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

LAND USE ANALYSIS FOR AGROFORESTRY INTERVENTIONS IN THE ASUNAFO NORTH DISTRICT OF THE BRONG AHAFO REGION, GHANA

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By

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DECLARATION

I hereby declare that this submission is my own work towards MSc. Degree, and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT

Land is an important asset especially in tropical African countries including Ghana where majority of the people are small-scale farmers. For many years, land uses have been dictated by livelihood orientations. The study aimed at identifying and analyzingexisting land use systems for agroforestry development intervention in the Asunafo North District in the Brong Ahafo region of Ghana. The study describes socio-economic, environmental features and land use systems in the district; diagnoses major production constraints of the major land use systems, and identifies research needs for the development of AGF interventions.This study employed Micro Diagnosis and Design methodology developed by ICRAF to collect data.The data of the study came from household survey with randomly selected 112 farmersin eight communities. Results showed that majority of respondentswere natives (63.4%)whiles 36.6% were migrant farmers.The principal occupations were farming (76.8%), trading (7.1%), artisan (7.1%) and public service (9.0%). Major source of energy used was fuelwood (60.2%), charcoal (23.2%) and LPG (16.6%). Most farmers kept multiple farmlands with different crop types (Annuals, perennials, tree crops, and intercropping), combinations (pure stand and mixed stand) and land sizes; predominantly less than 5 acres for annuals and perennials and greater than 10 acres for tree crops. Predominant crops included oil palm, cocoa, citrus, yam, plantain and tomatoes, in pure stands and different combinations.Most respondents (79.5%) lacked technical knowledge on tree management. All respondents practiced fallows ranging from 1 – 6 years. Livestock, including chicken, guinea fowl, goats, sheep and cattlewere keptunder semi-intensive systems.Theconcludedthat the major problems confronting the district are lack of cash, scarcity of land, access to good and improved Crop varieties, inadequate rainfall, lack of storage, poor crop varieties, insect and pest infestation, soil erosion and credit facilities. Findings of the study suggest that the introduced agroforestry intervention can improve the economic status of farmers and ecological stability of the area only if establishment costs are subsidized and land tenure problems are solved.

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LIST OF ACRONYMS

ACRONYM	INTERPRETATION
ADRA	Adventist Development and Relief Agency
D & D	Diagnosis and Design
DAMTDP	District Assembly Medium Term Development Plan
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FAO	Food and Agriculture Organization
GSS	Ghana Statistical Service
GTZ	Gesellschaftfürnternationale
ICRAF	International Centre for Research in Agroforestry
IDRC	International Development Research Centre
MoE	Ministry of Education
MoFA	Ministry of Food and Agriculture
UNICEF	United Nation Children's' Emergency Fund

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CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Land is the most important asset especially in tropical African countries including Ghana where majority of the people are small-scale farmers. For many years, land uses have been dictated by livelihood orientations. Several land use types have evolved with civilization and have come to stay. Man's continuous livelihood is to a very large extent supported by the environment in which he finds himself. Civilization thrives on the environmental subsystems in order to achieve development. It could be emphasized that, the most relevant livelihood on earth has been agriculture since time immemorial (MoFA, 2010). Agriculture is the most important livelihood in Ghana and Africa as a whole. About 60% of Ghanaians depend on agriculture as a livelihood (MoFA, 2010).

In the past, when population density was low and land was in abundance, shifting cultivation and bush fallow were practiced and these were able to sustain soil fertility and yields by ensuring soil regeneration before usage (FAO, 1982). This was due to the lands' ability to recycle and build-up mineral nutrients as a result of long fallow periods. The main reason why shifting cultivation was widely practiced was to allow the regeneration of soil fertility and this was possible due to abundance of land as a result of low human population.

World population is now estimated to be about 7.042 billion with a growth rate of above 1.8% per annum in the 1950s, 1960s and 1970s (Jean-Noël, 1980). The trend is expected to continue into the future (World Population Prospects, 2008; US Census Bureau, 2012). Africa is said to be the second most populated continent after Asia, with about 1 billion people constituting 15.0% of the world's population (World Population Prospects, 2010). World Bank (2012) reported that global food crisis is on the increase and more than 17million people are facing starvation in West Africa's Sahel region. Ghana's population has not been an exception. Ghana Statistical Service (2011) reported that the country has seen tremendous increment ever since, with a population growth rate of 3% per annum. The population of Ghana increased from 8 million in 1970s to over 24 million in the year 2010 (Ghana Statistical Service, 2011). The implication is that feeding the ever-growing population would pose major challenges to the country. Most of Ghanaian farmers rely on old-age farming system such as shifting cultivation which faces competition with land acquisition. Consequently, high population has led to land hunger, land scarcity, land fragmentation, low yields and deforestation (Ghana Statistical Service, 2011). The high demand for food and land for the rapidly growing Ghanaian population has emphasized the need to improve productivity of land through sustainable agriculture.

Agriculture is the backbone of the Ghanaian economy and subsequently, the rural economies in the country. The major farming system in many districts in Ghana is mixed cropping, which is about 81%, followed by plantation farming (15%) and mono cropping, (4%). Most of the farmers use traditional methods of farming (95%) while only 5% use both traditional methods and modern technologies (MoFA, 2010). The dominance of traditional farming does not only lead to low productivity, but also poses serious consequences on the natural environment which may inhibit the proper functioning of most environmental sub-systems. The practice of continuous cropping with long cultivation cycles and short fallows lead to land degradation, low crop yields and low forage production (MoFA, 2010). Research has shown that, the solution to this problem might be the introduction of sustainable land use system, which would be to increase food production on one hand and also to guarantee sustained cultivation on a unit of land without the development of the negative effects of environmental degradation (Agyeman and Brookman-Amissah, 1987).

Agriculture is the mainstay of the Asunafo North District economy. It employs about 64% of the economical active labor force. Nearly every household in the district is engaged in farming or agriculturally related activity. Notwithstanding the importance of agriculture in the Asunafo North District, much of the agricultural potentials in the district remain unutilized due to the type of farming system employed there. For instance, out of a total of 12,261 hectares of arable land, only 3,167.6 hectares is currently utilized, a significant portion dedicated to the fallow system (GSS, 2011), and this cannot sustain such an ever booming population.

It is generally accepted that Agroforestry (AGF) technologies can help address issues of land degradation, loss of soil fertility and the scarcity of land for separate agricultural and forestry establishments (Nair, 1998; Young, 1997; Scherr, 1991). There is the need, therefore to introduce agroforestry techniques that are relevant to the needs of the farmers in the Asunafo North District to ensure adoption. Location-specific problems require location-specific technologies. However, in order to introduce the appropriate Agroforestry technologies that would be feasible for the district, there is the need to understand existing land use constraints, problems and the role of trees, as well as the socio-economic background characterizing the livelihoods of the locality in context. There is also need to review problems associated with selected agroforestry technologies for solving particular problems. Hence, the study seeks to analyze Land Use Systems, ascertain the constraint and needs of the farmers, and design appropriate agroforestry interventions that will be appropriate to the situations under investigation and packaged in local context in the Asunafo North District.

1.2 PROBLEM STATEMENT

Majority of population in sub-Sahara Africa, are saddled with agricultural problems due to the dynamics of increased population, limited resources and the resultant scramble for resources and unsustainable agricultural practices. These result in scarcity of land, reduced fallow periods, declining soil fertility, environmental degradation, and low level of mechanization which eventually affects yields, energy demands (fuel wood) and these have resulted in rampant rural poverty (UNICEF, 1999). According to the Ghana Statistical Services (2008), these unfortunate conditions have been identified to be associated with rapid population growth and concomitant food demand, farming practices and methods. For instance, the Asunafo North District is said to have a population growth rate of 2.8% per annum. Thus, as food demand increases, rural communities meet this demand by adopting appropriate management interventions that would put at par supply and demand.

However, this expectation is not evident in the Asunafo North District and many rural communities that are regarded as the “food basket” of Ghana’s economy.
Therefore, demand for food satisfaction remains a major challenge to the existing traditional agricultural land use systems.

As with the majority of rural folks, farmers in the Asunafo North District are mainly subsistence in nature: the main objective being to produce enough food for their household. However, even household demands have not been met by farm supplies on many occasions, usually due to the increased population pressure on the land, leading to reduced fallow periods. Consequently, farmers resort to farming practices that create environmental degradation such as soil erosion, and destruction of vegetation by indiscriminate bush burning, land clearing and overgrazing (Matthews and Tunstall, 1991; World Bank, 1991; Sharma, 1992). Therefore, there is the need to develop and implement interventions that will address these multiple problems, bearing in mind the limitation of land as a factor.

1.3 JUSTIFICATION

Agroforestry has demonstrated the capability of solving biophysical and socio-economic problems faced by small scale farmers. Thus, it has been recognized to have the potential of addressing a wide range of community needs including; the potential to mitigate deforestation because it addresses the issue of tree planting; ability to combat land depletion due to the potential for soil conservation; contribution to poverty alleviation by conserving soil fertility and increasing yield; maximizing land output (ICRAF, 1993).

For such a system to function properly, it becomes requisite to introduce sustainable land use practices that would be appropriate in mitigating the challenges above. Such a technology must be able to conform to the local context and suitable for adoption in the locality under investigation. To be able to design such an intervention it is very relevant that one understands the local context (socio-eco-cultural and political dimensions) within which such interventions would be implemented.

1.4 MAIN AND SPECIFIC OBJECTIVE

The aim of the study is to identify and analyze existing land use systems for agroforestry development intervention in Asunafo North District (Brong Ahafo region).

The specific objectives are to:

(a) Describe the socio-economic characteristics of the Asunafo North District

(b) Describe the most important agricultural production and land use systems in the study areas selected within the District

(c) Diagnose the major production constraints of the major land use systems

(d) Identify research needs for the development and recommendation of Agroforestry interventions

1.5 RESEARCH QUESTIONS

It is against these specific objectives that the study addressed the following research questions:

1. What are the existing physical and socio-economic factors that influence the choice of agricultural methods used?
2. What are the most dominant land use systems in the District?

3. What constraints impede effective operation of the current land-use systems?
4. Does willingness to abandon age-old agricultural methods for new adoptions exist?
5. What conditions would be requisite to ensure adoption of agroforestry interventions?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 WHAT IS AGROFORESTRY

Agroforestry is a collective name for land use systems where woody perennials like trees, shrubs, palms and bamboos are deliberately used on the same land management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequences (AFTA, 2000; Nair, 1993; Young, 1989; Lundgren, 1987). AFTA (2000) emphasized that in agroforestry systems, there are both ecological and economical interactions between the different components. This definition implies that: Agroforestry normally involves two or more species of plants (or plants and animals) at least one of which is a woody perennial; An agroforestry system always has two or more outputs; The cycle of an agroforestry system is always more than one year and; even the simplest agroforestry system is more complex, ecologically (structurally and functionally) and economically than a monocropping system (Branca *et al*., 2011).

Traditionally, agroforestry has been practiced by farmers for a long time in which trees and shrubs are allowed to grow on cropland either to provide shade or fuel wood. In sequential agroforestry such as shifting cultivation practice trees and shrubs are used in soil fertility regeneration during fallow periods. However, the modern practice of incorporating fast growing, mainly leguminous trees into farming system to provide fodder, fuel wood, to check erosion, improve soil fertility through litter fall and nitrogen fixation is of recent development.

2.1.2 History of Agroforestry

The need for Agroforestry became apparent in the 1970's when increasing erratic rainfalls, combined with rising population, and growing need for food and fuel wood, began to cause various damage to previously fertile land. King (1987) reported that in Europe, until the

Middle Ages, it was the general custom to clear-fell degraded forest, burn the slash and cultivate food crops for varying periods on the cleared area. In addition plant trees alongside agricultural crops. The situation, however, was different in Africa (Forde, 1937), where mixed cropping were practiced under scattered trees. Meanwhile, most part of the tropics suffered from shifting cultivation, which inculcated fallowing for soil fertility maintenance, though population was booming in the late 70's and early 80's. This implies that the traditional shifting cultivation with it low productivity and extensive use of land was no longer feasible or environmentally sound. In order to keep land under cultivation in many areas, the interval between fallow periods was being drastically shortened, and it became impossible to produce enough food without compromising the fertility and stability of the fragile tropical soils (Kwesiga *et al*., 1999)

Therefore, in 1960's and 70's saw increasing concern for forested land being under severe pressure. This concern was thought to be necessitated by commercial exploitation (especially of timber resources), fuelwood need, and traditional method of farming using shifting cultivation. From Nair (1993), the most significant single initiative that contributed to the development of agroforestry came from the International Development Research Center (IDRC) in Canada. Consequently, IDRC engaged John Bene, a retired forester in 1975, to study the problem confronting the sector and come out with appropriate recommendations. He assembled a team of experts from several continents to study the problem. Subsequently, Bene published his report in 1977, titled "Tree, Food and People; Land management in the tropics". He recommended the establishment of a council to deal with the problems of trees in farming systems. According to Nair (1993), the establishment of the International Council for Research into Agroforestry (ICRAF) in 1977 was necessitated by the lack of information on which agroforestry systems might be effectively based and the fact that the available research was being conducted in a haphazard and unplanned way. The term "Agroforestry" was coined, ICRAF was established and the ancient practice of agroforestry was institutionalized for the first time (Nair, 1993). Bene *et al.* (1977) emphasized that the war against hunger, inadequate shelter and environmental degradation can best be accomplished by the creation of an internationally financed council for research in agroforestry, to administer a comprehensive program leading to better land-use in the tropics.

2.1.1 Attributes of agroforestry

According to Nair (1993), agroforestry has several attribute: Productivity - Most, if not all, agroforestry systems aim to maintain or increase production (of preferred commodities) as well as productivity (of the land). Thus agroforestry can improve productivity in many different ways. These include; increased output of tree products, improved yields of associated crops, reduction of cropping system inputs, and increasing labor efficiency; Sustainability - by conserving the production potential of the resource base, mainly through the beneficial effects of woody perennials on soils. Thus agroforestry can achieve and indefinitely maintain conservation and fertility goals; Adoptability - the word "adopt" here means "accept" and it may be distinguished from another commonly used word "adapt" which implies "modify" or "change". The fact that agroforestry is a relatively new word for an old set of practices means that, in some cases, agroforestry has already been accepted by the farming community. However, the implication here is that improved new agroforestry technologies that are introduced into new areas should also conform to local farming practice (Nair, 1989).

2.1.3 The need for agroforestry

The need for agroforestry cannot be over emphasized, especially with high population growth rate in Ghana (3% per annum) with concomitant demand for food, fodder, fuelwood and other forest products. Accordingly, Eckolms (1975) report raised the alarm and referred to it as the "other energy crisis". The report estimated that in the early to mid-1970's "no less than 1.5 billion people in developing countries derived at least 90% of their energy requirements from wood and charcoal, and another billion people meet at least 50% of their energy needs this way; this essential resource is seriously threatened; and the developing world is facing a critical firewood shortage as serious as the petroleum crisis". This concern, further strengthened and supported by views and estimates of other renowned authorities, inspired several detailed studies and comprehensive reports such as the much acclaimed publications on fuelwood crop (NAS, 1980). Despite the lack of agreement on the specifics of the problem, it was universally accepted that fuelwood shortage is a very serious problem with global effect. Several measures were recommended to address the problems of fuelwood, low soil fertility , the most significant being the promotion of tree-planting programs initiated in the late 1970s to early 1980s especially in the dry tropics which included fuelwood production as one of the (if not the) major objectives (Kerkhof, 1990). Since several of these programs involved tree planting by farmers on their own farms or communally or publicly owned lands, they were generally known as agroforestry (for fuelwood production). Agroforestry as a land–use system sequentially combines the production of food, livestock and forest products on the same land unit to ensure sustainability. Thus, agroforestry offers great potential to negotiate for food production, livestock rearing and forestry interests (Rocheleau *et al.*, 1988).

2.1.4 Classification of Agroforestry systems

Nair (1993) emphasized that in order to understand and evaluate existing agroforestry systems and to develop action plans for their improvement it is expedient to classify the various forms of the system according to some common criteria (Table 2.1). Agroforestry systems have been classified based on the following (Nair, 1993);

1. Structural basis – refers to the composition of the system and spatial arrangement of the wood components.
2. Functional basis – the major function or role of the system, emphasis being laid on the woody components
3. Socioeconomic basis – level of input of management or intensity or scale of management and commercial dimensions.
4. Ecological basis – environmental significance and ecological compatibility of the system, assuming that certain systems are better suited for certain environmental conditions.

Table 2.1 Classification of Agroforestry systems

Categorization of systems based on their Grouping of systems (according to structure and function their spread and management)

Structure	Function	Agro-ecological	Socio-
(nature and arrangement of components, woody ones)	of component, (role and/or input level	environmental adaptability	economic especially and especially woody management ones

Nature of components	Arrangements of components			
Agrisilviculture (crops and trees incl. shrubs/trees and trees)	*In space (spatial)* Mixed dense (e.g. home garden) Mixed sparse (e.g. most systems of trees in pastures)	*Productive function* Food Fodder	*Systems in/for* Lowland humid tropics Highland humid tropics (above 1, 200 m a.s.l., Malaysia)	*Based on level of technology input* Low input (marginal)
Silvopastoral (pasture animals and trees)	Strip (width of tree to be more than one tree) Boundary (trees on edges of plots/fields)	Fuelwood Other woods Other products	Lowland sub humid tropics (e.g. savanna zone of Africa, Cerrado of South America)	Medium input High input
Agrosilvopastoral (crops, pasture and trees)	*In time* (temporal) Coincident Concomitant Overlapping Sequential (separate) Interpolated	*Protective function* Windbreak Shelterbelt Soil conservation Moisture conservation Soil improvement Shade	Highland sub humid tropics (tropical highlands) (e.g. in Kenya, Ethiopia)	*Based on cost/benefit relations* Commercial Intermediate Subsistence
Others (multipurpose tree lots, apiculture with trees, aquaculture with trees, etc.)				

Source: Nair (1985) in Nair (1993)

2.1.5 Conditions for establishing agroforestry systems

According to Agyeman (1991), there are certain conditions that must prevail for the successful introduction and adoption of new and innovative systems such as Agroforestry. The local resources should be considered before identifying necessity to extend assistance for the system. The community needs such as food, shelter, energy and water must also be considered. A technology is said to be useful when it fully serves community needs. For sustainability under the stress of increasing population pressure, the envisaged production

systems should be able to conserve the environment. The role of various groups in the community must be recognized. Agyeman (1991) for example if males, females and children have specific roles in the society, the introduction of a technology that undermines the traditional structure and form of organization will
definitely fail.

2.1.6 Constraints in adopting agroforestry systems

Generally, there are some technical problems that may be considered in proposing agroforestry technologies. Keil *et al.*, (2005) and Ajayi *et al.*, (2007) reported recent research has investigated the role of various cultural, environmental, political, and socioeconomic factors that affect the adoption of agroforestry technologies with the aim of understanding the biophysical and socio-economic factors that influence farmer adoption. 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), reveal that several factors are most likely to affect adoption of agroforestry technologies need to be addressed by research.

2.2 AGROFORESTRY AS A TOOL FOR SOCIO-ECONOMIC DEVELOPMENT IN RURAL COMMUNITIES

Agroforestry has the potential to improve the use of agricultural and other lands, thereby contributing to economic growth through increased and more sustainable food and wood production. Most of the rural people throughout the continent are living through a period of rapid and dramatic changes in land use patterns, economic conditions and the natural environment and this is where famine and drought have become increasingly common. Agroforestry practices have been advocated to be the key to sustainable land use management. This land use system is most appropriate for the economic and social development of rural communities.

Agroforestry may help in soil conservation and microclimate amelioration, soil nitrogen fixation and provision of shade. E.g. working in an open field in a hot weather is not an easy task. Therefore, there is the need for shade in and around fields in semi-arid savannah zones. Hence the shade provision alone, which may be associated with agroforestry has socio-economic benefits as it improve the working conditions of the farmer in the dry areas and raised their productivity (Steppler and Nair, 1987). Other contribution to rural development is its role in the enhancement of soil productivity and the sustainability of the rural agricultural production systems.

2.3 AGROFORESTRY AND SUSTAINABLE LAND USE

A land use system is described to be a distinctive combination of crops, livestock, tree and/or the integration of multiple production systems on a given area of land, albeit a farm, region, or watershed. Subsequently, it has been emphasized that land use systems are determined by an interacting combination or ecological, physical, political, socioeconomic and technological realities and potentials, facing the land users. Although there is usually a fairly large number of unique land use systems in any geographical area, analyses and understanding of their management and performance reveal recurring, common or typical patterns of land use in the area, and these are pertinent to any intervention on livelihoods of the local people. An understanding of these patterns is relevant to the implementation of any agroforestry intervention.

Sustainability is the ability of the agricultural system to maintain a certain well-defined level of performance (output) overtime, and if required, to enhance that output without damaging the essential ecological integrity of the system (Jodha, 1990). Sustainable agriculture and rural development are defined as the management and conservation of the natural resource base and the orientation of technological and institutional change, in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development conserves land, water, and plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable (FAO, 1995). However, this definition has been simplified as sustainable land use is that which meets the needs for production of present land users, while conserving for future generations the basic resources on which that production depends.

As noted by Barbier (1989), a sustainable resource use therefore requires that the resources be utilized at rates less than or equal to the natural or managed rates of regeneration; The generation of waste at rates less than or equal to the rates at which they can be absorbed by the assimilative capacity of the environment; The optimization of the efficiency with which exhaustible resources are used, as determined by the rate at which renewable resources can be substituted for exhaustible and by technological progress.

Sustainability can therefore be considered in four aspects, which include;

Production: This is the total outputs of the system per unit area over time.

- Efficiency: This is the ratio of conversion of various inputs into outputs.
- Stability: It is the degree of fluctuation around the production trend, and
- Resilience: The speed of restoration of output trends after a major disturbance.

Although sustainability means different things to different people, based on ecological principles, sustainable agricultural systems are those whose productivity can continue, indefinitely without undue degradation of other ecosystems (Dover and Talbot, 1987).

2.4 AGROFORESTRY AND ENVIRONMENTAL DEGRADATION

The greed for more has put pressure on natural resource in many communities and countries. Several human activities including the mining, agriculture, and fishing have resulted in degradation of our natural resources. Generally, logging, mining and agriculture have triggered large scale deforestation. Currently, forests cover about 4 billion hectares, about 31 percent of the earth's land surface (FAO, 2010). Over a period of 5000 years, the cumulative loss of forest land worldwide is estimated at 1.8 billion hectares – an average net loss of 360 000 hectares per year (Williams, 2002). According to FAO (2010) population growth and the burgeoning demand for food, fibre and fuel have accelerated the pace of forest clearance, and the average annual net loss of forest has reached about 5.2 million hectares in the past ten years.

Within a century, Ghana has lost a total forest cover from 8.2 million hectares to 1.6 million hectares with only 19.5% remaining. This coincides with the District Forest

Service Divisions report that for instance, the Bonkoni forest reserved was about 2010kmabout seventy years ago and has reduced to its current size of 108.564km. This happens because the rapidly growing population is demanding increasing quantities of food, fibre and fuel from the land. In addition, increasing quantities of new land being brought into cultivation are of poor quality and less productive than land previously being used in production, thereby exacerbating the problems of soil degradation.

In addition, environmental sound traditional agricultural practices attuned to low population densities have not been able to adjust rapidly enough to the decreasing land per person ratios, resulting in practices that are environmentally damaging (FAO, 1986). Usually many of the technologies that have been introduced to date tend to exacerbate the trend towards erosion and unsustainability by dominating the environment through the use of machinery, chemicals, irrigation and other capital-intensive inputs (Conway, 1987; Francis and Hilderbrand, 1989). To prevent unsustainability and hence prevent erosion, Francis and Hilderbrand (1989) suggested that technologies must be compatible with the environment and such environmentally sound technologies according to them are found in agroforestry systems.

2.5 LAND USE SYSTEMS

A land use system is a population subgroup in which the features and the constraints of the farming systems are sufficiently homogenous to yield similar results if a given agroforestry technology is introduced into those farming systems (Raintree, 1987). It is further expounded as consisting of distinctive combination of soils, crops, livestock, trees and/or other production systems which occupy a given unit of land where specific outputs are desired and obtained by a given unit (Raintree, 1987). Land use systems in many nations are influenced primarily by the means of land acquisition and market dynamics.

According to Environmental Protection Agency (EPA, 1996/97) there are four main categories of land holding in the country. These are: State lands, which are lands, acquired by government and are held in trust for the people of Ghana; Vested lands, which are lands, vested in the state in trust for the original owners under the Administration of Lands Act 1962 (Act 123); Stool/family lands which are group-owned lands governed by customary tenure systems and held by stool/family heads in trust for all members of the group and private lands held in varying degrees of quantum by individuals, corporate bodies and , institutions among others.

2.5.1 Land Tenure and Related Issues

A serious factor affecting the success of agroforestry is the land tenure system. Mercer (2004), Pattanayak *et al.*, (2003) and Evans (1992) pointed out that tenure is enormously complex and associated problems are some of the most difficult obstacles to development in the tropics. Land, however, remote or apparently uninhabited belongs to someone or some clan or village. This land may not be put into use and every piece of it is claimed and argued over. When land use charge is suggested. Boundaries of family land are often undefined and not clearly demarcated resulting in many land disputes. Moreover, access to customary land requires the consent of majority of members of the family. Evans (1992) pointed out that the patterns of technology adoption would be shaped by the structure of opportunities and constraints presented by the rules of tenure. For instance Caveness and Kurts (1993) found out that land ownership was one of the predominant factors affecting the adoption of agroforestry technologies. Nonetheless, Raintree (1991) stated that land

without security makes adoption of the tree planting innovation out of question. The need for the flexible system of land tenure together with its security would provide platform for agroforestry adoption, in the vast agricultural lands of tropical
Africa (Mercer, 2004).

The land tenure system prevents the use of farmland as collateral for credit and also it discourages the adoption of innovations and individual initiative in farming. Many government innervations at tenure reformation have given rise to clashes between landowners and tenants (Asenso-Okyerre *et al.*, 1993). The most favorable position for tree planting is where land is privately owned and individuals hold a secure title to the holdings they farm (Meinzen-Dick, 2006; Mercer, 2004; Pattanayak *et al*., 2003; Foley and Bernard, 1984). Hoskins (1987) pointed out that in most traditional Africa cultures, where land is owned on communal or semi-communal basis, individuals do not have permanent possession of land but are granted rights by the village leaders or family heads to farm particular patches of land for a certain period. In some countries such as Burkina Faso, the land is reallocated every few years. Under these circumstances there is no incentive for any farmer to invest efforts in the long term enterprise of tree planting.

In Ghana, agroforestry is an important land use 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 land use (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 land use strategy to connect patches of the remaining forest fragments through conservation corridors in the southwestern parts of the country (Ofori *et al.*, 1990).

In all these cases, even though the intention is to preserve forest cover and protect trees against indiscriminate cutting, the effect is rather counter-productive when efforts are being made to engage farmers in tree growing. The problems of tree tenure added to the problem of long production period between investment and harvest of products makes forest based projects unattractive to rural communities or individuals as compared to agricultural crops, the benefits of which can be reaped in a few months.

2.5.2 Markets

Markets are a vital tool in any production system. Hence, according to Hedge (1990), the required criteria for farmers to grow any new tree species would depend among others the assured demand for the produce and ready market outlets, minimum support undue at which tree growing is profitable, and generation of cash surplus as the most meaningful incentive for most farmers. It is only with a coordinated effort to market the forestry produce at a remunerative price that afforestation programs can be implemented successfully with the active participation of the rural folks.

2.5.3 Farming Systems

Farming systems are particular arrangement of farming enterprises such as cropping, livestock keeping, processing farm products that are managed in response to the physical, biological and socio-economic environment and in accordance with the farmer's goals, preferences and resources (Shaner *et al.*, 1982). According to Nukunya, (1971) and Benneh (1973), the farming systems in Ghana may be divided into four namely; the bush fallow in land rotation system and the permanent system such as oil palm, cocoa, citrus culture in the humid zone and shea butter in the savannah zone, compound farming specialized horticulture (e.g. Pineapples and shallots in Anloga and large scale arable farming (e.g. rice, cotton and tobacco).

The dominant farming systems in the Brong-Ahafo Region of Ghana can be described generally as subsistence farming with minimum external input with an average field size of 1.2 hectares. Report by (Albert 1996) conforms to the Asunafo North District Assembly's Report (2007) that the farming system in the District is largely carried out on small scale basis (subsistence). Additionally, the average acreage cultivated ranges between 4 – 6 acres for all crops. According to the report, much of the agricultural potentials in the District remain unutilized, for instance, out of a total of 12,261 hectares of arable land, only 3,167.6 hectares is currently utilized. Again, the 1984 census of agriculture of Ghana revealed that there were about 139,900 land holders with 253,800 plots and with an average of 1.8 plots per holder. The average size of holding lies at about 3.5 hectares. More than 60% of the holders farm were less than 2.5 hectares. This indicates the majority of agricultural production in this country comes from small scale farmers. Two main land use types, namely the compound and bush farming systems prevail in the Brong-Ahafo region (Rudat *et al.*, 1993). Traditionally there are clear-cut patterns of land use and cropping in Ahafo area at the region and for that matter Asunafo North District (Dunhauser *et al.*, 1992).

2.5.4 Cropping Systems

Generally, five major cropping systems can be identified. These include plantaincocoyam based, cassava-maize based, oil palm based, vegetable based and groundnut pepper based cropping systems (Diehl *et al.*, 1986). The cropping system involves the extensive practice of mixed–cropping. Crop grown in commercial quantities in the district include plantain, maize, cassava, oil palm, groundnut and vegetables. The most common mixtures in the mixed cropping patterns are plantain/maize/cassava-cocoyam, maize groundnut, vegetables and oil palm yam (Ibrahim, 1984). These crops are on average more than 90% of the cases cultivated in mixtures (Steiner, 1982).

2.5.5 Livestock Systems

Livestock are an integral part of the agricultural systems of Africa and especially important to the poor who derive a larger proportion of their meagre incomes from livestock than do the wealthier (Delgado *et al*., 1999).Livestock production is not common in the District; however, there are few livestock farmers in the rearing of pigs, sheep and goat with few poultry farmers. Unlike crop production, livestock production is quite limited to some households. Livestock rearing requires so much time and attention. Poultry production is mostly about chicken and can be found in most households in the district. Chicken is widely reared than livestock because it is relatively easy raising them.

Livestock productions in the district are affected by inadequate agric. extension services.

2.5.6 Shifting Cultivation

Shifting cultivation is a traditional agricultural land use in especially the tropics, practiced by local communities and accounts for the major proportion of agricultural land use in the communities (Greenland, 1974). Hauck (1974) defines shifting cultivation as an agricultural system in which temporary clearings are cropped for fewer years than they are allowed to remain fallow. This form of farming is no longer common, because rapid population growth has increased food demand tremendously to the level that fallow periods had to be reduced and the forestry sector had to give way gradually to agricultural needs.

This has led to unprecedented deforestation, lowering of soil productivity, loss of biodiversity, increased soil erosion and weed infestation, and consequently lowered crop yield (Okigbo, 1984a). Unfortunately, the continued relying on expanding cultivated areas has not been able to contribute substantially to resolving the food crisis, because not all the available land is equally productive (Okigbo, 1984b). It is not even economical on the long run. Utilization levels of land and water resources are close to maximum potentials and future growth will be possible only through better management of a fixed resource base (Banuri and Holmberg, 1992).

Intensive rather than extensive use would be the way out of the log jam (Fagbemi, 1997). In order to achieve the twin goal of satisfying increasing demands for food as well as retain the biologically beneficial effects of shifting cultivation, many workers have in the last two decades advocated the development of land use systems based on age-old practices of intentionally mixing trees in crop animal production fields (Nwoboshi, 1980).

Agroforestry however, has been advocated as a means to reduce pressure on forest margins, in forest reserves and national parks. The principle is that, by providing timber, fuelwood, and other forest products on farms, the need for illegal cutting will be reduced. Schemes with this objective have been attempted in Kenya and Madagascar. For instance, in Sumatra, Indonesia, farmers who integrated rice production with tree, crops and home gardens exerted only minor extractive pressure on adjacent forest, compared with farmers with only one enterprise (ICRAF, 1995).

2.6 ADOPTION OF NEW TECHNOLOGIES BY FARMERS

Adoption is the decision to use a practice on a continued basis and personal satisfaction with it (Akubuilo *et al.,* 2007; Rogers, 1995). Spontaneous spread is the most dependable proof of acceptability of any improved technology and the adoption of any improved technology would depend on its benefits to the practitioners (Adams, 1982). Adoption is not a sudden event but a process. The adoption of a new practice takes time for some to accept. The final decision is usually the result of a series of influences operating through time. Also the process by which new ideas spread from one culture to another is referred to as the diffusion process. Therefore, the adoption of innovations of proven value provides the means of achieving sustained increases in farm productivity and income
(Adams, 1982).

2.6.1 Stages of Adoption of Innovative Technologies

Rural communities adopt new technologies or innovations at different rates. Some are more innovative than others. On the basis of the relative time taken by rural communities to adopt innovation, Rogers (2003) and Rogers and Shoemaker (1971) categories adopters into:

- Innovators (Awareness stage 2.5% of the population) - The individuals at this stage become aware of the technology or innovation but not yet motivated to probe further.
- Early adopters (13.5% of the population) - The individuals feels that the technology may be relevant to their needs, hence, actively seeks information on the subject.
- Early majority (34% of the population) - At this stage the individual attempts to evaluate the possible costs and benefits of adopting the innovation.

- Late majority (34% of the population) - Here, if the individual evaluation is favorably, he may decide to give the innovation a trial, by applying it on a small scale to determine its validity under the individual's condition.
- Laggards (16% of the population) – The farmer's experienced after the trial stage. The farmer decides to apply the innovation or not.

2.6.2 Factors that Militate against Willingness to Adopt Innovative Technologies

There are three main factors affecting willingness to adopt or reject a given technological innovations. These are situational, socio-economic and personal factors (Tawio *et al.*, 1989): The situation factors affecting adoption include, the size of the farm being operated, land tenure status of the farmer, sources of information and contact with extension agents and whether the farmer is a full time operator or has any subsidiary occupation: Although, economic profit is evidently an incentive to adopt agricultural innovation, social and cultural factors often act as barriers to change. Adams (1981) has generalized that adoption of technologies was much lower in traditional systems as compared to modern ones.

Family values, from point of view, are significantly related to the acceptance of innovation and Basu (1969) study revealed the existence of some kind of interpersonal relationship between matters of communication with one's family and the adoption of improved farm ideas: Finally, the personal factors influencing adoption include age, educational level and farming experience. The relationship between age and adoption of innovation has been studied by several researchers. Conflicting findings have been reported. According to Basu (1969) there is no relationship between age of the farmer and adoption. Ndoumbe (2004), Odera *et al*., (2000), Gockowski and Rogers (1962) emphasised that age was not related to innovations. Younger farmers tend to be physically stronger than older ones and thus they can adopt the innovation fast.

Education has also been identified to play a major role in the adoption process. The higher the farmer's educational level, the higher is his income as generalized by Wilson (1955). Bonsu (1969) also noted that in his study on the adoption of hand tractor that level of education was irrelevant because more farmers received the initial information by seeing and hearing about it than reading about it. Stoll-Kleemann and Oriordan (2002) of the opinion, that education does not influence adoption.

2.6.3 Factors Responsible for the Rejection of Innovative Technologies

According to Rogers (2003), for a technology to be readily accepted and adopted it must have easily grasped advantages, be compatible with local customs, not too complicated but easy to test and easy to observe. The rejection of modern farming is attributed to: Incompatibility of the new method with existing conditions; The high cost of the adoption of the practice; The failure of the practice to prove superior or effective; The anticipation of desirable consequences as a result of the adoption of practice; Ignorance about the practice; Lack of resources and skills (Rogers, 2003).

2.6.4 Perception of Farmers in the Adoption Process

In general, the attitudes, perceptions, aspirations, objectives, goals and interests of farmers greatly influence their behavior towards innovations. Many theoretical and research findings are emerging in favor of the problems of understanding of farmers behavior in technology development. Clayton (1985) for instance has argued that it is highly desirable for policy makers to have some view about farmers' behavior and farmers' response to economic and non-economic variables. Based on Clayton (1985) assertion, it could be deduced that without understanding farmer's views, agricultural planning and policies may meet government objectives but will have little or no sense at the farm level. He further points out that understanding the farmer requires awareness of the decisions and action and an insight into the objectives the farmer and his family seek to achieve.

2.6.4.1 Factors that affect farm level decisions

Clayton (1983) grouped the multiple objectives that affect farm level decision and consequently their behavior as: An adequate and assured family food supply; Income to purchase a required level of material needs; a certain degree of crudity reflecting farmer's circumstances and psychology; Observance of socio-cultural customs and obligations and; A satisfactory amount of leisure.

2.6.5 Positive Attributes of Innovative Technologies

Rogers (1962 and 2003) said innovations have five characteristics from the point of view of farmers which affect their rate of adoption. These are relative advantage, compatibility, complexity, trialbility and observability: Relative advantage is the degree to which the innovation is recognized as being better than the idea it is intended to replace and measured in terms of economic gains; Compatibility – is the degree to which the farmers perceived an innovation to be consistent with his values, Complexity – is the degree to which an innovation is understood and can be used by the farmer; Trialbility – is the extent to which the technology can be tried out by the farmer; Observability – is the degree to which results of an innovation can be perceived by the farmers.

2.7 THE AGROFORESTRY DIAGNOSIS AND DESIGN (D & D)

2.7.1 D& D Methodology

Diagnosis and Design (D & D) is a methodology for diagnosis of land management problems and design of agroforestry solutions. It was developed by ICRAF to assist agroforestry researchers and development field workers to plan and implement effective research and development projects. It is a discovery procedure for identifying the agroforestry – related needs and potentials of existing land use systems (Raintree, 1987). D & D principles are borrowed procedures from other methodologies used by research and development agencies and institutions (Raintree, 1987). The methodology is unique because it enables the user to describe and analyze the existing land use system, diagnose their constraints and causal factors and consequently design appropriate agroforestry technologies to alleviate those constraints. When these constraints are identified and alleviated, it would help to improve the land use systems performance for the benefit of rural households. Raintree (1987) emphasized that the Diagnosis and Design (D & D) is a systematic and objective methodology developed by ICRAF to initiate, monitor, and evaluate agroforestry programs. According to Huxley and Wood (1984) D & D plays an important role in all phases of agroforestry research programs.

2.7.2 Concepts and procedures of D & D

There is an adage in the medical profession that "diagnosis must precede treatment" Anyone concerned with problem solving applies this principle in one way or another. In the work of the automobile mechanic, the radio repairman, the forester, or the farmer, the ability to solve a problem begins with the ability to define what problem is. A clear statement of the problem is often all that is needed to suggest a solution. D & D is simply a systematic approach to the application of this principle in agroforestry. The basic procedures of D & D as depicted in the diagram below can be further divided into smaller steps as circumstance might warrant.

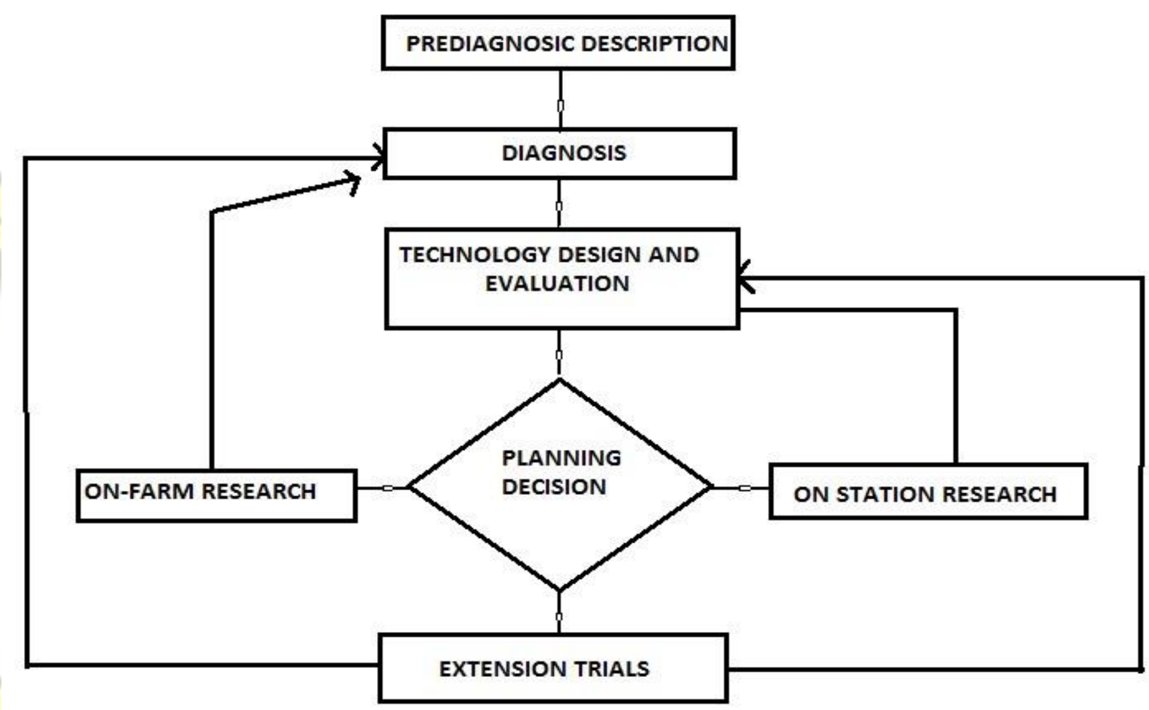

Fig. 2.1 Flowchart of iterative activities and feedback in D & D (source: Raintree, 1987)

The basic D & D process as outlined in the Fig. 2.1 is repeated throughout the life of the project that follows, so as to refine the original diagnosis and improve the technology design in the light of new information from On–farm research trials, more rigidly controlled on-station investigation and eventually trials in an expanded range of sites. The basic Procedures of the diagnosis and design (D&D) methodology (Stages of D&D) explained by Raintree (1987) are represented on Table 2.1 shown below.

Table 2.1: Basic Procedures of the Diagnosis and design (D&D) Methodology (Stages of D&D)

D&D STAGES	BASIC QUESTIONS TO ANSWER	KEY FACTORS TO CONSIDER	MODE OF INQUIRY
PREDIAGNOSTIC	Definition of the land use system and site selection (which system to focus on?) How does the system work? (how is it organized, how does it function to achieve its objective)	Distinctive combinations of resources, technology and land use objectives. Production objectives and strategies, arrangement of components.	Seeing and comparing the different land use systems. Analyzing and describing the system.
DIAGNOSTIC	How well does the system works? (What are its problems. limiting constraints, problem generating syndromes and intervention points?)	Problems in meeting system objectives (production shortfalls, sustainability problems) Casual factors, constraints and intervention points	Diagnostic interviews, direct field observation. Troubleshooting the problem subsystems.
DESIGN AND EVALUATION	How to improve the system? (What is needed to improve system performance)	Specification for problem solving or performance enhancing interventions.	Iterative design and evaluation of alternatives
PLANNING	What to do develop and disseminate the improved system?	Research and development needs extension needs.	Research design project planning
IMPLEMENTATION	How to adjust to new information?	Feedback from onstation research, onfarm trials and special studies.	Re-diagnosis and redesign in the light of new information.

2.7.3 Key Features of D & D

As discussed earlier, D & D is a methodology that has been developed specially for agroforestry applications, with emphasis on a comprehensive diagnosis of the problem, followed by design and implementation of appropriate interventions to solve the diagnosed problems. Its prominent features are:

- Flexibility: D & D is discovery procedure which can be adapted to fit the needs and resources of a wide variety of land users.
- Speed: D & D is an open-ended learning process. Since initial designs can almost always be improved, the D & D process need not end until further improvements are no longer necessary.

Finally, D & D is based on the premise that, by incorporating farmers into research and extension activities subsequent recommendation and interventions will be more readily adopted.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 STUDY AREA, LOCATION AND SIZE

The study area was Asunafo North District in the Brong-Ahafo Region of Ghana. The District lies within the geographical area of the Brong-Ahafo Region (Fig. 3.1) and was carved out of the then Asunafo District in 2004 by an Act of parliament through a legislative instrument and was inaugurated in August 2005 (Asunafo North District Medium Term Development Plan, 2007).

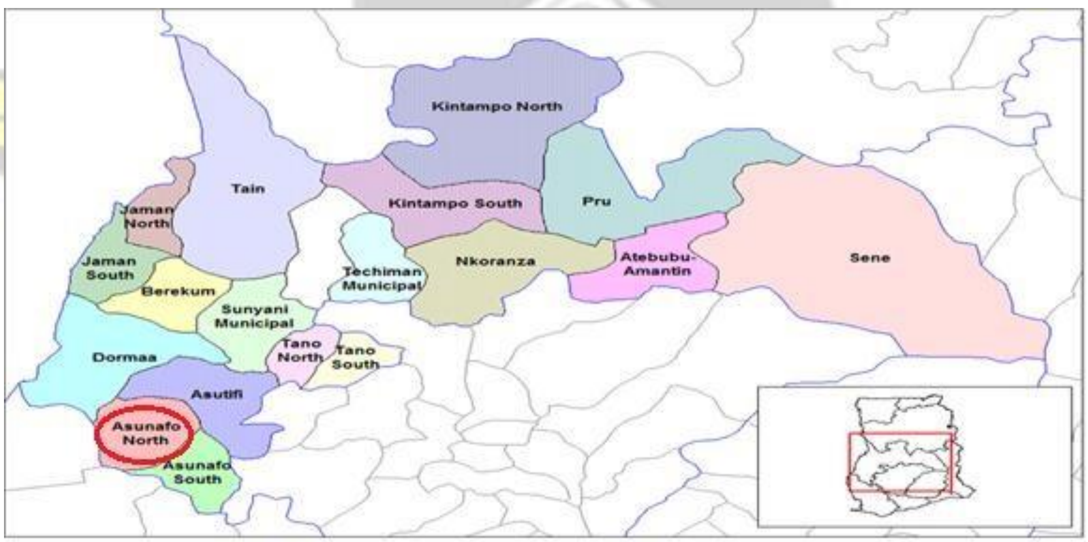

Fig. 3.1 A map of the Asunafo North District (circled with red ink) in Brong Ahafo region of Ghana

The District lies between latitudes 6^{o} 27N and 7^{o} 00N, and longitudes 2^{o} 50W. It shares common boundaries with Asutifi in the North-East, Dormaa District on the North-West and Juaboso-Bia and Sefwi-Wiawso Districts in Western Region on the South-West boarders and Asunafo south District in the Brong-Ahafo Region on the South-Eastern. According to the ANDAMTDP (2006), the total land size of the district is 1093.7km^2 with 389.7km^2 in forest reserves. The District has a population of 110,827 (Ghana Statistical Service, 2000). This is made up of about 51% female and 49% males with a growth rate of 2.6% which compares favorably with the regional and national growth rates of 2.5% and 2.6% respectively within the same period (Ghana Statistical Service, 2000).

3.2 BIOPHYSICAL CHARACTERISTICS OF THE STUDY AREA

3.2.1 Climate and Vegetation

Asunafo North District experiences the Wet-Semi Equatorial type of climate.

Temperature is uniformly high throughout the year. The hottest temperature of about 30^{o}Chas been recorded in month of March. The mean monthly temperature for the district is about 25^{o}C (District Meteorological Service, 2005). The District experiences a double maxima rainfall pattern with the mean annual rainfall ranging between 1250 mm and 1750 mm. The major rains occur between April and July with the minor rains falling between September and October. There is a short dry spell in mid-August before the prolonged dry season from November and March. The main planting season starts with the onset of the major rains (District Meteorological Service, 2005). The relative humidity of the District is highest in the wet season ranging between 75%-80% while the dry season gives the lowest range between 20-25%.

The District lies within the semi-deciduous forest belt of Ghana. The main vegetation cover is the closed forest type. The main forest reserves are Bonsombepo (135.90 km^2), Ayum reserves (112.85 km^2) and Bokoni reserve (108.564 km^2).The forest contains different species of timber, some of which are A*ntiaris toxicaria, Nauclea diderrichii, Nesogordoniapa paverifera, Milicia excelsa, Ceiba pentandra* and*Terminalia superba*; and these trees are highly valuable for timber industries (MoFA, 2012).

3.2.2 Relief and Drainage

Asunafo North District lies within the central part of the forest-dissected plateau of the physiographic region of Ghana. There are different types of rocks in the district; these include the pre-Cambrian Birrimian and Tarkwarian formations. The Municipality has a gently rolling landscape ranging between 500 feet and a little over 1000 feet (above sea level). The topography is more rugged towards the North-Eastern (Mim area) and South Western (Abuom). There are two main rivers (Goa and Ayum) among several smaller streams in the district (District Assembly, 2007).

3.2.3 Soil type and characteristics

The major soil groups in the district are the forest ochrosols. These soils are highly colored (due to high quantities of Fe^{3+}) and are highly fertile. The forest ochrosols are generally slightly to moderately acid in the topsoil (pH 6.5 – 5.1 in 1:1 soil: water ratio). However, Agyili *et al.*, (1992) and Dwomo and Asiamah (1993) discovered that

moderate to strong acid soil reactions prevail in cultivated sites in this zone. These soils are suitable for a wide range of crops especially tree crops such as cocoa, coffee, oil palm, para-rubber, citrus and food crops such as plantain, cocoyam, maize, yams, and cassava (Asunafo North District Medium Term Development Plan, 2008).

The major limitations for sustained agricultural productivity are the moderately steep to steep (8 – 20%) terrain that exists in some portions of this zone and leads to; accelerated erosion. It has been revealed in recent times that the soils have become low in nutrients, especially nitrogen and phosphorus (due to prolonged period of cultivation of the same piece of land). The primary source of nutrients in these traditional agricultural systems is organic matter. Base saturation is often high but cation exchange capacity (CEC) is low, usually above 16 cmol (+) kg day. The soils show good responses to fertilizer amendments shortly (Asunafo North District Medium Term Development Plan, 2008).

3.3 SOCIO-ECONOMIC CHARACTERISTICS OF THE STUDY AREA

3.3.1 Population

The Asunafo North District is one of the 170 districts in Ghana. It was carved out of the then Asunafo District in 2004 by an Act of parliament through a legislative instrument and was inaugurated in August 2005. The District has a total population of 110,827 (Ghana Statistical Service, 2000). The district's population is heavily concentrated within the ages of 0-34 years. The labour force constitutes 53% of the population in the District, with the dependent population constituting 46.7%. According to the 2010 census report, the male population is 49% and that of the female is 51%. The rural population of the District is79, 352which constitutes 71.6% of the total population while the urban population is 31,475 representing only 28.4% of the entire population of the District. Therefore, this clearly demonstrates that the District is predominantly a rural-base community (Asunafo North District Medium Term Development Plan, 2006). Among the major towns and villages in the district are Goaso (the capital), Mim, Abuom, Bediako, Kasapin, Gyasikrom, Pomaakrom, Abuom, Akrodie and Asuadai.

3.3.2 Ethnicity and Religious Beliefs

Ethnicity is defined as tribal groups of people that have a common cultural tradition. The major categories of ethnic groups in the Asunafo North District are Akans, Ewes, Northerners and Ga-Adangbes. The predominant ethnic group is the Akans who constitute more than 80% of the entire population. In the urban centres however, Akans constitute 79%, Ewes 8%, Northerners 9% and Ga-Adangbes 4% (GSS, 2010). The Akan dominance as depicted in the rural urban areas is reflected in the District domain. Thus in the district about 80% of the entire population are reported to be Akans (District Assembly, 2007). All the other ethnic groups form a minority population. One can therefore infer a less tendency towards ethnic conflict. There is a high degree of homogeneity, culturally, thus encouraging consensus in decision making for development
(District Assembly, 2007).

The dominant religion in the rural areas of the District is Christianity which covers about 83%, Islam 16% and traditional religion 1% in that order. In the urban centres, the same picture is portrayed with Christianity as the dominant religion followed by Islam and traditional religion respectively (Ghana Statistical Service, 2010).

3.3.3 Economic activities

Agriculture is the major occupation of the people in the Asunafo North District and employs about 64% of the potential labor force. Majority of the people are smallholder subsistence farmers, mostly cultivating staples like maize, beans, cassava, cocoyams and yams. A few households also cultivate vegetables and fruits that are mainly for sale (UNICEF, 1999). Agro-based industries including palm oil extraction, cassava processing, soap making, akpeteshi distilling and pockets of cashew processing offer employment to about 44.5% of the people in the agricultural sub sector.

There has been a gradual reduction in the level of employment in the agriculture sector to the informal commercial sector. This is attributed largely to acquisition of capital for trading by some farmers (District Assembly Statistical Report, 2007). Petty trading has risen from 19% in 2002 to 24% in 2006 representing a 10% increase. The other major trading activity is in the area of building and construction materials including items like cement, iron rods, plywood has similarly increased. The industrial sector recorded a substantial improvement in the District within the last three years. Major small scale industries include the metal based industries, manufacturing and automobile servicing (Asunafo North District Medium Term Development Plan, 2008). The service sector also saw a significant improvement in terms of service delivery to the local economy. The service sub-sector includes tailors, and seamstress, hairdressers, teachers, nurses, the judiciary service, Ghana Police Service, civil and public servants have contributed immensely to the economy. Though livestock production is not popular in the district, there are a few farmers engaged in keeping poultry, rearing of pigs, sheep and goats.

Livestock rearing is quite tedious, requiring so much time and attention. Longtau *et al.*, (1999) revealed that poultry production in rural communities is mostly about chickens, and these can be found in most households in the District.

3.4 Research Design

Kincaid (2001) defined research design as a plan outlining how information is to be collected for an evaluation such as identifying data gathering methods, the instruments to be used, how the instruments will be administered, and how the information will be organised and analysed. 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, Fowler (1993) added 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.

In this study, reconnaissance and socio-economic survey (Babbie, 1992) were used. These surveys helped to familiarize with the farmers and seek 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 assess some of the main biophysical and socioeconomic factors in these selected communities.

A structured questionnaire was used to obtain data on the socio-economic characteristics of the farmers. This design was selected because it facilitates the collection of a wide range of information and can also be used for describing a large sample, making it possible to ask many questions on a given topic.

The questionnaire assessed the biophysical, socio-economic, agricultural production and services characteristic of the study area. Information was gathered on household characteristics, land use history, production resources and farm management and production sub-systems. 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 land use analysis for agroforestry interventions in the study area. A structured questionnaire was prepared and pre-tested for quantitative data. Information gathered through observation are presented descriptively while field data collected using structured questionnaires were analysed using Statistical Package for Social sciences (SPSS), version 16.

3.5 Familiarization visit/Exploratory (Pre –diagnostic Stage)

This stage, the pre-diagnostic stage consists of all the activities carried out before the implementation of the diagnostic survey. The sample frame of this study consists of all the communities in the Asunafo North District. A three-day visit was made to 4 communities comprising Mim, Betoda, Dominase, and Kasapin to familiarize with the opinion leaders and chiefs of the communities to ask for their view on their farm operations and perceptions of agroforestry. It also helped to establish contact with farmers in the communities where the actual formal survey took place and rapidly evaluate some of the main biophysical and socioeconomic factors in these selected communities. Some decentralized Departments in the District including Ministry of Food and Agriculture and the District Assembly were visited to collect secondary information.

3.5.1 Pre-testing of questionnaire

It 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 employing the procedures that are planned for the main study (Fowler, 1993). According to Fowler (1993) the major goals of pre-testing a questionnaire are to answer the following questions,

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?

Questionnaires were pre-tested in 4 communities and involved 15 farmers. The aim of pre-testing is to sharpen and fine tune the instruments by correcting possible weaknesses and inadequacies that the items may have. 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). These 4 communities and

15 farmers were used because the researcher considered them as having similar characteristics with the study area that were sampled for the actual study. 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.

3.6 Selection of Research Communities and Respondents

According to Bernard (2002) 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. 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.

The study area is made up of about 220 communities, zoned into six agricultural extension operational zones by the MoFA. Eight communities were randomly selected.

These communities were Betoda (Zone 1), Mim and Bonkoni (Zone 2), Ntesere, Dominase and Apenkro (Zone 3), and Abidjan and Kasapin (Zone 4). 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. 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. 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, 112 farmers were purposively chosen from the eight communities randomly selected

3.6.1 Sample size determination

These extension operational zones were used as a basis for the selection of communities. Sample communities were randomly selected from the agriculture extension operational zones. The zones and their respective communities investigated are Betoda (Zone 1), Mim and Bonkoni (Zone 2), Ntesere, Dominase and Apenkro (Zone 3), and Abidjan and Kasapin (Zone 4) [Table 3.1]. The number of responding households was determined by the equation:

$$\eta = \frac{N}{1 + N(\alpha)^2}$$

where η=sample size, N=sample frame and ∝=confidence level (95%) **(Israel, 1992)**

Table 3.1 Sampled communities with their populations

ZONES[a]	COMMUNITY[a]	POPULATION[b]	FARMERS INTERVIEWED

1	Betoda	8,330	32
2	Mim	13,421	46
	Bonkoni	698	03
3	Ntesere	2,001	06
	Dominase	2,220	08
	Apenkro	200	02
4	Abidjan	610	03
	Kasapin	3,660	12
	Total	**33,370**	**112**

[Source: a = Field Survey, 2013, b = Ghana Statistical Service, 2010]

The households were located in the 4 agricultural operational zones that were randomly selected from the district. A total of 112 farmers (one from each household) were randomly sampled from the eight communities in the zones identified. Respondents were household heads, who manage production units. Table 3.1 shows the zones, their communities, populations and number of farmers sampled.

3.7 DATA COLLECTION METHOD

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 the secondary sources included a review of existing literature on the study (Babbie, 1992). The study adapted from the D & D methodology developed by ICRAF to collect relevant data and information for the study. The instruments used for the data collection were: questionnaires, focus group discussions, and field observations.

3.7.1 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). A total of 112 questionnaires were administered from January to April 2013.

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 eight selected communities to obtain more detailed information on farmers' on land use analysis for agroforestry interventions. Each focus group discussion

was made up of ten participants who were farmers and each discussion lasted approximately 1 hour 30mins. Observations were made when field visits were carried out to observe farming practices. The selection of farmers' farms was randomly done. Field observation helped to get the general idea of how farmers manage agroforestry technologies in the District.

3.7.2 Secondary data collection

The secondary sources of literature included reports and relevant documents from the Asunafo North District Assembly, Ministry of Food and Agriculture (MoFA), Environmental Protection Agency (EPA) and the District Forestry Service (DFS).

3.8 Limitations of the study

- The study might not represent the overall farmer population in the District since; there are many more farmers engaged in farming than interviewed.
- The extensive of data collection is limited by cost. That is more data collection better examination of farmers.
- The large area of the district resulted in a challenge to find communities where agroforestry has been introduced and those without agroforestry due to lack of a sampling frame for the communities.

3.9 Data Analysis

The data gathered were cleaned and coded before analysis. Analysis was done both qualitatively and quantitatively. With the quantitative data analysis, the number of times a particular response was given was scored and analyzed using the Statistical Package for Social Sciences (SPSS). The analytical tools used in this study included percentage tables, frequency distribution and bar charts. Chi - square analysis was used to assess differences between communities in personal and demographic characteristics as well as evaluate relationships between variables and significance of relevant parameters at 5% level.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

The results and discussion in this chapter are presented under six major thematic areas comprising socio-economic features, descriptions of land-use systems, and agricultural production systems (crops, animals and trees production subsystems), tree products and marketing, and supporting services in the Asunafo North District of Brong Ahafo Region.

4.1 SOCIO-ECONOMICS CHARACTERISTICS OF RESPONDENTS

Age of respondents

The age distribution of respondents in the study area is in Table 4.1. Majority (51.8%) fall within the age group of 34 – 48 years while the youth (18 – 33 years) constitute 20.5%. Slightly over 10.7% were in the 49 - 60 years age group with 17% being over 60 years. A close analysis of the distribution between the different age groups shows that 72.3% of all respondents fall within the active age group (18 – 48 years). Researches 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. Pattanyak *et al.*, (2003) iterated that with the pool of youthful labour to draw on, it should not be difficult to incorporate labourintensive tree integration and agroforestry activities into their farming systems.

However, chi-square test indicated significant differences (P = 0.001) between sample communities in the ages of respondents (Table 4.2). According to Njoku (1991) the level of technology adoption by small-scale farmers is influenced by several factors including age. DAMTDP (2008) revealed that the district's population is heavily concentrated within the ages of 1 – 34 years. This study found that the 34 – 48 years age group was dominant (51.8%) among the farmers in the Asunafo North District.

Table 4.1 Age Groups of Respondents in the Asunafo North District

Age group (years)	Number of Respondents	% of Respondents
18-33	23	20.5
34-48	58	51.8
49-60	12	10.7
Over 60	19	17
Total	112	100.0

(Source: Field Survey, 2013)

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Table 4.2 Chi-square analysis of differences in Personal and Demographic characteristics of respondents between communities in the Asunafo North District

Personal/ Characteristics	COMMUNITIES Betoda n=32	Mim n=46	Bonkoni n=3	Ntesere n=6	Apenkro n=2	Dominase n=8	Abidjan n=3	Kasapin n=12	Chi-square test χ^2 **α = 0.05**	Significance
SEX									χ^2 =3.712	
Male 12.5 Female	16.1	15.2 25.9	1.8 0.9	2.7 2.7	1.8 0	2.7 4.5	0.9 1.8	4.5 6.3	df = 7 (14.067, 0.05) **p - value = 0.812**	**NS**
AGE GROUP	18-33									
8.9		4.5	0	1.8	0	5.4	0	0	χ^2 =46.931	
34-48	12.5	20.5	0	1.8	1.8	1.8	2.7		df = 21 (32.671, 0.05) **p - value = 0.001**	S
49-60	5.4	4.5	0.9	0	0	0	0	0		
Above 60	1.8	11.6	1.8	1.8	0	0	0	0		
MARITAL STATUS										
Single 2.7		5.4	0	0.9	0	0.9	0	0.9	χ^2 =24.564	
Married	16.1	25.9	2.7	3.6	1.8	0	2.7	8	df = 21 (32.671, 0.05) **p - value = 0.267**	NS
Divorced	3.6	5.4	0	0.9	0	4.5	0	0.9		
Widowed	6.3	4.5	0	0	0	1.8	0	0.9		
EDUCATIONAL STATUS										
Primary	5.4	12.5	1.8	3.6	0	4.5	1.8	0	χ^2 =41.522	
J.H.S.	7.1	8.9	0.9	0	0	0	0.9	0	df = 28 (41.337, 0.05) **p - value = 0.048**	S
S.H.S.	2.7	3.6	0	1.8	0	0	0	2.7		
Tertiary	1.8	1.8	0	0	0	0.9	0	3.6		
None	11.6	14.3	0	0	1.8	1.8	0	4.5		
ORIGIN									χ^2 = 3.326	
Native	17.9	26.8	0.9	3.6	1.8	4.5	0.9	7.1	df = 7 (14.067, 0.05) **p - value = 0.853**	NS
Migrant	10.7	14.3	1.8	1.8	0	2.7	1.8	3.6		
ETHNICITY		26.8	0.9	3.6	1.8	4.5	0.9	6.3		
Akan	20.5								χ^2 = 13.645	

Ewe	3.6	8.9	0.9	0.9	0	1.8	0.9	1.8	df = 21 (32.671, 0.05) **p - value = 0.884**	NS
Northerner	2.7	2.7	0.9	0	0	0.9	0	2.7		
Ga	1.8	2.7	0	0.9	0	0	0.9	0		
NUMBER OF CHILDRE N	6.3			1.8		5.4	0	0.9		
Less than 5		6.3	0		0					
5 to 9	6.3	23.2	0.9	1.8	1.8	1.8	2.7	9.8	$\chi^2 = 46.013$	S
10 to 15	12.5	11.6	1.8	1.8	0	0	0	0	df = 21 (32.671, 0.05) **p - value = 0.001**	
More than 15	3.6	0	0	0	0	0	0	0		
Demographic	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**		

NS and S means not significant and significant respectively

Gender of respondents

Results of the study indicate that there were more female farmers (58%) compared to male farmers (42%) in the study area (Fig. 4.1). The dominance of female farmers in the study area conforms to the Ghana Statistical Service (2000) report, which revealed the ratio of male to female to be 49:51. This suggests a large percentage of females are interested in farming practices but complained that their decision depended on the males since the farm lands belong to them. According to Scherr (1995) who noted 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. This finding of Scherr (1995) is in agreement with the statement of the female in the district. Gladwin and McMillan (1989) reported that, innovative approaches such as agroforestry technologies to replenish Africa's soil fertility are likely to depend on African rural women, who by custom produce the food crops in many African communities.

Chi-square analysis showed that there were no significant differences ($p = 0.812$) between the sample communities in the gender status of respondents. Therefore gender does not seem to influence the practice of agroforestry in the study area. It was found that women were more than men in the practice of agroforestry technologies. In a study of tree planting in Kenya, Scherr (1995) found significant gender differences, with male headed households planting more trees than women. 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.

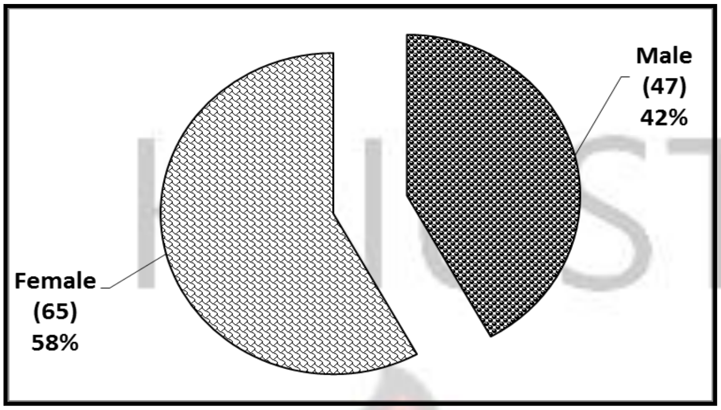


Fig. 4.1 Gender of Respondents in the Asunafo North District

Marital status of the respondents

The marital statuses of respondents could be categorized into four groups. These are singles (10.7%), married (60.7%), divorced (15.2%) and widowed (13.4%) [Table 4.3].The marital statuses were ascertained not to be significantly different (p = 0.267) between communities (Table 4.2). Fig. 4.2 depicts the percentage of respondents and their respective number of children.

Table 4.3 Marital Status of Respondents in the Asunafo North District

Marital Status	Number of Respondents	% of Respondents
Single	12	10.7
Married	68	60.7
Divorced	17	15.2
Widowed	15	13.4
Total	112	100.0

(Source: Field Survey, 2013)

Number of children of the respondents

About half (48%) of respondents have between 5 – 9 children with 28% having 10 – 15 children. A fifth of the respondents (20%) have less than 5 children whiles only 4% have more than 15 children. It is obvious from the figure that family sizes are generally large, with 76% of respondents having between 5 and 15 children. Differences between the numbers of children of respondents among the communities investigated were significant (p = 0.001) [Table 4.2]. In rural areas, large family sizes are attributed to high labour hiring for agricultural purposes. Marriage type influence innovation acceptance (Njoku, 1991). Since the respondents are basically farmers, number of children is influenced by the intensity of labour scarcity. Mercer and Hyde (1992) declared that agroforestry technology adoption is influenced by labour availability.

Hence, where labour is scarce, farmers would raise some through marriage and birth. 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. 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 than increase number of children.

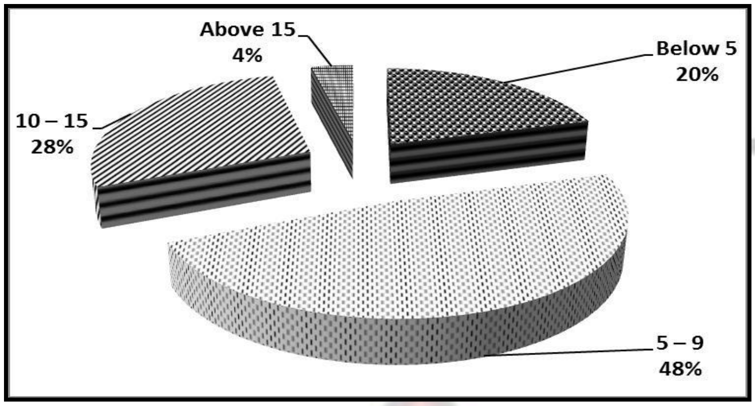
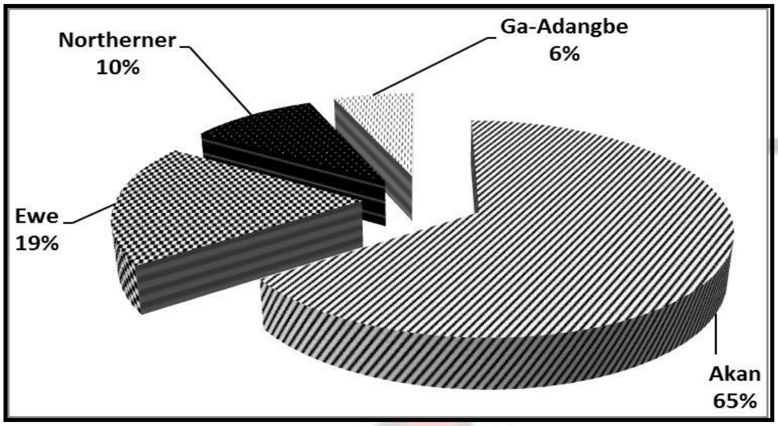


Fig. 4.2 Number of Children of Respondents in the Asunafo North District

Ethnicity of the respondents

The survey revealed that both native farmers and migrant farmers live in the District. Majority of respondents were identified to be natives (63.4%) whiles 36.6% were migrant farmers. Differences in ethnicity (native and migrant farmers) of respondents in the study area was not significantly different (p = 0.884) (Table 4.2). This disagreed with the District Assembly's (2007) report which stated that majority (80%) of inhabitants is native Akans with other tribes being only 20.0%. The present study reveals significant influx of migrants into the District between 2007 and 2014. The migrants were from

Northern region (northerners), Volta region (Ewes) and Greater Accra (Ga-Adangbe). These were basically farmers, engaged mostly in pure stands or mono cropping of plants such as cocoa, citrus, maize and yam. The Akans dominated (65%) in the district whiles Ga-Adangbe ethnic group recorded the lowest, 6% (Fig. 4.3).



`Fig. 4.3 Ethnic Groups of respondents in the Asunafo North District

Educational Background of the respondents

The study revealed that 33.9% of respondents have had no formal education; whiles 8.0% were tertiary school leavers (Table 4.4). 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. The low level of education may create conservatism among farmers (Anon, 1987), and this results in opposition to innovation and timely intervention. While Clayton (1983) reported that farmers reject technologies because of incomes and risks involved.

Anon (1987) emphasized that innovations are only adopted by the educated that are more able to identify the pros and cons of the innovations. According to Wilson (1955) higher the farmer's educational level, the higher is his income and his adoption of innovative technology (Lionberger, 1990). Chi-square test found the level of education of respondents significant (P = 0.048). 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 has a significant effect on the adoption of agroforestry technologies in the study area. This result disagrees with Stoll-Kleemann and Oriordan (2002) which reported that low level of education was not significant to agroforestry adoption.

Table 4.4 Educational Background of Respondents in the Asunafo North District

Educational Background	Number of Respondents	% of Respondents
Primary	33	29.5
JHS	20	17.9
SHS	12	10.7
Tertiary	9	8.0
None	38	33.9
Total	112	100.0

(Source: Field Survey, 2013)

4.2.2 Occupation of the respondents

The principal occupations of respondents were farming (76%), trading, 7.1%, artisan7.1%, and public service, 9.0% (Table 4.5). These findings are in close agreement with DAMTDP (2008) which indicated that 64% of people in the District are engaged in farming. This result suggests agroforestry could be considered to have the potential to be readily adopted since large percentage of the respondents is farmers. Sheikh *et al.*, (2003) reports farmers are already associated with risk and therefore easily accept new technologies. Pannell (1999) adds that farmers are conscious of new technologies because of their farming practices.

Table 4.5 Occupation of Respondents in the Asunafo North District

Principal Occupation	Number of Respondents	% of Respondents
Farming	86	76.8
Trading	8	7.1
Artisan	8	7.1
Government worker	10	9.0
Total	112	100.0

(Source: Field Survey, 2013)

4.2.3 Cash Subsystems and sources of income

Farming was the most common primary source of income (78.9%), followed by petty trading (10.5%), sale of fuelwood (5.7%), others-government work (4.9%) [Table 4.6]. This suggests farming is the main practice farmers used to generate income to support household needs such as food, shelter etc.

Table 4.6 Source of income in the Asunafo North District

Primary source of income	Number of Respondents	% of Respondents
Farming	97	78.9
Petty trading	13	10.5
Sale of fuelwood	7	5.7
Others	6	4.9
Total	112	100.0

(Source: Field Survey, 2013)

4.2.4 ENERGY SUBSYSTEM

Major sources of energy identified in the Asunafo North District

The major source of energy in Asunafo North District as shown in Table 4.7 is fuelwood (60.2%), followed by charcoal (23.0%) and LPG (16.2%). The fuel is used for domestic purposes such as cooking, fencing etc. No one among the respondents used electricity.

Relwani (1979) emphasized that fuelwood is the most important source of energy in rural communities. Therefore, the study agrees with Relwani (1979) affirmation that the primary source of energy for tropical rural communities is fuelwood. According to Alavalapati and Nair (2001) farmers implement agroforestry systems to address household needs such as food, fodder, and fuelwood.

Table 4.7 Major source of energy in the Asunafo North District

Major source of energy	Number of Respondents	% of Respondents
Charcoal	26	23.0
Fuelwood	68	60.2
LPG	19	16.2
Total	112	100.0

(Source: Field Survey, 2013)

Source of fuelwood

Table 4.8 indicates that the Asunafo North District of the Brong Ahafo region, gathering fuelwood from trees on farm registered 51.8%, then gathering from bush, 36.6%, and buying from the market, 11.6%. 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.

Table 4.8 Means of getting fuelwood in the Asunafo North District

Ways of getting fuelwood	Number of Respondents	% of Respondents
Gathered from bush	41	36.6
Gathered from trees on farm	58	51.8
Bought from market	13	11.6
Total	112	100.0

(Source: Field Survey, 2013)

4.3 DESCRIPTION OF LAND-USE AND FARMING SYSTEMS

4.3.1 Land acquisition or ownership

Evans (1992) pointed out that tenure is enormously complex and associated problems are some of the most difficult obstacles to development in the tropics. Caveness and Kurts (1993) found out that land ownership was one of the predominant factors affecting the adoption of agroforestry technologies. Three main modes of land ownership were found to exist in the study area. These are family ownership (47.3%), hiring (27.7%) and individual/personal ownership (25%) [Table 4.9]. Most of the lands are family-owned. This is not in line with Foley and Bernard (1984) that the most favorable position for tree planting is where land is privately owned and individuals hold a secure title to the holdings they farm. Land is a very valuable asset in Ghanaian rural communities (MoFA, 2010) landowners may not sell their lands out right to farmers. The family type of landownership makes it virtually impossible for any individual to sell those lands belonging to the family.

The hired lands may be attributed to the influx of non-natives into the District for agricultural purposes. Although hiring (27.7%) was identified as the second main mode of land acquisition in the District, its use for agroforestry activities was observed to be low. Hoskins (1987) pointed out that in most traditional Africa cultures, where land is owned on communal or semi-communal basis, individuals do not have permanent possession of land but are granted rights by the village leaders or family heads to farm particular patches of land for a certain period. However, it would also be anticipated that pressure on farmlands will increase tremendously due to increase of hiring farmlands in the coming years and this will impact negatively on soil conservation. Consequently, the previous traditional methods of land fallowing will not be attractive to farmers, hence continuous farming (which will deplete the soil of natural regeneration of fertility and increase the prospects of soil erosion) with heavy emphasis on chemical inputs will be practiced.

Table 4.9 Land ownership in the Asunafo North District

Land ownership	Number of Respondents	% of Respondents
Hired	31	27.7
Family	53	47.3
Individual/Personal	28	25.0
Total	112	100.0

(Source: Field Survey, 2013)

4.3.2 Land-use history

Table 4.10 reveals that forested land constituted 54.5% whiles cropland recorded 45.5%. Most forested lands were seen to be primary forests, though small patches of secondary forests existed due to the practice of shifting cultivation, land rotation and fallowed croplands were also identified. The result suggests the likelihood of more forest clearance for agricultural purposes in the coming years as farmers continue to look for more fertile land. This expectation is harmful to the forestry sector, population growth and expansion of human settlements and infrastructural developments is imminent. 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 greenhouse gases, provide more diverse streams of income and reduce poverty.

Table 4.10 Land-use type before occupation in the Asunafo North District

Land-use	Number of Respondents	% of Respondents
Forest	61	54.5
Cropland	51	45.5
Total	112	100.0

(Source: Field Survey, 2013)

4.3.3 Field condition before occupation

Twenty-four percent (24%) of respondents described their lands as moderately fertile (24.1%), fertile (32.1%) and very fertile (43.8%) [Table 4.11]. No farmer described his/her field as poor or of low fertility. This can be attributed to the fact that most farmlands were established on primary forests or long term fallowed lands (MoFA, 1985). Tropical forest lands have been described to be very fertile due to the high rate of mineralization resulting from the humid microclimatic conditions that prevail together with warm temperatures. This facilitates decomposition of organic matter which aids soil fertility. Thus, when forested lands are cleared, very fertile soils are made available for agricultural purposes.

Table 4.11 Field condition before occupation in the Asunafo North District

Field condition	Number of Respondents	% of Respondents

Very fertile	49	43.8
Moderately fertile	27	24.1
Fertile	36	32.1
Total	112	100.0

(Source: Field Survey, 2013)

4.3.4 Methods of land preparation by farmers in the study area

Table 4.12 shows that manual clearing without burning – "proka" (55.4% of respondents) was the major land preparation method practiced in the District, followed by manual clearing and burning (26.8%), chemical weed control (16.9%) and minimum tillage (0.9%) respectively. Consequently, the dominance of the manual clearing with or without burning (82.2%) is indicative of the fact that forested lands are being cleared, since chemical weed control are mostly not applicable to these lands. This could be because most of the farmlands were previously forested and very fertile. Indigenous knowledge about mulching and its effect on soil fertility abound in the district, and this explains why 'proka' (manual clearing without burning, which allows regeneration of soil fertility) dominates all land clearing practices with 55.4%.

Table 4.12 Method of land preparation in the Asunafo North District

Land preparation	Number of Respondents	% of Respondents
Manual clearing and burning	30	26.8
Manual clearing without burning (Proka)	62	55.4
Chemical weed control	19	16.9

Minimum tillage	1	0.9
Total	112	100.0

(Source: Field Survey, 2013)

4.3.5 Types of farmlands kept by farmers in the study area

Four types of farmlands were identified. These are 75.9% annual crops, 52.7% tree/perennial crops, 40.2% biennial crops and 16.1% intercropping in the district (Table 4.13). Rural folks normally cultivate crops that would yield immediate return. This explains why annual crops dominated over the other types of crops. This finding agrees with Gregerson *et al*., (1989), that farmers usually compare the expected benefits of tree planting on their land with the benefits they can get by using their land for other farming systems. Nair and Dagar (1991) contributed that this opinion of farmers could make developing strategies to encourage farmers to plant trees difficult and however characteristics of farms and farmers in relation to tree planting in existing agroforestry systems must be studied. However, for insurance and/or security against future unexpected crop failure, farmers would cultivate perennial and biennial crops.

Table 4.13 Types of croplands kept by respondents in the Asunafo North District

Croplands	Number of Respondents	% of Respondents
Annual crops	85	75.9
Biennial crops	45	40.2
Tree/ Perennial crops	59	52.7
Intercropping	18	16.1
Total	***207**	**184.9**

(Source: Field Survey, 2013)

***Total number of respondents greater than 112 due to multiple responses by some farmers**

4.4 AGRICULTURAL PRODUCTION SYSTEMS

The agricultural production systems in the District deal with how farmers placed tag on agricultural practices to maximize production. This section of the study comprise of crop, livestock and tree production.

4.4.1 Crop production in the study area

Aspects of crop production investigated included types of crops planted, use of improved seeds, and ways of improving fertility, yield trends and major constraints (farming resources, plant growth and farm management and marketing constraints). The type of prevalent crop production identified by farmers in the District is subsistence crop production.

Crop production and crop patterns

Agricultural production in the study area comprises food crops, tree/tree crop and animal production systems. Depending on the production goal of farmers, food and tree crops may be cultivated in mixed or pure (monoculture) stands (Table 4.14). Most respondents under study (82.1%) kept both pure and mixed stands, whiles 14.3% and 3.6% kept only mixed and only pure stands respectively. Thus, whiles most farmers cultivate both pure and mixed stands, they tend to mixed cropping for domestic usage and pure stands as source of cash inflows. Mixed stands normally include cash crops like cocoa, oil palm or citrus, intercropped with subsistent crops like maize, cassava, beans, plantain and/or cocoyam. In these combinations, the annuals are incorporated in the early years. Other mixed stands include variety of vegetables on the same piece of land, plantain, cocoyam and pepper, maize, cassava and beans, and yam, maize and vegetables. Pure stands are typically matured cocoa, citrus and oil palm; others include pure stands of yam, maize, cassava and plantain. Consequently, in rural areas, farmers will keep food crops like plantain, cocoyam and pepper on mature cocoa, oil palm and citrus farms. However, little attention is given to food crops on mature pure stands. This particular type of farming is very common in the Ahafo part of the region and for that matter the study area.

According to Langyintuo (1989), farmers would keep both pure and mixed stands in order to maximize output at any given time. This work agrees with the above affirmation as Table 4.14 indicates that both pure and mixed stand holdings constituted 82.1% of farm types. Ibrahim (1984) emphasized this declaration by stating that apart from the traditional mixed stand holdings; sole cropping or monocropping (pure stand) is also significant to the economic life of rural communities.

Table 4.14 Type of crop stands kept by in the Asunafo North District

Type of Crop stand	Number of Respondents	% of Respondents
Pure stand	4	3.6
Mixed stand	16	14.3
Pure and Mixed stand	92	82.1
Total	112	100.0

(Source: Field Survey, 2013)

Use of improved seeds by farmers

Less than 50% (34.8% -39respondents) indicated the use of improved seeds. They gave various reasons for the use of improved seeds of cocoa, oil palm, maize, beans and orange. Among them, 97.4% attributed the use of improved seeds to increased yield and 2.6% left blank space (Table 4.15). In addition, 73% of farmers said they did not use improved seeds because of their scarcity whiles 27 % cited high cost (Fig. 4.5). Consequently, majority of the farmers accept the supremacy of improved seeds to local varieties, since it led to increase yield. However, accessibility of improved seeds is a major setback (73%) to the adoption. Few farmers attributed the neglect of improved seeds to high cost of purchase (27%), indicating that farmers have seen that the benefits of increased yield far outweigh the cost of purchasing the improved seeds. Therefore, for effective maximization of land output, MoFA must make available improved seeds, and at affordable price for farmers to be able to purchase it to increase yield.

Table 4.15 Reasons for use of improved seeds in the Asunafo North District

Reason for use of improved seeds	Number of Respondents	% of Respondents
Increased yield	38	97.4
No reason	1	2.6
Total	39	100.0

(Source: Field Survey, 2013)

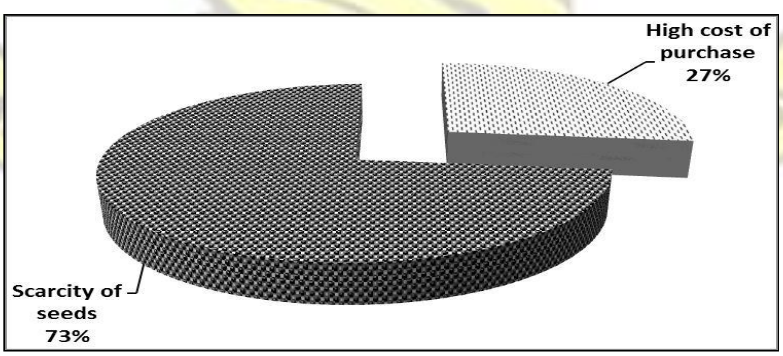


Fig. 4.5 Reasons for not using improved seed in the Asunafo North District

The practice of fallow by farmers in the area under study

When respondents were asked whether they practiced fallow, 75.4% practiced and 24.1% left blank space. From Table 4.16, 45.5% of respondents fallowed their land for a period of 1 – 3years, whiles 27.7% fallowed for 4 – 6years, and only 2.7% fallowed for periods greater than 6years in the Asunafo North District Fallow period above 6years was found to be practiced at only Betoda (2.7%). The respondents who did not practice fallow gave two reasons; scarcity of land (74%) and high population growth (26%) [Fig.4.6]. The present study agrees with the findings of Donhauser *et al.*,(1992) who identified fallow periods to prevail from 1 – 3 years after 4 – 5 years of continuous cultivation. The short fallow periods could be due to increase population pressure on land resulting from expansion in family sizes, driven by the quest to increase farm labour. This was confirmed by Albert (1996) and Hesse (1997) when they stated that in densely populated areas, arable land becomes scarce. Farmers have to reduce fallow periods to less than 2 years and increase chemical inputs (fertilizer application) in order to meet nutrient demands.

Table 4.16 Fallow duration practiced in the Asunafo North District

Fallow duration (years)	Number of Respondents	% of Respondents
1 – 3	51	45.5
4 – 6	31	27.7
Above 6	3	2.7
No answer	27	24.1
Total	112	100.0

(Source: Field Survey, 2013)

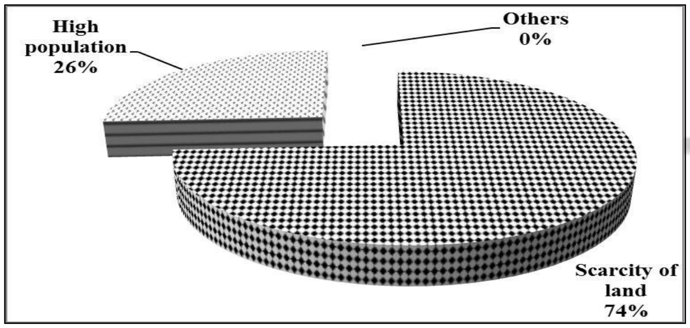


Fig. 4.6 Reasons for not practicing fallow in the Asunafo North District

Soil fertility management practices

Analysis of data revealed that most respondents (68.8%) in the District practiced fallow for soil fertility improvement whereas 57.1% used fertilizers (Table 4.17). 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). According to Steiner (1984) stated that increasing fallow improves soil fertility significantly. Since most farms were previously forested, farmers have relied on the natural regenerative ability of the soil to improve fertility. 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). Franzel *et al*., (2004) emphasized that improved fallows benefit farmers in the form of greater food crop yields, representing increased returns to land and labour.

Table 4.17 Method of soil fertility improvement in the Asunafo North District

Soil fertility improvement	Number of Respondents	% of Respondents
Application of fertilizer	64	57.1
Fallow maintenance	77	68.8

Total	*141	125.9

(Source: Field Survey, 2013)

***Total number of respondents greater than 112 due to multiple responses by some farmers**

Trend in crop yield

Table 4.18 indicates that while 72.3% of the farmers in the study District identified crop yields to be increasing, 16.1% indicated yields were stable and 11.6% indicated decreasing trend in crop yield. Fig. 4.7 shows that two reasons were identified for both increasing and stable yield (Fallow and fertilizer application), and three reasons for decreasing yield (No fallow, no fertilizer and poor cultural practices).

Table 4.18 Trend in crop yield in the Asunafo North District

Trend in yield	Number of Respondents	% of Respondents
Increasing	81	72.3
Stable	18	16.1
Decreasing	13	11.6
Total	112	100.0

(Source: Field Survey, 2013)

Fig. 4.7 Reasons for increasing crop yield in the Asunafo North District

The study showed that for stable trend in crop yield, most respondents attributed it to Fertilizer application (56%), followed by good cultural practices (33%) and fallow practice

(11%) respectively (Fig. 4.8). From Fig. 4.9, reasons for decreasing yield were attributed to poor cultural practices (47%) followed by lack of fallow periods (29%) and low fertilizer input (24%) respectively. Steiner (1984) asserted that yields would decrease with decreasing soil fertility and this is resultant of increased population pressure on land and associated reduction in fallow periods. The study agrees with this assertion since both absence of fallow and fertilizer constituted 52.9% of the factors contributing to decreased yield in the study District.

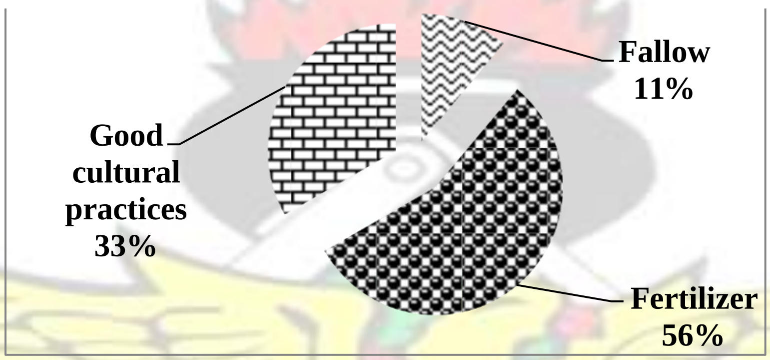


Fig. 4.8 Reasons for stable crop yield in the Asunafo North District

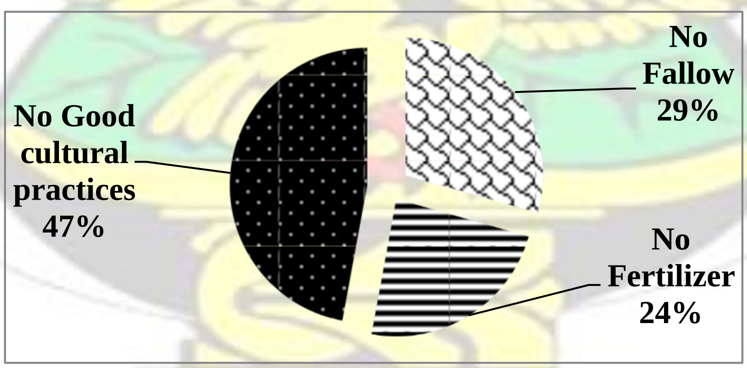


Fig. 4.9 Reasons for decreasing crop yield in the Asunafo North District

4.4.2 Crop production constraints

Major resource constraints

Lack of cash was the highest resource constraint (53.6%) followed by scarcity of land (27.7%), low labour force (12.5%) and poor infrastructure (6.3%) in the District (Table 4.19). While Steiner (1984), Albert (1996) and Hesse (1997) reported that land was a major constraining factor, it was linked with increased population and decreased fallow. As family sizes continue to increase, available resources become inadequate for sustenance. Whenever rural folks perceive financial constraints, they tend to invest more into their major sources of income (farming) in order to increase yield, therefore affecting their short-term cash returns. However, scarcity farmland expansion is attributed to land acquisitions. At times; it is under litigation from family members and thus prevents one another from further cultivation of such lands.

Table 4.19 Major crop resource constraints in the Asunafo North District

Major resource constraint	Number of Respondents	% of Respondents
Land	31	27.7
Labour	14	12.5
Infrastructure	7	6.3
Cash/inputs	60	53.6
Total	112	100.0

(Source: Field Survey, 2013)

Constraints on plants growth

Assessment of the constraints on plants growth showed that inadequate and erratic rainfall (45.5%), poor crop varieties (40.2%) and low fertility (6.3%) in that order (Table 4.20). Over-reliance on rainfall has significant impact on crop growth. Thus current climatic changes have impacted the trend in crop farming since irrigation facilities are not available and farmers must necessarily wait for favorable rainfall patterns. This suggests farmers experienced low harvest of crops when there is unflavorable patterns of rainfall.

Table 4.20 Constraints on plant growth in the Asunafo North District

Constraints on plant growth	Number of Respondents	% of Respondents
Low fertility	7	6.3
Inadequate/erratic rainfall	51	45.5
Poor crop varieties	45	40.2
No answer	9	8.0
Total	112	92.0

(Source: Field Survey, 2013)

***Total number of respondents less than 112 due to lack of responses from some respondents**

Farm management constraints

The reported farm management constraints for the Asunafo North District were such that weeds and insect pest recorded the highest (45.4%), whiles soil erosion, diseases and thefts recorded 34.8%, 11.6% and 7.1% respectively (Table 4.21). It is obvious that weeds/insect pest and soil erosion pose significant threat to crop production in the district. The problem of the weeds could be attributed to the ‘Proka’ land preparation approach adopted by most farmers. This method returns viable weed seeds and seedlings into the soil which may sprout profusely at the onset of rainfall. Moreover, land cultivation without appreciable number of trees incorporated into the farm exposes farmlands to agents of soil erosion such as wind and running water. This is the more reason why the adoption of appropriate agroforestry practices such as trees on farmlands, taungya and boundary planting are important. 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. From the results, stealing (theft) was the least constraint to farm management and this could be attributed to the rural environment where every member of society is known and closely watched. This helps to minimize social deviations such as thefts.

Table 4.2
1 Farm management constraint in the Asunafo North District

Farm management constraint	Number of Respondents	% of Respondents
Soil erosion	39	34.8
Weed/Insect pests	52	45.4
Diseases	13	11.6
Thefts	8	7.1
Total	112	100.0

(Source: Field Survey, 2013)

Marketing challenges

With the exception of Bonkoni, all other communities had poor road network, such that for the entire district, poor road was highest (58.9%), then poor storage facility (25.0%) [Table 4.22]. Road networks have significant impact on farm produce. Lack of road facilities may cause farmers to reduce crop production, due to increased spoilage of farm produce resulting from difficulty in transportation. 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. According to Place and Dewees (1999) found that ready market for agroforestry products influence agroforestry adoption.

Table 4.2

2 Challenges in selling crop products in the Asunafo North District

Challenges in selling crop products	Number of Respondents	% of Respondents
Poor road network	66	58.9
Poor storage facility	28	25.0
No answer	18	16.1
Total	112	100.0

(Source: Field Survey, 2013)

4.4.3 Animal production in the study area

The study on animal production looked at the types of livestock kept, sources of feed, methods of feeding, and major livestock production constraints.

Livestock kept in the study area

Chicken, guinea fowl, goats, sheep and cattle were livestock kept by the respondents in the Asunafo North District. All the respondents reported keeping goats. Eighty – three percent (83.0%) kept chicken, 52.7% kept sheep, 49.1% kept guinea fowl and 35.7% kept cattle (Table 4.23). These were kept purely on subsistent basis. Livestock are reared to complement household protein needs, especially during festive occasions. This is in agreement with Delgado *et al*., (1999) which stated that livestock are an integral part of the agricultural systems of Africa and especially important to the poor, who derive a larger proportion of their meagre incomes from livestock than do the wealthier.

Table 4.2

3 Livestock kept by respondents in the Asunafo North District

Livestock	Number of Respondents	% of Respondents*
Chicken	93	83.0
Guinea fowl	55	49.1
Goats	112	100
Sheep	59	52.7
Cattle	40	35.7
Total	**359***	**320.5**

(Source: Field Survey, 2013)

***Total number of respondents greater than 112 due to multiple responses by some farmers**

Sources of livestock feed and feeding methods

Four major sources of livestock feed were identified in the study area. These are leftovers, fodder, pastures (open grass field) and cereals. The most common source of harvested feed was leftover (96.4%), followed by fodder (59.8%), lawns/pastures (33.9%) and cereals (13.4%) respectively (Table 4.24). The non-utilization of commercial feed can be attributed to the fact that animal rearing was carried out at the subsistent level and for farm work. This suggests that agroforestry has promising potentials for reducing deforestation while increasing food, fodder, and fuel wood production (Benge, 1987; Caveness and Kurtz, 1993; Young, 1997).

Table 4.24 Sources of animal feed in the Asunafo North District

Source of animal feed	Number of Respondents	% of Respondents
Leftover	108	96.4
Fodder	67	59.8
Pastures	38	33.9
Cereals	15	13.4
Total	***228**	**203.5**

(Source: Field Survey, 2013)

Table 4.2

***Total respondents greater than 112 due to multiple responses by some farmers**

Systems of feeding livestock in the Asunfo North District

According to Rosegrant (2009) keeping livestock is an important risk reduction strategy for vulnerable communities and livestock are important providers of nutrients. The use of intensive system of feeding (livestock are confined in well sited, constructed and ventilated structure or housing units) livestock was identified only in Dominase by 12.5% of the farmers interviewed. It became evident that most people used the semi-intensive system (livestock are confined in structures but allow to go out to search for food and water) of feeding farm animals (75.0%), followed by the extensive system (livestock are allow to go out to search for food and water and not kept in structures) and (51.8%) and intensive system (1.8%) respectively for the entire district (Table 4.25). The existence of the semi-intensive system of feeding livestock implies that farmers may be intensifying animal production, thus, shifting from subsistence to a more commercial system. This shows new technology options combined with market opportunities can induce farmers to diversify and intensify systems of livestock production. Depending on the natural resource base and management systems, intensification can sustain and improve productivity over time in the study area. According to Delgado *et al*., (1999) livestock are an important livelihood asset for the poor in Africa, has the potential to provide a platform for the poor in Africa to reap a disproportionate share of the benefits of this demand growth in Livestock Revolution.

Table 4.25 Systems of feeding livestock in the Asunafo North District

System of feeding livestock	Number of Respondents	% of Respondents
Intensive system	2	1.8

Semi-intensive system	84	75.0
Extensive system	58	51.8
Total	***144**	128.6

(Source: Field Survey, 2013)

***Total number of respondents greater than 112 due to multiple responses by some farmers**

4.4.4 Major animal production constraints identified in the study area

Challenges identified in keeping livestock in the study area

The problem of theft in livestock production was the major constraint (50.9%). This was followed by accidents (33.9%), diseases (27.7%), pests (18.8%) and lack of water (11.6%) respectively (Table 4.26). In such rural Districts, it stands to reason that pests and diseases are not major issues, but theft and accidents. This is due to the extensive system of housing and feeding the animals, which exposes them to negative elements as theft and accidents.

Table 4.26 Challenges facing livestock rearing in the Asunafo North District

Problems	Number of Respondents	% of Respondents
Diseases	31	27.7
Pests	21	18.8
Thefts	57	50.9
Accidents	38	33.9
Lack of water	13	11.6
Total	***160**	**143.2**

(Source: Field Survey, 2013)

***Total number of respondents greater than 112 due to multiple responses by some farmers**

Availability of ready market for livestock in the Asunafo North District

Two main problems were identified as militating against ready market; these are poor road networks and long haul distance to market places. Poor road network contributed to

7.1% of the problem whiles long haul distance to market recorded 6.3% (Table 4.27). Poor road network and long haul distance affect market produce and also regulates the number or size of animal farm. Poor road network does not give incentive/motivation for going into farming or expanding existing farms. 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 explore and expand markets. 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. According to Place and Dewees (1999) found that ready market for agroforestry products influence agroforestry adoption.

Table 4.27 Reasons for lack of livestock market in the Asunafo North District

Why no ready market	Number of Respondents	% of Respondents
Poor road network	8	7.1
Long haul distance	7	6.3
No answer	97	86.6
Total	112	100.0

(Source: Field Survey, 2013)

4.4.5 Tree production in the Asunafo North District

Presence of trees on farmlands

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. The assessment of the abundance of trees on farmlands revealed that trees were present to different extents. The total number of trees on farmland was categorized into below 5 trees, 5 – 10 trees and above 5 trees. From the results, most farmers (33.0%) kept 5 – 10 trees on their farmlands, followed by those who kept less than 5 trees (25.0%) and above 10 trees (17.9%) respectively (Table 4.28). According to Nair (1989) and Young (1989), the presence of tree on farmlands, emphasizes the practice local knowledge of the need for agroforestry practices. Whiles Nair (1989) stressed that 5- 10 trees hectare of farmland qualifies to be categorized as agroforestry. Young (1989) indicated that for any farmland to be categorized as agroforestry there must be more than 10 trees per hectare of farmland.

Table 4.28 Number of trees on farms in the Asunafo North District

Number of trees (per hectare)	Number of Respondents	% of Respondents
Less than 5	28	25.0
5 – 10	37	33.0
Greater than 10	20	17.9
No trees on farms	27	24.1
Total	112	100.0

(Source: Field Survey, 2013)

Mass tree-planting activity in the Asunafo North District

Many studies have stressed the importance of trees to rural households around the world (Falconer, 1990). Analysis of tree planting activities in the study area showed that mass tree planting exercises on school land was the highest (41.5%), church land (31.7%), chief's palace (14.6%) and community land (12.2%) [Table 4.29]. It was revealed that seven sources of seedlings contributed to the mass tree planting exercises; Forestry

Commission (FC), Ministry of Food and Agriculture (MoFA), Chief, Headmaster, Ministry of Education (MoE). The contribution of the MoE to mass tree planting was highest (30.4%), then FC (26.1%), MoFA (23.9%), Assemblyman (8.7%), Chief and Church (4.3% each) and Headmaster (2.2%) in the District [Fig. 4.10]. From the results, it could be seen that, tree-planting awareness in the District is high and major stakeholders are all involved in tree-planting exercises. However, there is the need to extend this awareness and exercise to farmers and farmlands respectively. This confirms 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.

Table 4.29 Location of mass tree planting exercise in the Asunafo North District

Location of mass tree planting	Number of Respondents	% of Respondents
School	17	41.5
Church	13	31.7
Palace	5	12.2
Community land	6	14.6
Total	41	100.0

(Source: Field Survey, 2013)

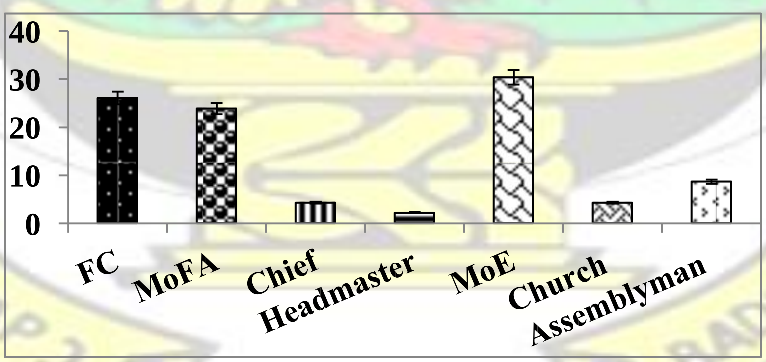


Fig. 4.10 Source of seedlings for mass tree planting in the Asunafo North District

Motivations for tree planting and tree planting technologies

Preventing destruction of crops by livestock (live fencing), boundary security and prevention of conflicts (Boundary planting), soil fertility improvement/planting selected trees on farmlands and supplementing household food/income (Home gardens) were identified as motivations for tree planting. The home garden system was identified at Mim, Apenkro and Kasapin; 8.5%, 33.3% and 7.7% respectively. Most respondents (35.7%) plant trees along their boundaries, whiles 25.9% incorporated trees for improved fallows, 4.5% for home gardens and 1.8% for live fencing in the District of the Brong Ahafo Region (Table 4.30). Farmers are motivated to adopt tree-planting technologies, mostly not with the deliberate intention of tree-crops interactions, but for security (55.2%; live fencing and boundary planting). However, about 40% understand the importance of trees to soil fertility regeneration during the fallow period. There is need to emphasize the positive interactive effect of trees on cropland through agriculture extension services, in order to promote agroforestatry. 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.

Table 4.30 Tree planting technologies in the Asunafo North District

Technologies	Number of Respondents	% of Respondents
Live fencing	2	1.8
Boundary planting	40	35.7
Tree on farms	29	25.9
Home gardens	5	4.5
No answer	36	32.1

Total	112	100.0

(Source: Field Survey, 2013)

It became evident through the survey that boundary demarcation, improvement of soil fertility and fencing off animals were the major benefits derived from the tree planting system adopted; other minor benefits were categorized under "Others". The "Others" category recorded 6.7% at Mim. 52.2% (boundary conflict resolution) was the highest, followed by 40.6% (improvement of soil fertility), 4.3% (fencing animals) and 2.9% (Others) in the entire Asunafo North District (Fig. 4.11).

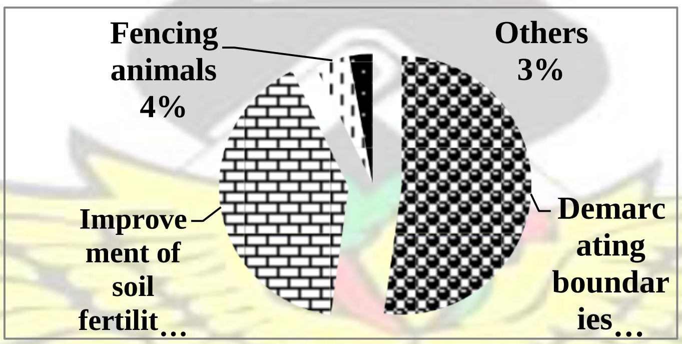


Fig. 4.11 Motivation for tree planting in the Asunafo North District

Purpose for which farmers would plant trees in the Asunafo North District

Assessment of the desires of farmers with respect to trees to plant in future revealed that most respondents (43.8%) desire to plant more fuelwood trees, whiles 39.3% would want to plant fruits trees and 13.4% desiring to plant fodder trees (Table 4.31). Since fuelwood constitute the major energy source in rural communities (Donhauser *et al.*, 1992) it became the most desirable tree component to plant; however, the economic implications of fruit trees, as declared and outlined by Donhauser *et al.*, (1992), made them the immediate subordinate economic enterprise to fuelwood. Further investigation carried into the reason for the trend in the choice of trees showed three reasons; income (53.1%), Household use (37.9%) and Feeding animals (9.0%)[Fig. 4.12]. This is in agreement with Alavalapati and Nair (2001) which report it may appear that farmers implement agroforestry systems to address household needs such as food, fodder, and fuelwood. In addition, Nair (1998) emphasised 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.

Table 4.31 Purpose for which farmers would plant trees in the study district

Trees desired to plant	Number of Respondents	% of Respondents
Fuelwood trees	49	43.8
Fodder trees	15	13.4
Fruits tress	44	39.3
No answer	4	3.6
Total	112	100.0

(Source: Field Survey, 2013)

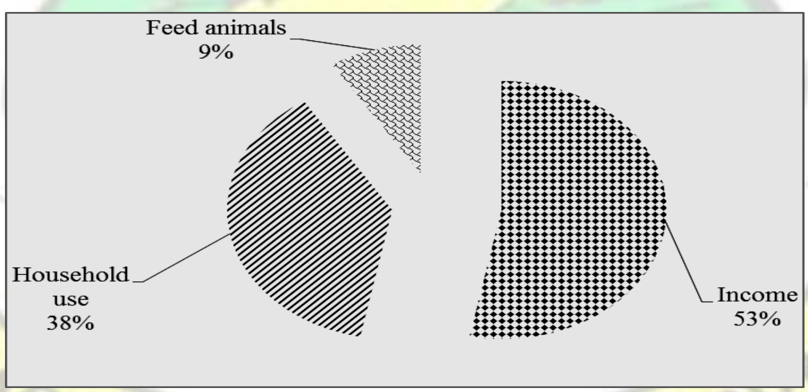


Fig. 4.12 Reasons for desired future trees in the Asunafo North District

4.4.6 Major tree production constraints identified in the Asunafo North District

Effect of trees on crop yield in the Asunafo North District

Thevathasan *et al*. (2004) state tree-influenced microclimatic modifications may act in such a way as to increase the overall productivity of the associated agricultural crop. Investigation into farmers' perception of how trees affect crop yield showed that three benefits were identified; checking erosion, adding nutrients and providing shade. From Table 4.32, 59.9% of farmers declared that trees add nutrients to the soil, 50.0% reported that trees check erosion and 2.7% emphasized that trees provide shade.

According to Steiner (1984), controlling erosion could significantly improve soil fertility. Steppler and Nair (1987) reported that trees in agroforestry systems provide shade and are of significant socio-economic implications to the farmer. 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).

Table 4.32 Roles of trees in crop yield in the Asunafo North District

Contribution	Number of Respondents	% of Respondents
Check erosion	56	50.0
Add nutrients	66	59.9
Provide shade	3	2.7
Total	***125**	**112.6**

(Source: Field Survey, 2013)

***Total number of respondents greater than 112 due to multiple responses by some farmers**

Problems posed by trees in the Asunafo North District

From the point of view of respondents, the major problems posed by trees growing on farmlands are excessive shading, harboring of pest, allelopathic effect, competition for nutrients and competition for water were the major problems. Harboring of pest was highest (47.3%), followed by allelopathic effect (30.4%), shading (28.6%), competition for nutrients (22.3%) and competition for water (22.4%) [Table 4.33]. It is therefore important to encourage farmers in the district to embark on agroforestry since some of these problems listed can be addressed through the adoption of agroforestry technologies. The presence of some tree species can suppress the growth of weeds on farm lands (Scherr, 1991). Steppler and Nair (1987) reported that the provision of shade associated with agroforestry has some socio-economic benefit such as improving productivity in dry areas. Farmers seem to have knowledge about the problems associated with tree on farms, suggesting long-term experience with trees.

Table 4.33 Problems posed by trees in the Asunafo North District

Problems	Number of Respondents	% of Respondents
Shading	32	28.6
Harbor pests	53	47.3
Allelopathic effect	34	30.4
Competition for nutrients	25	22.3
Competition for water	24	21.4
Total	***168**	**150.0**

(Source: Field Survey, 2013)

***Total number of respondents greater than 112 due to multiple responses by some farmers**

Tree management constraint

The major reported constraints to tree management in the District were unavailability of labour (13.4% of respondents) and poor technical know-how (79.5%) [Table 4.34]. Seven percent of respondents did not have any constraints and said they managed their trees effectively. Management approaches adopted by the group included pruning (mainly to reduce shade on farm) during the cropping season. Some trees were also pruned to provide fuelwood and poles for staking yam, which is widely cultivated in the District. By far, the most important constraint was poor technical knowledge (about 80% of respondents). This could most likely be attributed to the poor nature of the extension services. This gives an indication of farmers' need for extension advice, since they admitted that that they lacked technical knowledge on tree management. Therefore, for widespread adoption of Agroforestry practices as well as the effective management on trees on farms, extension personnel must step up efforts in reaching up to the farmers with requisite knowledge to tree management. Mekoya *et al*., (2008) found that agroforestry technologies are knowledge intensive and therefore require enough education in the adoption process.

Table 4.34 Tree management constraint in the Asunafo North District

Constraint	Number of Respondents	% of Respondents
Unavailability of labour	15	13.4
Poor technical know-how	89	79.5
No answer/Not sure	8	7.1
Total	112	100.0

(Source: Field Survey, 2013)

4.5 Tree Products and Marketing in the Asunafo North District

4.5.1 Tree products got from farms in the study area

Table 4.35 shows that tree products harvested from farms included fuelwood, charcoal, fruits, poles, furniture, fodder and medicine. In the entire district, fruits were the major tree products harvested from farms (57.1%), followed by fuelwood (50.9%), charcoal (44.6%), poles (32.1%), furniture (24.1%), medicine (17.9%) and fodder (12.5%) respectively

[Table 4.35]. Results of this study agree with the findings of Relwani (1979) that fuelwood is the most important source of energy in rural communities. 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. FAO (1985) reported that as long as fuelwood could be collected without paying for it, farmers had little incentive to plant fuelwood producing trees.

Table 4.35 Tree products from farms in the Asunafo North District

Tree products	Number of Respondents	% of Respondents
Fuelwood	57	50.9
Charcoal	50	44.6
Fruits	64	57.1
Poles	36	32.1
Furniture	27	24.1
Fodder	14	12.5
Medicine	20	17.9
Total	***268**	**239.2**

(Source: Field Survey, 2013)

***Total number of respondents greater than 112 due to multiple responses by some famers**

Overall analysis revealed that 86% of farmers sold their tree products at the local market, with 14% for the home category (subsistence), in the Asunafo North District (Fig. 4.13). Social marketing research identifies perceptions of the barriers and benefits necessary to change behaviour among individuals in relation to the marketing of agroforestry products

(McKenzien 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.

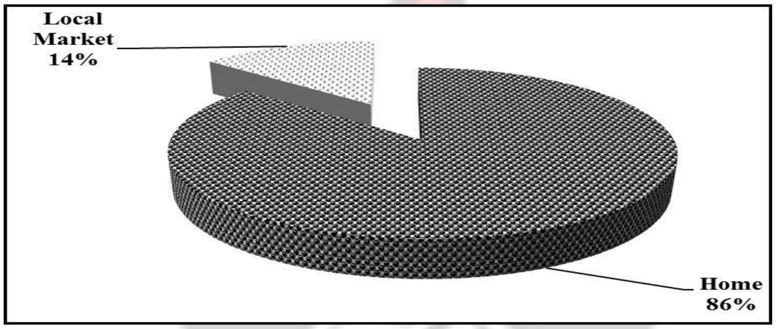


Fig. 4.13 Markets for tree products in the Asunafo North District

4.5.2 Major tree products and marketing constraints identified in the study area

Further investigation revealed that high costs and scarcity of tree products were the major problems identified by the respondents for this study. Most farmers (89.3%) in the Asunafo North District of Brong Ahafo region recognized high tree products costs as major problem whiles 4.5% emphasize that the problem lays in the scarcity of tree products (Table 4.36). The trend could be a result of the influx of urban traders to market centers during market days. During such periods, there is price hikes, thus products become expensive for rural folks who cannot compete with these urban traders in purchasing the products. This implies there is no better markets structure for this farmers in the District. This finding disagree with Terray (1974) which found that better markets for agroforestry products provide a way for poor farmers to generate income. From the view of He Feng *et al*., (2007) credit availability for farming can help rural farmers increase their production and consumption by purchasing available quantity of tree products in the market.

Table 4.36 Challenges to tree products marketing in the Asunafo North District

Challenges	Number of Respondents	% of Respondents
High costs of products	100	89.3
Scarcity of products	5	4.5
None	7	6.2
Total	***105**	**100.2**

(Source: Field Survey, 2013)

***Total number of respondents less than 112 due to lack of responses by some farmers**

4.6 Supporting Services in the Asunafo North District

4.6.1 Agricultural extension activities in the study area

The study revealed that agricultural extension services received through MoFA was 10.7%, followed by MoE (8.9%) and CRA (0.9%) for the Asunafo North District (Table 4.37). It was ascertained that the last extension period fell into 3 groups; below 6 months (< 6 months), from 6 to 12 months (6 – 12 months) and above 1 year (> 1 year). From Table 4.6, 68.2% of the respondents emphasized that the last extension date was less than 6 months, followed by extension period greater than 1 year (22.7%) and 6 – 12 months extension period (9.1%) [Fig. 4.14]. It follows that there has been a recent increase in extension services activities in the district carried out mostly by the ministries. However, the efforts of the ministries could be complemented by farmer organizations and private sectors in order to improve upon productivity. 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 emphasized that, farmers may be more willing to trust and listen to fellow farmers than to extension personel who often come from outside the community (Chew, 1989).

Table 4.37 Sources of extension services in the Asunafo North District

Source of extension service	Number of Respondents	% of Respondents
MoFA	12	10.7
CRA	1	0.9
MoE	10	8.9
No knowledge	89	79.5
Total	112	100.0

(Source: Field Survey, 2013)

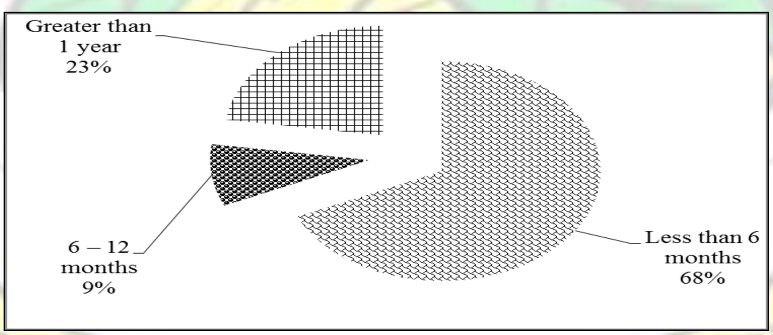


Fig. 4.14 Last extension date in the Asunafo North District

4.6.2 Non-Governmental Organizations in the communities under study

Non-Governmental Organizations are active in only Betoda and Mim and these were GTZ (GesellschaftfürInternationale) and ADRA (Adventist Development and Relief Agency). Whiles 8.0% each responded for GTZ and ADRA at Betoda, all respondents at Mim identified both GTZ and ADRA as non-governmental organizations operating in the community. GTZ represented 8.0% and ADRA, 8.0%, in the Asunafo North District (Table 4.38). Thus, the limited presence of these organizations in the district impacts negatively on extension services.

It was revealed that GTZ and ADRA provided three kinds of assistance to farmers at Betoda and Mim. These were provision of technical knowledge (such as application of fertilizers, pests and diseases control, bushfire control etc.), improved seed and farm equipment. Provision of technical knowledge was 76.5%, then provision of improved seeds (17.6%) and provision of equipment (5.9%) for the entire district (Fig. 4.15). MoFA (2012) informed that the services of agric-centred external organizations are woefully inadequate in many rural communities that need them the most. Therefore, these services from GTZ and ADRA could be extended to other communities in the district so that other farmers may also benefit and increase yield of farm produce. 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).

Table 4.38 Non-governmental organizations active in the Asunafo North District

Non-Governmental Organization	Number of Respondents	% of Respondents
GTZ	9	8.0
ADRA	9	8.0

No answer	94	83.9
Total	112	100.0

(Source: Field Survey, 2013)

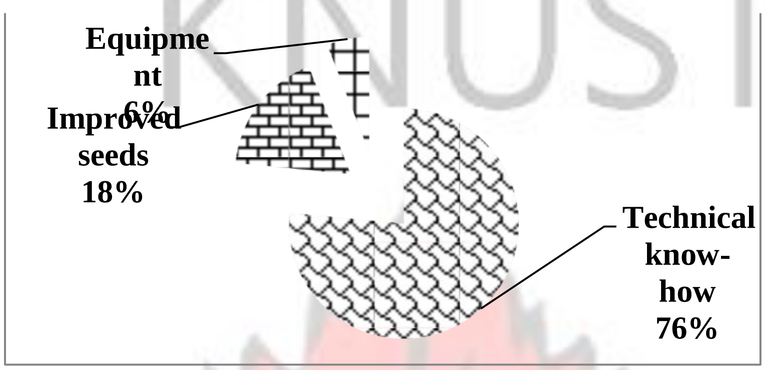


Fig. 4.15 Services provided by non-governmental organization in the Asunafo North District

4.6.3 Farmers associations in study area

There are two main farmer or producer associations in the Asunafo North District. These are Cocoa Growers Association with highest (14.3%) membership followed by Vegetable Growers Association (10.7%) [Table 4.39]. Farmers' associations do not seem to be vibrant in the district as only 28 out of the 112 respondents belonged to such associations. However, this is a very important tool for the implementation of good agricultural innovations. When farmers work in groups, it yields synergistic effects which facilitates training, sourcing of credit and effective marketing of farm produce. Farmers must therefore be encouraged to form farmers associations that will benefits individual farmers. This in line with Boehringer (2001) that effective partnership among farmers and individuals and organizations engaged in research and extension is critical to success in scaling-up agroforestry. 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.

Table 4.39 Membership of producer associations in the Asunafo North District

Farmers Associations	Number of Respondents	% of Respondents
Cocoa Growers Association	16	14.3
Vegetable Growers Association	12	10.7
Not members	86	75
Total	112	100.0

(Source: Field Survey, 2013)

4.6.4 Storage facilities in the study area

Two kinds of storage facilities were available among the communities that had storage facilities; domestic preservation (store crops in their homes) and Community Silos. Community silos (19.6%) was used more than the domestic preservation (3.6%) [Table 4.40]. It follows that means of storage is a major constraint faced by farmers since only 26 respondents out of the 112 respondents had some means of preservation. This has a tendency of reducing yields as many may go waste if not properly stored. Community silos tend to limit the available storage space for all farmers. It follows that, farmers must be empowered to establish their individual storage shelves and silos, and this could be achieved through farmers association and external organizations. Research conducted by Hoskins (1987) revealed that, selection of an appropriate market infrastructure can increase the availability of agroforestry products in markets. He Feng *et al*., (2007) suggested that credit availability for farming can help rural farmers increase their production and consumption by constructing silos for storage.

Table 4.40 Storage facilities in the Asunafo North District

Storage facility	Number of Respondents	% of Respondents
Domestic preservation	4	3.6
Community silos	22	19.6
No storage facility	86	76.8
Total	112	100.0

(Source: Field Survey, 2013)

Personal, Banks and Friends were the crediting types identified. The number of people sourcing credit from the banks (25%) is more than those sourcing from friends (15.2%) and personal/self-financing (12.5%) [Table 4.41]. The absence of credit facilities tend to limit production inputs, hence yield. To encourage agriculture in the district, credit facilities must be available and easily accessible. It agrees with Boehringer (2001) that it demands providing technical information and training to the practitioners, micro-finance, and formal credit systems, improving market access, and strengthening organizational linkages.

Table 4.41 Source of credit facilities in the Asunafo North District

Credit facility	Number of Respondents	% of Respondents
Personal	14	12.5
Banks	28	25
Friends	17	15.2
No credit facility	53	47.
Total	59	100.0

(Source: Field Survey, 2013)

4.6.5 Assessment of road networks in the study area

Road network problems existed for all the communities under study. Fig. 4.18 shows that majority of the respondents (82.1%) emphasized the absence of good road network and

17.9% was recorded for those who affirmed the presence of road networks. The nature of roads and road networks contribute significantly to agricultural production in rural districts. Roads linking communities in the study are in poor condition and in most cases motors are unable to move, especially in the rainy season. An overwhelming majority (82%) of respondents attested to this fact whiles 18% thought roads were not too bad. It needs to be mentioned here that the extent to which respondents perceived the nature of the road network depended on their communities of residence. From the survey, it was discovered that those who revealed that there were no good road network were respondents at Bonkoni. Since road networks facilitate the transportation of goods from farm sites to markets, poor roads must be repaired and new ones constructed to help the farmers.

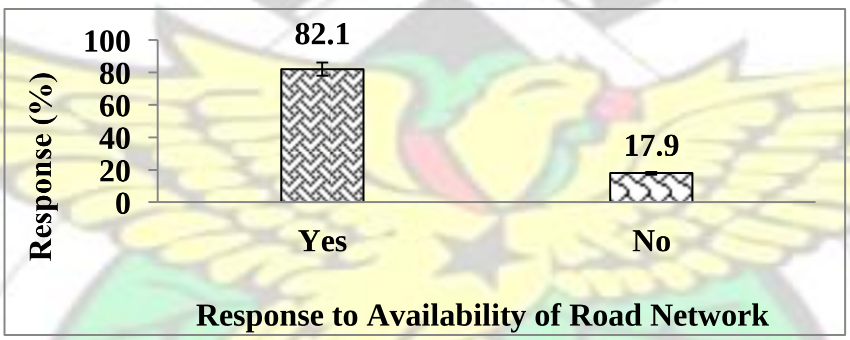


Fig. 4.16 Response problems with road network in the communities

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

The study determined the socio-economic feature or environment, described the important agricultural production and land use systems, diagnosed the production constraints of the major land use systems and identified research of the development.

Based on this finding of the study, the following conclusions have been drawn:

5.1.1 The socio-economic feature or environment of the study area

Majority of respondents (58%) were females between the age group of 34 – 48 yrs who farm on family lands. Whiles primary source of income was identified to be farming and petty trading was the next most important income source. More than 20% of all income is invested back into farming. Income from non-tree products were in the form of sale of fuelwood, charcoal, fruits and fodder respectively. Consequently, the main sources of energy were fuelwood and charcoal. Fuelwood is gathered from bush, trees on farm and occasionally bought from the market. 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. The major source of labour on farms was identified to be from households, then community labour. Hired labour is significantly non-existent; it was only recorded at Mim (17.4%). Finally to conclude, it must be emphasised that the successful promotion of agroforestry as a solution to the various land use problems in the district would depend on secure land rights and adequate education in the adoption of agroforestry technologies.

5.1.2 Major important agricultural production and land use systems of the study area

The most important agricultural production/land use systems maize based land-use system (maize as main crop intercropped with plantains, cassava and yams), cocoa agroforestry (cocoa as main crop intercropped with plantain, cassava and maize in the early years before canopy closure) and citrus, oil palm production system. Manual clearing without burning (‘Proka’) from secondary and occasionally primary forests is the major cultural practice before planting. Farmers farmed multiple lands with different crop types (Annuals-e.g. maize, biennials e.g. cassava, perennial/tree crops e.g. cocoa, and mixed cropping/intercropping e.g. plantain and cocoyam, maize and beans), combinations (pure stand and mixed stand) and varying land sizes (predominantly less than 5 acres for annuals and perennials and greater than 10 acres for tree crops). Pure stands were mostly oil palm, cocoa, citrus, yam, plantain and tomatoes. Most respondents did not use improved seeds due to unavailability of the seeds and where available, high cost. Trends in yields were overwhelmingly identified to be increasing and this was attributed to fallow practice and fertilizer application. Fallow was practiced by all the communities, with periods ranging from 1 – 6 years (it also became clear that labour worked regularly on farms and labour strength was highest for 5 – 10 people). The study also revealed that animals kept included poultry (chicken and guinea fowl), small ruminants (goats, sheep and guinea pig) and cattle with goats being the most important. Method of keeping farm animals was predominantly semi-intensive with the main sources of feed including leftover, fodder and cereals (maize, wheat) respectively.

5.1.3 Production constraints of the major land use systems

The major crop production constraints were determined to be lack of cash and scarcity of land. Thus, access to good and improved crop varieties is scarce. Inadequate rainfall, lack of storage, poor crop varieties, insect and pest infestation, soil erosion and credit facilities were also major problems confronting the district. Moreover, the major problem in keeping livestock was theft and diseases. Tattooing, fencing and regular counting were methods of protecting livestock. Tree management constraints were identified as poor technical-know-how (79.5%) and unavailability of labour (13.4%). Thus, farmers overwhelmingly emphasized that they do not have enough land to spare for tree planting. Majority of respondents at Betoda and Kasapin understood the importance of trees on their farmlands whiles the other communities no one identified link between the contribution of trees and their crop yield. In order to increase income, farmers would like to plant fruit trees and trees for fuel.

5.1.4 Research needs and interventions of the study area

Research needs

Research needs exist to increase tree components to improve existing monocropping system and identifying means for expanding the animal production sector. There is need to pilot model farms in the Asunafo North District patterned after agroforestry interventions such as trees on cropland, introduction of fuelwood trees, fruit trees, fodder trees, live fencing and home gardens. Thus, extension services must be able to demonstrate the relevance of their technology for farmers' adoption through piloting of model farms.

The principal occupation in the study area is farming (76%). Assessment of the desires of farmers with respect to trees to plant in future revealed that most respondents (43.8%) desire to plant more fuelwood trees, whiles 39.3% would want to plant fruits trees and 13.4% desiring to plant fodder trees. Investigation needed to identify whether the farmers in the district are aware of climate change and its impact on their farming activities ranging from the time of planting their crops, emerging pest and diseases to time of harvesting. .

The farmers' attitude on forest in the district is very poor. They tend to remove most of the forest trees during land preparation. The number of fields kept by respondents ranged from 1 to 4 fields. Farmers are increasing their farm size by expanding their existing farms and establishing new farms in addition to old and low yielding ones. Therefore, a research programme must be conducted to reveal the level of awareness of farmers in the district concerning human activities that causes climate change.

Potential interventions

Several interventions, both agroforestry and non-agroforestry are potentially available for introduction to solve identified problems. This section looks at these potential technologies and proceeds to recommend specific ones for the constraints in the Asunafo North District. The research needs for the development and/or improvement of technologies are also elaborated upon.

There is need to educate farmers as well as encourage them to plant selected upper storey/canopy trees on farmlands, especially food crop farms that have lost most of their tree cover. Integration of these upper storey multi-purpose canopy trees will also provide products like stakes, fodder, poles for building livestock housing, fuelwood and windbreaks. The multipurpose trees could provide fruits, fodder and fuelwood (Nair, 1993**).**

Among rural folks, fuelwood constitute the most important source of household energy. Thus, as population increases, twigs, fallen trees and branches become increasingly unavailable for fuelwood, and attention is shifted to primary and secondary forests. Thus, the threat of the fuelwood crisis rises. Therefore, the inclusion of viable and compatible fuelwood trees on farmlands would help farmers in the district. This will also help reduce the current rate of deforestation due to the fuelwood drive (Nair, 1993).

Nair (1984) contended that fruit trees are very dear to the rural folks. This current study also explained the importance of fruit trees to the farmers. Fruit trees are common components in home gardens and are well adapted to local climatic conditions. Since it was ascertained from the study that fruits constituted a major tree product harvested from farms, and as such are used for both food and cash, it is imperative that farmers are educated on the need to integrate more fruit trees on their farms. Hence the practice of mixed agroforestry system which integrates local fruit trees relevant to the livelihoods of the farmers (EMBRAPA, 1982; Subler and Uhl, 1990) would be appropriate for the Asunafo North District.

Live fencing is used to prevent livestock from causing damage to crops. Fodder trees and fruit trees could serve for live fencing as well as windbreaks. These trees could serve several purposes since they are multipurpose trees. While they serve as windbreaks, they could also serve for fodder for livestock. Windbreaks may reduce damage to crops by wind as well as reducing soil erosion.

There is need to pilot model farms in the Asunafo North District patterned after the interventions described in this study. Such an approach results in positive benefits that are quantifiable would be easily adopted by farmers as evidence of the success of such an approach would not be farfetched. Thus, extension services must be able to demonstrate the relevance of their technology for farmers' adoption. The most appropriate method is to institute model farms on several plots on individual farmers land alongside their current method. Here the farmer will have the opportunity to monitor crop performance and yield and compare local methods with the introduced method.

5.2 Recommendations

From the results of the study, the following recommendations are made.

- To sustain the traditional practice of agroforestry and the adoption of new technologies to solve problems of decreasing soil fertility and soil erosion, awareness campaign is need for farmers to adopt alley cropping which entails growing food crops between hedges grow of planted shrubs and trees preferably leguminous species. The hedges are pruned periodically during the crops growth to provide biomass (which, when, returned to the soil, enhances its nutrient status and physical properties and to prevent shading of growing crops. The underlying scientific principle of this technology is that, by continually retaining fastgrowing, preferably nitrogen fixing trees and shrubs on crop-producing field, their soil improving attributes (such as recycling nutrients, suppressing weeds, and controlling erosion on slopping land) will create soil conditions similar to those in the fallow phase of shifting cultivation (Kang, 1980).

- Farmers should be encouraged and educated to adopt agroforestry for fuelwood production on farmlands, especially food crops that have lost most of their tree cover. The integration of these upper storey multi-purpose canopy trees not only provide fuelwood to end the "energy crisis" and deforestation in the study area but also provide products like stakes, fodder, poles for building livestock, housing and windbreaks (Nair, 1993).

- Accidents were seen as one of the major constraints confronting rearing of livestock in particular. The study therefore recommends live fencing in order to prevent the animals from moving about and being hit by moving vehicles and traps in the villages. In semi-arid zones, livestock often graze in the shade of trees, especially "*faidherbia albida*" which is known for its ability to improve grass production around it and provide shade as well.

- There is urgent need for extension services in the district in the form of providing good crop varieties, technical knowledge and farm equipment, especially at Bonkoni, Ntesere, Apenkro, Dominase and Abidjan. Extension services should focus on tree components, their benefits and their complete integration for sustainability. Farmer organization should also be encouraged.

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APPENDIX

Sample Questionnaire used for the study

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

QUESTIONNAIRE ON LAND USE ANALYSIS

1.1 PERSONAL/DEMOGRAPHIC/SOCIO-ECONOMIC INFORMATION

1. Farmer's No./Name:……………………………………………………………
2. Location:…………………………………………………………………..
3. Community:……………………………………………………………….
4. Date:…………………………………………………………………………...
5. Sex: Male [ ] Female [ ]
6. Age (Actual)
(a) 18 – 33 [ ]
(b) 34 – 48 [ ]
(c) 49 – 60 [ ]
(d) 60 and above [ ]
7. Origin: (a) Native (b) Migrant
8. Which ethnic group do you belong to?
(a) Akan [ ] (b) Ewe [ ] (c) Northerner [ ] (d) Ga-Adangbe [ ]
9. Educational Status
(a) Primary [ ]
(b) MSLC/J. H. S. [ ]
(c) S. H. S. [ ]
(d) Tertiary [ ] **(e)** None [ ]
(f) Others specify………………………………………………………………
…………………..
10. Marital Status
(a) Single [ ]
(b) Married [ ]

(c) Divorced [ ] **(d)** Widowed [ ]

11. No. of children:

(a) 0 – 4 [ ] **(b)** 5 – 9 [ ] **(c)** 10 and above

1.2 OCCUPATION

1. What is your major occupation? (a) farming (b) trading (c) artisan (d) government employee (e) others specify…………………………….
2. What other minor jobs are you engaged in? (a) petty trading (b) farming **(b)** hunting (d) sale of fuelwood (e) others specify…………………………….
3. How long have you been living in this area?
   (a) Less than 5 yrs [ ]
   (b) 5 – 15 yrs [ ]
   (c) Over 15 yrs [ ]

2.0 LAND-USE HISTORY 1.

Who owns the land?

(a) Hired [ ] (b) Family [ ] (c) Personal [ ] (d) Gift [ ]

2. If hired, what is the tenureship agreement? ……………………………….…….
3. Under the terms are you allowed to plant trees?
   (a) Yes [ ] (b) No [ ]
4. If yes, what type of trees do you plant?...
5. Do the trees pose any problem(s) to the crops?
   (a) Yes [ ] (b) No [ ]
6. If yes, list some of the problems.…………………………………………………
7. What type of Land Use was practiced before you took over to farm?
   (a) Forest [ ]
   (b) Cropland [ ]
   (c) Grazing [ ]
   (d) Woodlot [ ]
8. What was the condition of the field when you came?
   (a) Very fertile [ ]
   (b) Moderately fertile [ ]
   (c) Fertile [ ]
   (d) Low/poor fertility [ ]
9. How many fields do you maintain?...
10. What crops do you cultivate on each of these fields?
    (a) Annuals only (b) Biennials only (c) Tree crop/Perennials only (cocoa, oil palm, citrus, etc.) (d) Alley farming/Intercroping
11. What is the average size of each farm?

TYPES OF FARM	ACREAGE

12. Do you allow your land to go fallow after some years of cultivation?
(a) Yes [ ] (b) No [ ]

13. If yes, what is the length of your fallow period?
(a) 1 – 3 yrs [ ] (b) 4 – 6 yrs [ ] (c) Above 6 yrs [ ]

14. If No, why?
(a) Scarcity of land [ ]
(b) High population [ ]
(c) Others Specify:…………………………………………………………………

15. What method of land preparation do you use before planting your crops?
(a) Manual clearing and burning [ ]
(b) Manual clearing and no burning (proka) [ ]
(c) Chemical weed control [ ]
(d) Minimum tillage [ ]
(e) Others specify:……………………………………………………………………

3.0 PRODUCTION SUB-SYSTEMS 3.1
CASH SUB-SYSTEMS

1. What is your major source of income?
   (a) Farming [ ]
   (b) Collection of NTFP's [ ]
   (c) Petty trading [ ]
   (d) Sales of fuelwood [ ]
   (e) Others specify:…………………………………………………………………………
2. Do you have any secondary sources of income? Yes [ ] No [ ]
3. If yes, what are they?...
4. How much of your income do you invest in your farm?
   (a) 10% (b) 5% (c) 20% (d) above 20%
5. Do you specifically get income from trees?
   (a) Yes [ ] (b) No [ ]
6. If yes, specify: ………………………………………………………………

3.2 CROP SUB-SYSTEM

1. How do you prepare the land for cropping?……………………………………
2. Which crops do you grow on your farms?
   (a)……………………………………. (d)…………………………………..
   (b) ……………………………………. (e) …………………………………
   (c) ……………………………………. (f) ……………………………………

3. Which crops do you grow in:
(a) Pure stand? (b) Mixed stand?
(i)……………………………………. (i)…………………………………..
(ii) ………………………………… (ii) …………………………………
(iii) ………………………………… (iii) …………………………………

(iv)…………………………………..   (iv)………………………………….
4. Do you use improved seeds?
(a) Yes [ ]   (b) No [ ]
5. Why?...
6. Which of these crops are/is mostly consumed at home?..................................
7. Which of these crops are/is mostly sold for income?
8. What has been your trends in yield over the years?
(a) Increasing [ ]   (b) Stable [ ]   (c) Decreasing [ ]
9. What do you think are the contributing factors for this situation?…………………
10. Which of the following is your major resource constraints?
(a) Land [ ] (b) Labour [ ] (c) Infrastructure [ ] (d) Cash/Inputs
(e) Others specify:……………………………………………………………….
11. How do you improve the fertility of your soil (land)?
(a) Application of fertilizer [ ]
(b) Fallow system [ ]
(c) Others specify:…………………………………………………………………
12. What constraints do you have on your plant growth?
(a) Poor soil [ ]
(b) Low fertility [ ]
(c) Inadequate rainfall [ ]
(d) Poor crop varieties [ ]
13. What farm management constraints do you have?
(a) Flooding [ ]
(b) Soil erosion [ ]
(c) Weeds, insect pests [ ]
(d) Diseases [ ]
(e) Theft [ ]
14. Do you have any challenge in selling your products?
(a) Yes [ ]   (b) No [ ]
15. If yes, specify:……………………………………………………………………….
16. Do trees contribute to yield of your crops?
(a) Yes [ ]   (b) No [ ]
17. If yes, specify:………………………………………………………………………..

3.3 ANIMAL SUB-SYSTEM
LIVESTOCK PRODUCTION
1. What type of animals do you keep?

TYPE	NUMBER
Chicken	
Guinea fowl	
Goats	
Sheep	
Cattle	

2. What system (intensive, semi-intensive, extensive)of livestock keeping do you practice for each type?
   (a) Chicken……………………………………………………………… (b) Guinea fowl………………………………………………………………
   (c) Goats ……………………………………………………………….. (d) Sheep …………………………………………………………………….
   (e) Cattle ……………………………………………………………………..
3. How do you feed your livestock?
   (a) Zero grazing (intensive system) [ ]
   (b) Semi-intensive system [ ]
   (c) Extensive system [ ]
4. Do you get enough feed?
   (a) Yes [ ] (b) No [ ]
5. If yes, what is the source of your feed?…………………………………………
6. If no, how do you supplement your feed?………………………………………
7. What are the problems/challenges in keeping the livestock?……………………
8. How do you protect your livestock from theft?………………………………
9. Do you have readily available market for your livestock products?
   (a) Yes [ ] (b) No [ ]
10. If no, specify:……………………………………………………………………

3.4 ENERGY SUB-SYSTEMS

1. What is your major source of energy?

(a) Electricity [ ] **(c)** Fuelwood [ ]
(b) Charcoal [ ] **(d)** LPG gas [ ]

2. Do you plant trees on your farm?

   (a) Yes [ ] (b) No [ ]

3. How do you get your fuelwood?
   (a) Gathered from bush [ ]
   (b) Gathered from trees on farm [ ]
   (c) Bought from market [ ]
4. Which tree products do you buy?..

4.0 LABOUR AND MANAGEMENT

1. What is your main source of labour on your farm?……………………………
2. How many people work on your farm?..
3. Do you hire labour?
   (a) Yes [ ] (b) No [ ]
4. If yes, for which farm operations do you hire labour?……………………………
5. If labour is hired, what is the source of cash for this purpose?……………………
6. Do the labour work on trees on your farm?

(a) Yes [ ] (b) No [ ]

7. If yes, which type of tree management do the labour practice?

(a) Prunning [ ] (b) Lopping [ ] (c) Coppicing [ ] (d) Pollarding [ ]

(d) Others specify:…………………………………………………………………....

8. What are some of the constraints you have in tree management?

(a) Unavailability of labour [ ]

(b) Poor technical know-how by labour [ ]

(c) Others specify:……………………………………………………………………

5.0 LAND-USE AND TREES ON FARM

1. Do you have trees on crop fields?

(a) Yes [ ] (b) No [ ]

2. If yes, list the names of the trees in your field.…………………………………..

3. Did you plant the trees yourself?

(a) Yes [ ] (b) No [ ]

4. How many trees have you planted? (a) Between 5 and 10 [ ]

(b) More than 10 [ ]

(c) Less than 5 [ ]

5. What is the arrangement of trees on your farm?

(a) Zonal [ ]

(b) Scattered [ ]

(c) Linear [ ]

(d) Others specify:……………………………………………………………………

6. Do trees on your farm pose problems to your farming?

(a) Yes [ ] (b) No [ ]

7. If yes, list the problems.…………………………………………………………..

8. Do you have enough land to plant trees?

(a) Yes [ ] (b) No [ ]

9. If no, give reasons………………………………………………………………….

10. What type of trees would you like to plant?

(a) Trees for fuelwood [ ]

(b) Trees for fodder [ ]

(c) Trees for fruits [ ]

(d) Others specify: ……………………………………………………………………

11. Why the choice of these types of trees?……………………………………….

12. Have there been any tree planting activities in your community?

(a) Yes [ ] (b) No [ ]

13. If yes, where?…………………………………………………………………..

14. Who provided the tree seedlings?…………………………………………………………………………..

15. Which problems did the trees face?……………………………………….

16. Which of the following motivates you to plant trees on your farm?

(a) Live fencing [ ]

(b) Boundary planting [ ]
(c) Improved fallows [ ]
(d) Home gardens [ ]

17. What benefits do you derive from the systems above?……………………………..

6.0 TREE PRODUCTS AND MARKETTING

1. Name the most common tree products from your farm (e.g. charcoal, fuelwood, fruits, fodder, medicine, etc.)

TREE	PRODUCTS

2. Do you sell any of the tree products?
(a) Yes [ ] (b) No [ ]

3. If yes, which tree products do you sell?……………………………………..

4. Where do you sell these products?
(a) Home [ ]
(b) Local market [ ]
(c) Others specify: ……………………………………………………………………

5. Which of these products are most important for subsistence?**......**…………..

6. Which tree products do you buy?
(a) Pole [ ]
(b) Building materials [ ]
(c) Furniture [ ]
(d) Fuelwood [ ]
(e) Others specify:……………………………………………………………………

7. Do you have any problem(s) in acquiring any of these tree products?
(a) Yes [ ] (b) No [ ]

8. If yes, specify:……………………………………………………………………..

7.0 SUPPORTING SERVICES

1. Do you get agricultural ectension services?
(a) Yes [ ] (b) No [ ]

2. If yes, state the source……………………………………………………………

3. When was the last time you had any extension visit?....................................

4. Do you get credit facilities for your farm production?
(a) Yes [ ] (b) No [ ]

5. If yes, what is the source of the credit?……………………………………………..

6. Do you belong to any farmers' organization?
(a) Yes [ ] (b) No [ ]

7. If yes, name the organization……………………………………………………….

8. Are there any external organizations operating in your community?

(a) Yes [ ] (b) No [ ]

9. If yes, fill in the table below:

Name of Organization	**Services**

10. Do you have storage facilities to store your yields?

(a) Yes [ ] (b) No [ ]

11. If yes, state the form of the preservation.

………………………………………………………………………………………

……………………………………………………………………………………..

12. Do you have problem(s) of road network?

(a) Yes [ ] (b) No [ ]