fallows benefit farmers in the form of greater food crop yields, representing increased returns to land and labour (Franzel *et al*., 2002). Planted tree-fallows were compared with grass fallow and continuous cropping with or without fertilizers and results show that, the tree fallows increased subsequent maize yields over the control crops; maize after grass fallow and continuous maize without inorganic fertilizers (Mafongoya and Dzowela, 1998).

2.2.5 Silvopastoral Systems

Silvopastoral systems are a type of agroforestry system designed for livestock production which combines grass or leguminous species with woody shrub and tree species to provide forage and ecological benefits (Isaac *et al*., 2005; Reis *et al*., 2009). Silvopastoral systems provide more ecosystem services than open pasture lands (Buttler *et al*., 2009). They favour biodiversity by creating complex habitats that support diverse plants and animals and harbour a richer soil biota, and increase connectivity between forest fragments (Haile *et al*.; 2010). In farmed landscapes, silvopastoral systems provide food and cover for birds serving as wildlife corridors where unique species can be found (McAdam *et al*., 2007). The combination of grasses and trees also helps retain soil and water, protecting watersheds and soils from erosion and nutrient pollution (Michel *et al*., 2007). Ultimately, silvopastoral systems can remain productive for longer periods than conventional pastures, thus reducing the pressure to clear more forests (Steinfeld *et al*., 2006). From the farmers' point of view, trees planted in silvopastoral systems also offer a variety of direct benefits. Trees provide marketable wood products such as timber, veneer logs, pulpwood, firewood, as well as non-timber products such as nuts, leaves, roots and bark for medicinal uses, and forage for livestock (Bellefontaine *et al*., 2002). At the same time, trees in silvopastoral system also provide a range of indirect benefits that are often overlooked by farmers, because they originate from more complex mechanisms. Trees maintain and improve soil fertility as they contribute to nitrogen fixation and nutrient uptake from deep soil horizons (Nair *et al*., 2007b). They also improve the physical conditions of the soil because their root systems counteract compaction, reduce surface runoff and erosion, and enhance water infiltration (Ayres *et al*., 2009).

2.3 Socio-Economic Considerations in Agroforestry

Over the past three decades, agroforestry research has broadened from primarily biophysical investigations to include results observed by sociologists, anthropologists, and environmental conservation and economic development agencies in rural areas (Mercer and Miller, 1998). Successful integration of biophysical and socio-economic analyses into academic and agency research represents one of the challenges facing agroforestry. Alavalapati and Nair (2001) report that it may appear that farmers implement agroforestry systems to address household needs such as food, fodder, and fuelwood. The operating efficiency of the system may be less important to the agroforestry practitioner than social values such as personal sense of aesthetics or its acceptability within the community (Kurtz, 2000; Rule *et al*., 2000). Many innovative practices introduced by a top-down approach disregarding socio-economic realities have produced disappointing results for implementing agencies (Rogers, 1995). However, understanding the existing social framework can increase the chances of acceptance and commitment to both traditional and introduced technologies (Rochelau, 1998). Because of these reasons, agroforestry adoption success is of great increasing concern to researchers. It is therefore important to monitor the trends in socio-economic research in agroforestry to identify strengths and weaknesses in the current state of knowledge and to provide guidance for further investigation and more productive feedback loops between researchers and practitioners (Pattanayak *et al*., 2003). When the science of agroforestry focused on the tropics, the most often identified socio-economic issues critical to agroforestry system's success in smallholder systems included land tenure, labour, and marketability (Nair, 1993).

Labour in economic analysis usually refers to the physical and mental contribution of men and women to the production of outputs (Hoekstra, 1990). Hired labour is most often valued at the prevalent market wage, while family labour is costed at its value in the next best enterprise (Hoekstra, 1990). Most agroforestry interventions will require some degree of change in either the utilization of, or the total requirement for labour. Under conditions of under-employment or unemployment, agroforestry may actually improve labour efficiency, while in other circumstances shortages may present serious constraints to the adoption of certain technologies such as alley cropping. In economic analysis, valuation will obviously be more difficult where land prices are not established in a market setting. In such cases, opportunity cost may be utilized to approximate value. In densely populated areas, the allocation of land to agroforestry will probably require the exclusion of other activities. The fitting valuation in these circumstances may be the monetary contribution of land to output under a known agricultural undertaking (Prinsley, 1990). Hyman (1983) mentioned that farmers motivated to plant trees are often faced with a shortage of available labour for crop production. Thus farmers whose main source of income is agriculture might be discouraged to allocate family labour for tree planting activities. Hocking *et al*., (1996) has highlighted that large scale farmers tend to plant trees to some degree separated from the homestead. Moreover, farmers usually compare the expected benefits of tree planting on their lands with the benefits they can attain by using their labour for other farming systems (Gregerson *et al*., 1989). Studies conducted by Thacher *et al*., (1996) pointed out that long-term investment in tree planting is most likely if labour constraints faced by the farmers inhibit alternative economical and viable investments.

The social orientation of agroforestry as well as the unsuitability following the agricultural technology development pathway for agroforestry has been emphasized by many social scientists (Burch and Parker, 1991). The theoretical perspectives of the contributions that social sciences can make to agroforestry have been reviewed by Burch (1991) and concluded that four types of studies illustrate the range of empirical studies that can help agroforesters plan and prepare for action, as well as provide a basis for project progress. These are:

1. Assessment studies: Social benefits and costs are measured and assigned to government, project, and village levels.
2. Tenure studies: The theory and methods for examining the influence of tenure upon the success of agroforestry programs.
3. Community studies: Factors affecting adjustment and response by the community to different kinds of innovations.
4. Adoption studies: Elements that influence the adoption process of new or improved technologies by the clientele group.

Besides providing insights on socio-economic factors associated with agroforestry systems, studies suggest that social and economic research in agroforestry is advancing (Nair *et al*., 2004).

2.4 Farmer Perceptions of Tree Planting and Management

Many studies have stressed the importance of trees to rural households around the world (Falconer, 1990). Leakey *et al*., (2003) highlight the role that the promotion of indigenous fruit trees could play in poverty alleviation strategies for the humid forest zone of West and Central Africa. Garrity (2004) underscores the potential contribution of indigenous fruit trees in eradicating poverty and hunger, a top priority for the achievement of the Millennium

Development Goals. Arnold and Dewees (1995) list a number of factors that may drive farmers' decisions to retain and plant trees of different species. According to Edwards and Schreckenberg (1997), these can broadly be divided into factors internal to the household such as farm size, land tenure, access to labour and capital, education, and ethnic background of household decision makers and factors external to the household such as prevailing land-use system, relative availability of off-farm resources, market access, the policy and legislative context.

Arnold and Dewees (1998) argue that strategies to encourage tree planting on farms need to be based on an understanding of farmers' tree management in the context of household livelihood strategies, pointing out that little is known about farmers' perceptions of the value of trees and the constraints they face in developing tree resources. Studies from Wiersum (1984) reveal that rural people are often familiar with tree growing but have different attitudes towards trees and these attitudes can affect tree growing on farms. Some studies in developing countries have stressed scarcity of fuelwood as one of the key factors to motivate farmers in planting trees (Dewees, 1992). FAO (1985) reported that as long as fuelwood could be collected without paying for it, farmers had little incentive to plant fuelwood producing trees. Godoy (1992), however, raised the question on the assumption that high fuelwood demand stimulates tree production, suggesting that this is only the case of tree planting when there is a fuelwood crisis. Thus, the high purchasing cost of fuelwood may motivate farmers to plant trees. FAO, (1985) again reports that activities at the initial stage of tree planting are labour intensive, and these activities usually coincide with crop harvesting operations.

2.5 Knowledge Transfer of Agroforestry Technologies in Farming Communities

Although there are formal sources of information on pertinent management practices such as institutional-based knowledge, previous research has shown that little of this information reaches the desired recipients, and selected target farmers who are often not representative of the whole farming community (Boahene *et al*., 1999). It is assumed that to substitute for or balance this lack of information, other types of informal sources of information must be created within farming communities. Farmers who cannot access information from external sources can presumably draw on knowledge within their social networks and transfer information through social interactions (Conley and Udry, 2001). Bodin *et al*., (2006) report that, Social networking which is a method that is most often used to elicit, visualise, and analyse social relations and social networks, is a suitable tool to examine properties of farmer knowledge transfer.

The use of diverse farming knowledge is necessary for the maintenance of complex agroforestry technologies. Thus, the determination of how techniques advance in agroforestry, specifically through farmer communication and learning networks, is critical to understand barriers for farmer access to information (Kiptot *et al*., 2006). Assuming that informal sources of information are embedded within farming communities and are available to farmers through social interactions, the analysis of the social structure is a rational research approach by which to uncover communication patterns. Thus, identification of key actors in the development and transfer of agroforestry technologies can provide insight into information dissemination and may be a path to a productive land use management (Mortimore and Adams, 2001).

2.6 Promotion of Agroforestry Technologies among Small Scale Farmers

Promotion of agroforestry requires first and foremost that technologies designed meet farmers' needs and match their circumstances. It also necessitates providing technical information and training to the practitioners, micro-finance, and formal credit systems, improving market access, and strengthening organizational linkages. The design of promotion strategies must take into account appropriate biophysical and socio-economic conditions as well as policy changes needed to support adoption (Boehringer, 2001). Effective partnership among farmers and individuals and organizations engaged in research and extension is critical to success in scaling-up agroforestry. In addition, collaboration with universities and colleges can strengthen agroforestry research and help build the capacity of future researchers (Denning, 2001).

Studies from many countries with a long history of agroforestry promotion provide useful information on how to increase the adoption of agroforestry technologies (Chambers, 1991). Jacobson (1999) reports that considerable commitment of resources and training of extension personal may be necessary. The use of farm leaders or promoters may be another useful feature in extension of agroforestry technologies. Promoters are farmers who have been trained by project staff to teach and provide guidance to other farmers (Chew, 1989). It was emphasised that, farmers may be more willing to trust and listen to fellow farmers than to extension personel who often come from outside the community. Current and Scherr (1995) reveal that the economic viability of agroforestry can be greatly increased through improved markets for tree products. Wiersum (1984) also reports that, elimination of unfavourable tenure and land use regulations should be considered in order to reduce the risk of tree planting for small scale farmers, and to ensure that they reap the benefits of their efforts.

2.7 Gender Considerations in Agroforestry

Potters (1997) points out that several studies have taken a close look at gender differences in adoption of agroforestry technologies. It was found that when documenting farmers' knowledge and perceptions about variation within tree species, it is essential to recognise potential gender differences, because men and women may value different tree species. For instance, many women cultivate trees in homegardens for fruit, medicines, and other products that they use in the household and sell in local markets. In a study of tree planting in Kenya, Scherr (1995) found significant gender differences, with male headed households planting more trees than women. Gladwin *et al*., (2002a) also found that women in female- headed households in Eastern Zambia were significantly more likely to adopt improved fallows than men in male-headed households. It has been reported that women in Southwest Nigeria face constraints in adopting alley farming technology due to gender-bias in land allocation and inheritance systems or rights to plant or own trees (Fabiyi *et al*., 1991).

Versteeg and Koudokpon (1993) found that there has been gender bias in the selection of who participates in on-farm trials of agroforestry technologies, with men being mostly preferred. Gladwin and McMillan (1989) report that, innovative approaches such as agroforestry technologies to replenish Africa's soil fertility are likely to depend on adoption by African rural women, who by custom produce the food crops in many African communities, while men produce the export crops. As food producers, women farmers are the key to reversing the crisis and increasing domestic food production in Africa. But their lack of power within their own households is a unique problem facing them in their roles as African food producers. Scherr (1995) found that gender differences in agroforestry technologies are still quite significant. In one study, men had more trees on their farms than women. Men tended to plant trees in cropland for cash while women's farms had trees used primarily for fuelwood. These differences reflect men and women's differential ability to independently decide how trees will be used and allocated. Women are not permitted to make decisions without consulting their husbands, and are also less likely to question men at the institutional and state levels (Scherr, 1995).

2.8 Factors Affecting the Adoption of Agroforestry Technologies

Recent research has explored the role of various cultural, environmental, political, and socio-economic factors that affect the adoption of agroforestry technologies with the aim of understanding the biophysical and socio-economic factors that influence farmer adoption (Keil *et al*., 2005; Ajayi *et al*., 2007a). These studies have led to a greater understanding of farmer decision making and have allowed research and extension personnel to evaluate dissemination efforts to better facilitate farmers and increase the numbers of adopters. Available literature, particularly in recent reviews of Pannell (2003) and Place and Dewees (1999), indicate that several factors are most likely to affect adoption of agroforestry technologies. These include: risk and uncertainty, household preferences, resource endowments, land tenure, market constraints, inadequate extension work, and policy constraints.

2.8.1 Risk and Uncertainty

Although risk and uncertainty have long been recognized as important in reducing adoption of a variety of agroforestry technologies, relatively little empirical research has directly addressed the issue (Pannell, 2003). As Marra *et al*., (2003) point out that, the issue of risk in adoption has rarely been addressed adequately, and strong empirical evidence to test the common view of its importance and impact has been rare. Pannell (2003) mentioned that for sustainable agricultural and land conservation systems like agroforestry, risk and uncertainty appear to be more important to adoption decisions. Shively (1997) also examines the roles of farm assets and relative consumption risk to explain patterns of contour hedgerows at the farm level.

2.8.2 Household Preferences

Mercer and Pattanayak (2003) state that, assuming that farm households are heterogeneous, farmers will exhibit different adoption patterns depending on their attitudes and preferences for a number of factors including risk tolerance, conservation priorities, and intra-household homogeneity among different households. Also, since preferences are extremely difficult to measure directly, a variety of variables are usually used to examine the impact of preferences on adoption of agroforestry technologies. Demographic variables such as age, education, and gender have long been examined as potential determinants of landowner propensity to adopt conservation practices such as agroforestry technologies (Traore *et al.*, 1998). Studies by Feder and Umali (1993) reveal that empirical results on these variables have been mixed, citing several studies indicating that age is negatively associated with adoption due to the shorter planning horizons of older farmers. However, high educational level has been found in numerous studies to have a positive relationship to adoption of conservation practices (Adesina *et al.*, 2000).

2.8.3 Resource Endowments

The assets and resources available to farmers for investing in new agroforestry technologies such as labor, land, livestock, savings and credit are critical to adoption decisions (Hyde *et al.*, 2000). Both the theoretical and empirical literature indicates that, early adopters tend to be the better-off households who are better situated to take advantage of new innovations with uncertain prospects. These households are more likely to have the necessary ‘risk capital’ such as larger incomes and more labour or land to facilitate risky investment in unproven technologies (Scherr, 1995). Scherr and Franzel (2002) found that, inadequate supply of tree seeds is considered a problem to the expansion of agroforestry technologies. Even though there is demand for tree seeds from farmers, they are often unable to obtain them because of cost or inadequate supply. A reliable seed supply and distribution system on a much greater scale is required to increase adoption of agroforestry technologies but at the moment there are few incentives for private sector investment in this area. A good seed production strategy will provide seeds and seedlings of good quality and combine both the informal and formal sectors of production. The informal sector is made up of individual farm households as well as small-scale, independent nursery owners and seed vendors. The formal sector would include public and private organizations with specialized roles in supplying new tree species and varieties (Kindt *et al*., 2006).

2.8.4 Land Tenure

Land tenure has long been considered a critical factor in determining the adoption and long-term maintenance of agroforestry technologies (Mercer, 2004; Pattanayak *et al*., 2003). Bruce and Fortmann (1988) state that land tenure systems that do not guarantee continued ownership and control of land are not likely to be conducive to the adoption of long-term practices such as agroforestry. Ehrlich *et al*., (1987) added that secure land rights have proven pivotal in determining whether the benefits of agroforestry reach the intended beneficiaries. Mercer (2004) reviews agroforestry adoption research from the tropics and found that in studies which tenure was a significant variable, secure land tenure was positively associated with adoption. Pattanayak *et al*., (2003) also found that landowners are more likely than tenants to adopt agroforestry technologies. Fraser (2004) studied land tenure and soil conservation practices and found that while renters tend to plant crops with short-term returns, land owners were associated with investment in long-term crops. Again, Kurtz (2000) relates renter and owner adoption problems to agroforestry and states that if an operator is not certain that a payoff from an investment is forthcoming during the period in which a land resource is used, it is not likely that the investment will be made. Several empirical studies of agroforestry adoption by Pattanayak *et al*., (2003) reviewed that more secure land tenure always had a positive impact on adoption. In a few cases land tenure was an insignificant predictor of adoption (Adesina *et al*., 2000). At the farm level, the most important institutional arrangement affecting agroforestry is property rights to land. Property rights to land shape farmers' expectations of whether and how they will be able to appropriate long-term benefits from investing in tree planting and management (Meinzen-Dick, 2006). Studies in Cameroon, Kenya, Mali, Uganda and Zambia have found that tenants without long-term land rights are restricted in their ability to plant or harvest from trees because of insecurity of tenure (Place, 1994).

2.8.5 Marketing of Agroforestry Products and Constraints

Social marketing research identifies perceptions of the barriers and benefits necessary to change behaviour among individuals in relation to the marketing of agroforestry products (McKenzie-Mohr and Smith, 1999). Bohannan and Dalton (1968) report that, since the advent of trade networks in Africa, smallholder farmers with trees on farm or in their common areas have been drawn into markets for benefit and survival and that trade in certain tree products such as timber, fuelwood, charcoal, medicinal products, honey, nuts and fruit has gone on for many years.

Terray (1974) reports that better markets for agroforestry products provide a way for poor farming households to generate income. Hellin and Higman (2002) also state that if agroforestry technologies are to contribute poverty reduction, farmers must explore and expand markets. Gabre-Madhim (2002) working on smallholders' access to markets, noted that post-reform markets in Africa continued to be characterized by high transaction costs, limited market information, lack of coordination, missing markets for storage and finance, lack of smallholder market power and increased risk. Research conducted by Hoskins (1987) revealed that, selection of an appropriate market infrastructure can increase the availability of agroforestry products on markets. Also, policies which support appropriate market infrastructure and needed skills with respect to traditional and introduced agroforestry technologies appear to offer opportunities for effective rural development (Gabre-Madhim, 2002).

Scherr and Franzel (2002) have mentioned that market constraints also play a significant role in hindering the scaling-up of agroforestry. Agroforestry extension and research has tended to emphasise increasing production levels of trees and crops but these efforts have been undertaken with little regard for demand or price. Recent work has shown that market conditions play a critical role in farmer adoption of agroforestry technologies. It was found that when the price of maize in Zambia decreased, farmers were more likely to use improved fallows to reduce the area under maize cultivation allowing them to increase production of higher value cash crops on other fields. If agroforestry is to be adopted on a scale that has meaningful economic, social and environmental impacts, it is crucial that markets for agroforestry tree products are expanded. For this to occur there must be stronger links between tree domestication and product commercialization (Leakey *et al*., 2006).

2.8.6 Inadequate Extension Work

The issue of appropriate extension work for increasing agroforestry technology adoption is of particular importance because agroforestry is a relatively ‘knowledge intensive’ practice. Several researchers have cited national extension systems in many sub-Saharan African countries as a major barrier to scaling-up agroforestry (Scherr and Franzel, 2002). They note a lack of rigorous, organized and locally adapted extension messages, the general weakness and limited resources of government extension systems, lack of agroforestry training for extension workers, and the unclear assignment of responsibility for agroforestry between agricultural and forestry extension institutions.

2.8.7 Policy Constraints

Place and Prudencio (2006), reports that there are significant policy based constraints to the expansion of agroforestry in Africa. Experts in agroforestry are clear that an enabling policy environment that favours smallholder rural development is an essential condition for the success of agroforestry. They are equally clear in their belief that the lack of institutional support for agroforestry is a major policy related constraint to agroforestry development in Africa and an issue which has not been adequately addressed in agroforestry research. Studies reveal the need for specific types of policy action and cite factors that are both essential to scaling-up agroforestry and are strongly influenced by public policy. Food and Agriculture Organization has worked to raise awareness of agroforestry technologies at the national policy level of developing countries and to dispel the idea that tree resources are only important for small-scale farmers and make only a limited contribution to sustainable resource management (Sadio, 2006).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Study Area

The study was conducted in the Asunafo South District located in the southern part of the Brong Ahafo Region of Ghana, (Fig. 3.1). It lies between latitudes 6˚10’ N and 6˚45’ N and longitudes 2˚45’ W and 0˚45’ W. The temperature of the district is uniformly high all year round with the hottest month being March with about 30˚C. The mean monthly temperature is about 25.5˚C. The district experiences a double maxima rainfall with the mean annual rainfall ranging from 1250 mm to 1750 mm. The relative humidity of the district is highest in the wet season ranging from 75% and 80% whiles the dry season gives the lowest, ranging from 70% and 75% (Asunafo South District Annual Report, 2009).

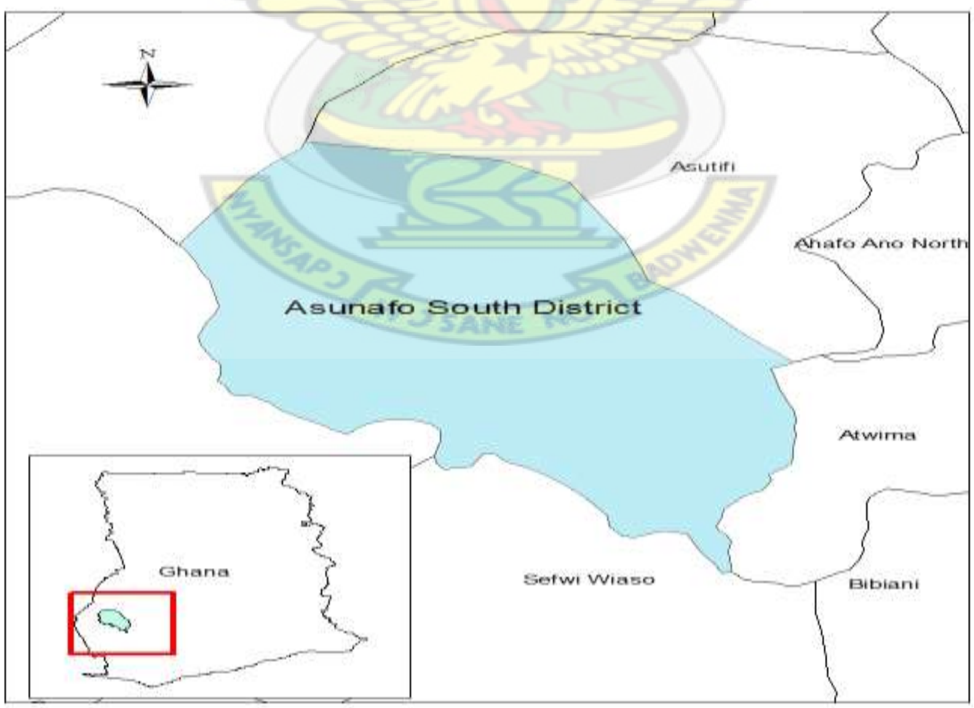

Fig 3.1: Map of Asunafo South District

3.1.1 Selection of Research Sites

The research was carried out in 12 selected communities from 56 communities in the district. These communities were Alavanyo, Anum, Thousand, Pomakrom, Dotom, Dodowa, Gyasikrom, Dantano, Ntonso, Pesewkrom, Agyaponkrom, and Muntumi (Fig. 3.2). These research sites were randomly selected whiles respondents selected purposively because of the availability of data from farmers who are practicing agroforestry and those who could potentially adopt agroforestry in the study area. Bernard, (2002) states that the main goal of purposive sampling is to focus on particular characteristics of a population and availability of data that are of interest, which will best answer the research questions of the study.

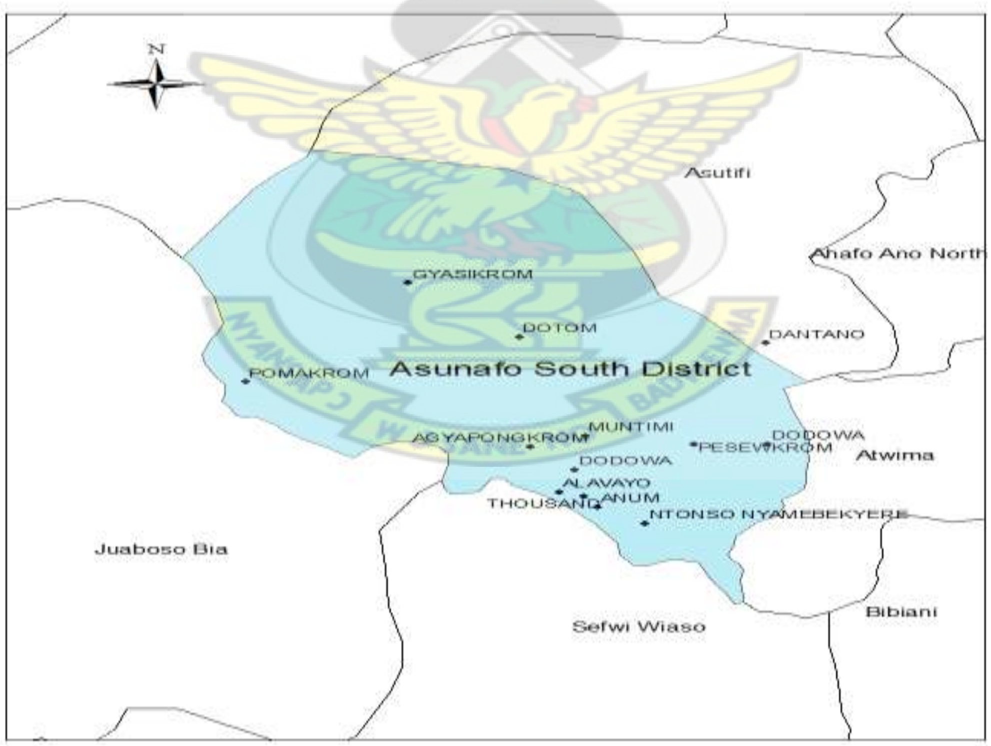

Fig. 3.2: Asunafo South District with Communities selected as Research Sites

The communities selected have some common geographical characteristics. The underlying rocks of these communities are the pre-cambrian, Birimian and Tarkwaian formations. Two main rivers (Tano and Sui), among several smaller streams, which are mainly seasonal in character, drain these communities. The major soil group which covers the surface area of the communities is forest ochrosols. These soils are generally alkaline and support fruit trees including cocoa. The forest in these communities contains large species of trees some of which are Onyina (*Ceiba pentandra*), Odum (*Milicia excelsa*), Ofram (*Terminalia superba*), Emire (*Terminalia ivorensis*), and Mahogany (*Khaya senegalensis*). The main crops grown by farmers in these communities are plantain, cassava, cocoyam and maize, (Oduro, 2003).

3.2 Research Design

A research design is a plan outlining how information is to be gathered for an assessment or evaluation that includes identifying data gathering methods, the instruments to be used, how the instruments will be administered, and how the information will be organised and analysed (Kincaid, 2001). It is used to structure the research to show how all the major parts of the research such as the samples, and methods of data collection work together to address the main research questions. It also ensures that the requisite data is collected accurately in accordance with the problem at hand (Gregor, 2002). Furthermore, it provides information on important decisions needed to be made concerning the type of questions to use, as well as the content, wording, order and format of questionnaires (Fowler, 1993).

Reconnaissance survey and socio-economic survey (Babbie, 1992) were employed in this study. Reconnaissance survey was undertaken on 4th January, 2011 to 16th January, 2011. It helped to familiarize with the farmers and solicit their views on their farm operations and perceptions of agroforestry. Some of the Departments in the District such as the Ministry of Food and Agriculture (MOFA) and the District Assembly were visited where a list of all the communities were obtained. It also helped to establish contact with farmers in the communities where the actual formal survey took place and rapidly appraise some of the main biophysical and socio-economic factors in these selected communities.

The socio-economic survey was conducted from 27th January, 2011 to 6th February, 2011. A semi-structured questionnaire was used to obtain data on the socio-economic characteristics of the farmers. Data was obtained on farmers' household characteristics, occupational characteristics, farm management, perceptions of agroforestry and socio-economic factors that influence farmers' decision of adopting agroforestry technologies. Purposive sampling (Albertin and Nair, 2004) was used to select respondents. Questionnaires, focus group discussions, and field observation methods were applied to collect detailed information on the adoption of agroforestry technologies in the study area. A semi-structured questionnaire was prepared and pre-tested on 23rd January, 2011 for quantitative data. Information gathered through observation are presented descriptively while field data collected using semi-structured questionnaires were analysed using Statistical Package for Social sciences (SPSS), version 16.

3.2.1 Designing Data Collection Instruments

A semi-structured questionnaire was designed as an instrument to collect data for the field work. A Semi-structured questionnaire is a questionnaire consisting of both open-ended and closed questions (Le Compte *et al*., 1992). This design was selected because it facilitates the collection of a wide range of information than a structured questionnaire and can also be used for describing a large sample, making it possible to ask many questions on a given topic (Leung, 2001). Pre-testing of questionnaire was conducted to ensure its feasibility and applicability on the field. Pre-testing of a questionnaire generally means administering a questionnaire to respondents selected from the target population using the procedures that are planned for the main study (Fowler, 1993). The main goals of pre-testing a questionnaire are to answer the following questions, (Fowler, 1993);

- Do respondents have difficulty understanding words, terms, and concepts?
- Are sentences too complex?
- Do respondents interpret the question as the researcher intends?
- Do respondents use different response categories or choices than those offered?
- Are respondents willing and able to perform the tasks required to provide accurate and complex answers?
- Are respondents attentive and interested in the questions?

The questionnaire was pre-tested with twenty one farmers from the three communities outside the research sites and then revised to incorporate farmers' suggestions on the dynamics of agroforestry technologies adoption in the district. The questions sought farmers' socio-economic background and farming systems, and emphasis was placed on farmers' perceptions of adopting agroforestry technologies. The reliability of information was verified with the key informants such as chiefs, agriculture extension workers, forestry officials, and some farmers in the district. Weisberg *et al*., (1989) states that for questionnaires to be reliable, a question must be answered by respondents the same way each time.

3.2.2 Selection of Respondents

Data collection is crucial in research as the data is meant to contribute to a better understanding of the research and therefore, it is necessary that selecting the method of obtaining the data and from whom the data will be collected should be considered (Bernard, 2002). Communities were selected randomly whiles respondents chosen purposively. Random sampling Zhen *et al*., (2006) was used to select communities because the reconnaissance survey identified all communities where agroforestry adoption had taken place and those without agroforestry. Twelve communities were randomly selected. However, purposive sampling was used to select farmers because it was found during the reconnaissance survey that farmers who had adopted agroforestry and those who were not practicing agroforestry could be found together in the communities. Therefore, the best method of obtaining farmers who have adopted agroforestry was to apply purposive sampling. Albertin and Nair (2004), report that both random and purposive sampling can be combined to produce a good method of sampling. Also in a successful research conducted by Zhen *et al*., (2006), they purposively chose respondents in randomly selected communities to which they administered questionnaires. In all, 120 farmers were purposively chosen from the twelve communities randomly selected.

3.3 Data Collection Methods

Data was obtained from two main sources, these were primary and secondary. Primary sources are original sources from which the researcher directly collects data that have not been previously collected whiles secondary sources are sources containing data collected and compiled for another purpose (Babbie, 1992). The instruments used for the data collection were: questionnaires, focus group discussions, and field observations.

3.3.1 Primary Data Collection

A questionnaire is a research instrument consisting of a series of questions for the purpose of gathering statistically useful information from respondents (Gillham, 2008). Administering a questionnaire is a valuable method of collecting a wide range of information from a large number of respondents. However, inappropriate questions, incorrect ordering of questions, or bad questionnaire format can make the research valueless, as it may not accurately reflect the views and opinions of the respondents (Bryman, 2001). In this study, questionnaires were administered to ten respondents each from the twelve communities selected as research sites. A total of 120 questionnaires were administered from 27th January, 2011 to 6th February, 2011.

Focus group discussions were organised to gather information from the farmers. Krueger (1994), defines a focus group as a group of people who possess certain characteristics and provide information of a qualitative nature in a focused discussion. An advantage of a focus group discussion is that the participants can use the thoughts and comments of others to help stimulate and formulate their own thoughts. In addition, participants' comments and reactions can often provide valuable insights into approaches for revising questions and questionnaires (Royston *et* *al*., 1986). Focus group discussions were organised in the twelve selected communities to obtain more detailed information on farmers' perceptions of adopting agroforestry technologies. Each focus group discussion was made up of seven participants who were farmers and each discussion lasted approximately 1 hour.

Observations were made when field visits were carried out to observe farming practices. The selection of farmers' farms was done randomly. Field observation helped to get the overview of how farmers manage agroforestry technologies in the district. The observation included some indigenous trees that could be incorporated into agroforestry activities.

3.3.2 Secondary Data Collection

The secondary source included a review of existing literature of the study area. Information was also obtained from some of the Departments in the District especially Ministry of Food and Agriculture (MOFA), Forest Services Division, and the District Assembly. The secondary data was used to supplement, and also in some cases compare with the primary data obtained from the field.

3.4 Data Analysis

Data analysis is an operation performed on a given set of data to extract the required information in an appropriate form such as diagrams, reports, or tables (McDonald, 2009). Jolliffe (1986) states that most researchers recommend using a computer to help sort and analyse data. The obvious reason for this is to ensure that the data analysed are correct and complete. Also, using a computer can reduce the bias and increase the precision and achieve consistency of the results especially regarding those produced by social science computer software. As a result of this, data collected was analysed using Statistical Package for Social sciences (SPSS), version 16. The survey data was coded, entered into a spreadsheet and checked prior to analysis. Cross-tabulation with selected variables, percentages and frequencies was taken. Percentages were based on either the total number of respondents or total responses, details of which are provided in figures and tables. Chi-square test was used to test the significance of variables such as age, education, gender, occupation, farm size, and land tenure (Clark and Cooke, 1992).

3.5 Limitations of the Study

Limitations of the study are as follows:

1. The large area of the district resulted in a challenge to identify communities where agroforestry has been introduced and those without agroforestry due to lack of a sampling frame for the communities.
2. There was a problem with some farmers as they found it difficult to identify some indigenous trees found on their land to determine their knowledge of trees and as a result, the researcher consulted specialist from the Forestry Department for assistance.

3. Obtaining secondary data from the District Assembly was also a major challenge because the district is one of the newly created districts in the country and therefore some information about the district was not documented.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents the results and the analysis of data obtained from the research work. Data was obtained on farmer characteristics such as gender, age, level of education, and religion. Information was also obtained on land tenure issues, farm size, farming systems, and source of farm labour. In addition, data was obtained on the farmers' perceptions of adopting agroforestry technologies in the study area. One hundred and twenty semi-structured questionnaires were administered to the respondents during data collection. Statistical Package for Social Sciences (SPSS), version 16 was used for the data analysis.

The farmers' perception of agroforestry adoption has been determined using cross tabulation to estimate the impact that a set of socio-economic characteristics of the respondents will have on adoption of agroforestry technologies in the study area. Considering the key variables used, statistical tests found that some of the variables were significant whiles others were not significant. The cross-tabulation was on the practice of agroforestry and the key variables that could influence farmer's decision in the adoption of agroforestry technologies in the study area. Chi-square was used to test the variables at 5% level of significance.

4.1 Gender Distribution of Respondents in the Study Area

Out of the 120 respondents selected for the research, 64.2% were males and 35.8% were females, (Table 4.1). Although the female respondents constituted a smaller percentage of respondents, a lot of them showed interest in adopting agroforestry technologies but added that their decision depended on the males because the farm lands belong to them. This is in line with Scherr (1995) who found in a study of economic factors in farmer adoption of agroforestry that females are not permitted to make decisions to adopt agroforestry technologies without consulting their husbands.

Table 4.1: Gender Distribution of Respondents in the Study Area

Sex	No. of Respondents	Percentage of Respondents
Male	77	64.2
Female	43	35.8
Total	**120**	**100.0**

Source: Field Survey, January/February 2011.

The chi-square test for gender was not significant ($P>0.05$) and therefore gender does not seem to influence the practice of agroforestry in the study area. It was noted that women have been marginalised by men in the practice of agroforestry technologies. Fabiyi *et al*., (1991) reported that gender was negative to adoption because women in Southwest Nigeria face constraints in adopting alley farming technology due to gender-bias in land allocation and rights to plant or own trees. Women integration in the adoption of agroforestry technologies cannot be undermined as Gladwin and McMillan (1989) reported that, innovative approaches such as agroforestry technologies to replenish Africa's soil fertility is likely to depend on African rural women, who by custom produce the food crops in many African communities.

4.2 Age Distribution of Respondents in the Study Area

The largest age group of the respondents was the age group of 25-34 years constituting 36.7% of the 120 respondents. The age group of respondents 1-17 years formed the lowest age group representing 1.7% (Table 4.2). Majority of the respondents were less than 45 years. This age group gives the potential for agroforestry technology adoption in the study area. Findings from Adesina *et al*., (2000) on alley farming adoption in the southwest Cameroon, and Boahene *et al*., (1999) on cocoa adoption in Ghana support that young farmers are more likely to adopt agroforestry technologies. However, chi-square test indicated age not significant ($P>0.05$) and therefore does not seem to influence the practice of agroforestry in the study area. Odera *et al*., (2000), and Gockowski and Ndoumbe (2004) also found that age does not influence the adoption of agroforestry.

Table 4.2: Age Distribution of Respondents in the Study Area

Age Group (Years)	No. of Respondents	Percentage of Respondents
1-17	2	1.7
18-24	17	14.2
25-34	44	36.7
35-44	24	20.0
45-54	16	13.3
55-64	13	10.8
Above 64	4	3.3
Total	**120**	**100.0**

Source: Field Survey, January/February 2011.

4.3 Educational Level of Respondents in the Study Area

Generally, the level of education among the 120 respondents was low. Majority of respondents (21.7%) and 40.8% had junior high school education. A greater proportion of respondents (29.2%) had no formal education, (Fig 4.1).

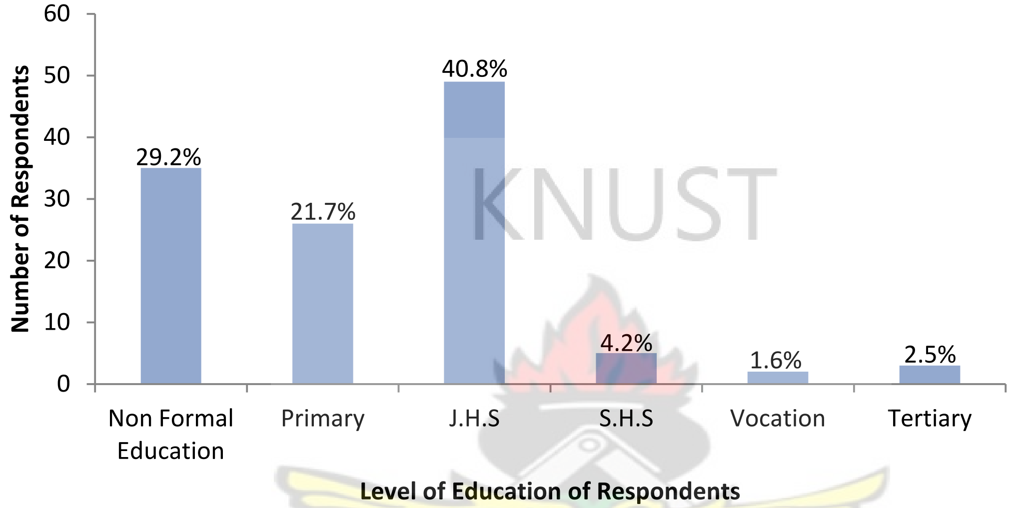

Fig 4.1: Educational Level of Respondents in the Study Area

Source: Field Survey, January/February 2011.

This low level of education could affect the adoption of agroforestry technologies in the district. According to Adesina *et al*., (2000) farmers with a higher education level are more likely to adopt new technologies compared to less educated farmers. Mekoya *et al*., (2008) also emphasised that agroforestry technologies are knowledge intensive and therefore require high levels of education. Chi-square test found the level of education of respondents not significant ($P>0.05$). Meanwhile, Lapar and Ehui (2004) and Sheikh *et al*., (2003) have stated that in many studies, education significantly influences adoption of improved soil conservation technologies. However, education did not have a significant effect on the adoption of agroforestry technologies in the study area. This may be as a result of the low level of education as Stoll-Kleemann and O'riordan (2002) mentioned that low level of education was not significant to agroforestry adoption.

4.4 Religion of Respondents in the Study Area

Christianity was found to be the dominant religion among the respondents in the study area representing 73.4%; the other religions constituted 13.3% each of the 120 respondents (Table 4.3). The high proportion of respondents being Christians suggests that the church could be the most likely social institution for the dissemination of information to ensure adequate adoption of agroforestry technologies in the district. This is in line with Conley and Udry (2001) who stated that farmers who cannot access information from external sources can presumably draw on knowledge within their social networks and transfer technology information through social interactions. Fliegel (1993) and Rogers (1995) reported that inadequate communication sources and communication channels in transmitting information on innovations can affect its development.

Table 4.3: Religion of Respondents in the Study Area

Religion	No. of Respondents	Percentage of Respondents
Christianity	88	73.4
Islamic	16	13.3
Traditional	16	13.3
Total	**120**	**100.0**

Source: Field Survey, January/February 2011.

4.5 Occupation of Respondents in the Study Area

The main occupation in the study area was found to be farming (Fig 4.2). Majority of the respondents were farmers constituting 75% of the 120 respondents. Trading was identified as the second main occupation among respondents representing 10.8%. Furthermore, some respondents were public/civil servants and artisans who practiced farming as a secondary occupation. Occupation was found to be significant ($P<0.05$) from the chi-square test. This was because farming is the main occupation in the study area. Agroforestry could therefore be considered to have the potential to be readily adopted since majority of the respondents are farmers. Sheikh *et al.,* (2003) states that farmers are already associated with risk and therefore easily accept new technologies. Pannell (1999) also reports that farmers are aware of new technologies because of their farming practices.

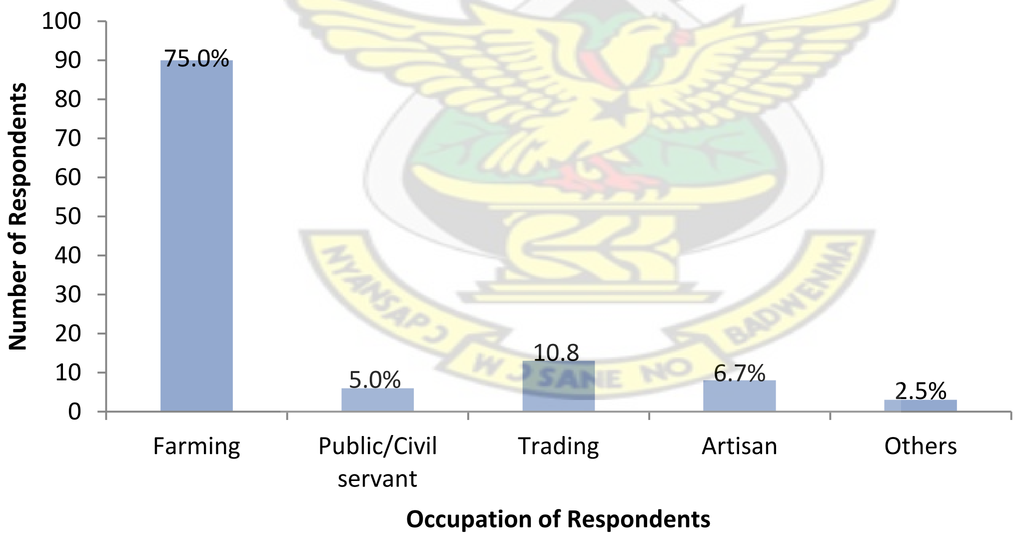

Fig 4.2: Occupation of Respondents in the Study Area

Source: Field Survey, January/February 2011.

4.6 Land Tenure within the Study Area

The respondents reported that farmers in the study area could obtain land through family, purchase, freehold, and lease arrangements (Table 4.4). Majority (42.5%) of respondents obtained land through the freehold system. Findings from the study indicated that most of the farmers in the district who practiced agroforestry were engaged in the taungya system where the land was provided by the Government. In this system the farmers are allowed to grow their agricultural crops and plant trees for the Government. Farmers leave the land when the land can no longer support the growth of their agricultural crops.

Table 4.4: Source of Land for Respondents in the Study Area

Source of Land	No. of Respondents	Percentage of Respondents
Family	36	30.0
Purchase	13	10.8
Freehold	51	42.5
Lease	2	1.7
Others	18	15.0
Total	**120**	**100**

Source: Field Survey, January/February 2011.

Although family (30.0%) was identified as the second main mode of land acquisition in the District, its use for agroforestry activities was observed to be low. This was because farmers had the notion that they could benefit more from their land when used to grow agricultural crops than planting trees. This is in line with Gregerson *et al*., (1989), that farmers usually compare the expected benefits of tree planting on their land with the benefits they can attain by using their land for other farming systems. Nair and Dagar (1991) reported that this perception of farmers could make developing strategies to encourage farmers to plant trees difficult and therefore characteristics of farms and farmers in relation to tree planting in existing agroforestry systems must be studied. Some of the respondents also obtained their land through purchase (10.8%) and very few of them obtained their land on lease (1.7%).

4.7 Farm Size of Respondents in the Study Area

Farm sizes of respondents in the study area were found to be generally small. Majority (65%) of the respondents had farm sizes between 1-2 acres whiles few respondents (1.7%) had above 8 acres (Fig 4.3). The small farm sizes in the district could be a factor which discouraged farmers from adopting agroforestry technologies. This is because farmers may not risk accepting new technologies because of the small size of their farms. Cramb *et al*., (1999) found that farmers with large farm sizes could invest resources in new technologies and get better returns, which encourage adoption of conservation technologies. The effect of farm size on adoption in the study area was found to be significant ($P<0.05$) according to the chi-square test and therefore can influence adoption of agroforestry technologies. Farmers with large farm sizes are willing to invest their land into agroforestry as suggested by Cramb *et al*., (1999) that farmers who have large farm sizes are more likely to adopt improved soil conservation technologies. This is similar to the findings of Amsalu and Graaff (2007), who found that in Ethiopia farmers with large farm sizes are more likely to invest in soil conservation measures as the farmers can take more risks, including relatively high investment, and survive crop failure.

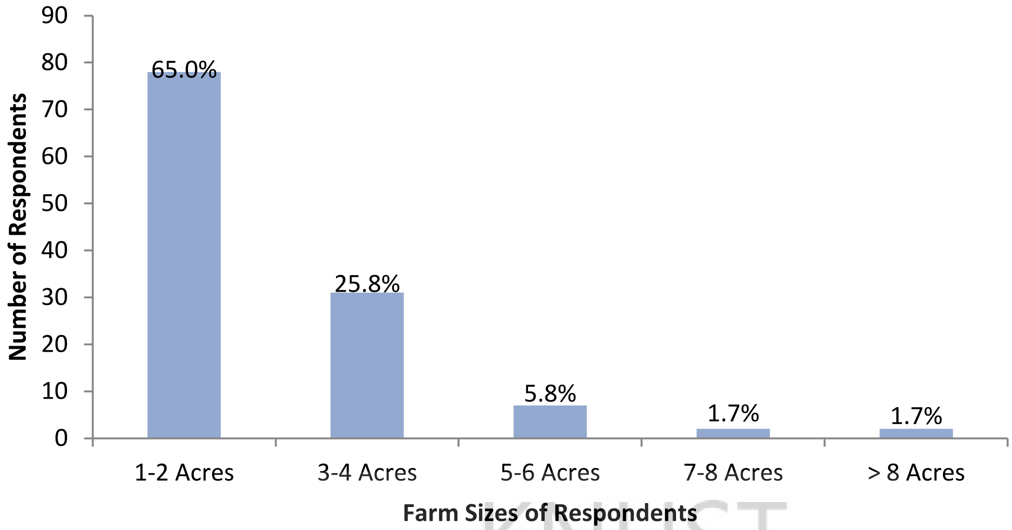

Fig 4.3: Farm Sizes of Respondents in the Study Area

Source: Field Survey, January/February 2011.

4.8 Sources of Labour for farming in the Study Area

The family was found to be the main source of labour for farming in the study area constituting 39.1% followed by 32.8% of the 120 respondents who farmed on their own (self) without any assistance (Table 4.5). The study indicated that 27.3% used hired labour whiles 0.8% of the respondents engaged in communal labour. The study indicated that farmers who used their family labour for tree planting were few because of the growing of the agricultural crops. This is in agreement with Hyman (1983), who mentions that farmers whose main source of income is agriculture might be discouraged from allocating family labour for tree planting activities. Farmers mentioned that financial support to hire labour would encourage them to adopt more agroforestry technologies.

Table 4.5: Source of Farm Labour of Respondents in the Study Area

Type	No. of Respondents	Percentage of Respondents
Communal	1	0.8
Family	50	41.7
Hired	35	29.2
Self	42	35.0
Total	***128**	**106.7**

Source: Field Survey, January/February 2011.

NB: *Some respondents gave more than one response

Chi-square test indicates that source of labour was significant ($P<0.05$) and therefore could affect the practice of agroforestry in the study area. This could be as a result of farmers who are able to hire labour to increase the labour force on their farms. Oluoch-Kosura *et al*., (2001) found hired labour to influence adoption positively possibly because the hired labour increased labour availability on farms. This supports the findings of Keil *et al*., (2005) who found adoption of improved fallows of leguminous trees for soil fertility improvement increases with increasing availability of labour. Okuro *et al*., (2002) also found hiring of labour to be positively related to adoption of integrated use of manure and inorganic fertilizer.

4.9 Major Farm Problems of Respondents

The major problems farmers face in undertaking farming activities were; soil fertility decline (21.2%), pests and diseases attack (11.1%), bush fires (9.0%), inadequate supply of credit facilities (24.1%), destruction of farms by timber contractors (15.3%), invasion of weeds (9.1%)

and inadequate market centers (10.2%). It is therefore important to encourage farmers in the district to practice agroforestry since some of these problems listed can be addressed through the adoption of agroforestry technologies. Agroforestry is thought to have the potential to improve soil fertility through the maintenance or increase of soil organic matter and biological nitrogen fixation from nitrogen fixing tree species (Young, 1997). Agroforestry species that replenish soil fertility have the potential to reverse soil fertility decline, thereby increasing crop yields (Nair, 1998). The presence of some tree species can suppress the growth of weeds on farm lands (Scherr, 1991). Terray (1974) also found that better markets for agroforestry products provide a way for poor farmers to generate income. Research conducted by Hoskins (1987) revealed that, selection of an appropriate market infrastructure can increase the availability of agroforestry products in markets. Also, policies which support appropriate market infrastructure and needed skills with respect to traditional and introduced agroforestry technologies would appear to offer opportunities for effective rural development. In addition, He Feng *et al*., (2007) states that credit availability for farming can help rural farmers increase their production and consumption.

4.10 Tree species Planted by Farmers in the Study Area

Farmers in the district had previously planted trees and even indicated the desire to plant more trees when provided with tree seedlings depending on the products and services that could be obtained from such trees. Tree species planted by the farmers in the study area were: Teak (*Tectona grandis*), Ofram (*Terminalia superba*), Emire (*Terminalia ivorensis*), Mahogany (*Khaya senegalensis*), Cassia (*Cassia siamea*), and Gliricidia (*Gliricidia sepium*), (Table 4.6).

Table 4.6: Tree species Planted by Farmers in the Study Area

Tree species Planted by Farmers	No. of Respondents	Percentage of Respondents
Teak (*Tectona grandis*)	52	43.3
Ofram (*Terminalia superba*)	33	27.5
Emire (*Terminalia ivorensis*)	14	11.7
Mahogany (*Khaya senegalensis*)	21	17.5
Cassia (*Cassia siamea*)	11	9.2
Gliricidia (*Gliricidia sepium*)	10	8.3
Total	***141**	**117.5**

Source: Field Survey, January/February 2011.

NB: *Some farmers gave more than one response

Tree species like the Teak (*Tectona grandis*), Ofram *(Terminalia superb)*, and Mahogany (*Khaya senegalensis*) were given to farmers who were practicing taungya system in the area to plant because of their economic value. Gliricidia was observed to be planted by farmers to provide shade for cocoa seedlings at the initial stage of growth either in the nursery or farm. Scarcity of fuelwood was observed to be a problem in the area but none of the farmers mentioned planting trees for fuelwood production. This is in line with the report from FAO, (1985) that as long as fuelwood could be collected without paying for it, farmers have little incentive to plant fuelwood producing trees. However, it is in contrast to the report from Godoy, (1992) that high fuelwood demand stimulates tree production, suggesting that this is only the case of tree planting when there is a fuelwood crisis.

4.11 Farmers Knowledge of Indigenous Trees

The findings from the research revealed that knowledge on indigenous trees can be obtained from farmers because of their ability to identify most tree species found on their farms (Table 4.7). De Foresta *et al*., (2000) states that farmers have knowledge and experience of integrating trees in their farming systems for centuries. Therefore, developing new strategies for encouraging farmers to grow trees in existing systems can be designed if characteristics of the farms and farmers in relation to tree planting in existing agroforestry systems are studied (Nair and Dagar, 1991).

Table 4.7: Perceived Characteristics of Indigenous Trees by Farmers in the study Area

Tree species	Desirable Characteristics	Undesirable Characteristics
1. Onyina (*Ceiba pentandra*)	Improve soil fertility.	Has a large crown cover; attracts pests to farm.
2. Odum (*Milicia excelsa*)	For timber, provide less shade	High uptake of nutrients from the soil.
3. Otie (*Pycnanthus angolensis*)	Provide shade conducive to raise cocoa seedlings	Branches break easily.
4. Bese (*Cola nitida*)	Fruits have high economic value For building and fuelwood	Have allelopathic effect on crops.
5. Essa fufuo (*Celtis mildbraedii*)	Grow fast, has long life span	Absorbs too much water.
6. Ofram (*Terminalia superba*)	For timber and building	Provides many branches.
7. Mahogany (*Khaya senegalensis*)	Conserve water in the soil	Provide too much shade.
8. Onyamedua (*Alstonia boonei*)	Has high medicinal value	Has bigger crown.
9. Nyankyerene (*Ficus exasperata*)	Grows very fast, for timber	Absorbs too much water.
10. Emire (*Terminalia ivorensis*)	Grows very fast, for timber	Provides too much shade.

Source: Field Survey, January/February 2011.

Djossa *et al*., (2008) found that farmers leave trees on farmlands when preparing land for cropping. This situation is not different in the study area as farmers allow certain tree species to grow on their farms for various benefits such as soil fertility improvement (41.1%), fuelwood production (22.3%), and timber production (11.1%). It was found that most farmers (63.4%) were particularly concerned about the shade that some trees provide on their farms. This is because most farmers in the area are cocoa farmers and have the perception that shade causes cocoa pods to rot.

4.12 Livestock Production as a Component of Agroforestry

Keeping livestock is an important risk reduction strategy for vulnerable communities and livestock are important providers of nutrients (Rosegrant, 2009). Some of the livestock reared by farmers in the study area were; sheep, goats, rabbits, and pigs. The main purpose of rearing livestock by the farmers was found to be domestic. Respondents rearing livestock for domestic purposes constituted 78.9% whiles those rearing for commercial purposes represented 21.1% (Table 4.8).

Table 4.8: Respondents' Reasons for Rearing Livestock

Purpose	No. of Respondents	Percentage of Respondents
Domestic	45	37.5
Commercial	12	10
Total	***57**	**47.5**

Source: Field Survey, January/February 2011.

It must be mentioned that a total of 63 respondents representing 52.5% were not rearing livestock.The majority of the respondents reared livestock for domestic purposes thus allowed the animals to feed on free range (64.3%). Also, 30.4% of the respondents fed their animals with fodder and 5.3% of them took their animals for grazing. The identification of indigenous tree species suitable for fodder production will enhance livestock production in the study area. This is because Abate *et al*., (1992) found fodder to improve livestock production and this has widely been used by farmers in Kenya. The major problems farmers encounter in the rearing of livestock included: diseases infection (47.3%), wild animal attack (38.2%), animals knocked down by vehicles (8.1%) and restriction by some chiefs in the rearing of certain type of domestic animals (6.4%).

4.13 Farmers Knowledge and Practice of Agroforestry

Awareness of a practice is a precondition to adoption (Pannell, 1999). Beyond awareness is the degree of knowledge regarding the practice. Therefore, knowledge becomes critical in association with complex practices such as agroforestry due to uncertainty (Pannell, 1999). The field survey reveals that some respondents have knowledge of agroforestry through Non-Governmental Organisations (NGO's) and Government or Forestry officials. It was found that 64.2% of the 120 respondents had knowledge of agroforestry whiles 35.8% had no knowledge. Some farmers (37.1%) were aware of the benefits of agroforestry and therefore practiced it. Those farmers expressed the desire to adopt more agroforestry technologies if they receive assistance from Government or Non-Governmental Organisations. This is in line with Shiferaw and Holden (1998), who state that farmers in Ethiopia adopt improved soil conservation technologies because of materials and financial support provided by Non-Governmental

Organisations. However, a greater percentage of farmers (62.9%) in the study area were not practicing agroforestry. Farmers practiced agroforestry in the study area for provision of food, generation of income, benefits from trees, support from government and NGO's, leaving a legacy for future generations, and free supply of tree seedlings (Table 4.9). Atta-Krah *et al*., (2004) found that farmers are more favourable to conserve in their fields species that they perceive are readily unavailable in the wild. This finding appears to confirm previous results from Murniati *et al*., (2001) who found that in the area where timber is the main product harvested from forests, farmers expressed a strong interest in growing high quality timber species in their mixed gardens to ensure a future timber supply.

Table 4.9: Farmers' Reasons for Practicing Agroforestry in the Study Area

Reasons for Practicing Agroforestry	No. of Respondents	Percentage of Respondents
1. Provision of food for household	64	53.3
2. Generation of income	26	21.7
3. Benefits derive from trees	31	25.8
4. Support from government and NGO's	13	10.8
5. Leaving a legacy for future generations	1	0.8
6. Free supply of tree seedlings	19	15.8
Total	***154**	**128.2**

Source: Field Survey, January/February 2011.

NB: *Some farmers gave more than one reason.

It was found that the main reason for farmers practicing agroforestry in the study area was the provision of food for the household (Table 4.9). It was also identified that a reasonable percentage (20.1%) of farmers practiced agroforestry because of products such as firewood that they derived from trees. This suggests there is the potential for the adoption of agroforestry technologies by farmers in the study area. However, the small percentage of farmers (0.6%) who practiced agroforestry with a reason of leaving a legacy for the future generation suggests that majority of the farmers were interested in the immediate benefits that could be obtained from the practice.

Hedgerow intercropping, homegarden, taungya system, and woodlot establishment were the main agroforestry technologies adopted by farmers in the study area. The findings revealed that majority (46.7%) of the respondents practiced taungya system with the least (1.3%) been woodlot establishment, (Table 4.10). Majority of the farmers practiced taungya system because farmers obtained the land freely from the government and had total benefits of their agricultural crops. It was also found that a small percentage (14.7%) of farmers have homegardens.

Table 4.10: Agroforestry Technologies Practiced by Respondents in the Study Area

Agroforestry Technologies	No. of Respondents	Percentage of Respondents
Hedgerow intercropping	28	23.3
Homegarden	11	9.2
Taungya system	35	29.2
Woodlot establishment	1	0.8
Total	***75**	**62.5**

Source: Field Survey, January/February 2011.

A total number of 45 respondents with a percentage of 37.5% did not practice any of the technologies mentioned. Agroforestry technologies provide various products, such as building materials, food, and medicinal materials and have long played significant ecological and socio-economic roles (Schroth *et al*., 2001). Farmers who have adopted agroforestry technologies in the study area obtain benefits as the technologies provide some needs such as food, cash, fuelwood, fodder, poles and mulch (Table 4.11). Pottinger *et al*., (1998) states that multipurpose species provide livestock fodder, fuelwood, timber, mulch and human food in agroforestry systems.

Table 4.11: Needs of Farmers Satisfied by the Agroforestry Technologies

Needs	No. of Respondents	Percentage of Respondents
Food	68	56.7
Cash	41	34.2
Fuelwood	12	10.0
Fodder	4	3.3
Poles	1	0.8
Mulch	2	1.7
Timber	6	5.0
Total	***134**	**111.7**

Source: Field Survey, January/February 2011.

NB: *Some farmers gave more than one response

Agroforestry technologies have a higher potential to improve soils compared with arable crop land because of the increased rates of organic matter addition and retention due to improved aggregation and changes in litter quality (Nair *et al*., 2007b). In several studies addition of mulch from woody species led to significant increases in organic matter, which is mainly associated with the active soil organic matter pool (Phiri *et al*., 2001). Furthermore, agroforestry technologies incorporating multipurpose species have considerable potential to reduce the fuelwood deficit (Jensen, 1995). Despite the benefits that can be derived from the practice of agroforestry, some farmers listed reasons preventing them from adopting agroforestry technologies, (Table 4.12).

Table 4.12: Farmers' Reasons for not Practicing Agroforestry in the Study Area

Reasons	No. of Respondents	Percentage of Respondents
1. Inadequate knowledge of agroforestry	29	24.2
2. Inadequate Land	39	32.5
3. Long rotation period of most tree species	18	15.0
4. Insecure tree tenure	16	13.3
5. No interest to practice agroforestry	11	9.2
6. Felling of trees destroying agricultural crops	16	13.3
Total	***129**	**107.5**

Source: Field Survey, January/February 2011.

NB: *Some farmers gave more than one reason

The findings suggests that majority of the farmers (30.2%) are not practicing agroforestry because of inadequate land. It was realised that farmers in most cases are reluctant to use their land to plant trees because of the long rotation period of most tree species. It was also realised that some farmers had no knowledge of agroforestry because of low level of education on agroforestry technologies. Lapar and Ehui (2004) reported that a high level of education leads to a better understanding of new technologies which enhance adoption of improved technologies.

4.14 Tenant Farming in the Study Area

Findings from the study revealed that tenant farming is a common practice in the study area and therefore its effect on the adoption of agroforestry technologies needs to be examined. Results showed that 65.8% of the 120 respondents said tenant farming did not affect their decision whiles 34.2% admitted that tenant farming could affect their decision of adopting agroforestry technologies, (Table 4.13). Tenant farming was found to be significant ($P<0.05$) from the chi-square test.

Table 4.13 Respondents engaged in Tenant Farming in the Study Area

Response to Farmers Engaged in Tenant Farming	No. of Respondents	Percentage of Respondents
Yes	41	34.2
No	79	65.8
Total	**120**	**100**

Source: Field Survey, January/February 2011.

Majority of the farmers (65.8%) who mentioned that tenant farming did not affect their decision to adopt agroforestry technologies gave the reason that if only there was a document to determine how the products from the technology would be shared it could be practiced successfully. Sjaastad and Bromley (1997) state that entitlement documents give the landlord and tenant a guaranteed investment to a technology. On the other hand, farmers (34.2%) who admitted that tenant farming can affect their decision, mentioned reasons including: tenants being blamed for the death of trees, conflict resulting in the sharing of products and finally some chiefs claiming total ownership of trees. Boffa, (1999) reports that in Northern Ghana, locust bean trees belong to only tree chiefs regardless of the tenure rights over the lands on which they stand.

4.15 Factors Perceived by Farmers to Affect their Decision of Adopting Agroforestry Technologies

The socio-economic factors identified by farmers that affect their decision to adopt agroforestry technologies are as follows: land tenure (42.3%), risk and uncertainty (20.6%), low level of education (28.0%) and market availability (9.1%) (Place and Dewees, 1999; Pannell, 2003). The findings revealed that land tenure was one of the major factors that affected farmers' decision of adopting agroforestry technologies in the district. This factor has generally affected majority of the farmers who are tenants. This was because tenants do not have guaranteed ownership and control of land to plant and own trees. This has made farmers insecure to practice agroforestry since they may not be the intended beneficiaries of the technology. This is in line with Wiersum, (1984) that, elimination of unfavourable tenure and land use regulations should be considered in order to reduce the risk of tree planting for small scale farmers, and to ensure that they reap the benefits of their efforts. Chi-square test found land tenure not significant ($P>0.05$) and therefore does not affect the practice of agroforestry in the study area. Nair and Dagar (1991) found that land tenure does not influence the adoption of agroforestry technologies.

Risk and uncertainty were also identified as farmers fear that compensation from agencies who introduce the technology to them may not be given in case of failure. Some farmers mentioned that they would not risk using their own funds to maintain the agroforestry technologies that have already been introduced to them. This was because some agencies had disappointed them because they did not provide adequate financial support for establishing the technology. This has become a serious threat to the adoption of agroforestry technologies as it has reduced some farmers initial enthusiasm to embrace agroforestry in the district. Rogers (1995) found that financial support from agencies and Non-Governmental Organisations influences farmers' decision to adopt improved soil conservation technologies. Risk and uncertainty were found to be significant (P<0.05) from to the chi-square test. Pannell (2003) found risk and uncertainty to be significant in agroforestry adoption studies.

In addition, the findings revealed that low level of education was also a factor that accounted for (62.9%) of farmers not practicing agroforestry in the study area. This is because some farmers (35.8%) have no knowledge of agroforestry and as a result have no interest in the various technologies. Moreover, farmers who have been introduced to agroforestry did not receive enough education especially at the initial stage of establishment and its subsequent maintenance resulting in the failure of some agroforestry technologies implemented. Mekoya *et al*., (2008) found that agroforestry technologies are knowledge intensive and therefore require enough education in the adoption process. The low level of education was not significant (P>0.05).

Ready market for agroforestry products was also a major concern to the farmers. Farmers stated clearly that they could improve their living conditions and reduce poverty when they get ready markets for their products. This is in line with Hellin and Higman (2002) who state that, if agroforestry technologies are to contribute to poverty reduction, farmers must have good markets for agroforestry products. They emphasised that despite the environmental attractions of agroforestry, agroforestry technologies can have a dim future if it supplies few direct monetary benefits to farmers. The effect of market availability on adoption in the study area was found to be significant (P<0.05) according to the chi-square test and therefore can influence adoption of agroforestry technologies. Place and Dewees (1999) found that ready market for agroforestry products influence agroforestry adoption

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study has presented the relevant issues in relation to the adoption of Agroforestry technologies in the Asunafo South District. The study determined farmers' perceptions of indigenous trees and identified the socio-economic factors that influence the adoption of agroforestry technologies in the study area.

5.1.1 Farmers' Perceptions of Adopting Agroforestry Technologies in the District.

The study revealed that some respondents had knowledge of agroforestry through Non-Governmental Organisations (NGO's) and Government or Forestry officials. It was found that 64.2% of the 120 respondents had knowledge of agroforestry whiles 35.8% had no knowledge. Some farmers (37.1%) were aware of the benefits of agroforestry and therefore practiced it. However, a greater percentage of farmers (62.9%) in the study area did not practice agroforestry. Hedgerow intercropping, homegarden, taungya system and woodlot establishment were the main agroforestry technologies that had been adopted by farmers in the study area. Reasons why farmers practice agroforestry in the study area were: provision of food, generation of income, benefits from trees, support from government and NGO's, leaving a legacy for future generations, and free supply of tree seedlings. Reasons some farmers gave for not adopting agroforestry technologies in the district include; inadequate knowledge of agroforestry, inadequate land, long rotation period of most tree species, insecure tree tenure, no interest to practice agroforestry, and felling of trees destroying agricultural crops.

5.1.2 Farmers' Perceptions of Indigenous Trees suitable for Agroforestry Technologies.

The findings from the research revealed that knowledge of indigenous trees could be obtained from farmers because of their ability to identify most tree species found on their farms. The field survey found that farmers have knowledge of indigenous trees which support agroforestry as they allow certain tree species to naturally grow on their farms and tend them for various benefits such as soil fertility improvement, fuelwood production, water conservation, and timber production. Gliricidia was observed to be planted by farmers to provide shade for cocoa seedlings at the initial stage of growth either in the nursery or farm. Farmers were particularly concerned about the shade that some trees provide on their farms. This is because most farmers in the area are cocoa farmers and have the perception that shade causes cocoa pods to rot.

5.1.3 Socio-Economic Factors that can influence Agroforestry Adoption in the District.

The major socio-economic factors identified by the farmers that affect their decision to adopt agroforestry technologies include land tenure, risk and uncertainty, and inadequate education on agroforestry. Land tenure has generally affected the farmers who are tenants since it was discovered that the tenants do not have rights to own land in the study area. Risk and uncertainty were also identified as farmers have fears that compensation may not be given in case of failure in the practice of agroforestry from the Government or Non-Governmental organisations who introduce the technology to them. Finally to conclude, it must be emphasised that the successful promotion of agroforestry as a solution to the various landuse problems in the district would depend on secure land rights and adequate education in the adoption of agroforestry technologies.

5.2 Recommendations

- Adequate education must be given to farmers to promote adoption of agroforestry technologies in the district since it was found that some farmers (35.8%) have no knowledge on agroforestry and as a result have no interest in the practice.
- Secure land rights when enforced would enhance adoption of agroforestry technologies. Furthermore, educating landlords and tenants about land conservation and promoting tree planting would enhance the practice of agroforestry in the district.
- There must be inclusion of farmers' knowledge in the design of agroforestry interventions in other to ensure effective solutions to their various landuse problems.
- Local stakeholders such as the chiefs and the Government must implement some policies that would offer females opportunity to make their own decisions to practice agroforestry since they play a major role in the promotion of agroforestry.

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APPENDIX

Research Questionnaire

A. Personal and Household Characteristics

1.1 Gender: Male ( )   Female ( )

1.2 Age: 1 - 17yrs ( ) 18-24 ( ) 25-34 ( ) 35-44 ( ) 45-54 ( ) 55-64 ( ) Above 64 ( )

1.3 Level of education: Non formal education ( ) Primary ( ) J.H.S ( ) S.H.S ( ) Vocation ( ) Tertiary( )   Other (specify)……………………………………………………………………..

1.4 Religion: Christian ( ) Islamic ( ) Traditional ( ) Others (specify)…………………………

1.5 What is your main occupation? Farming ( ) Public/Civil servant ( ) Trading ( ) Artisan ( ) Other (specify)……………………………………………………………………………………...

1.6 What is your secondary occupation? Farming ( ) Public/Civil servant ( ) Trading ( ) Artisan ( ) Other (specify)……………………………………………………………………....

1.7(a) Do you own land? Yes ( )/No ( )

(b) How did you obtain your farm land? Family land ( ) Purchase ( ) Freehold ( ) Lease ( ) Others (specify) ( )……………………………………………………………………………………

1.8(a) Did you have any problems with land acquisition? Yes ( )/No ( )

(b) What are these problems?..

B. Farming Related Land-use Systems

2.1 How many farms do you have? ………………………………………………………..............

2.2 Kindly provide the following information.

Farm (s)	Size (Acres)
1.	1 - 2
2.	3 - 4
3.	5 - 6

4.	7 - 8
5.	> 8

2.3 Which of the following source of labour do you use on your farm?

Family ( ) Hired ( ) Communal ( ) Self ( )

2.4 What are the major problems you encounter on your farm?..

C. Knowledge on Trees

3.1 Do you have trees on your land? Yes ( )/No ( )

3.2 What type of trees did you plant? ....

3.3 What type of trees generated naturally? …………………………………………………...

3.4 Kindly provide the following information.

Type of Trees	Desirable Characteristics	Undesirable Characteristics

D. Animal Rearing

4.1 What type of animals do you rear? ....

4.2 What is the purpose of rearing? Domestic ( ) commercial ( ) Other (specify)…………..

4.3 How do you feed your animals? Fodder ( ) Grazing ( ) Other (specify)………………….

4.4 What major problem(s) do you encounter with your animal rearing?.......................................

E. Farmers Knowledge on Agroforestry

5.1 Have you heard about agroforestry? Yes ( )/No ( )

5.2 Are you practicing it? Yes ( )/No ( )

5.3 Why are you practicing agroforestry?...

5.4 Which of the following agroforestry technology(s) do you practice?

Home garden ( )   Taungya system ( )   Woodlot establishment ( )   Fodder banks ( )

Hedgerow intercropping ( )   Other (specify)…………………………………………………

5.5 Which of the following needs of your household does/do the technology(s) satisfy?

Food ( ) Cash ( ) Fuelwood ( ) Fodder ( ) Poles ( ) Mulch ( ) Timber ( )……………...

5.6 Why are you not practicing agroforestry?..

5.7 Do tenant farming affect your decision to adopt agroforestry technology? Yes ( )/No ( )

Reason………………………………………………………………………………………