KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

KUMASI

COLLEGE OF SCIENCE

DEPARTMENT OF THEORETICAL AND APPLIED BIOLOGY

ASSESSMENT OF COLLABORATIVE FOREST MANAGEMENT PRACTICES AND IMPACT ON FOREST MANAGEMENT AND SOCIO-ECONOMIC DEVELOPMENT OF FRINGE COMMUNITIES IN THE AOWIN SUAMAN DISTRICT OF GHANA

A THESIS SUBMITTED TO THE DEPARTMENT OF THEORETICAL AND APPLIED BIOLOGY, COLLEGE OF SCIENCE KWAME NKRUMAH UNIVERSITY IF SCIENCE AND TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN ENVIRONMENTAL SCIENCE

BY:

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CERTIFICATION

I, ASARE KOFI CLEMENT OHENE, hereby declare that except for the references to the work of other authors, which have been dully acknowledge, I have personally, under supervision, undertaken these activities herein submitted and that no previous work for a degree has been submitted here or elsewhere.

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DEDICATION

I dedicate this study to God Almighty and my caring wife, Mrs. Fustina Ohene Asare, and children, Agyepomah Ohene Asare and Ohenewaa Ohene Asare.

ACKNOWLEDGEMENT

Space will not allow me to express my heartfelt gratitude to God Almighty Father. In short, I say may your name be praised and glorified. I am full of appreciation to my diligent supervisor, Rev. Stephen Akyeampong and Mr. Akwasi Ampofo –Yeboah, a brother and a lecturer in the Faculty of RNR, UDS, Tamale for their objective critics and valuable inputs to make this work a success. I am indeed, indebted to other authors who made their works available throughout the studies. Finally, my profound gratitude goes to my wife, Mrs. Fustina Ohene Asare for the moral support and the unwavering companionship. May God be with us all.

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LIST OF ACRONYNMS

CFM	-	Collaboration Forest Management
SRA	-	Social responsibility Agreement
CCFs	-	Chlorofluorocarbons
NTFPs	-	Non Timber Forest Product
FSD	-	Forest Services Division
FC	-	Forestry Commission
CCF	-	Chief Conservator of Forest
MA & D	-	Market Analysis and Development
TUC	-	Timber Utilization Contract
OASL	-	Office of the Administration of Stool Lands
TRMA	-	Timber Resources Management Act
DM	-	District Manager
TOS	-	Timber Operational Specifications
HFZ	-	High Forest Zone
GDP	-	Gross Domestic Product
CDA	-	Cost Benefit Approach
TEV	-	Total Economic Value

ABSTRACT

The study was conducted in the Yoyo and Tano Ehuro Forest Reserves in Enchi Forest District, in the Western Region. It was done in five communities; Jensue, Yakase, Adonikrom, Anwiafutu, and Nyankamam. Whereas Collaborative Forest Management (CFM) is employed in the management of Yoyo Forest Reserve such is done for the management of Tana Ehuro Forest reserve. The objectives of the study were to investigate Collaborative Forest Management Strategies practiced, to find out the socio economic impact of CFM on forest fringe communities and finally to estimate in area, volume, and cost the extent of forest destructions/ encroachment in the reserve where CFM is practiced against a reserve where CFM is not practiced. In each community, 20 respondents were randomly selected for a sample size of 100. The respondents were interviewed using semi-structured questionnaire. Field measurements were conducted on merchantable tree species found in the 800 meter squared area based on which calculations were done. It was revealed the CFM strategies that existed were effective, ranging from the involvement of fringe communities in the maintenance of forest boundaries, rehabilitation of degraded forest areas to the provision of fund, dubbed Community Investment Found (CIF). The CFM has had positive impact on communities. Ninety Nine Percent (99%) of respondents have had training by the FSD. 80% of respondents stated that the CFM had reduced their reliance on the forest resource, however, respondents proved that they encountered loss in 2007 during a week-long flood. The Tano Ehuro Forest Reserve is about 84% destroyed costing stakeholders Ghc 93,931,740 whiles Yoyo is 30% - 40% destroyed costing stakeholders Gh¢ between 142,087.2 and 189,449.6.

CFM should be enforced and strengthened by all forest districts in forest management. More alternative livelihood aids to fringe communities should be encouraged and a more intensive training be given to potential beneficiaries of the CIF followed by regular monitoring. Regeneration of the degraded areas be initiated by major stakeholders. Yoyo Forest Reserve should be strictly protected since it contains valued economic species.

CHAPTER ONE

1.0 INTRODUCTION

Collaborative Forest Management in general is loosely defined as a working partnership between the key stakeholders in the management of a given forest - key stakeholders being local forest users and state forest departments, as well as parties such as local governments, civil groups and non-governmental organizations, and the private sector (Agyemang and Affum, 2006).

To collaborate means, ideally, to work in partnership. Collaboration becomes essential once social. Forestry moves beyond small-scale community forests to large, productive, and public resources. The focus on partnerships is less ambiguous than the term 'participatory' approach. Agyemang and Affum (2006) found out that 'participation' as used in participatory forest management can mean different things, ranging from manipulation or co-option, in which lip-service is paid to local involvement. Participatory Forest Management therefore evolved under various names in different geographical locations. It is an umbrella term that refers to collaborative forest management, joint forest management, community forestry and shared forest management (Hobley, 1996).

Indeed, for many years local people were often viewed as destroyers of forests through agricultural activities such as grazing and land clearance. As the global forest area shrinks, the reasons for forest loss have been subjected to intense debate and analysis,

and forester perceptions of the role of local people are gradually changing from that of villains to potential collaborators. While farming is portrayed as a threat to forests in mainstream environmental discourses, this is not reflected in statistics on sources of timber. In the Ghanaian high-forest, 20 percent of the land has been appropriated by the state for forest reserves. Yet during the 1990s more than 80 percent of timber exports originated from off-reserve areas, largely consisting of farmland. In other words, farming areas continued to produce as much timber as the forest reserves, in addition to providing agricultural crops. Although farming areas do not contain closed canopy forest, farmers have managed to preserve forest resources of considerable value in them. This system of farm production of timber in Ghana is increasingly threatened, however, by the extension of concession systems into farming areas, in which trees are appropriated by a small number of timber concessionaires without recognizing the role of farmers in creating these resources.

Recent legislation criminalizes the exploitation of timber by farmers or by small-scale chainsaw operators who, unlike logging companies, pay farmers for the timber they exploit on their land. Increasingly alienated from a timber industry that expropriates resources and destroys crops without proper compensation, many farmers are now choosing to destroy timber saplings that regenerate on their farms (Amanor, 1999).

1.1 PROBLEM STATEMENT

1.2 JUSTIFICATION

Forests in Ghana are a major national resource and as such are considered by various governments to be of strategic national interest. However, Government has so far failed to manage these resources properly. Due to under-investment in the forest sector and limited people's involvement in decision-making processes, resource use has been both unsustainable and far below optimal levels. If managed correctly, the forests offer great potential in terms of contribution to the national development objectives of poverty alleviation, promotion of gender balance and equity, economic development and environmental protection. For a long time Government revenue gained from the forests has been much lower than potential timber revenue (Mayers and Vermeulen, 2002).

Since 1981, the annual rate of deforestation in Ghana has been 2% or 75000 hectares each year. Ghana's tropical forest is now 25% of its original size (Hagan, 2004).

The reserves in the Aowin Suaman have virtually been converted to cocoa farms by encroachers (MLFM, 2006) and this warrants a scientific study.

1.3 GENERAL OBJECTIVE

To assess the impact of Collaborative Forest Management (CFM) on forest management and the socio economic development of communities in the Enchi Forest District.

1.3.1 Specific Objectives

1. To investigate Collaborative Forest Management strategies practiced in the Enchi Forest District
2. To assess the socio economic impact of Collaborative Forest Management on fringe communities.
3. To estimate in area, volume, and cost the extent of forest destructions in a reserve where CFM is practiced against a reserve where CFM is not practiced.

1.4 SIGNIFICANCE OF THE STUDY

The study of Collaborative Forest Management is important not only to the individuals and communities. First, the issues of effectiveness and usefulness of CFM to stakeholders will be known since fringe communities have lived with the various strategies of CFM. Secondly how CFM has impacted economically on fringe communities will be known after the studies. Thirdly after this objective has been achieved, the destruction can be quantified in monetary terms; although the total benefits that a forest area would be providing, if it were intact cannot be accurately quantified. After the study, stakeholders will be made to know what they have lost through the destruction and therefore any move to protect the forest resources will be supported by them.

Finally, it is assumed that the destroyed area is a fraction of the 297 forest reserves that exist and are consciously protected in Ghana. This study will provide a basis for an

update of the total area of forests that have been destroyed in Ghana and the data will add to the existing literature on CFM in Ghana.

CHAPTER TWO

LITERATURE REVIEW

2.1 BACKGROUND OF COLLABORATIVE FOREST MANAGEMENT IN GHANA

The collaborative forest management program owns its genesis from a former Chief Conservator of Forest (CCF) and the forestry Department. The Department was concerned that over time the rights and benefits, which were supposed to go to the local people, had been denied them. The rationale for initiating the collaborative management programme was to explore how to ensure that more benefits flows to the local people from forest management (Hobley, 1996).

The objective of the collaborative forest management programme was therefore to explore the potential for collaboration with local people. These objectives were in three folds:

- To explore and develop the potential for collaborative approach to forest management inside and outside forest reserves.
- To provide the forestry Commission with information and analysis to inform policy making on a range of resource management issues including tree tenure and trees in farming systems
- To strengthen the capacity of the forestry commission to address local people's needs in forest management activities including forest resources (Forestry Commission, 2004)

To this end the principle of enhancing or modifying forest management to ensure that they address local needs and engender local co-operation was accepted and enshrined in the new forest and wildlife policy of Ghana. The collaborative forest management program begun with a study of forestry issues based on resource issues and problems.

- **MANAGEMENT OF NON-TIMBER FOREST PRODUCTS (NTFPS):**

This program revealed that local people interest in forest resources is largely focused on the exploitation of NTFPs for household and commercial uses. The program also looked at different aspects of NTFPs exploitation, processing and management (MLF, 1997).

MANAGEMENT OF OFF-RESERVE FORESTS:

Before this program the Forest Service Division has concentrated its management on only forest reserves. However, the maintenance of the remaining trees and forest outside reserves was becoming a concern to the FSD during this program. While the FSD remains directly responsible for the day-to-day management of trees and other forest resources. The program worked to create a new framework for management of forests outside reserves, which enable communities to manage trees, and off reserve forests and forest resources. These include management of trees in farming systems and management of dedicated forests. Forest reserve management planning focuses on three aspects of forest management through a series of workshops and consultations. These include involvement of communities in forest management planning, integrated forest management process and revenue sharing from management of forest and forest resources.

Therefore, the issues of rights and revenues from forest management have been reviewed and recommendations made in the review of forest legislations (Forestry Commission, 2004)

PROTECTION STRATEGIES AND RESOURCE ASSESSMENT

This program focused on the scope for communities to be involved in the management of protected areas. Communities' views were sought on the Divisions protective strategies for forest protection. This program focused on the development of new methods to assess the non-timber forest products resources in relation to the needs of local people. Other forest inventories that can be carried out by the community were also explored. Example under the dedicated forest management concept local communities made an inventory of the resources in their forest reserves and this helped them to write their management plans for those reserves. In addition pilot work on NTFP cultivation was carried out in some communities (Asare, 2000).

- **INDIGENOUS KNOWLEDGE AND COLLABORATIVE INSTITUTIONS**

It is very useful to build on knowledge that already exists. Indigenous knowledge was sought on all the programs of the unit and combined with scientific knowledge a great deal of success. A recent theme in the entire field program was the process by which collaboration can be developed and the institutional forms that it should take. This includes a structure, rule agreements contacts, committees etc. with a legal backing. To this end community Forest Committees and Community Biodiversity Advisory Groups

have been formed in some forest District to oversee the management of forest resources in both forest reserves and outside forest reserves (Asare, 2000)

2.1.1 Initiatives in Off-Reserve Forest – Forest Policy Context

There has been a major shift in forest policy outside reserves. The 1948 policy of progressive utilization without replacement of unreserved forests was replaced in 1994 by a commitment to sustainable management of unreserved forests. When the Forest Service Division took the responsibility for regulating timber utilization outside reserves, its efforts focused on correcting and securing the resource base through a series of interim measures, which has been replaced with a number of legislations. The potential for local management of patches of forest, fallows, timber trees in farms and plantations certainly exists. However, some problems have also become clear. These problems include confusion and mistrust between FSD and local forest owners, a lack of planning capacity in land holding communities and a tendency to replicate a more restrictive and bureaucratic elements of on-reserve management in their own forests and a limited capacity on the District Managers part to support local forest management (Asare, 2000).

The off-reserve forest, which was intact in 1948, was considerable and destined to be converted to farmland but in a controlled manner. This was to ensure that no timber went to waste while allowing the reserve to regenerate. While in the 1994 policy there were no specific objectives for unreserved forest management as there is on on-reserve, there is a strategy of:

"Revision of resource management standards and techniques for preparation of detailed prescriptions and plans to guide the sustainable management of forest reserves and wildlife protected areas, as well as unreserved forests in order to bring about the

"Conservation and sustainable development of the Nation's forests and wildlife resources for maintenance of environmental quality and perpetual flow of benefits to all segments of society.

Other strategies include:

- "Inclusion of unreserved forests under FSD's management systems for regulation of uncontrolled harvesting expeditious collection of relevant fees and ultimate conformity with criteria for sustainable resource development.
- Promotion of resource development programs aimed at reforesting suitable harvesting sites, rehabilitating degraded mining areas and afforesting denuded lands.
- Encouragement of local community initiatives to protect natural resources for traditional domestic and economic purposes, and support with the reservation of such lands to enable their legal protection, management and sustainable development.
- Introduction of a competitive procedure for allocation of forest utilization contracts to eliminate unnecessary speculators and to ensure that capable and properly equipped processors have access to adequate and sustainable resources

- Development of consultative and participatory mechanisms to enhance land, tree tenure rights of farmers and ensure access of local people to traditional use of natural products (Forestry Commission, 2004)

To this end, a temporary committee was formed to review the laws in the forestry sector and to prepare ideas on the contents of a new consolidated forest Act. Provisions were therefore made for two categories of forest resources outside reserves: trees on non-forest land dedicated forests.

Formerly farmers had no right to benefit from the exploitation of timber trees on their farms. This was a major disincentive to the preservation and planting of trees in farming systems. There are three aspects of management of trees on non-forest land, which are of concern to the FSD: Promotion of tree planting, Allocation of timber felling rights and Monitoring and regulation of timber harvesting (Forestry Commission, 2004).

The FSD wants to move to a situation where all planted trees on non-forest land belong unequivocally to the person who is identified as having invested his or her labor in the planting of the trees. For naturally occurring trees rights are vested in the president in trust for the stool. The president represented by the FC can grant right to these trees through a timber utilization contract. The District Assembly receives royalties when the trees are felled; the farmer on whose farm the tree grew receives nothing. In pre-colonial times usufruct rights conferred entitlements to the surface soil to harvested crops on to economic trees. The stool only had rights to trees on land not allocated to a

particular family. Under the 1992 constitution revenue from royalties is shared between the stools and the District Assembly.

Before the colonial period indigenous land and tree tenure supports the view that on divestiture, the rights to naturally occurring trees on their land should ideally revert to the holders of cultivation rights. At least cultivators should share royalties for timber trees on already cleared land with traditional council and district assemblies.

2.1.2 Timber Harvesting in Non-Forest Land

In recent times the FSD has developed rules, regulations and legislations to govern the exploitation of timber trees in accordance with the forest and wildlife policy and for the benefit of farmers and local communities who have invested their time, labor and sometimes money in tree planting and tending. Amongst the regulations are the timber resources management Act, the timber resources management regulations and the act that bans the sawing of logs with chainsaw.

2.1.3 The Timber Resource Management Act

The timber resource management act (Act 574) was passed in 1997. The act defines and explains the following

Table 1: Details of CFM in Act 574 of 1997

ACT 547	Collaborative Aspects
Application for timber right	a) proposal to assist in addressing social needs of the communities who have interest in the applicants proposed area of operations
Land subject to timber rights	2.b. land with timber grown or owned by any individual group c. land subject to alienation holding land with farms
Terms	e) provision of prompt payment of rents, royalties, compensation and such management and service charges as prescribed by law f) Annual rents payable to the landlord or owners of the area of land relevant to grants

Ministry Lands and Forestry (1997)

2.1.4 Integrated Forest Management Planning Process – The Current Way

In order to meet the policy demand for collaborative forest management, an integrated forest management process is being used to develop management plans for forest reserves. The purpose of adopting such a process is to ensure that local communities participate in the planning and decision making process in forest management. Basically the process involves about 10 steps

i. Formation of reserve planning team
ii. Inauguration and training of reserve planning team
iii. Resource assessment and inventories
iv. Socio-economic surveys

v. Information gathering – maps, old plans, reserve settlement agreements. Logging history etc.

vi. Preparation of Draft management plans

vii. Reserve planning workshop

viii. Review of draft management plans

ix. Submission of final plan

Community Forest Committee

During the pilot studies around the forest fringe communities it became evident that they want to have a voice in the day-to-day activities towards the sustainable management of the forests. In addition to this a major drawback to the collaborative forest management program was the luck of a recognizable and well informed body who will liaise with the forest service division and the forest fringe communities to ensure that their aspirations, knowledge and needs from forest resources and forest management is expressed and realized. Furthermore, forest fringe communities lacked a voice in forest policy formulated and implementation, while the timber men are strongly represented. There was also no awareness and knowledge in forest management laws and legislations even the right of the forest fringe communities were not known. Because the communities lacked knowledge in forest management laws and legislation, they could not monitor the activities of the FSD and the timber contractors (Forestry Commission, 2004).

Though the FSD has certain provision for the communities to benefit from the establishment of forest-based livelihood, they could not exploit these opportunities.

To this end the Community Forest Committees are being formed to permanently represent the forest fringe communities on forest management issues at the national level and to improve upon the knowledge and capacity for collaboration at the local level.

Other functions of the committee include

- Enhance and encourage widespread participation in forestry matter especially those that will affect the communities
- Mobilize wide stakeholder awareness and participation in the forest management planning process
- Educate and assist in the development of social responsibility agreements

Monitor the implementation of the social responsibility agreements (Forestry Commission, 2004).

2.2 FOREST MANAGEMENT-THE COMMUNITY WAY

During the pilot studies around the forest fringe communities it became evident that they want to have a voice in the day-to-day activities towards the sustainable management program where the lack of a recognizable and well informed body who will liaise with Forest Service Division and the forest fringe communities to ensure that their aspirations, knowledge and needs from forest resources and forest management is expressed and realized.

Furthermore, forest fringe communities lacked a voice in forest policy formulation and implementation, while the timber men were strongly represented. There was also no awareness and knowledge in forest management laws and legislations. Even the rights of the forest fringe communities were not known. Because the communities lacked knowledge in forest management laws and legislation, they could not monitor the activities of the FSD and the timber contractors. Though the FSD has certain provision for the communities to benefit from the establishment of forest-based livelihoods, they could not exploit these opportunities.

To this end the community forest committees were formed to permanently represent the forest fringe communities on forest management issues at the national level and to improve upon the knowledge and capacity for collaboration at the local level.

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- Mobilize wide stakeholder awareness and participation in the forest management planning process
- Educate and assist in the development of social responsibility agreements
- Monitor the implementation of the social responsibility agreements.

Specially the CFCs will play important roles and responsibilities at the national, regional, District and local level, at the national, regional and district levels the CFCs will

i. Participate in forest policy review and formulation
ii. Preparation of proposals to promote the welfare of communities through forest resources management
iii. .General recommendations on forestry that will lead in to improving forest management (Forestry Commission, 2004).

At the District and local level the committee will be responsible for the following:

2.2.1 Forest Protection

Over the past decade most forest reserves and off reserves in the high forest zone of Ghana has been experiencing annual forest fires. The CFCs are therefore expected to help in preventing and fighting forest fires in their community. This could be done by

- Planting green fire belts along the forest boundary
- Education on the dangers of fire and fire management especially during the dry seasons
- Formation of fire volunteer squad
- Development and enforcement of by-laws to protect fire and sanction defaulter

In addition to this the CFC in collaboration with the community can suggest measures to conserve forest resources in their locality.

They will also be responsible for encouraging and supporting the arrest and reporting of offenders to the forest services and/or the police.

In line with their protective functions, CFCs are encouraged to check the permit of people they suspect to be engaging in illegal operations.

2.2.2 Forest Rehabilitation

The taungya system has been the main way in which communities were involved in forest management. A review of the past taungya system was done and this helped to inform the development of pilot programs.

The review also helped the Division to develop new strategies and systems for forest rehabilitation called the modified taungya system. In 2001 the government of Ghana lunched plantation activities as one of its poverty reduction strategies. In the modified taungya and plantation development program CFC and forest fringe communities are expected to:

- Assist in the identification of degraded portions of the forest for rehabilitation.
- Establish nurseries from which the FSD will obtain seedlings for forest rehabilitation.
- Undertake forest rehabilitation activities – tree planting, transplanting, pegging, tree tending.
- Encourage and assist communities to plant trees on their farms.

2.2.3 Boundary Cleaning and Patrolling

The boundaries of the forest reserve are cleaned to ensure that farms are not extended to the reserves. In addition it ensures that wildlife in the forest do not enter into the farms of those who share a common boundary with the forest reserve. The FSD used the forest guards to patrol and clean the forest boundary at regular intervals. Currently local communities are given contracts to perform such duties.

Role of CFC's in boundary cleaning

- Help identify people in the community who can clean forest boundaries
- Supervise and monitor forest boundary cleaning
- Ensure that communities receive payments for boundary cleaning on time

2.2.4 Monitoring

- The CFC's will participate in the annual audit workshops of the forest service division to assess progress in the execution of forest reserve management plans at the district level.
- They will also monitor and assess the performance of FSD staff against expected output as enshrined in the service charter.
- Participate in and monitor the implementation of district forest development plans
- Monitor the operations of timber contractors to comply with TUC provisions (Forestry Commission, 2004).

2.2.5 Management of Non-Timber Forest Products

Non-timber forest products include all forest resources that are not timber. These are found in both forest reserves and non-forest reserves-farms fallow lands, dedicated forests. In the past they have been known to play a vital role in the livelihoods of forest fringe communities in diverse ways. One of the major issues that came up during forest reservation was how to ensure that local communities benefit from forest resources through reserve settlement proceeding upon which an agreement was signed between the owners of the forest and the government represented by the FSD. Most of the agreement granted free access to forest fringe communities for the collection of specific forest products – timber and non-timber forest products. Each forest reserve had its own agreement. Under the reserve settlement agreement this right of access was captioned customary rights, communal rights or domestic use rights. These rights were further transported into the forest reserve working plans for each reserve and then to the management plans under the section, which deals with management for local people. However, many, people in the forest fringe communities do not exercise or enjoy these rights either because.

- they are not aware of them or
- they have been arrested by the FSD when they entered the reserve
- the resources they need are not available in the forest or
- they are other alternatives sources
- there are other alternative products

In the forest service division non-timber forest products are managed by a permit system for commercial exploitation. NTFP exploiters are therefore expected to obtain a permit from the district manager of the FSD before gaining access to the forest. The service charter stipulates that NTFP permits should granted or otherwise within two weeks on Submission of application. The FSD is also expected to send a feedback to the applicant if permit cannot be granted explaining to him/her reason why they cannot be granted. The previous management of NTFPs by the then Forestry Department was geared towards regulating the exploitation of NTFPs through a system of permit allocation. Those interested in gathering NTFPs in forest reserves had to apply to the DM for permission to collect a stated quantity of a particular product within a certain stipulated time after which the permit expired. Generally, people obtain permits only if they are collecting for commercial purposes. In reality it is required that anybody who enters the forest reserve to gather NTFP should have permission from the Forestry Department (Forestry Commission, 2004).

2.2.6 Forest-Based Livelihood Options: Market Analysis and Development (MA&D)

Marketing opportunities are emerging throughout the world as trends towards economic liberalization and governmental decentralization are opening new markets and giving local communities more decision-making power in the management of their forest resources. Local communities therefore have more opportunities to benefit from forest resources and also have a greater incentive to better manage and protect those resources.

However, increasing demand for forest products, which increases their commercial value, can result in overexploitation of the resource base. Therefore it is now recognized that forest products need not be only financially viable but also environmentally and socially sustainable.

2.2.7 Establishment a Forest-Based Enterprise

Before one sets out to do anything, let alone establish an enterprise, one must be clear in the one's mind the basic objective for doing that. Developing an enterprise of such nature is to ensure increased incomes for communities on a sustainable base. The goal is to promote sustainable income generation activities for forest dependent communities. To establish a successful, profitable and sustainable forest-based enterprise the following must be carefully considered.

2.2.8 Resource Sustainability

Increasing demand of any particular product may result in its over-exploitation. The selected product must be available in quantities that are not likely to be depleted easily. In the event that it is likely to be exhausted it must be renewable. Market Analysis &Development (MA&D) provides safeguards for developing markets and products that do not lead to over-exploitation.

2.2.9 Market Sustainability

Such a product must have a wide market that does not easily fluctuate. Changes in the market environment can be assessed, and products adapted in order to remain competitive and attractive to the targeted consumers.

2.3 SOCIAL/INSTITUTIONAL SUSTAINABILITY:

The product must be socially acceptable. MA&D assists in identifying potential areas of conflict and promotes equitable distribution of benefits.

2.3.1 Technical Sustainability

The technology to work on the raw material must also be available. It must be possible to renew the resource in the event that the resource base is threatened. MA&D provide long term benefits for community members who learn to utilize and maintain equipment and gain understanding of production, manufacturing and marketing processes.

2.3.2 Participation

The community members developing enterprise are the main decision-makers, even though they may need the initial support of a facilitator. One of the long-term goals of MAD is for community members to develop their enterprises further and operate them independently.

2.3.4 Capacity Building

MA&D focuses on capacity build and strengthening institutions at the local level in order to provide the support local people need to control their own resources and to develop and run small enterprises.

2.3.5 Strategic Alliance:

MA&D relies heavily on the formation of strategic alliances with businesses, companies and organizations. These alliance help to establish market links between local

enterprises and markets, assists entrepreneurial development through training and capacity building, and provide potential sources of financing. The flow of information that comes from these partnerships is critical for local people who do not have easy access to marketing information and credit (Asare, 2000).

2.3.6 Policy and Legislation

The forest and wildlife policy of Ghana has as its guiding principle "the conservation and sustainable developments of the Nation's forests and wildlife resources for maintenance of environmental quality and the flow of benefits to all segments of society. Some of the strategies provided by the policy to ensure the achievement of the principle include the following:

- "the rights of people to have access to natural resources for maintaining a basic standard of living and their concomitant responsibility to ensure the sustainable use of such resources".
- "provision of strong incentives to encourage responsible use: for example, long term concessions, equitable access, appropriate fees.
- "the need for economic and development incentive to stimulate private enterprise and encourage respect for regulations, thus offsetting real and perceived cost imposed by loss of access or restriction of use".
- "a share of financial benefits from resource utilization should be retained to fund the maintenance of resource production capacity and the benefit of local communities".

- "initiation of continued contract and liaison with local authorities and communities to pursue integrated development activities related to sustainable research management".

The forest and wildlife policy of Ghana emphasizes the need for forest fringe communities to benefit from timber exploitation.

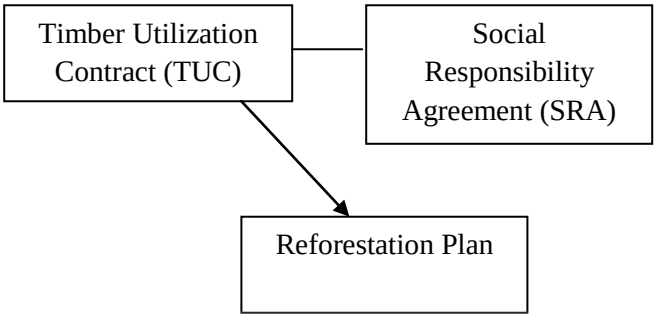
BENEFITS FROM FOREST AREAS FOR FOREST FRINGE COMMUNITIES

Indirect service benefits e.g., water supply, humidity and moderation of temperatures. Use benefits e.g. domestically used timber, fuel wood and NTFPs. Income benefits include NTFP with market value, coffee, honey, spices, fuel wood and timber whiles an example of Environmental capital is land for agricultural clearance. These benefits are largely exploited by women and minority groups (Ribbot, 2002).

2.4 CONCEPT AND DEFINITION OF SOCIAL RESPONSIBILITY AGREEMENT (SRA)

The (SRA) is an undertaking by the winner of the contract to assist the communities and inhabitants of the land area encompassing the forest from which the timber is to be harvested with amenities, services and benefits.

Figure 1: Phases of TUC acquisition process



Forestry Commission (2004)

In simple terms, the SRA is an agreement between a TUC holder and the landowning communities (forest fringe communities), which spells out the social obligations of the contractors to the landowning communities during its operations. This agreement forms part of the terms and conditions of the TUC and provide a mechanism for communities to monitor the activities of the TUC holder.

The monetary benefit from the SRA is not part of the royalties paid through the Office of the Administrator of Stool Lands (OASL) to landowners. It is funded directly by the TUC holder to the beneficiary communities for social development purposes in return for the communities' role in forest resource protection and regeneration (Agyemang and Affum, 2006).

2.4.1 What is the purpose of a Social Responsibility Agreement?

Section C of the Forestry Commission's Manuals of Procedures, explains that "the SRA is a mechanism to ensure that all TUC operations are carried out in a socially responsible manner with due respect for all the rights of landowning communities" It is

intended to ensure that the TUC holder(s) respect the existing rights as well as the social and cultural values of landowning communities. Furthermore, it gives opportunity to landowners to indicate the manner in which the TUC holder should operate on their land.

Currently, the disbursement of royalties does not ensure that direct benefits accrue to communities where forest resources are extracted. In principle, royalties that go to the District Assembly should be used to support community development initiatives, but in practice this does not happen. Such monies get 'lost' in the big pot of the District Assembly's development funds and hardly ever get back to the communities where timber exploitation occurs. Invariably, it is the District Assembly which decides on the community that must benefit from the royalty, which may not necessarily be the communities where timber has been extracted. Similarly, revenues from timber exploitation that go to the traditional council and chiefs rarely get down to the community level.

While the purpose of the SRA is to regulate timber-harvesting operations and to ensure direct benefits go back to landowning communities, indirectly, it is recognized that the SRA will smoothen out the relationship between the landowning communities and the TUC holder, which, in many instances, in the past has been quite hostile.

2.4.2 Polices and Legal Basis of Social Responsibility Agreement (SRA)

The legal reform of the concession system was affected through the 1997 Timber Resource Management Act (TRMA) (Act 547) and the accompanying 1998 Timber Resource Management Regulation (LI 1649). These new legal instruments emphasize the need for legal contracts between the state, communities in timber operational areas and the timber-harvesting right holders – as embodies in the TUCs.

2.4.3 Forestry Commission's Obligation on SRA under its Service Charter

The Forestry Commission's Service Charter calls for "an atmosphere of working together to manage Ghana's Forest and wildlife resources through collaboration with local government, landowners, forest fringe communities and non-governmental organizations so that everyone can monitor and evaluate its plans and activities".

The FC and its staff are, therefore, in effect, under obligation to ensure that SRAs are properly negotiated between the applicants and the communities in the TUC area and the terms adhered to. Failure to ensure this constitutes a breach of the FC Service Charter. The communities and the other parties may then raise a complaint for redress.

2.4.4 The Constitution of Social Responsibility Agreement (SRA)

The SRA is in two main parts

A. The code of Conduct

The code of conduct stipulates the manner in which the contactor is expected to operate to ensure that all timber operations are conducted with due respect for the rights of the

communities inside or adjacent to the TUC area. It ensures respect for local customs, beliefs, infrastructure and livelihoods.

Example of SRA Code of Conduct

- Consultations with communities with respect to taboo days
- Respect for community rights to NTFPs
- Respect for sacred area
- Respect for customary rights
- Protection of water sources
- Employment of local people

B. The Social Obligation

The social obligations are specific agreements drawn up between the community and the contractor based on the stumpage or the value of lumber being removed from the TUC area. The SRA should specify the particular commitments of the TUC holder to support development initiatives of the local communities either in cash equivalent or a commitment for other goods, services or infrastructure support. This is what ensures that the communities financially benefit directly from the exploitation of timber resources from their area.

Examples of SRA Social Obligation

- The provision of infrastructure, such as school, borehole, etc;
- Provision of building materials for schools;
- Employ some inhabitants;
- Establishment of a community development fund; and

- Provision of off-cuts (Agyemang and Affum, 2006)

2.4.5 SRA Development Process

The process for developing an SRA is initiated by the FSD during the identification of the TUC area. The District Manager (MD) will consult with the landowning communities (the stool chief, odikro, the CFCs and Unit Committee) to ensure that areas, which the community wishes to exclude from logging, are identified. The DM will ask the communities to specify reasonable social terms for the Timber Operational Specifications (TOS). Section B of the Manual of Procedure (MOP) reiterates that the "preparation of the TOS and SRA will need to be Carried out in greater detail with more time allocated to consultation" in the off-reserve areas.

Once the TUC area has been advertised, applicants may wants to approach the communities to ensure that they understand all aspects of the TOS. Following the pre-qualification of the contractors, however, they would need to negotiate to draw up the proposals for the Timber Resource Evaluation Committee (TREC) to evaluate. That is when the main negotiations start. The procedure for developing SRA is described in the TUC identification procedure.

The procedures include the following:

- Identification of potential TUC area by the FSD and the community;
- Advertisement of TUC area;
- Identification of TUC area by timber contractor;
- Consultations among stakeholders – FSD, Community;

- Development of Timber Operations Specification (TOS);
- Negotiation and development of SRA (Agyemang and Affum, 2006)

2.5 FOREST RESOURCE MANAGEMENT

Forest management involves planning for sustainable harvested, with particular attention paid to forest regeneration. Most countries replant far less forest than is harvest or converted to other uses, but there are some outstanding examples of successful reforestation. China, for instance cut down most of its forest 1,000 years ago and has suffered centuries of erosion and terrible floods as a consequence. Recently, however, a massive reforestation campaign has been started. An average of 4.5 million hectares per year was replanted during the last decade. South Korea also has had very successful forest restoration programs. After losing nearly all its trees during the civil war 30 years ago, the country is now about 70 percent again (Agyemang and Affum, 2006).

In spite of being the world's largest net importer of wood, Japan has increased forest to approximately 68 percent of its land area. Strict environmental laws and constraints on the harvesting of local forest encourage imports so the Japan's forest is being preserved while it uses those of its trading partners (Agyemang and Affum, 2006).

Many reforestation projects involve large plantations of a single species. When profits from these forest plantations go to absentee landlords of government agencies, local people have little motivation to protect fires or keep grazing animals out of newly

planted areas. Promising alternative agro forestry plans are being promoted by conservation and public service organizations such as the New Forest Fund and Oxfam. These groups encourage planting of mixed species, community woodlot including fruit and nut trees as well as fast –growing, multipurpose tress such as Leucaena. Millions of seedlings have been planted in hundreds of self-help project in Asia, Africa, and Latin America. As in most environmental and social solutions, a combination of species and methods are needed. The new forest policy, promulgated in 1994, lays emphasis on sustainability, multiple use values and participatory management.

In order to operationalise the new commitment to participation, the Forest Service Division established a collaborative Forest Management Unit in 1993 with a mandate to explore and develop the potential for local people's involvement in high forest management. Ghana Forest Service has developed production strategies to ensure an equitable distribution of benefits of forest resource management and utilization and to provide for people's involvement in forestry. This is one of the aspects of the integrated forest management system developed to ensure that our forest resources are managed in accordance with the provisions of the 1994 Forest and Wildlife Policy. The policy calls for the multiple use of objectives of protection, production and in the interest of the people of Ghana.

A policy selection felling system based on a 40-year felling cycle is applied to mange timber harvesting within the high forest zone (HFZ). The timber resources Management Act (Act 547 of 1997) provides the management of timber production areas (on and off-

reserves) through a system of competitive tender and the award of Timber Utilization Contracts (TUCs).

2.5.1 Management Zones

The total managed forest reserve of Ghana is estimated to be 1,634, 100ha (Forestry Commission, 2004). This area has been categorized into zones as follows:

Table 2: Management zones within forest reserve of Ghana

Management Zones	Area of Reserve (ha)	% of Forest Area
Timber production area	762,400	47
Permanent protection	352,500	21
Convalescence area	122,000	7
Conversion area	127,200	8
Not inventoried areas (conversion)	270,000	17
Total reserve area	1,634,100	100

Forestry Department /NRM (1995)

The area under convalescence can be rehabilitated through natural regeneration and protection over one felling cycle (40 years). The remaining 397,000 ha is almost devoid of timber trees and is currently the potential area available for conversation to forest plantations. The timber production area (762,400 ha) is the residual area after accommodating the large grain protection areas and is well –stocked forest for sustainable timber productions.

2.5.2 Policy Context

At the UN conference on Environment and Development in Rio in 1992, a non-legally binding statement of Forest Principles was negotiated. This recognized the need to conserve, manage and sustainably develop types of forests: it also recognized the sovereign rights of nations to unitize their forest. The international Tropical Timber organization has already developed guidelines on the sustainable management of forest, with the aim that-by the year 2000-timber exports from member countries originate from sustainably managed forest. The African Timber organization is considering the development of its own certification scheme. Sustainable management of forest will continue to have a high profile as an issue on the international agenda. It must, however, also be seen in the context of issues such as trade liberalization (MLF, 1994)

2.5.3 Forest Policy Development in Ghana

In Ghana there have been three formal government forest policy statements. The first was formulated in 1946 and approved by the Governor-in- council in 1948. The second was announced in 1994 as the Forest and Wildlife Policy with the third in 1998 as the Forestry Act. The 1948 policy which remained in force for nearly half a century has had a pronounced impact on forest and people. Emphasis was on protection and management of the reserves with the implicit expectation that all forest outside the permanent forest reserves will ultimately be converted to agricultural land. In this way there was a systematic removal of all known timber species then before the farmers arrived who did not arrived though at the anticipated time. The forest policy adopted in 1948 can in retrospect be said to be a generalized statement of intent; bones without

meat. This is perhaps due to the fact that the measures required to implement the policy were not explicitly made a part of the policy, neither was there any firm commitment from the state to provide the resource required for such implementation. The 1980s witnessed a failing in the policy and legislation and general public outcry and discontent about the 1948 forestry policy. These frustrations led to some in-house forestry department review exercise beginning around 1948 (MLF, 1994)

2.5.4 The 1994 Forest and Wildlife Policy

The process of formal policy revision that culminated in the 1994 Forest and Wildlife Policy was accelerated in the 1980s. The 1994 policy presents an attempt to project the general concerns of the Ghanaian populace. It specified principles on rights of local access to basic natural resources, local democracy, participatory management and protection of forest and wildlife resources (MLF, 1994).

In 1994, Forest and Wildlife policy seems to have provided a good strategic framework for actions within the forestry sector. The new policy established the government's aim as being the conservation and sustainable development of forest resources. As intimated the major flaw of this policy was that it alienated most stakeholders particularly forest owners and the traditional authority in the consultative process. Considering the key thrust of the policy-enabling wider participation, the process remains notable for its lack of articulation with any man on the farm or woman gather near the forest. It thus however creates an encouraging opportunity for people to force the hand of government to uphold what is in the policy (MLF, 1994).

2.5.5 The 1998 Forestry Act

This act aims at consolidation and replacement of all existing forestry legislation. It proposes clear identification of land and forest-holding communities as the primary clients of a proposed Forest Service, which will pursue sustainably forest management. We are however not optimistic that this new policy will be exonerated from the flaw that were associated with its predecessors. Particularly in the area of participation and above all setting the tone for the development of institutions that will focus on holistic sustainable forest management approaches rather than being timber biased (Amanor, 1999).

2.5.6 Forest and Forest Reserves

Forest can be described as plant communities dominated by trees. It may be defined as vegetation of which predominant life form is the tree. It is an ecosystem, which is dominated by trees. Based on these considerations, a forest community (of plant and animals) constitutes an ecological ecosystem embracing diverse life forms and functional relationship (Owusu, 1999). Ghana Forestry Department, now Forestry commission was established in 1908 upon recommendations by a colonial Nigerian forester, Mr. N.H Thompson, who reiterated the need to conserve, preserve and manage the forest resource of Gold Coast (Owusu, 1999).

2.5.7 Ghana's Forest Reserves

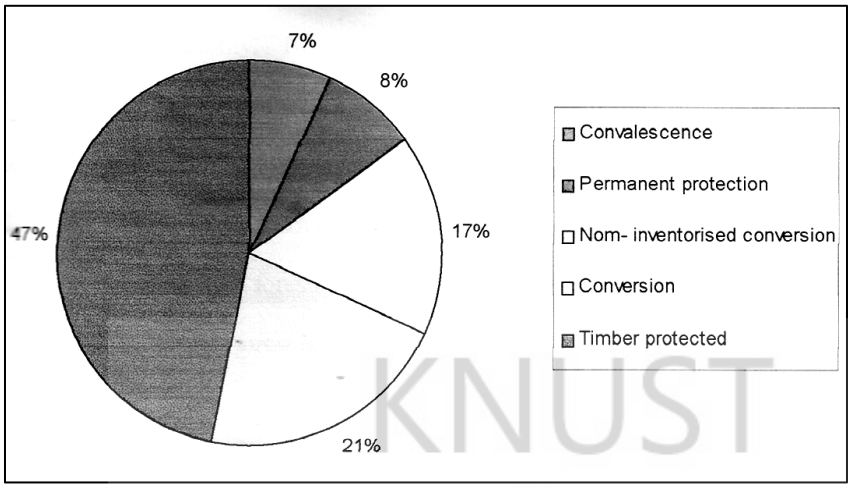
Forest reserves, however, are vegetations protected for their productive and protective functions to the environment (Myers, 1989). These reserves are mostly complex in

nature and made mixture of deferent ecosystems (Martin, 1992). The forested countries have had tourism opportunities as a result of the complexity (Chrisolm, 1990), as well as the creation of employment for the youth (Dasgupta, 1993). Forest reservations started in 1920s until the 1940s, upon decisions by the then colonial government. As a result, about 16% of the total land area of Ghana was set aside as forest (266 forest reserves, 18 terrestrial wild life reserves and 5 coastal wetlands/ Ramsar site reserves.

The reserve have permanent protections areas that consist of Hill Sanctuaries, shelterbelts, special Biological protection areas, intact Forest Sanctuaries and provenance and fire protection areas 60% of the entire area is inaccessible for logging (except at high cost) and 16% degraded.

Only 15% is well stocked and accessible (protected on grounds of genetic diversity). Others are convalescence areas and conversion areas, which require replanting. 762,400 ha representing 47% are classified as being capable of timber production. The total area is 1,634,100 ha (Antwi, 1999).

Figure 2: Areas of Forest Reserves in Ghana



Forestry Department/ FRMP 1995.

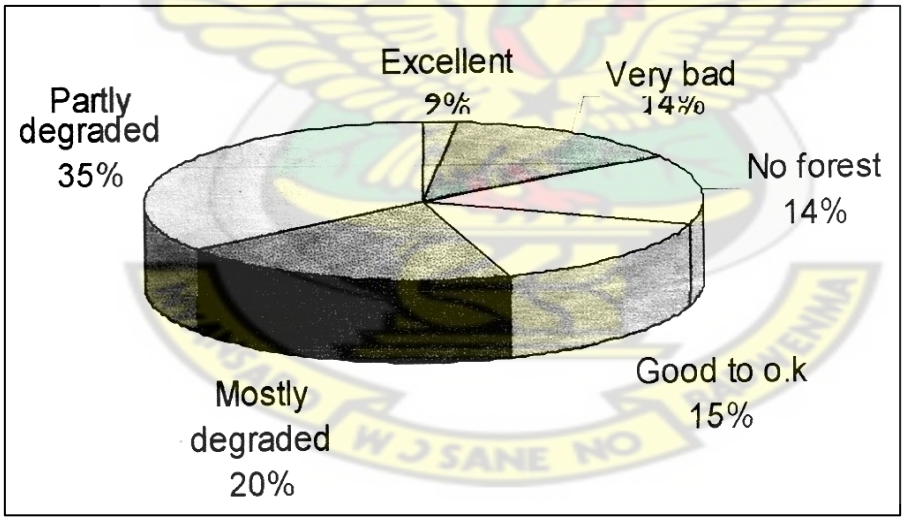
With the off-reserves, 400,000 ha of forest is seen in the form of patches, secondary forest and traditionally protected lands /areas, and the remaining being occupies by cocoa, annual crop farms fallow lands and unimproved pastures.

2.6 CURRENT STATE OF GHANA'S FOREST RESERVES

At the click of the century, about 1/3 of Ghana's land area was covered by forest. As a result of deforestation, the forests, over the years have experienced drastic decline in terms of quality and quantity. Between 1981 and 1985 the deforestation rate in off reserves was estimated at about 220 kilometers squared per annum (Antwi, 1999). He observed that reforestation trailed at 5% of the deforestation rate. Satellite imagery available depict that the forest resources have their boundaries intact but the situation is different when one enters the forest. Today the deforestation rate (annually) in Ghana has been 2% and the tropical forest is now just 25% of its original size (Hagan, 2004).

The problems of forestry in Ghana have been with us since long. The national land policy of Ghana (June 1999) lists of some of the major problems and constraints affecting the land sector, among others as; indeterminate boundaries of stool / skin lands leading to conflicts and litigation between lands users and land owing groups, and inadequate security of land tenure due to conflict of interest between and within land owing groups and the state and land racketeering (Owusu, 1999). Antwi, (1999) notices that the quality within the forest reserves has been significantly eroded, talk of Disiri Forest Reserve, Sukususku, Bodi, Manzan, Tano Ehuro and among others Bia Tawya Forest reserve. He concluded that most of these reserve has been invaded by farmers and may not classified as forest reserves.

Figure 3: Conditions of forest reserves in Ghana



Hawthorne and Abu Juam (1995)

The total area of the reserves is 1,774, 500 ha and this figure differs from that in the figures above because it includes the following reserves which are now under the jurisdiction of the Game and Wildlife Department; Ankasa, Bia, and Assin/Attandanso Game production Reserves and Kakum National Park (Antwi, 1999).

2.6.1 Importance/ Benefits of Forest Reservations

The importance of forest resources is numerous, ranging from environmental protection, ecological concerns, economics and domestic advantages, spiritual and cultural benefits in a broader perspective. They prevent global warming, through absorption of carbon dioxide by the plants resulting in the prevention of significant rise in temperature (Cannell, 1989).

Ecologically, the forest harbors most of the earth's life forms. The fauna of the high forest zone includes 225 species of mammals, over 721 species of birds and amphibians and reptiles (Owusu, 1999). After cocoa and minerals, sawn timber and logs constitute the third largest item in Ghana, and in Indonesia, however, timber ranks second as export income earner to oil (NRC, 1989).

In the area of spiritual and cultural, several animals have cultural associations with family clans and are used as totem symbols. It is a taboo to hurt, capture or destroy totem animal. All forests are generally considered in the traditional practice as sacred natural endowment with all life forms. The demand for forest resource can be put into local, national and international (Myers, 1992).

The local demand for forest products are the needs of specific consumers living in a specific geographical area. Forest reserves are known to provide the primary food source to fringe communities. Chemicals, dye, gums, resin, which usually serve as raw materials, are all obtained from forest reserves (Daily and Ehrlich, 1994).

2.6.2 Tourism

The creation of the national parks has undoubtedly helped to protect rain forces. Yet, as national parks are open to the public, tourism is damaging some of these areas. Often, national parks are advertised to tourist before adequate management plans have been developed and implemented. Government sees tourism as an easy way to make money, and therefore tourism is encouraged whilst strict management strategic are given far less government support. Ecotourism or environmentally friendly tourism should educate the tourist to be environmentally aware. It should also be of low impact to its environment.

Unfortunately, many companies and resorts who advertise themselves as eco-tourist establishments are in fact exploiting the environment for profit. In Australia, for example, the rainforest is being threatened by excessive tourism. Clearing for roads and pollution of waterways are two of the major problems in this area. The wet tropics management Authority which oversees the surrounding World heritage area is promoting tourism to the area before any management plans have been formulated, before any effective waste management strategy has been devised and before any eco-friendly power alternatives have been fully explored.

2.6.3 Economics of Deforestation

In terms of economic performance, the forestry sector accounts for about 11% of the total export earnings. Between 1954 and 1976, tropical hard wood exports increased in value from $272 million to $4.2 billion (Myers, 1989). It rose to $ 9.1 billion in 1980 (FAO, 1983). The timber industry alone contribute 6% Gross Domestic Produce (GDP) and employs a labor force of about 100, 000 and provides live hood for about 2 million people. The total production of round wood in 2000 was 21,765,000 cubic meters (769,540,000 cu ft), with 95% burnt as fuel. Sawn wood production was 243,000 cu m (8.6 million cu m) with export of US S4 76.8 million. Total export of forest products in 2000 amounted to US $ 137 million (Chande's, 2006).

In the limited sense, however, deforestation refers to a complete clearance of forest resources and their substitution by other uses (Abeney, 1999).

The distinguishing factor between the causes of deforestation and fundamental forces underlying the causes can be based on; competition between human and non-human for space and failure in the working of national and international economics systems. The failure means the economic systems to reflect the true value of environmental systems in the working economy. This, in significant ways has contributed to a situation where intrinsic functions of the tropical forests are not marketed and, as such, ignored in decision making (Abeney, 1999).

Early records depict that at the turn of the century, Ghana had about 88,000 kilometer squared of forest. Around 1950, it reduced to 42,000 kilometer squared with

deforestation rate estimated at 22,000 ha per year. It was observed that the economic timber species are running out after nearly hundred years of forest clearance in Ghana for cocoa and food crop farms logging. Since 1981, the annual rate of deforestation in Ghana has been 2% or 75, 000 ha. Ghana's tropical forest area is now just 25% of its original size (Hagan, 2004).

About 11.3 million ha of forest and wood land are lost annually in the world (FAO, 1983). The economy of Ghana is the poorer with such high deforestation rate. Since the colonial era the exploitation of timber for commercial purposes has been part of Ghana's economy (Hagan, 2004).

The total export of forest products in the year 2000 was US $137.6 million; however, unfavourable economy in the third world countries invariably renders the people poor, and has a bearing on the rate of deforestation (Chande's, 2006).

A 5 million US dollar, reduction in a country's debt can lead to a reduction of anywhere between 250 kilometers squared and 100 kilometers squared of annual deforestation, and (Antwi, 1999) maintains that the estimated cost of the loses of Ghana's forest cover is about 10.8 billion cedis per year in environmental related disasters such as strong winds, irregular weather\ patterns, illegal encroachments and others reduced rainfall. One approach to decision-making about tropical forest issue is the cost-benefit approach (CBA). Under CBA, decisions to 'develop' a tropical forest would have to demonstrate that the benefits from development exceed the net benefits from 'conversation.

Conversation could have two dimensions: preservation, which would be formally equivalent to outright non-use of the resource, and conservation which would involve limited uses of the forest consistent with retention of natural forest.

Conservation benefits are measured by the economic value of the tropical forest. Total Economic Value (TEV) comprises use and non-use values. Conservation is consistent with some sustainable uses of the forest, including sustainable timber harvesting. Direct-use values are fairly straightforward in concept but are necessarily easy to measure in economic terms. Thus, minor forest products output should be measurable from market and survey data, but the value of medicinal plants is extremely difficult to measure. Indirect values correspond to the ecologist's concept of ecological functions and discuss further below.

Option values relate to the amount that individuals would be willing to pay to conserve a tropical forest for future. That is, no use is made of it now but use may be made of it in the future. Option values is thus like an insurance premium to ensure the supply of something the availability of which would otherwise be uncertain. While there can be no presumption that option value is positive it is likely to be so in the current context.
Existence value relates to valuation of the environmental asset unrelated either to current or optional use.

Its intuitive basis is easy to understand because a great many people reveal their willingness to pay for the existence of environmental assets through wildlife and other

environment charities but without taking part in the direct use of the wildlife through recreation. To extent, this willingness to pay may represent 'vicarious' consumption.

Total Environment Value (TEV) can be expressed as:

(TEV) = Direct-use value + Indirect-use value +Option value + Existence value

It is important to note that the components of TEV cannot simply be aggregated.

There are trade-offs between different types of use value and between direct and indirect-use values. Direct-Use Values in the Tropical Forest.

Direct-use values may be classified broadly in terms of timber and non-timber uses. Non-timber products include fruits, nuts, rattan, latex, resins, honey, and wild meat.

2.6.4 The Effects of Farming in Fringe Communities

The major cause of deforestation is directly linked to the food security of fringe communities (Balnkespoor, 1991). Forestlands are converted into agricultural lands through shifting cultivation, pasture establishment or permanent cropping in these areas. If such conversations were sustainable, it would sound rational (Dagupta, 1993). Agricultural activities in and around forest reserves have had significant effect on the forest due to the unprofessional farming systems, and the watersheds are worse of a result. The effect of agriculture in and around forest reserves are inextricably linked to the increases in population and the influx of practical agriculture. As a result the landscape is deteriorated, soil fertility loss occurs with subsequent soil erosion and loss of biodiversity. Land use that result in the loss of economic species (Flora and fauna) would not be sustainable enterprise (Myers, 2001).

The effects have rendered the goals of sustainability unattainable, reducing the probability of ensuring food security in developing countries as anticipated. The cause of farming in forest reserves can be attributed to land holding size /farm size, which is quite a problem in the developing countries and this, compounds their poverty.

The results of skewed agricultural land ownership and low productivity are poverty and illegal encroachment of the forest estate (MacGillivray and Zadek, 1995). The second attributed to the neglect of rural folks by the government and other organizations in developing countries regarding their income status.

The economic growth of the rural people in its entirety is an indispensable prerequisite for the survival of the forest reserves (WCED, 1987). There has been much discussion about the effects of tropical deforestation on wildlife, quality of life for tropical forest people, local and global economies and the climate. But the nature of the problem is that most of these effects will not be felt until they are irreversible. By allowing deforestation to continue unchecked we are conducting an experiment of global proportions unparallel in the history of natural events and science. Scientists have begun to study the myriad complex interactions and interdependencies that occur within a complex system. Among the varied predictions are:

- Loss of people and cultures whose way of life depends upon the forest, along with a loss of their knowledge.
- An increase in barren land and desertification in drier tropical regions;
- Regional decreases in rainfall, exacerbating desertification;

- Global increases in temperature due to a rise in atmospheric carbon, leading to a rise in sea levels;
- Extinctions of large number of plants and animals species, including the loss of important wild life species and potentially important food and medicinal plants;
- Declines in temperate zones birds that migrate to the tropics;
- Increased exposure and erosion of soil;
- Loss of hydroelectric power potential; and
- An increasing downward cycle of rural poverty;

2.6.5 Why Deforestation/ Declining of Forests

It is evident, according to the 2000 population and housing census as against July 1994 population estimate of 17,225,188 that Ghana's population is on the ascendancy and inadvertently dwelling on the fixed land size. Competition for things that ensure life sustenance will surely occur. The main factors leading deforestation is the over dependence of rural people in developing countries on forest resources. In early 1980s there were 745 million small scale or smallholder framers in developing countries and 165 million landless peasants depended on forest (Abeney, 1999).

Deforestation in Ghana could be attributed to the following causes; slash and burn agricultural, which the single major factor is accounting for the loss of forest cover in most tropical countries.

Another is logging especially illegal timber contractors and excessive exploitation of fuel and other Non-Timber Forest Product (NTEP). The rest are wildfires, land management conflicts, illegal farming in forest reserves, surface mining and quarrying. Also, most of our productive forest reserves are sitting on precious deposit (Antwi, 1999). Illegal encroachment of forest resource over the years has contributed to the decline of forest size in the African continent. As a result poverty is endemic in 3rd world countries, though agrarian (Borrini-Feyerabend, 1996).

Land ownership is known to be highly concentrated in most developing countries, with land fragmentation as the picture, and as an employment opportunity, most of the youth do embark on illegal encroachment of the forest resource in order to survive (Borrini-Feyerabend, 1996).

CHAPTER THREE

MATERIALS AND METHODS

3.1 STUDY AREA

3.2 LOCATION

The study was conducted in the Tano Ehuro and Yoyo Forest Reserves in the Enchi Forest District. The Enchi forest district lies in the mid-western part of Western Region of Ghana between latitude 5° 25^1 N and 6° 14^1 N longitude 2° 30^1 W and 3° 05^1 W. It shares boundaries to the south with Jomoro district, East with Wasa Amenfi, North with Jaboso Bia and West with the Republic of La Cote D'Ivoire. The total land area of the district stands at 2,717.8 square kilometers representing about 11.66% of the total area of Western Region (Figure 4).

The district capital is Enchi. The district has a population of 119,133. It is one of the leading cocoa producers in Ghana. During 2003-2004 cocoa seasons the district recorded 71,901 metric tons (Poverty Alleviation Strategy, 2012, District Assembly, Enchi). There are nine (9) forest reserves in the district, namely; Boi Tano, Jema Asemkrom, Tano Ehuro, Yoyo, Disue, Dadieso, Tano Nimire, and Tano Anwia forest reserves (Figure 5 and 6). The size of the reserve areas in the district occupies almost 50 percent land area which is the leading producer of timber in the region. The most degraded reserve is Tano Ehuro.

Topography and Relief

The terrain of the district is described as a Forest dissected land with hills and valleys. The valleys are filled with rivers and streams which move with currents especially during the rainy seasons – The Equatorial Rains (Sept.) and Moonson (June, July, and August). Generally the district has an undulating terrain with hills rising up to heights 35 m and 366 above sea level (Poverty Alleviation strategy, 2002 District Assembly Enchi).

Drainage

A number of rivers and steams traverse the district. The Tano and Bia rivers and their tributaries, notably Boi and Disue respectively are the major rivers, which drain the district. Disue River for instance meanders considerably in its progress throughout the district (Poverty Alleviation Strategy 2002, District Assembly, Enchi).

Climate

The district experiences wet semi-equatorial climatic conditions. Temperature is generally high with an annual average of 26° C. The hottest months are March and April i.e. before the onset of the first time rains. The district experiences bimodal rainy seasons in a year. They are the major rainy season. Which occur from May to July and the minor season experienced in September and October. The average annual rainfall is between 15,000mm and 18,000mm in the district. The relative humidity in the district is generally high between 75% and 80% during the wet season and about 70% for the rest of the year. (Poverty Alleviation strategy 2002, District Assembly, Enchi).

Geology

Lower and upper birimian rock formation underlay the area. The geology formation of the district is richly endowed with good deposit, which is found in rock formations, and alluvia deposit in places such as Achimfo, Sewum, Acquah Allah, Dadieso and Karlo. (Proverty Alleviation strategy 2002, District Assembly, Enchi).

Experimental Procedure

Tano Ehuro represents non CFM practiced reserve whiles Yoyo Forest Reserve represents CFM practiced reserve.

Sampling Methods for the two Forest Reserves

River Ani Adjei, which runs through the reserve, was taken as a base line at a point near Ani Adjei village. Zoning of the destroyed areas/portions into 100 meter squares was done for the two study areas and a total of 800 meter square area selected for the study**.** Four (4) sites, each 100 sqm area were selected randomly and represented as the 1st upper bank, 2nd upper bank, 1st lower bank, and the 2nd lower of river Ani Adjei. A total of 400 square meter area was randomly taken around river Ani Adjei as sample plots. Data were then collected from the demarcated areas. In the case of Yoyo forest Reserve, river Kwasue which incidentally runs through the reserve was used as baseline near GSBA Pillar 15 and four (4) plots, 100 meters each were randomly selected for the study and represented as ; Plot 1, Plot 2, Plot 3 and Plot4 . Biodata on farmers were sought to enable the researcher know the background of people involved in the study.

These included information on gender, age, marital status, highest level of education among others

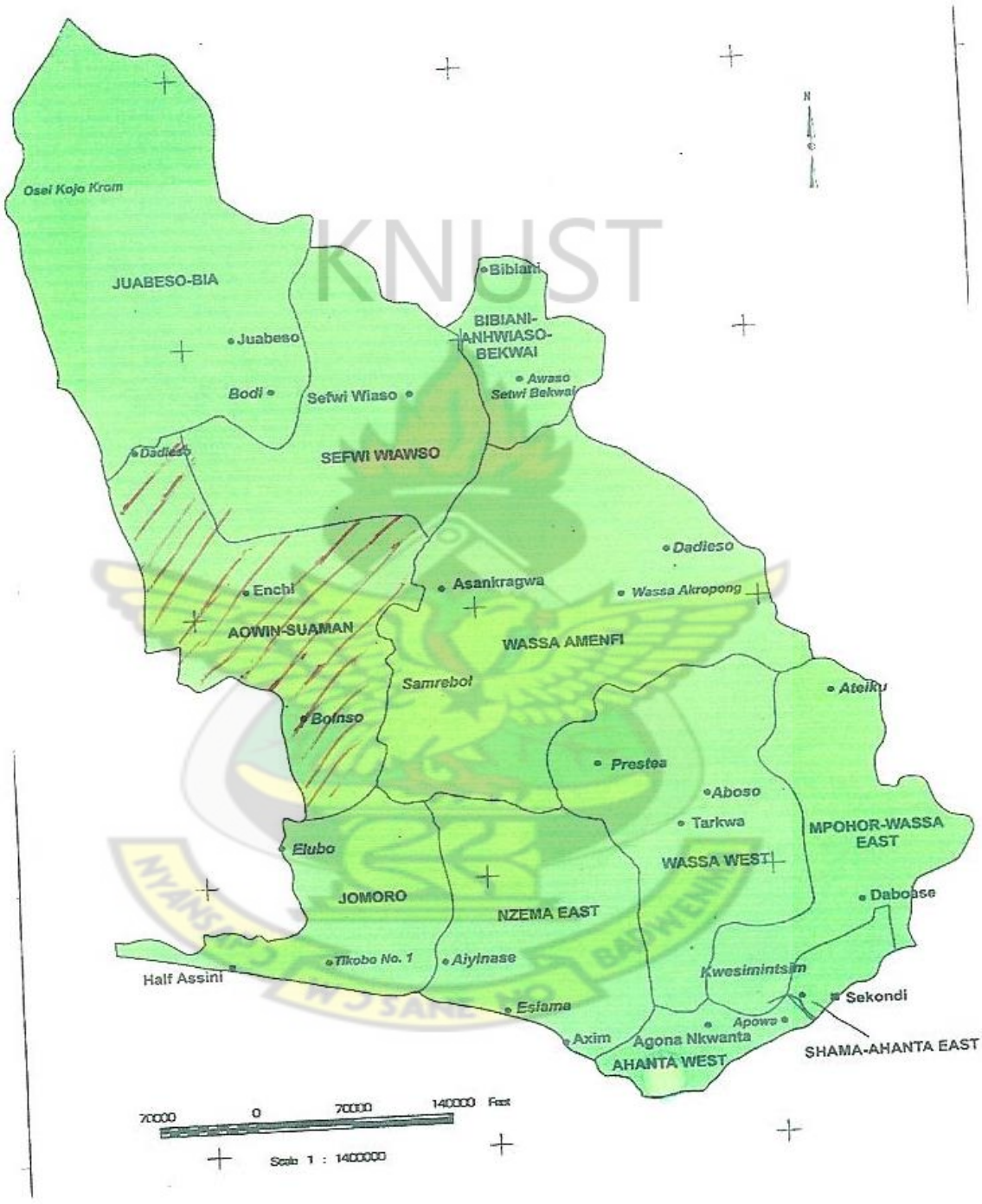


Figure 4: Map of Western Region Showing Aowin Suaman District

Poverty Alleviation Strategy (2002)

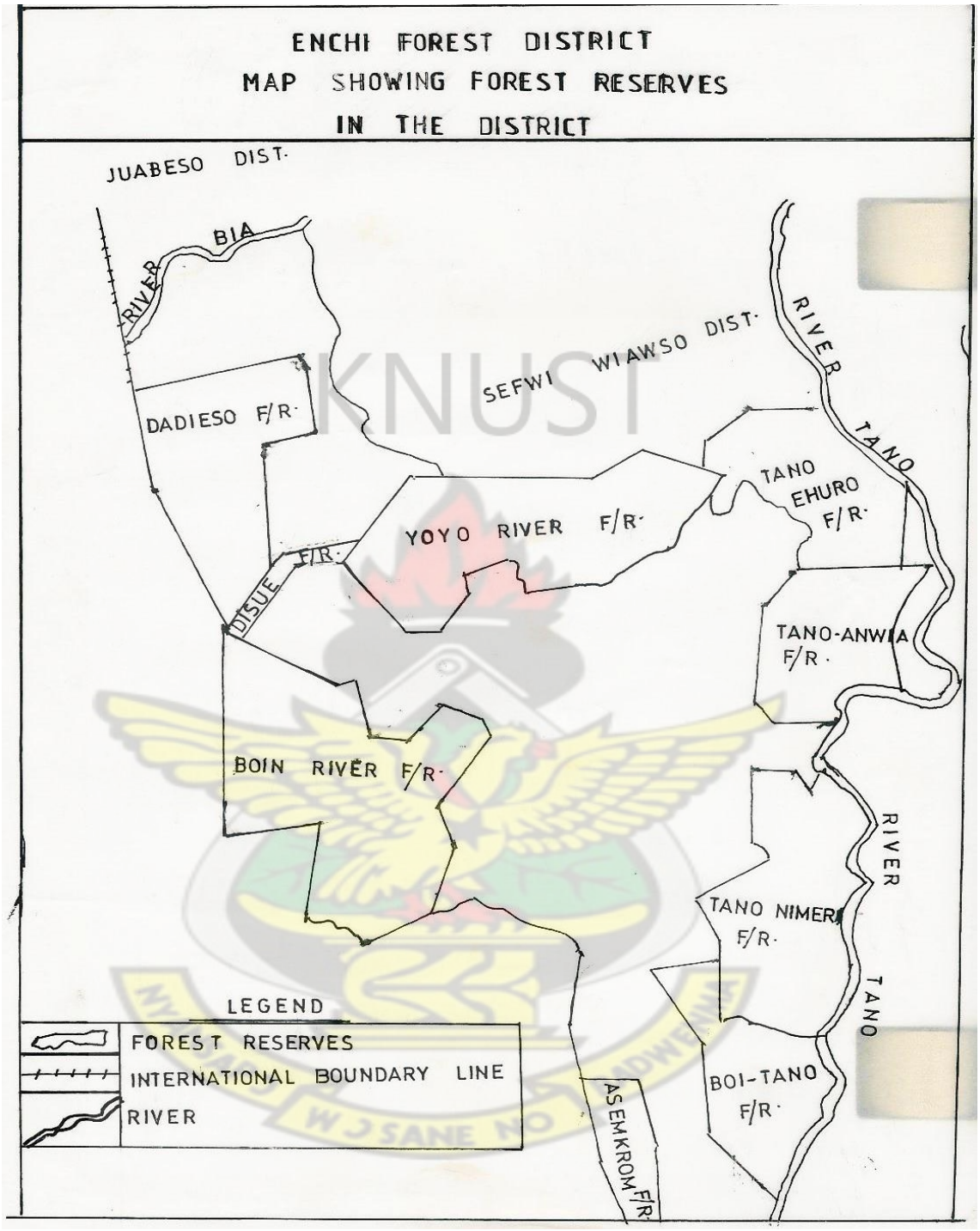


Figure 5: Map showing forest reserves in the Enchi forest District

Field Survey (2012)

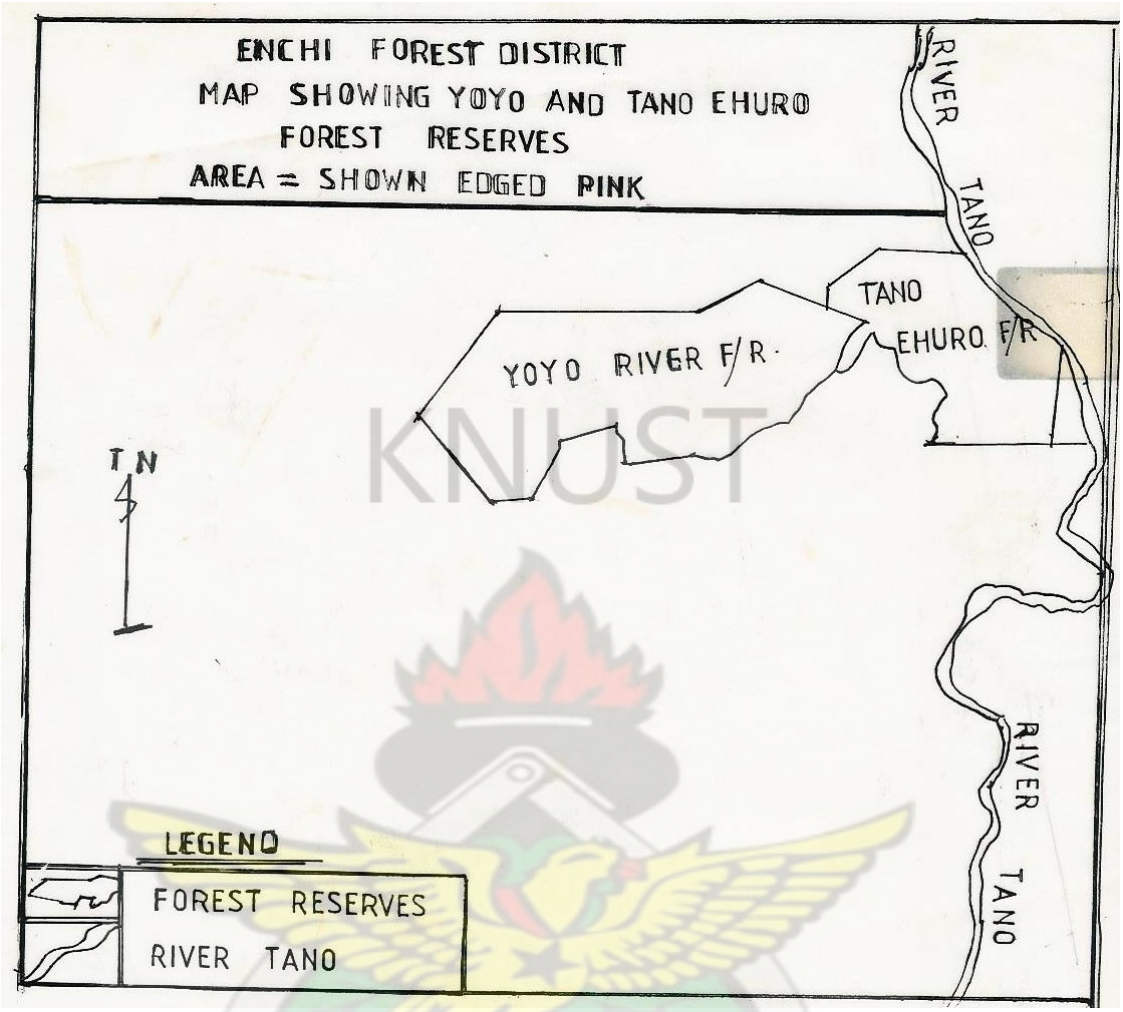


Figure 6: Map Showing Study Areas

Field Survey (2012)

FIELD DATA COLLECTION

Log information (Ll) collected included tree species, base diameter (Db), log length and tail diameter (Dt) for each commercial tree species identified. Similar measurements were applied to dead fallen commercial tree species identified. It is estimated that 7 fringe communities exist in the Yoyo forest reserve. 5 communities/ villages namely, Jensue, Yakase, Adonikrom, Anwiafutu, and Nyankamam were randomly selected for questionnaire administration. In each village 20 respondents, 18 years and above who

were household heads were interviewed. 100 respondents were selected for the study. Structured questionnaire were also administered to the district Forest Manager (appendix 1).

Volume Estimation of identified logs

The volume calculation was done following the prescriptions by the resource Management support Centre based in Kuamsi, Ghana. Calculations of volumes for each log identified over the four (4) plots were done. To calculate for the volume, measurements were done for the following; diameters at base 1&2 as (db1 & db2) and tail diameter 1&2 as (dt1& dt2), after which an average was determined as explained below:

Say:

For diameter at the base

$$\frac{db1 + db\ 2}{2} = a$$

For diameter at the tail

$$\frac{dt1 + dt\ 2}{2} = b$$

Values obtained for 'a' and 'b' in the expressions above were used to trace their respective volumes for one meter bole length of a log in the reckoner (book used by the Forestry Commission, which contains standard values for one meter of a bole length).

To obtain the actual volume for each log, the reckoner value was multiplied by the determined length of the log in meters.

Stumpage Fee Estimation for the identified logs

Stumpage fee for each log was calculated using the approved stumpage fee (table), used by the forestry commission (FC) against the volume obtained. To obtain the total stumpage fee for all the commercial trees destroyed, calculations were done, first for these stumpage fee of commercial trees destroyed within 400 sq m area, after which extrapolation was done to cover entire degraded area of 14,593.50 ha for Tano Ehuro Yoyo.

The data were collected in three (3) folds:

1. Reconnaissance survey of the reserve was done to ascertain the reality of the damage caused.
2. Questionnaire administration was done to obtain biological data, demographic characteristics, financing of agriculture, socio-political issues as well as socio economic issues. It was also used to validate the extent of damage of the reserve and impact of CFM on the socio economic lives of fringe communities.
3. Log information collection was done to obtain volumes for stumpage fee estimation on demarcated plots.

OPERATION OF CFM STRATEGIES

The operation of strategies is also summarized in the description below by the interviewee

- Formation of community based committees or organization (CBC e.g. CBAG) for the boundary maintenance of reserves.
- Boundary maintenance or clearing by a signed negotiated contract agreement basis with the communities (i.e. CBAG members)
- Training/sensitization programs for the communities (i.e. the Community based communities) and other interest groups on collaborative forest management concept.

The interviewee agreed that this program has been operational for 7 years. Additionally, he agreed that there were alternative livelihood programs for Fringe communities. The list is given as Community Investment Fund (CIF) to help community members in Fish Farming, Rip Farming, Grasscutter Farming, Snail Farming, Sheep Farming etc. (i.e. alternative livelihood schemes).

Data Analysis

Field data were summarized and analyzed using simple descriptive statistics (percentages and fractions) and tables. In cognizance to the objective of the study and the information obtained from the field, the above mentioned tools were employed.

CHAPTER FOUR

RESULTS

4.1 COLLABORATIVE FOREST MANAGEMENT STRATEGIES PRACTICED IN THE ENCHI FOREST DISTRICT

The interviewees gave the following as strategies of CFM strategies that exist in the Forest District:

- Maintenance of forest reserve boundaries by the Fringe communities on contract basis
- Rehabilitation of degraded forest reserves in Jema Asenkrom and Tano Nimiri forest reserves with the communities to provide income for them.
- Community Investment Fund (CIF) as a revolving fund to provide alternative livelihood schemes for the Fringe Communities to reduce dependency on forest reserves for survival.
- Communities being part of decision making process in forest management (Communities providing inputs in decision making process in forest management).

- **RESPONSE OF THE PROGRAMME**

According to the communities or beneficiaries of the scheme, the alternative livelihood was good and helpful but was bedeviled by a flood disaster which swept away most of their animals and structures in 2007. The remaining animals were also affected by post flooding epidemic of disease attack which led to most of them dying.

Repayment by the beneficiaries has therefore become a problem or challenge to battle with and called for assistance to revive them. Some of the beneficiary communities are Enchi, Jensue, Yakase, Adomkrom, Anwiafutu and Nyankaman. There are 9 forest reserves in the District namely Yayo River, Boin River, Disue River, Dadieso, Jema Asemkrom, Tano Nimiri, Boi-Tano, Tano Anwiah and Tano Eluro and CFM is practiced in the following forest reserves: Yoyo River, Boin River, Disue River, Dadieso, Jema Asemkrom, Tano Wimiri and Boi-Tano.

4.5 SOCIO ECONOMIC IMPACT OF CFM

- **Gender of Respondents**

The farmers were asked to indicate their sex. Table 3 is a summary of the results.

Table 3: Gender of Respondents

Gender	Frequency	Percent
Male	30	30.0
Female	70	70.0
Total	100	100.0

Information in Table 3 indicates that 30 percent of the farmers were males while majority of these farmers were women. Females therefore dominated.

- **Age of Respondents**

The summary of the responses for the age groups under study from the respondents is summarized in Table 4. Most of these farmers were in the age range of 20-29

representing a 78 percent. For the farmer between 30-39 years, there was a 21 percent representation and 1 individual was in the 40-49 age brackets.

Table 4: Age of Respondents

Range	Frequency	Percent
20-29	78	78.0
30-39	21	21.0
40-49	1	1.0
Total	100	100.0

Most of the individual farmers were in their active years of work as (20 – 39 years). Also this information is a positive reflection of the kind of individuals who are into farming within the study area with reference to the future of the venture.

- **Marital Status of Respondents**

Table 5: Marital Status

	Status	Frequency	Percent
	Single	23	23.0
	Married	75	75.0
	Widowed	1	1.0
	Divorced	1	1.0
	Total	100	100.0

23 percent of the respondents were single while 75 percent were married. There was 1 percent representation of farmers who were widowed and also an equal percentage for those who were divorced. This information brings on the board the likelihood of dependence of these farmers since most of them were married with a high probability of dependence.

- **Household Heads**

Respondents were questioned on whether they were household heads in their homes. This was to measure the level of dependence of these farmers by other individuals such as children, parents or any kinsmen. 40 percent of the farmers were household heads while 60 percent of them were not household heads.

Table 6: Status of Respondents at home

Options	Frequency	Percent
Yes	40	40.0
No	60	60.0
Total	100	100.0

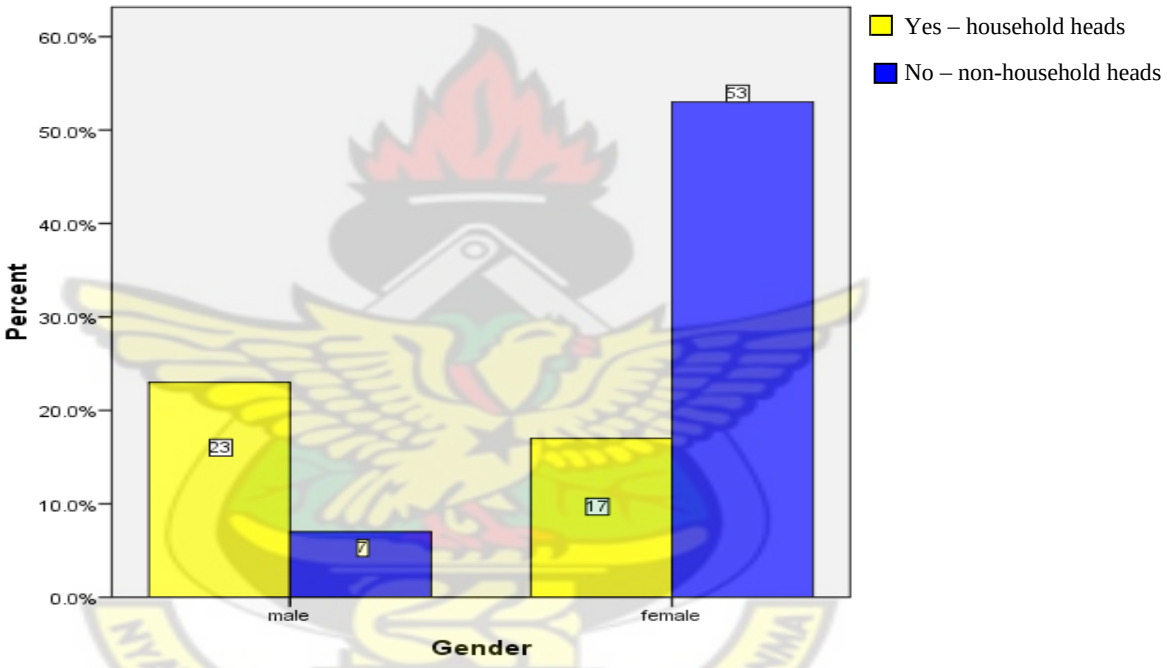


Figure 7: Status of respondents in household

The low number of individuals who are household heads is primarily because majority of the respondents were females. Common to local societies is to have the man being the household head. The data indicates that some women were household heads.

- **Level of Education**

The summary of the response for level of education attained is shown in Table 7. Majority of the respondents had Junior Secondary school as their highest level of education (i.e. 45 percent).

Table 7: Level of Education

Level of Education	Frequency	Percent
Primary	20	20.0
Middle school	25	25.0
JHS	45	45.0
SHS	10	10.0
Total	100	100.0

10 percent had completed Senior Secondary School. The farmers who had Primary and Middle school as their highest level of education were 20 percent and 25 percent respectively. There was no individual who has never had formal education before. This shows that there was a high probability of access to materials that had to read to a large extent especially since 55 percent had been to either Junior or Senior Secondary school.

- **Religion and Tribe**

There were more Christians than any other religious denominations representing up to 63 percent. 25 percent were into African Traditional Religion. Islamic religion and other religions recorded 9 percent and 3 percent respectively. This meant that the study area was dominantly a Christian Community.

Table 8: Religion of Respondents

Religion	Frequency	Percent
Islam	9	9.0
Christianity	63	63.0
African Traditional Religion	25	25.0
Others	3	3.0
Total	100	100.0

Out of these individuals, they were unevenly distributed into tribes as follows Brosa, Brong, Mamprusi and Ewe with 10 percent, 11 percent, 50 percent and 29 percent respectively. Most of the farmers were Mamprusi with next highest tribe in line being the Ewe tribe.

- **Impact of CFM**

To investigate the impact of CFM on Forest Management and Socio Economic Development of fringe communities, respondents were asked questions on whether they attended forest meetings, the consistency of attendance if they did, whether they have had any form of training from the Forest Services Department (FSD), the kind of training, etc.

Every farmer that was questioned had attended a forest meeting before. This shows the level of effectiveness of the forest meetings to have 100 percent of the respondents all having attended such a meeting before.

Figure 8 shows the level of consistency of individual farmers to the meetings. It shows that 85.9 percent were frequent or regular at meetings while a significantly small percent (i.e. 14.1 percent) were occasional at the forest meetings. Of all the respondents considered, 99 percent have had training by the FSD while 1 percent have not had any training by FSD.

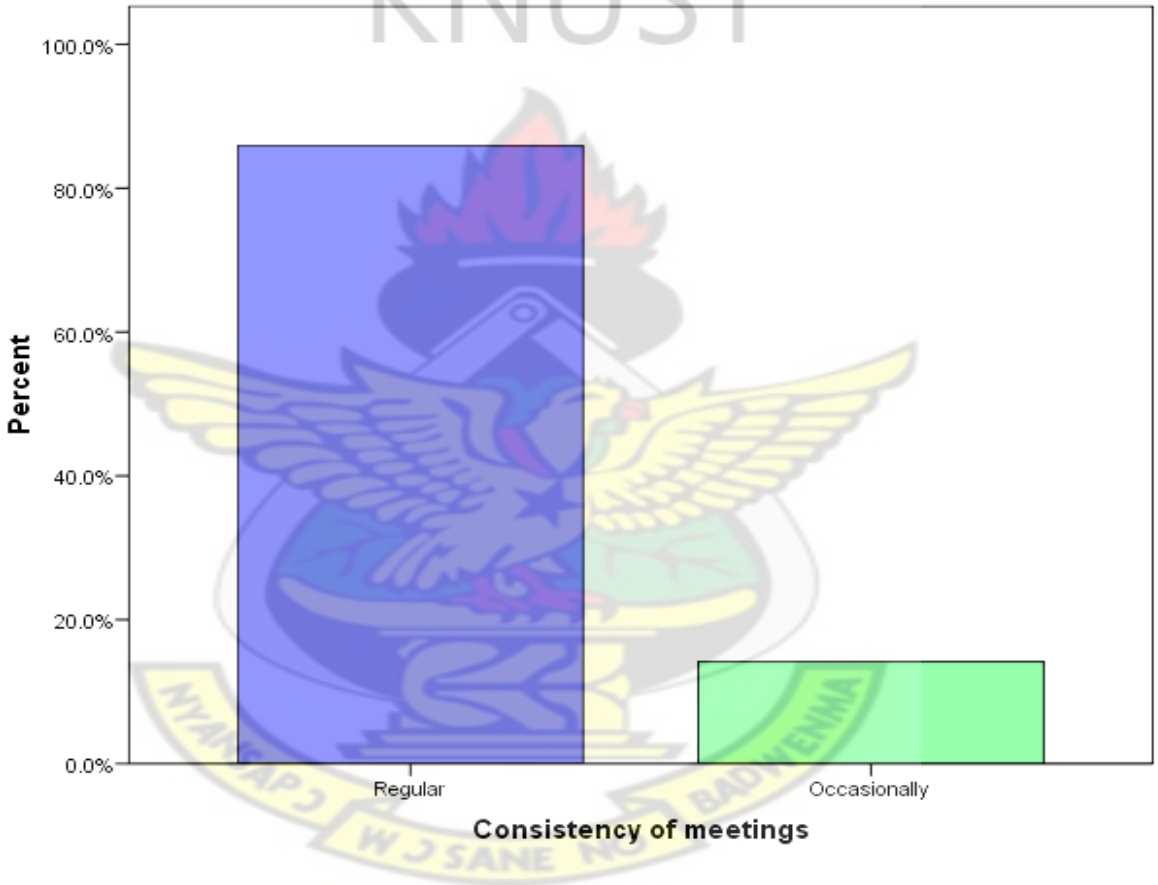


Figure 8: Percentage of Farmers and Consistency of Meeting Attendance

Table 9: Have you been given any training by FSD?

Options	Frequency	Percent
Yes	98	98.0
No	2	2.0
Total	100	100.0

The farmers who have had training by FSD were asked to detail the kind of training they have had. These were in five main categories of training: Grasscutter farming, Rip farming, Fish farming, Snail farming and Sheep farming.

Figure 9 is a bar chart showing various trainings and the percentage participation by the respondents.

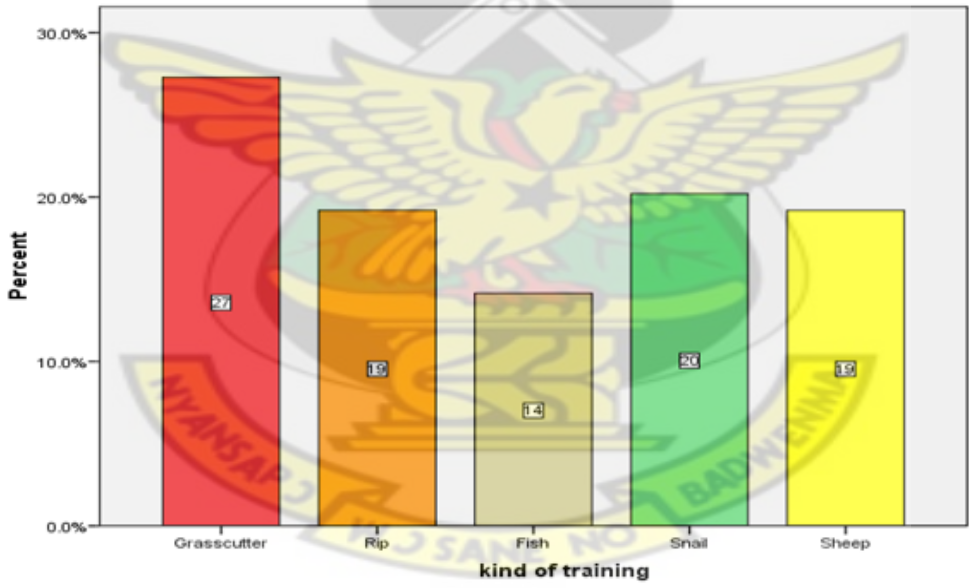


Figure 9: Percentage Distribution and Kind of Training

Most of the respondents benefited from Grasscutter farming representing 27.3 percent. For Rip farming, there was a 19.2 percent representation of the respondents participating. Fish farming, Snail farming and Sheep farming had 14.1 percent, 20.2

percent and 19.2 percent respectively. Every respondent agreed to having benefited from being given a facility before. The summary of the facilities provided and the percentage distribution is summarized in the table below.

Table 10: Kind of facility given

Facility given	Frequency	Percent
financial loan	75	75.0
Agric tools and equipment	25	25.0
Total	100	100.0
Total	100	100.0

As an answer to the research question on whether individual farmers have benefited economically from CFM, the response was a 78.4 percent affirmation and 21.2 percent negative. This means a significant positive response for effect of CFM economically on the farmers.

Table 11: Can you say that CFM has improved your economic gains

	Frequency	Valid Percent
yes	79	79
no	21	21
Total	99	100.0

Out of the farmers who responded positively to the effect of CFM as an economic gain, there were 3 specific options of economic categorization namely ability to save money, affordability of school fees of defendants and affordability of three square meals a day. 16. 2 percent indicated they were able to meet just one of the three economic gain options while 15 percent were able to meet two options out of the three economic gains. Majority (i.e. 68 percent) of the respondents were able to meet all three economic gains. This is summarized in Table 12 below.

Table 12: Level of benefit from CFM

	Options	Frequency
	One option	13
	Two options	12
	Three options	55
	Total	80
Missing	System	20
Total		100

Relating the question of if CFM has reduced farmers' reliance on reserve for survival, 81.6 percent of the farmers responded Yes while the rest (i.e. 18.4 percent) responded No.

Table 13: has CFM reduced your reliance on reserve for survival

		Frequency	Valid Percent
Valid	yes	80	81.6
	no	18	18.4
	Total	98	100.0
Missing	System	2	
Total		100	

Extent of Damage in Cost, Volume and Area in CFM Practiced Reserve (Yoyo) as against non CFM Practiced Reserve (Tano Ehuro)

Table 14: Stages of Destruction of Tano Ehuro Forest Reserve

Extent Of Damage Prior To The Study		
Description	**Size (ha)**	**Percentage (%)**
Area of twenty five (25) admitted farms	200	1.1
Degraded Area	13,057.50	74.2
Area with some forest covers (36 compartments). But currently understand assaults.	4,352.50	24.7
Revelation of the Extent of damage within the 36 compartments during the study		
Area of some forest cover about 24 compartments	2,816.50	64.7/16
Degraded area 12 compartments	1,536.0	35.3/8.7
Total area degraded = 14,593.50		
Representing 84%		

Filed survey (2012)

Prior to the encroachment, Tano Ehuro forest Reserve had a total area of (176.10 sq km) with 200 hectares of twenty-five (25) admitted farms. Priors to the study, an area of 13,057.50 had been degraded, and the areas with some forest cover were only 36

compartments, which was also under assaults. It was noted during the study that about 12 compartments within the 36 compartments, proclaimed to have some forest cover have been destroyed (Table 14). This means that 82.9% of the total area was degraded.

CALCULATIONS OF THE COST OF THE DEGRADED AREAS

FOR TANO EHURO

Selected Area 400 m^2

Estimated cost of selected Area GH¢ 2541.89

Cost per m^2 = $\frac{GH¢2541.89}{400\ m^2}$

= GH¢ 6.35

TOTAL AREA DESTROYED = 82.9% X 176100

= 145986.9

TOTAL COST OF ENTIRE AREA = total area x cost per m^2

= 145986.9 ^{M2} x 6.35

= GH¢ 927,600.76

FOR YOYO FOREST RESERVE

Selected Area = 400 m^2

Estimated Cost of Selected Area = GH¢ 2336.09

Cost Per m^2 = $\frac{2336.09}{400}$

= 5.84

Level of degradation from the researcher's point perspective ranges from 30% to 40%.

If the reserve is 30% degraded;

30% of 81.10 K m^2 = 81100 m^2 = 24330 m^2

Cost for entire degraded area = 24330 m^2 x GHC 5.84/ m^2

= GH¢142087.2

If the reserve is 40% degraded;

40% 81100 = 32440 m^2

Cost for entire degraded area = 32400 m^2 x 5.84/ m^2

= GH¢189,449.6

Therefore the cost of degradation for Yoyo Forest Reserve ranges between GH¢ 142,087.2 to 189,499.6.

Table 15: Some merchantable tree species and their stumpage fees, May, 2012

Common Name	Scientific Name	Stumpage fee (Gh¢) per cubic meter
Mahogany	*Khaya ivorensis*	24.28
Asanfena	*Anigeria robusta*	25.20
Denya	*Cylicodiscus gabunensis*	4.39
Danta	*Naosogordonia papaverfera*	4.62
Ceiba	*Ceiba pentandra*	4.78
Ofram	*Terminalia superba*	5.95
Wawa	*Triplochiton scleroxylon*	6.18
Emire	*Terminalia ivorensis*	10.68
Ananta	*Cynometra ananta*	2.39
Dua-bankye	*Dialium aubrevillei*	2.39
Otie	*Pycnanthus angolensis*	3.42
Makore	*Tieghemalla heckeli*	26.72
Dahoma	*Piptadeniastrum africanum*	3.59
Walnut	*Lovoa trichilioides*	22.61
Odum	*Milica excels/regia*	25.17
Ohaa	*Sterculia oblonga*	2.39
Esia	*Petersianthus macrocarpus*	2.39
Sopi	*Daniellea orgea*	6.54
Esa	*Celtis milbraedii*	3.19
Apapaye	*Turreanthus africanus*	10.65
Ayen	*Disthemontus bentamianu*	10.32

Forestry Commission (2012)

Table 16: Log Information at the 1st Upper Bank of River Ani Adjei

SCIENTIFIC NAME	LOG LENGTH (M)	LOG DIAMETER				VOLUME m^3	PRICE (Gh¢)
		Db1	Db2	Dt1	Dt2		
Terminalia superba	18	65	64	50	55	4.86	28.92
Terminalia superba	22	70	75	65	60	7.70	45.82
Terminalia superba	18	60	62	50	51	4.32	25.70
Pycnanthus angolensis	17	65	60	55	56	4.59	15.70
Ceiba pentandra	22	125	13	90	92	21.12	100.95
Disthemonantus bentamianus	14	60	68	50	55	3.78	39.01
Terminalia superba	16	80	85	65	60	6.56	39.03
Pycnanthus (Otie) angolensis	15	65	60	50	50	4.20	14.36
Ceiba pentandra	15	130	134	100	110	16.80	80.30
Pycnanthus angolensis (Otie)	22	95	60	60	65	11.44	39.22
TOTAL							**389.96**

Field survey (2012)

Table 17: Summary of Log Information at the 1st Upper Bank of River Ani Adjei of Tano Ehuro

Common name	Species Code	Scientific Name	Quantity	Volume m^3	Stumpage (Gh¢)	Amount (Gh¢)
Ofram	Ts	*Terminalia superba*	4	22.44	5.95	139.43
Otie	Pyc	*Pycnanthus angolensis*	3	20.23	3.42	69.28
Ceiba	Cp	*Ceiba pentandra*	2	37.92	4.78	181.25
Grand Total						**389.96**

Field Survey (2012)

Cieba pentandra had the highest cost in this study plot followed by *Terminalia superba.*

Only nine (9) commercial trees were identified.

Table 18: log information at the 2nd upper bank of river Ani Adjei

Trade Name	Log Length (m)	Log Diameter (cm)				Volume (m^3)	Price (Gh¢)
		Db1	Db2	Dt1	Dt2		
Dua Bankye	16	80	85	70	75	7.52	17.98
Dahoma	18	110	100	80	85	12.60	45.23
Otie	14	60	65	50	50	3.50	11.97
Dahoma	15	75	70	65	60	5.40	19.39
Lovea	23	80	85	65	70	9.43	213.21
Otie	22	60	65	50	55	5.72	19.61
Ohaa	15	65	70	50	45	3.90	9.31
Esia	25	70	75	60	65	10.25	24.52
Sopi	22	60	65	50	55	5.72	37.41
Esa	15	60	65	55	50	6.50	20.73
Esa	25	90	85	70	75	12.50	39.87
Ananta	15	60	65	50	55	3.90	9.32
Asoma	15	120	110	80	75	11.25	26.89
Dahoma	14	80	85	60	65	5.74	20.61
Dahoma	16	120	125	80	90	3.92	14.07
Ananta	12	90	85	60	55	5.05	12.07
Dua Bankye	10	60	65	50	55	3.12	7.46
Asoma	15	90	95	60	55	6.90	16.49
Denya	10	110	105	70	65	6.30	27.66
Lovoa	22	75	70	50	54	6.82	154.20
Esa	23	80	85	60	54	8.70	27.75
Ohaa	12	90	100	70	74	6.72	16.06
Dua Bankye	13	70	65	55	50	3.64	8.70
Apapaye	10	85	80	50	45	3.50	37.27
Dahoma	20	130	135	75	80	18.20	65.34
TOTAL							858.01

Field Survey (2012)

Table 19: Summary of log information at the 2nd upper bank of river Ani Adjei

Trade Name	Species Code	Scientific Name	Quantity	Volume (m^3)	Stumpage (Gh¢)	Amount (Gh¢)
Duabankye	Dia	*Dialium aubrevillei*	3	14.28	2.39	34.13
Dahoma	Pip	*Piptadeniastrum africanum*	5	45.86	3.59	119.64
Otie	Pyc	*Pycnanthus angolensis*	2	9.22	3.43	31.62
Walnut	Lov	*Lovoa trichilioides*	2	16.25	22.61	367.41
Ohaa	Sto	*Sterculia oblonga*	2	10.62	2.39	25.37
Esia	Pet	*Petersianthus macrocarpus*	1	10.25	2.40	24.52
Sopi	Dat	-	1	5.72	6.07	37.41
Esa	Cem	*Celtis madbraedii*	3	27.70	3.19	88.36
Ananta	Cyn	*Cynometra ananta*	2	8.95	2.39	21.39
Asoma	Pbi	*Parkia bicolor*	2	18.15	2.39	43.38
Denya	Cyl	*Cylicodiscus gabunensis*	1	6.30	4.39	27.66
Apapaye	Tur	*Turreanthus africanus*	1	3.50	10.65	37.27
Grand Total		**858.16**				

Field Survey (2012)

Twenty five (25) merchantable tree species were identified. In terms of cost Walnut had the highest followed by Dahoma. This plot is richer in species than the first upper bank.

Table 20: Log Information at the 1ST Lower bank of River Ani Adjei

Trade Name	Log Length (m)	Log Diameter (cm)				Volume (m^3)	Price (Gh¢)
		Db1	Db2	Dt1	Dt2		
Lovoa	16	70	5	50	54	4.96	112.14
Ananta	18	60	65	50	54	4.68	11.18
Ofram	19	90	95	70	75	9.88	58.79
Dahoma	20	80	84	60	65	8.20	29.43
Ananta	18	120	125	80	85	15.30	36.57
Dua Bankye	17	70	75	50	55	6.82	16.30
Dahoma	22	`70	74	50	54	7.04	25.27
Dahoma	18	90	95	60	65	8.64	31.02
Ceiba	18	150	154	90	95	22.14	105.83
Dahoma	22	90	95	60	65	10.56	37.91
Dahoma	14	100	105	70	74	8.54	30.66
TOTAL							**495.08**

Field Survey (2012)

Table 21: Summary of Log Information at the 1ST Lower bank of River Ani Adjei

Trade Name	Specie Code	Scientific Name	Quantity	Volume (m^3)	Stumpage (Gh¢)	Price (Gh¢)
Walnut	Lov	*Lovoa trichhiliodes*	1	4.96	22.61	112.14
Ananta	Cyn	*Cynometra ananta*	2	19.99	2.39	47.75
Ofram	Ts	*Terminalia superba*	1	9.88	5.95	58.79
Dahoma	Pip	*Piptaddeniastrum africanun*	5	42.98	3.59	154.27
Duabankye	Dia	*Dialium aubrevillie*	1	6.82	2.39	16.30
Ceiba	Cp	*Ceiba pentandra*	1	22.14	4.78	105.83
Grand Total						**495.08**

Field Survey (2012)

Table 22: Log Information at the 2nd Lower Bank of River Ani Adjei

Trade Name	Log Length (m)	Log Diameter (cm)				Volume (m^3)	Price (Gh¢)
		Db1	Db2	Dt1	Dt2		
Asanfena	15.40	52	46	40	45	2.460	61.99
Denya	20.80	100	84	72	68	10.69	46.86
Mahogany	17.30	68	74	50	58	5.630	136.70
DuaBankye	18.00	100	84	84	78	9.955	23.79
Danta	12.50	46	50	40	40	2.700	12.47
Odum	18.00	78	67	62	54	6.188	155.75
Dahoma	10.50	105	90	87	78	6.615	23.75
Esia	11.80	90	84	70	66	5.664	13.54
Makore	16.40	115	100	80	76	10.496	280.35
Asanfena	22.00	74	75	60	62	7.92	199.58
Wawa	14.50	82	74	56	56	5.22	32.26
Emire	15.00	68	60	50	56	4.05	43.25
Otie	17.00	70	65	56	52	4.93	16.86
Ananta	18	54	48	30	36	2.52	6.02
Dahoma	24.00	75	75	62	58	8.64	31.02
Danta	16.00	70	75	54	46	4.80	22.18
TOTAL							**798.84**

Field Survey (2012)

Table 23: Summary of Log Information at the 2nd Lower Bank of River Ani Adjei

Trade Name	Species Code	Scientific Name	Quantity	Volume m^3	Stumpage (Gh¢)	Price (Gh¢)
Asanfena	Anr	*Anigeria robusta*	2	4.380	25.20	261.57
Denya	Cyl	*Cylicodiscus gabunensis*	1	10.69	4.39	46.86
Duabankye	Dia	*Dialium aubrevillei*	1	9.955	2.39	23.79
Mahogany	Ki	*Khaya grandifoliola*	1	5.630		136.70
Danta	Nes	*Naosogordonia papaverfera*	2	7.500	4.62	34.65
Odum	Mil	*Milica excels//regia*	1	6.188	25.17	155.75
Dahoma	Pip	*Piptadeniastrum africanum*	2	15.245	3.59	54.77
Esia	Pet	*Petersianthus macrocarpus*	1	5.664	2.40	13.54
Makore	Tie	*Tieghemalla heckelii*	1	10.496	26.72	280.35
Wawa	Tri	*Triplochton scleroxylon*	1	5.22	6.18	32.26
Emire	Ti	*Terminalia ivorensis*	1	4.05	10.68	43.25
Otie	Pyc	*Pycnanthus angolensis*	1	4.93	3.43	16.86
Ananta	Cyn	*Cynometra ananta*	1	2.52	2.39	6.02
GRAND TOTAL						**798.84**

Field Survey (2012)

Table 24: Log Information at Plot 1 in Yoyo F/R (CFM Practiced)

Trade Name	Log length(m)	Log Diameters				Volume m^3	Stumpage (Gh¢)	Total Price (Gh¢)
		Db1	Db2	Dt1	Dt2			
Wawa	25.60	130	90	105	98	22.528	6.18	139.22
Wawa	16.40	98	75	76	66	8.036	6.18	49.66
Asanfena	21.00	110	108	88	84	15.960	25.20	402.19
TOTAL								**591.07**

Field Survey (2012)

Table 25: Summary of Log Information at Plot 1 in Yoyo F/R (CFM Practiced)

Trade Name	Species Code	Scientific Name	Quantity	Volume m^3	Stumpage (Gh¢)	Amount (Gh¢)
Wawa	Tri	*Triplochiton scleroxylon*	2	30.564	6.18	188.88
Asanfena	Anr	*Anigeria robusta*	1	15.960	25.20	402.19
GRAND TOTAL						**591.07**

Field Survey (2012)

Table 26: Log Information at Plot 2 in Yoyo F/R (CFM Practiced)

Trade Name	Log length	Log Diameters				Vol m^3	Stumpage (Gh¢)	Price (Gh¢)
		Db1	Db2	Dt1	Dt2			
Asanfena	16.0	74	72	52	51	4.960	25.20	124.99
Asanfena	14.20	66	68	48	50	3.834	25.20	96.62
Emire	18.20	78	76	56	56	6.552	10.68	69.97
Wawa	17.00	82	81	64	62	6.970	6.18	43.07
Wawa	24.00	88	85	58	64	10.500	6.18	65.26
TOTAL								**399.97**

Field Survey (2012)

Table 27: Summary of Log Information at Plot 2 in Yoyo F/R (CFM Practiced)

Trade Name	Species Code	Scientific Name	Quantity	Volume m^3	Stumpage (Gh¢)	Amount (Gh¢)
Asanfena	ANR	*Anigeria robusta*	2	8.794	25.20	221.61
Emire	Ti	*Terminalia ivorensis*	1	6.552	10.68	69.97
Wawa	Tri	*Triplochiton scleroxylon*	2	17.470	6.18	108.33
GRAND TOTAL						**399.97**

Source field survey (2012)

Table 28: Log Information at Plot 3 in Yoyo F/R (CFM Practiced)

Trade Name	Log Length	Log Diameters				Vol m^3	Stumpage (Gh¢)	Price (Gh¢)
		Db1	Db2	Dt1	Dt2			
Ofram	20.00	74	78	54	50	6.600	5.95	39.03
Ofram	19.60	80	70	62	57	7.056	5.95	41.98
Wawa	21.20	78	82	70	65	9.116	6.18	56.34
Mahogany	24.20	94	90	66	63	11.858	24.28	287.91
Emire TI	18.40	82	75	68	62	7.544	10.68	80.57
Wawa	16.20	84	86	70	58	7.290	6.18	45.05
Ofram	15.80	83	78	72	70	7.110	5.95	42.30
TOTAL								**593.43**

Field Survey (2012)

Table 29: Summary of Log Information at Plot 3 in Yoyo F/R (CFM Practiced)

Trade Name	Species Code	Scientific Name	Quantity	Volume m^3	Stumpage (Gh¢)	Amount (Gh¢)
Ofram	Ts	*Terminalia superba*	3	15.766	5.95	123.31
Wawa	Tri	*Triplochiton scleroxylon*	2	16.406	6.18	101.35
Mahogany	Ki	*Khaya grandifoliola*	1	11.858	24.28	287.91
Emire	Ti	*Terminalia ivorensis*	1	7.544	10.68	80.57
GRAND TOTAL						**593.43**

Field Survey (2012)

Table 30: Log Information at Plot 4 in Yoyo F/R (CFM Practiced)

Trade Name	Log Length	Log Diameters				Vol m^3	Stumpage (Gh¢)	Price (Gh¢)
		Db1	Db2	Dt1	Dt2			
Dahoma	14.40	84	85	72	73	6.912	3.59	24.81
Wawa	16.00	100	84	84	72	9.120	6.18	56.36
Wawa	21.00	90	76	68	67	9.450	6.18	58.40
Mahogany	18.00	102	100	78	74	11.340	24.28	275.33
Emire	16.50	78	78	65	64	6.600	10.68	70.49
Ofram	17.20	66	65	54	54	4.816	5.95	28.66
Wawa	16.60	74	70	56	55	5.312	6.18	32.83
Dahoma	20.00	86	85	73	73	9.800	3.59	35.18
Ofram	17.80	64	64	45	48	4.272	5.95	25.42
Asanfena	22.00	72	70	40	40	5.720	25.20	144.14
TOTAL								**751.62**

Field Survey (2012)

Table 31: Summary of Log Information at Plot 4 in Yoyo F/R (CFM Practiced

Trade Name	Species Code	Scientific Name	Quantity	Volume m^3	Stumpage	Amount
Dahoma	Pip	*Piptaddeniastrum africanun*	2	16.712	3.59	59.99
Wawa	Tri	*Triplochiton scleroxylon*	3	23.88	6.18	147.57
Mahogany	Ki	*Khaya grandifoliola*	1	11.340	24.28	275.33
Emire	Ti	*Terminalia ivorensis*	1	6.600	10.68	70.49
Ofram	Ts	*Terminalia superba*	2	9.088	5.95	54.08
Asanfena	Anr	*Anigeria robusta*	1	5.720	25.20	144.14
GRAND TOTAL						**751.62**

Field Survey (2012)

The above table summarizes log information obtained from plot 4 in Yoyo with mahogany obtaining the highest cost.

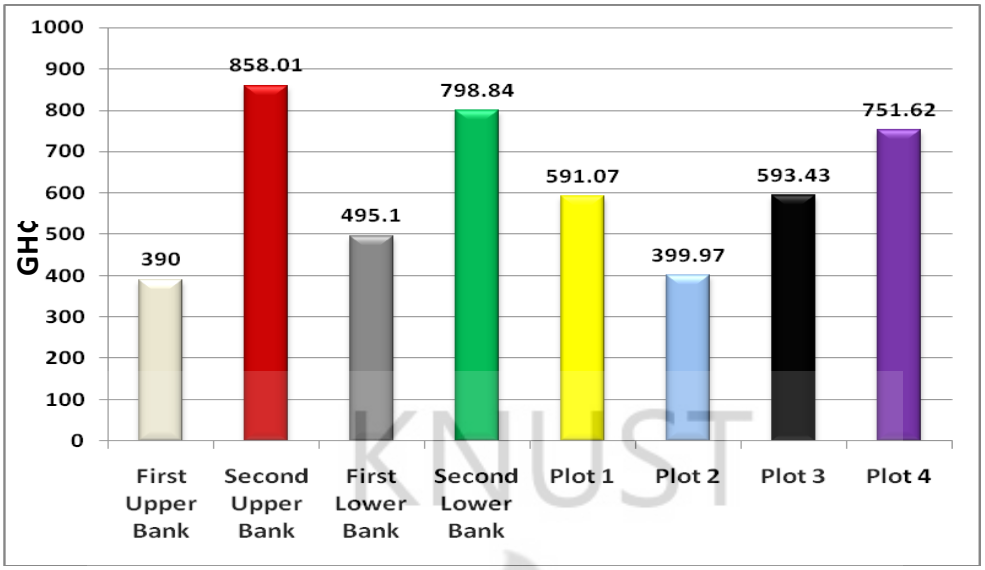


Figure 10: Study plots and cost gallery

The figure above provides the log information of the research around River Ani Adjei (Upper and lower banks) and then Yoyo (Plot 1 – Plot 4).

The figure displays the total price of trees in each area. The highest grand price is observed in the Second upper bank of River Ani Adjei with the minimum price occurring at the First Upper bank of River Ani Adjei as farmers farm whiles the trees stand making it difficult for FSD officers to trace forest destruction (plate 3 and 4).

Taking the number of trees into consideration, the mean per tree for each location is computed. The information is provided in the table below.

Table 32: Log Location and their Mean Prices

Location	Exact Position	Mean Price per Tree (Ghc)
River Ani Adjei	First Upper Bank	43.33
River Ani Adjei	Second Upper Bank	34.32
River Ani Adjei	First Lower Bank	49.01
River Ani Adjei	Second Lower Bank	49.93
Yoyo F/R (CFM Practiced)	Plot 1	197.02
Yoyo F/R (CFM Practiced)	Plot 2	79.99
Yoyo F/R (CFM Practiced)	Plot 3	84.78
Yoyo F/R (CFM Practiced)	Plot 4	75.62

This shows contrasting results to the grand total results. Based on the number of trees present, the highest value is observed in Plot 1 of Yoyo with a mean price per tree of GHC 197.02. In summary, the area where CFM is practiced records relatively high mean price per tree with a range of 75.62 – 197.02 which is recorded in Plot 4 and Plot 1 respectively.

The areas around River Ani Adjei provide relatively lower mean price per tree ranging from 34.32 – 49.93 recorded in the Second Upper bank and Second Lower bank respectively of the River Ani Adjei. Yoyo forest reserve was receiving fresh destructions (Plates 1 and 2).

Plate 1: Illegally Sawn Wawa (*Triplochiton scleroxylon*) wood at Yoyo Forest Reserve

Plate 2: Illegally felled Wawa log (*Triplochiton scleroxylon*) at Yoyo Forest Reserve

Plate 3: Illegally felled Asanfena (*Anigeria rubuster*)

Plate 4: One and Half Year old Cocoa Farm at the 2nd Upper Bank of River Ani Adjei of Tano Ehuro Forest Reserve

CHAPTER FIVE

DISCUSION

5.1 COLLABORATIVE FOREST MANAGEMENT STRATEGIES PRACTICED IN THE ENCHI FOREST DISTRICT

Collaborative forest management exists in the Enchi forest district and its effectiveness and sustenance can be largely attributed to the all-involving strategies employed by the FSD officials. One significant factor that has sustained the CFM for seven years is the provision of alternative livelihood scheme for fringe communities through a revolving Community Investment Fund (CIF) to support community members in Fish Farming, Grasscutter Farming, Snail Farming, Sheep Farming and Piggery among others, community involvement in signed contracts for the cleaning of forest boundaries and rehabilitation of degraded areas. The strategy has reduced the reliance on the forest resource by communities significantly as over 80% agreed to this assertion (Table 13).

Yoyo forest reserve where CFM practiced is safe and can be linked to Balnkespoor (1999), who maintains that the major cause of deforestation is directly linked to the food security of fringe communities. The belief that human impact on the environment is both progressive and negative is deep-seated. The issue of disallowing communities to enter forrest resourece is important in forestry as one always finds one product or the other to pick from upon entry. When free entry occurs it then becomes a recipe for forest encroachment, as the tendency of encroaching reserve increase as one is exposed

to the complex reserves (Chrisolm, 1990), and particularly when the reserves are known to provide the primary food source to fringe communities (Daily and Ehrlich, 1994).

The principle of enhancing or modifying forest management to ensure that they address local needs and engender local co-operation was accepted and enshrined in the new forest and wildlife policy of Ghana. The study revealed a clear involvement of fringe communities in the management of the Yoyo forest reserve in the Enchi Forest District. Agyemang and Affum (2006) established that Collaborative Forest management in its entirety is a working partnership between the key stakeholders in the management of a forest. Critical components of Forest Management include Forest protection, forest rehabilitation, boundary cleaning and patrol as well as monitoring, and are linked to the roles played by fringe communities (Forestry Commission, 2004).

According to the communities or beneficiaries of the scheme, the alternative livelihood scheme was good and helpful but was bedeviled by a flood disaster which swept away most of their animal and structures in 2007.

5.2 SOCIO-ECONOMIC IMPACT OF CFM

To investigate the impact of CFM on Forest Management and Socio Economic Development of fringe communities, respondents were asked questions on whether they attended forest meetings, the consistency of attendance if they did, whether they have had any form of training from the Forest Services Department (FSD), the kind of training, etc. Every farmer that was questioned had attended a forest meeting before.

This shows high level of effectiveness of the forest meetings since 100 percent of the respondents indicated having attended such a meeting before (Figure 5).

Forest management thrives when the economic status of fringe communities improved. Primarily, people with low income range reside and thrive on usage of natural resources freely available from forests. Hence the idea that the poor are both agents of forest degradation and victims of forest loss is not new (WCED 1987).

The low response for the number of individuals who are household heads is primarily because majority of the respondents were females. Common to local societies to have is to have the man be the household head. The data indicates that some women were household heads (Table 6).

According to the communities or beneficiaries of the scheme, the alternative livelihood was good and helpful but was bedeviled by a flood disaster which swept away most of their animal and structures in 2007. Repayment by the beneficiaries has therefore become a problem or challenge to battle with and called for assistance to revive them. This assertion by beneficiaries was interesting as 98% beneficiaries admitted (Table 9) having had training for the enterprise. The loss is subjective as Antwi (1999) maintains that the estimated cost of the losses of Ghana's forest related resources is about 10.8million Ghana cedis per year in environmental related disasters. Alternatively, the loss can be attributed to poor management or over reliance on that enterprise for survival due to poverty as Salmi (Borrini-Feyerabend, 1996) confirms that poverty is

endemic in the third world countries, though agrarian. Doubt is reserved for the sustenance of the CIF because this collaborates the assertion by Myers (2001) that land use that result in the loss of economic species (Flora and fauna) would not be sustainable enterprise. Beneficiaries agreed having benefited enormously from the alternative livelihood program particularly the provision of agro facilities, improvement of economic gains and a significant reduction on the reliance on forest reserve for survival (Tables 10, 11 and 12). This a positive news to hear from forest fringe communities as WCED (1987) supports that the economic growth of the rural people in its entirety is an indispensable prerequisite for the survival of the forest reserves.

Forests indeed have the potential for improving human welfare through supplementing income and functioning as safety nets (Agyemang and Affum, 2006). Lack of alternatives and excessive reliance on forest resources can also perpetuate poverty (Neumann and Hirsch, 2000).

In recent years however, the notion that environmental conditions first deteriorate but then improve as development proceeds attracts increased attention. Prevalent literature review outlines a historical relationship between economic development and changes in forest Cover (Rudul, 1998).

5.3 EXTENT OF DAMAGE IN COST, VOLUME AND AREA IN CFM PRACTICED RESERVE (YOYO) AS AGAINST NON CFM PRACTICED RESERVE (TANO EHURO)

Prior to the encroachment, Tano Ehuro forest Reserve had a total area of (176.10 sq km) with 200 hectares of twenty-five (25) admitted farms. Priors to the study, an area of 13,057.50 had been degraded, and the areas with some forest cover were only 36 compartments, which was also under assaults. It was noted during the study that about 12 compartments within the 36 compartments, proclaimed to have some forest cover have been destroyed (Table 14). This means that 82.9% of the total area was degraded (Table 14).

The deforestation rate in reserves has gained alarming proportion; Antwi (1999) noticed that the quality within some of the forest reserves has been significantly eroded. Accordingly, forest reserves such as Manza, Bodi, Desiri, Sukusuku, Bia among others have been invaded by farmers and may not be classified as forest and Tano Ehuro can be counted as one, and can be concluded, however, that the Tano Ehuro Forest Reserve is 84% destroyed, Representing a destruction of about 14,593.00 ha (Table 14).

Stumpage fees as at May, 2012 was collected and used against commercial trees species identified (Table 15). Calculations were done for each of the commercial tree species in the Eight (8) plots, namely, 1st upper bank, 2nd upper bank, 1st lower bank and 2nd lower bank of river Ani Adjei in favour of Tano Ehuro forest reserve and Plot 1, Plot 2, Plot 3 and Plot 4 in favour of Yoyo forest reserve.

With the Forest area of about 14,593 ha destroyed as a result of the encroachment, the study revealed an estimated destruction cost of Ninety three million, nine hundred and thirty one thousand seven hundred and forty Ghana cedis **(GHC 93,931,740)** stumpage fee in favor of Tano Ehuro Forest Reserve for 84% degraded, and a range of between One Hundred and Forty Two Thousand Eighty Seven Ghana Cedis Two Pesewa (GH¢ 142,087.2) and One Hundred and Eighty Nine Thousand Four Hundred and Ninety Nine Ghana Cedis Six Pesewa (GH¢ 189,499.6) for Yoyo Forest Reserve for a destruction rate of 30% and 40% respectively, and this collaborates the assertion that the economic timbers in Ghana are running out as a result of forest clearance for coca cultivation and food crops (Hagan, 2004). The figure for Yoyo is on the higher side since Collaborative Forest Management exists. It was also observed during the study that less number of trees were identified in Yoyo but tree species found were of high commercial value and demand, hence the high price.

However, it must be indicated that the estimate may not be accurate since some of the trees destroyed stood an equal chance of gaining weight or attracting high price due to change in demand, as demand for forest resources can be put into local, national and international (Myers, 1992).

At a distance, the Tano Ehuro Forest reserve is well stocked, but the situation is different when one enters the reserve as the farmers start cocoa cultivation from the inside of the reserve (Plate 4), and this confirms the assertion (Antwi 1999) that satellite imageries available depicts that the forest reserves have their boundaries intact but the

situation differs upon entry. The situation in the Tano Ehuro forest reserve further dwindles the quality of the timber protected areas which is estimated to be 47% (Figure 2) of the total areas of forest reserve in Ghana.

Over estimation could also be possible because some of the trees must have possessed certain undesirable qualities which must have rendered them economically unattractive at the time of fell. Natural disasters or wildfires must have destroyed some of them, as (Antwi, 1999) noticed that environmental disasters or wild fires can cause a loss of our forest cover estimated at about 10.8 billion cedis per annum.

The products and functions of a forest cannot be dully quantified and priced, hence, the total cost of the destruction within such degraded forest area of 14,593.0 ha, for Tano Ehuro Forest Reserve and 30% - 40% degradation of 81100 m^2 have not been dully quantified and priced, considering the complex nature of a forest (Martin, 1992). Undoubtedly, not all the resources that are destroyed in a forest can be quantified and priced, as environmental protection of forests, ecological concerns and spiritual and cultural importance of forests cannot be quantified (Cannell, 1989).

Forest reserves do not only provide economic advantages, which are usually quantified and priced, they also provide assorted benefits, many of which quantification and pricing are difficult, if not impossible.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

The study revealed an existence of CFM in the Enchi Forest District and operated through Community Biodiversity Advisory Groups (CBAG). CBAG members were part of decision making in forest management as 83% members frequently attended meetings, and who were also supported by FSD in the form of loans. It was observe that all CBAG members lived in Fringe Communities.

It was established that CFM had positive economic impact on fringe communities as 90% had had alternative livelihood training organized by FSD. Again 68% of members met all the three (3) economic gains and only 16.2% and 15% met one of the economic gains and two options of the economic gains respectively, and this reduced the level of reliance on forest reserve for survival by fringe communities by 81.6%.

The study again revealed that Yoyo Forest Reserve where CFM was practiced was at less risk in terms of destruction than Non – CFM practiced Forest Reserve, Tano Ehuro as reflected in the extent of damage and stumpage fee obtained.

It can be concluded, however, that as Yoyo is almost 30% - 40% degraded Tano Ehuro Forest Reserve is 84% destroyed, and the commercial tress that have been destroyed in the process, through fell to waste is estimated at Ninety three million, nine hundred and

thirty one thousand seven hundred and forty Ghana cedis **(GHC 93,931,740)** in respect of Tano Ehuro and a range of between One Hundred and Forty Two Thousand Eighty Seven Ghana Cedis Two Pesewas (**GH¢ 142,087.2)** and One Hundred and Eighty Nine Thousand , Four Hundred and Ninety Nine and Six Pesewas (GH¢ **189,499.6.)**

6.2 RECOMMENDATIONS

1. CFM should be enforced and strengthened by all forest districts in forest management;
2. More alternative livelihood aids to fringe communities should be encouraged;
3. A more intensive training be given to potential beneficiaries of the CFM followed by regular monitoring.
4. Regeneration of the degraded areas be initiated by major stake holders;
5. Yoyo Forest Reserve should be strictly protected since it contains valued economic species.

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APPENDICES

APPENDIX I

QUETIOSNAIRE ON THE ASSESSMENT OF THE COLLABORATIVE FOREST MANAGEMENT PRACTICE AND IMPACT ON THE SOCIO-ECONOMIC DEVELOPMENT OF FRINGSE COMMUNITIES IN THE ENCHI FOREST DISTRICT OF GHANA

BIOLOGICAL DATE OF RESPONDANTS

Name of community …… House number …….

Please tick (√)

1. Sex (Tick) Male [ ] Female [ ]

2. Age group
   i. Less than 20 [ ] ii. 20-29 [ ] iii. 30-39 [ ] iv. 40-49 [ ] v. 50-59 [ ]
   vi. 60-69 [ ] vii. 70 and above [ ]

3. Marital Status : i. Single [ ] ii. Married [ ] iii. Widowed [ ]
   iv. Divorced [ ]
4. Are you the Household head? i. Yes [ ] ii. No [ ]

5. Level of Education (Tick) i. Primary ( ) ii. Middle School ( ) iii. JHS ( ) iv. Secondary ( ) v. Tertiary ( ) vi. None ( ) vii. Other (Specify)

6. Religion: i. Islam [ ] ii. Christianity [ ]
   iii. African Traditional Religion [ ] iv. Others (specify)

7. Tribe: i. Brosa [ ] ii Brong [ ] iii. Mamprusi [ ] iv. Ewe [ ]
   v. Others (Specify)

QUESTIONAIRE FOR FOREST SERVICES DIVISION STAFF

CFM Strategies/forms Practiced in the Forest District

8. What CFM strategies exist in your forest district?.....
   .....
   ....

9. If yes describe how it is operated?.....
   .....

10. How long has it been operational if any?

11. Do you have any alternative livelihood programs for fringe communities?
    Yes [ ] No [ ]
    Mention them if yes

12. What is the response of the fringe communities towards the program? (State)

IMPACT OF CFM ON FOREST MANAGEMENT AND SOCIO ECONOMIC DEVELOPMENT OF FRINGE COMMUNITIES

13. Have you been invited to attend forest meetings before? Yes [ ] No [ ]

14. If yes how often is it? (Specify)
    ……

15. Have you been given any training by FSD? Yes [ ] No [ ]

16. If yes mention the kind of training received
    ……..

17. Have you been given any facility before? Yes [ ] No [ ]

18. If yes indicate the kind of facility received:

i. Financial Loan [ ] ii. Agric. Tools and Equipments [ ]

iii. Others (Specify) …….

STATE OF THE RESERVE BEFORE AND AFTER THE INTRODUCTION OF CFM

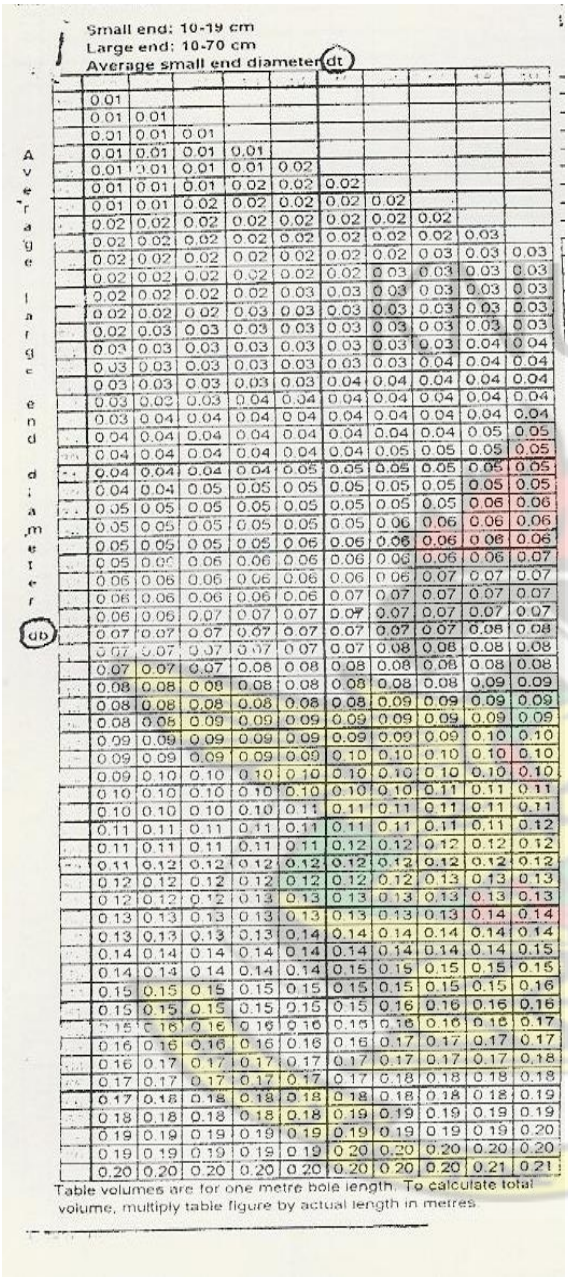
19. How will you describe the state of the forest before and after the introduction of CFM.

20. If there were forest destruction before the introduction of CFM, mention all the causes……
……
……

21. If the state of the forest has improved as a result of the introduction of CFM, describe its pattern……
……
……

APPENDIX II

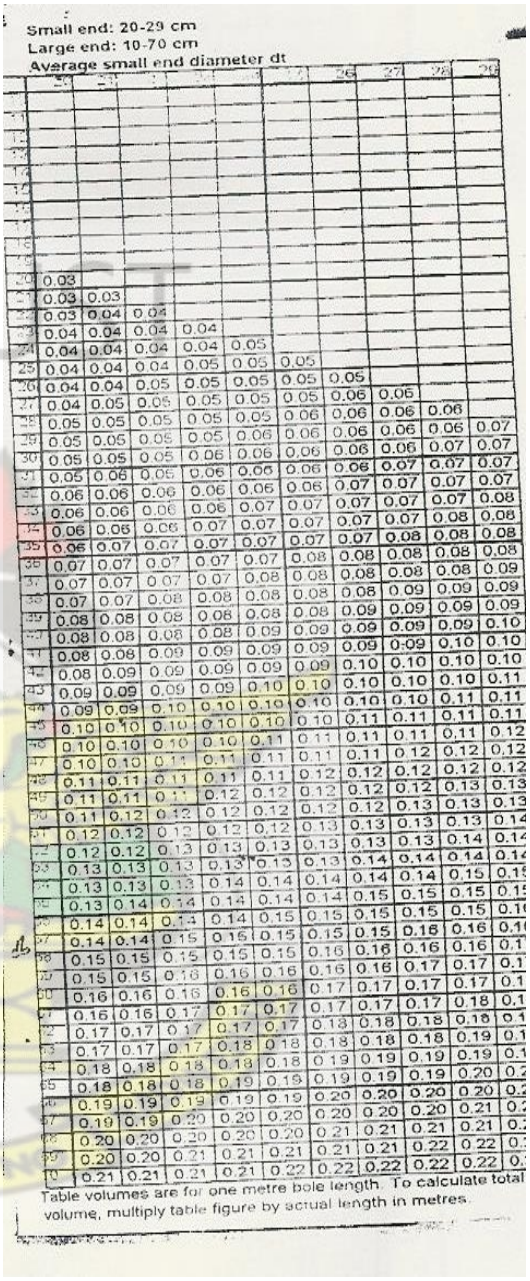
Tree Bole/ Log volume Table



Small end: 10-19 cm
Large end: 10-70 cm
Average small end diameter dt

Average large end diameter (db)

Table volumes are for one metre bole length. To calculate total volume, multiply table figure by actual length in metres.



Small end: 20-29 cm
Large end: 10-70 cm
Average small end diameter dt

Table volumes are for one metre bole length. To calculate total volume, multiply table figure by actual length in metres.

Small end: 30-39 cm
Large end: 30-90 cm
Average small end diameter dt

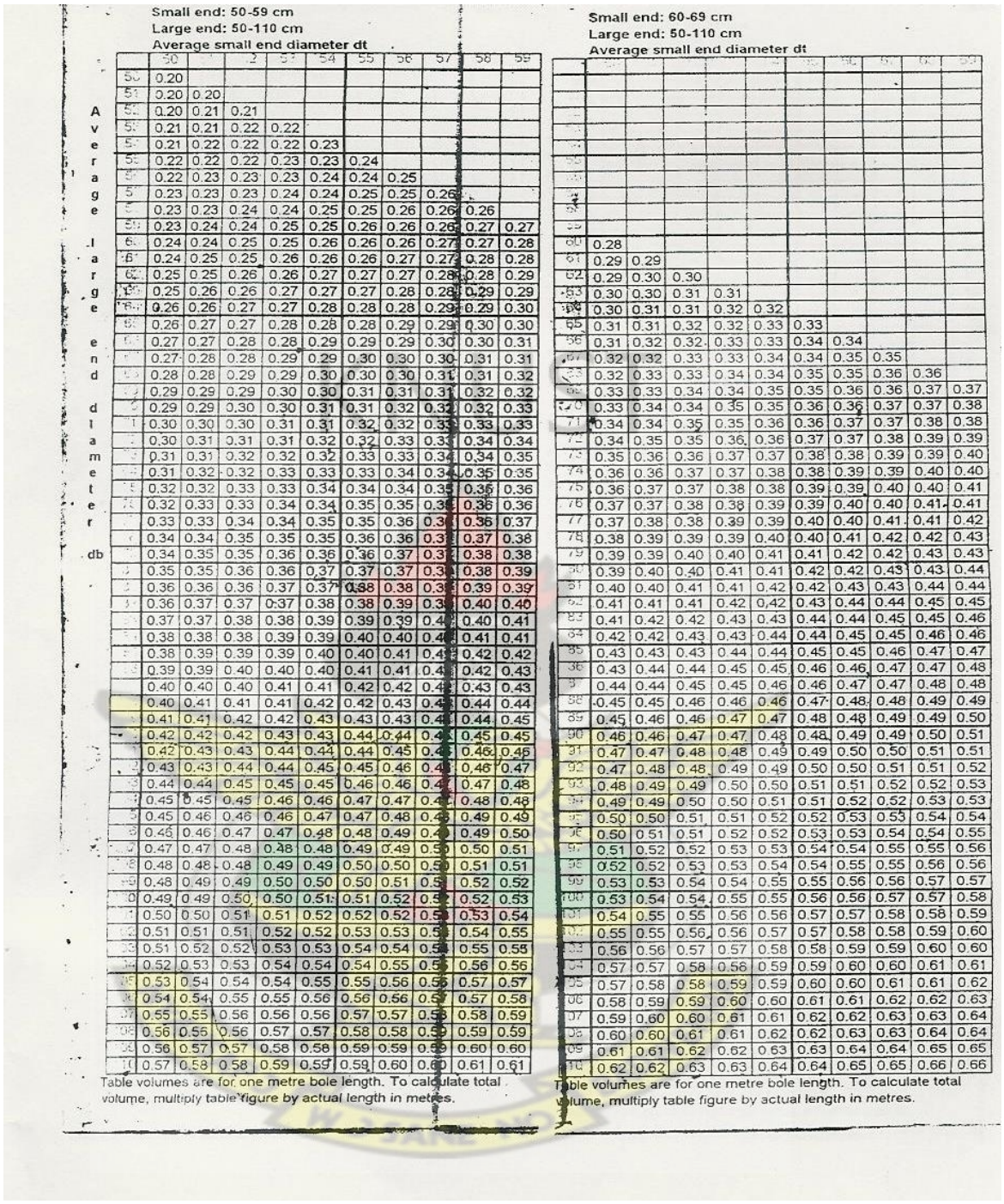
Average large end diameter db	30	31	32	33	34	35	36	37	38	39
30	0.07									
31	0.07	0.08								
32	0.08	0.08	0.08							
33	0.08	0.08	0.08	0.09						
34	0.08	0.08	0.09	0.09	0.09					
35	0.08	0.09	0.09	0.09	0.09	0.10				
36	0.09	0.09	0.09	0.09	0.10	0.10	0.10			
37	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.11		
38	0.09	0.09	0.10	0.10	0.10	0.10	0.11	0.11	0.11	
39	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.12	0.12
40	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.12	0.12	0.12
41	0.10	0.10	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.13
42	0.10	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.13	0.13
43	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.13	0.13	0.13
44	0.11	0.11	0.12	0.12	0.12	0.12	0.13	0.13	0.13	0.14
45	0.11	0.12	0.12	0.12	0.12	0.13	0.13	0.13	0.14	0.14
46	0.12	0.12	0.12	0.13	0.13	0.13	0.13	0.14	0.14	0.14
47	0.12	0.12	0.13	0.13	0.13	0.13	0.14	0.14	0.14	0.15
48	0.13	0.13	0.13	0.13	0.14	0.14	0.14	0.14	0.15	0.15
49	0.13	0.13	0.13	0.14	0.14	0.14	0.15	0.15	0.15	0.15
50	0.13	0.14	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.16
51	0.14	0.14	0.14	0.14	0.15	0.15	0.15	0.16	0.16	0.16
52	0.14	0.14	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.17
53	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.16	0.17	0.17
54	0.15	0.15	0.15	0.16	0.16	0.16	0.17	0.17	0.17	0.17
55	0.15	0.16	0.16	0.16	0.16	0.17	0.17	0.17	0.18	0.18
56	0.16	0.16	0.16	0.17	0.17	0.17	0.17	0.18	0.18	0.18
57	0.16	0.17	0.17	0.17	0.17	0.18	0.18	0.18	0.18	0.19
58	0.17	0.17	0.17	0.17	0.18	0.18	0.18	0.19	0.19	0.19
59	0.17	0.17	0.18	0.18	0.18	0.18	0.19	0.19	0.19	0.20
60	0.18	0.18	0.18	0.18	0.19	0.19	0.19	0.20	0.20	0.20
61	0.18	0.18	0.19	0.19	0.19	0.19	0.20	0.20	0.20	0.21
62	0.19	0.19	0.19	0.19	0.20	0.20	0.20	0.20	0.21	0.21
63	0.19	0.19	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.22
64	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.22	0.22
65	0.20	0.20	0.21	0.21	0.21	0.21	0.22	0.22	0.22	0.23
66	0.21	0.21	0.21	0.21	0.22	0.22	0.22	0.22	0.23	0.23
67	0.21	0.21	0.22	0.22	0.22	0.22	0.23	0.23	0.23	0.24
68	0.22	0.22	0.22	0.22	0.23	0.23	0.23	0.24	0.24	0.24
69	0.22	0.22	0.23	0.23	0.23	0.24	0.24	0.24	0.24	0.25
70	0.23	0.23	0.23	0.24	0.24	0.24	0.24	0.25	0.25	0.25
71	0.23	0.24	0.24	0.24	0.24	0.25	0.25	0.25	0.25	0.26
72	0.24	0.24	0.24	0.25	0.25	0.25	0.25	0.26	0.26	0.26
73	0.24	0.25	0.25	0.25	0.25	0.26	0.26	0.26	0.27	0.27
74	0.25	0.25	0.26	0.26	0.26	0.26	0.27	0.27	0.27	0.27
75	0.26	0.26	0.26	0.26	0.27	0.27	0.27	0.27	0.28	0.28
76	0.26	0.26	0.27	0.27	0.27	0.27	0.28	0.28	0.28	0.29
77	0.27	0.27	0.27	0.28	0.28	0.28	0.28	0.29	0.29	0.29
78	0.27	0.28	0.28	0.28	0.28	0.29	0.29	0.29	0.30	0.30
79	0.28	0.28	0.29	0.29	0.29	0.29	0.30	0.30	0.30	0.30
80	0.29	0.29	0.29	0.29	0.30	0.30	0.30	0.31	0.31	0.31
81	0.29	0.30	0.30	0.30	0.30	0.31	0.31	0.31	0.31	0.32
82	0.30	0.30	0.30	0.31	0.31	0.31	0.31	0.32	0.32	0.32
83	0.31	0.31	0.31	0.31	0.32	0.32	0.32	0.32	0.33	0.33
84	0.31	0.31	0.32	0.32	0.32	0.33	0.33	0.33	0.33	0.34
85	0.32	0.32	0.32	0.33	0.33	0.33	0.33	0.34	0.34	0.34
86	0.33	0.33	0.33	0.33	0.34	0.34	0.34	0.34	0.35	0.35
87	0.33	0.33	0.34	0.34	0.34	0.35	0.35	0.35	0.35	0.36
88	0.34	0.34	0.34	0.35	0.35	0.35	0.35	0.36	0.36	0.36
89	0.35	0.35	0.35	0.35	0.36	0.36	0.36	0.36	0.37	0.37
90	0.35	0.36	0.36	0.36	0.36	0.37	0.37	0.37	0.37	0.38

Table volumes are for one metre bole length. To calculate total volume, multiply table figure by actual length in metres.

Small end: 40-49 cm
Large end: 30-90 cm
Average small end diameter dt

Average large end diameter db	40	41	42	43	44	45	46	47	48	49
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40	0.13									
41	0.13	0.13								
42	0.13	0.14	0.14							
43	0.14	0.14	0.14	0.15						
44	0.14	0.14	0.15	0.15	0.15					
45	0.14	0.15	0.15	0.15	0.16	0.16				
46	0.15	0.15	0.15	0.16	0.16	0.16	0.17			
47	0.15	0.15	0.16	0.16	0.16	0.17	0.17	0.17		
48	0.15	0.16	0.16	0.16	0.17	0.17	0.17	0.18	0.18	
49	0.16	0.16	0.16	0.17	0.17	0.17	0.18	0.18	0.18	0.19
50	0.16	0.16	0.17	0.17	0.17	0.18	0.18	0.18	0.19	0.19
51	0.16	0.17	0.17	0.17	0.18	0.18	0.18	0.19	0.19	0.20
52	0.17	0.17	0.18	0.18	0.18	0.19	0.19	0.19	0.20	0.20
53	0.17	0.18	0.18	0.18	0.19	0.19	0.19	0.20	0.20	0.20
54	0.18	0.18	0.18	0.19	0.19	0.19	0.20	0.20	0.20	0.21
55	0.18	0.18	0.19	0.19	0.19	0.20	0.20	0.21	0.21	0.21
56	0.19	0.19	0.19	0.20	0.20	0.20	0.21	0.21	0.21	0.22
57	0.19	0.19	0.20	0.20	0.20	0.21	0.21	0.21	0.22	0.22
58	0.19	0.20	0.20	0.20	0.21	0.21	0.22	0.22	0.22	0.23
59	0.20	0.20	0.21	0.21	0.21	0.22	0.22	0.22	0.23	0.23
60	0.20	0.21	0.21	0.21	0.22	0.22	0.22	0.23	0.23	0.24
61	0.21	0.21	0.22	0.22	0.22	0.23	0.23	0.23	0.24	0.24
62	0.21	0.22	0.22	0.22	0.23	0.23	0.23	0.24	0.24	0.25
63	0.22	0.22	0.23	0.23	0.23	0.24	0.24	0.24	0.25	0.25
64	0.22	0.23	0.23	0.23	0.24	0.24	0.24	0.25	0.25	0.26
65	0.23	0.23	0.24	0.24	0.24	0.25	0.25	0.25	0.26	0.26
66	0.23	0.24	0.24	0.24	0.25	0.25	0.25	0.26	0.26	0.27
67	0.24	0.24	0.25	0.25	0.25	0.26	0.26	0.26	0.27	0.27
68	0.24	0.25	0.25	0.25	0.26	0.26	0.26	0.27	0.27	0.28
69	0.25	0.25	0.26	0.26	0.26	0.27	0.27	0.27	0.28	0.28
70	0.26	0.26	0.26	0.27	0.27	0.27	0.28	0.28	0.28	0.29
71	0.26	0.26	0.27	0.27	0.27	0.28	0.28	0.28	0.29	0.29
72	0.27	0.27	0.27	0.28	0.28	0.28	0.29	0.29	0.29	0.30
73	0.27	0.28	0.28	0.28	0.29	0.29	0.29	0.30	0.30	0.30
74	0.28	0.28	0.28	0.29	0.29	0.29	0.30	0.30	0.31	0.31
75	0.28	0.29	0.29	0.29	0.30	0.30	0.30	0.31	0.31	0.32
76	0.29	0.29	0.30	0.30	0.30	0.31	0.31	0.31	0.32	0.32
77	0.30	0.30	0.30	0.31	0.31	0.31	0.32	0.32	0.32	0.33
78	0.30	0.30	0.31	0.31	0.31	0.32	0.32	0.33	0.33	0.33
79	0.31	0.31	0.31	0.32	0.32	0.32	0.33	0.33	0.34	0.34
80	0.31	0.32	0.32	0.32	0.33	0.33	0.33	0.34	0.34	0.35
81	0.32	0.32	0.33	0.33	0.33	0.34	0.34	0.34	0.35	0.35
82	0.33	0.33	0.33	0.34	0.34	0.34	0.35	0.35	0.35	0.36
83	0.33	0.34	0.34	0.34	0.35	0.35	0.35	0.36	0.36	0.36
84	0.34	0.34	0.35	0.35	0.35	0.36	0.36	0.36	0.37	0.37
85	0.35	0.35	0.35	0.36	0.36	0.36	0.37	0.37	0.37	0.38
86	0.35	0.36	0.36	0.36	0.37	0.37	0.37	0.38	0.38	0.38
87	0.36	0.36	0.37	0.37	0.37	0.38	0.38	0.38	0.39	0.39
88	0.37	0.37	0.37	0.38	0.38	0.38	0.39	0.39	0.39	0.40
89	0.37	0.38	0.38	0.38	0.39	0.39	0.39	0.40	0.40	0.41
90	0.38	0.38	0.39	0.39	0.39	0.40	0.40	0.40	0.41	0.41

Table volumes are for one metre bole length. To calculate total volume, multiply table figure by actual length in metres.



Small end: 50-59 cm
Large end: 50-110 cm
Average small end diameter dt

Average large end diameter	50	51	52	53	54	55	56	57	58	59
50	0.20									
51	0.20	0.20								
52	0.20	0.21	0.21							
53	0.21	0.21	0.22	0.22						
54	0.21	0.22	0.22	0.22	0.23					
55	0.22	0.22	0.22	0.23	0.23	0.24				
56	0.22	0.23	0.23	0.23	0.24	0.24	0.25			
57	0.23	0.23	0.23	0.24	0.24	0.25	0.25	0.26		
58	0.23	0.23	0.24	0.24	0.25	0.25	0.26	0.26	0.26	
59	0.23	0.24	0.24	0.25	0.25	0.26	0.26	0.26	0.27	0.27
60	0.24	0.24	0.25	0.25	0.26	0.26	0.26	0.27	0.27	0.28
61	0.24	0.25	0.25	0.26	0.26	0.26	0.27	0.27	0.28	0.28
62	0.25	0.25	0.26	0.26	0.27	0.27	0.27	0.28	0.28	0.29
63	0.25	0.26	0.26	0.27	0.27	0.27	0.28	0.28	0.29	0.29
64	0.26	0.26	0.27	0.27	0.28	0.28	0.28	0.29	0.29	0.30
65	0.26	0.27	0.27	0.28	0.28	0.28	0.29	0.29	0.30	0.30
66	0.27	0.27	0.28	0.28	0.29	0.29	0.29	0.30	0.30	0.31
67	0.27	0.28	0.28	0.29	0.29	0.30	0.30	0.30	0.31	0.31
68	0.28	0.28	0.29	0.29	0.30	0.30	0.30	0.31	0.31	0.32
69	0.29	0.29	0.29	0.30	0.30	0.31	0.31	0.31	0.32	0.32
70	0.29	0.29	0.30	0.30	0.31	0.31	0.32	0.32	0.32	0.33
71	0.30	0.30	0.30	0.31	0.31	0.32	0.32	0.33	0.33	0.33
72	0.30	0.31	0.31	0.31	0.32	0.32	0.33	0.33	0.34	0.34
73	0.31	0.31	0.32	0.32	0.32	0.33	0.33	0.34	0.34	0.35
74	0.31	0.32	0.32	0.33	0.33	0.33	0.34	0.34	0.35	0.35
75	0.32	0.32	0.33	0.33	0.34	0.34	0.34	0.35	0.36	0.36
76	0.32	0.33	0.33	0.34	0.34	0.35	0.35	0.36	0.36	0.36
77	0.33	0.33	0.34	0.34	0.35	0.35	0.36	0.36	0.36	0.37
78	0.34	0.34	0.35	0.35	0.35	0.36	0.36	0.37	0.37	0.38
79	0.34	0.35	0.35	0.36	0.36	0.36	0.37	0.37	0.38	0.38
80	0.35	0.35	0.36	0.36	0.37	0.37	0.37	0.37	0.38	0.39
81	0.36	0.36	0.36	0.37	0.37	0.38	0.38	0.38	0.39	0.39
82	0.36	0.37	0.37	0.37	0.38	0.38	0.39	0.39	0.40	0.40
83	0.37	0.37	0.38	0.38	0.39	0.39	0.39	0.40	0.40	0.41
84	0.38	0.38	0.38	0.39	0.39	0.40	0.40	0.40	0.41	0.41
85	0.38	0.39	0.39	0.39	0.40	0.40	0.41	0.41	0.42	0.42
86	0.39	0.39	0.40	0.40	0.40	0.41	0.41	0.41	0.42	0.43
87	0.40	0.40	0.40	0.41	0.41	0.42	0.42	0.42	0.43	0.43
88	0.40	0.41	0.41	0.41	0.42	0.42	0.43	0.43	0.44	0.44
89	0.41	0.41	0.42	0.42	0.43	0.43	0.43	0.44	0.44	0.45
90	0.42	0.42	0.42	0.43	0.43	0.44	0.44	0.44	0.45	0.45
91	0.42	0.43	0.43	0.44	0.44	0.44	0.45	0.45	0.46	0.46
92	0.43	0.43	0.44	0.44	0.45	0.45	0.46	0.46	0.46	0.47
93	0.44	0.44	0.45	0.45	0.45	0.46	0.46	0.47	0.47	0.48
94	0.45	0.45	0.45	0.46	0.46	0.47	0.47	0.47	0.48	0.48
95	0.45	0.46	0.46	0.46	0.47	0.47	0.48	0.48	0.49	0.49
96	0.46	0.46	0.47	0.47	0.48	0.48	0.49	0.49	0.49	0.50
97	0.47	0.47	0.48	0.48	0.48	0.49	0.49	0.50	0.50	0.51
98	0.48	0.48	0.48	0.49	0.49	0.50	0.50	0.50	0.51	0.51
99	0.48	0.49	0.49	0.50	0.50	0.50	0.51	0.51	0.52	0.52
100	0.49	0.49	0.50	0.50	0.51	0.51	0.52	0.52	0.52	0.53
101	0.50	0.50	0.51	0.51	0.52	0.52	0.52	0.53	0.53	0.54
102	0.51	0.51	0.51	0.52	0.52	0.53	0.53	0.53	0.54	0.55
103	0.51	0.52	0.52	0.53	0.53	0.54	0.54	0.54	0.55	0.55
104	0.52	0.53	0.53	0.54	0.54	0.54	0.55	0.55	0.56	0.56
105	0.53	0.54	0.54	0.54	0.55	0.55	0.56	0.56	0.57	0.57
106	0.54	0.54	0.55	0.55	0.56	0.56	0.56	0.57	0.57	0.58
107	0.55	0.55	0.56	0.56	0.56	0.57	0.57	0.58	0.58	0.59
108	0.56	0.56	0.56	0.57	0.57	0.58	0.58	0.59	0.59	0.59
109	0.56	0.57	0.57	0.58	0.58	0.59	0.59	0.59	0.60	0.60
110	0.57	0.58	0.58	0.59	0.59	0.59	0.60	0.60	0.61	0.61

Table volumes are for one metre bole length. To calculate total volume, multiply table figure by actual length in metres.

Small end: 60-69 cm
Large end: 50-110 cm
Average small end diameter dt

Average large end diameter	60	61	62	63	64	65	66	67	68	69
60	0.28									
61	0.29	0.29								
62	0.29	0.30	0.30							
63	0.30	0.30	0.31	0.31						
64	0.30	0.31	0.31	0.32	0.32					
65	0.31	0.31	0.32	0.32	0.33	0.33				
66	0.31	0.32	0.32	0.33	0.33	0.34	0.34			
67	0.32	0.32	0.33	0.33	0.34	0.34	0.35	0.35		
68	0.32	0.33	0.33	0.34	0.34	0.35	0.35	0.36	0.36	
69	0.33	0.33	0.34	0.34	0.35	0.35	0.36	0.36	0.37	0.37
70	0.33	0.34	0.34	0.35	0.35	0.36	0.36	0.37	0.37	0.38
71	0.34	0.34	0.35	0.35	0.36	0.36	0.37	0.37	0.38	0.38
72	0.34	0.35	0.35	0.36	0.36	0.37	0.37	0.38	0.39	0.39
73	0.35	0.36	0.36	0.37	0.37	0.38	0.38	0.39	0.39	0.40
74	0.36	0.36	0.37	0.37	0.38	0.38	0.39	0.39	0.40	0.40
75	0.36	0.37	0.37	0.38	0.38	0.39	0.39	0.40	0.40	0.41
76	0.37	0.37	0.38	0.38	0.39	0.39	0.40	0.40	0.41	0.41
77	0.37	0.38	0.38	0.39	0.39	0.40	0.40	0.41	0.41	0.42
78	0.38	0.39	0.39	0.39	0.40	0.40	0.41	0.42	0.42	0.43
79	0.39	0.39	0.40	0.40	0.41	0.41	0.42	0.42	0.43	0.43
80	0.39	0.40	0.40	0.41	0.41	0.42	0.42	0.43	0.43	0.44
81	0.40	0.40	0.41	0.41	0.42	0.42	0.43	0.43	0.44	0.44
82	0.41	0.41	0.41	0.42	0.42	0.43	0.44	0.44	0.45	0.45
83	0.41	0.42	0.42	0.43	0.43	0.44	0.44	0.45	0.45	0.46
84	0.42	0.42	0.43	0.43	0.44	0.44	0.45	0.45	0.46	0.46
85	0.43	0.43	0.43	0.44	0.44	0.45	0.45	0.46	0.47	0.47
86	0.43	0.44	0.44	0.45	0.45	0.46	0.46	0.47	0.47	0.48
87	0.44	0.44	0.45	0.45	0.46	0.46	0.47	0.47	0.48	0.48
88	0.45	0.45	0.46	0.46	0.46	0.47	0.48	0.48	0.49	0.49
89	0.45	0.46	0.46	0.47	0.47	0.48	0.48	0.49	0.49	0.50
90	0.46	0.46	0.47	0.47	0.48	0.48	0.49	0.49	0.50	0.51
91	0.47	0.47	0.48	0.48	0.49	0.49	0.50	0.50	0.51	0.51
92	0.47	0.48	0.48	0.49	0.49	0.50	0.50	0.51	0.51	0.52
93	0.48	0.49	0.49	0.50	0.50	0.51	0.51	0.52	0.52	0.53
94	0.49	0.49	0.50	0.50	0.51	0.51	0.52	0.52	0.53	0.53
95	0.50	0.50	0.51	0.51	0.52	0.52	0.53	0.53	0.54	0.54
96	0.50	0.51	0.51	0.52	0.52	0.53	0.53	0.54	0.54	0.55
97	0.51	0.52	0.52	0.53	0.53	0.54	0.54	0.55	0.55	0.56
98	0.52	0.52	0.53	0.53	0.54	0.54	0.55	0.55	0.56	0.56
99	0.53	0.53	0.54	0.54	0.55	0.55	0.56	0.56	0.57	0.57
100	0.53	0.54	0.54	0.55	0.55	0.56	0.56	0.57	0.57	0.58
101	0.54	0.55	0.55	0.56	0.56	0.57	0.57	0.58	0.58	0.59
102	0.55	0.55	0.56	0.56	0.57	0.57	0.58	0.58	0.59	0.60
103	0.56	0.56	0.57	0.57	0.58	0.58	0.59	0.59	0.60	0.60
104	0.57	0.57	0.58	0.58	0.59	0.59	0.60	0.60	0.61	0.61
105	0.57	0.58	0.58	0.59	0.59	0.60	0.60	0.61	0.61	0.62
106	0.58	0.59	0.59	0.60	0.60	0.61	0.61	0.62	0.62	0.63
107	0.59	0.60	0.60	0.61	0.61	0.62	0.62	0.63	0.63	0.64
108	0.60	0.60	0.61	0.61	0.62	0.62	0.63	0.63	0.64	0.64
109	0.61	0.61	0.62	0.62	0.63	0.63	0.64	0.64	0.65	0.65
110	0.62	0.62	0.63	0.63	0.64	0.64	0.65	0.65	0.66	0.66

Table volumes are for one metre bole length. To calculate total volume, multiply table figure by actual length in metres.

Small end: 70-79 cm
Large end: 70-130 cm
Average small end diameter dt

Average large end diameter db

70	0.38									
71	0.39	0.40								
72	0.40	0.40	0.41							
73	0.40	0.41	0.41	0.42						
74	0.41	0.41	0.42	0.42	0.43					
75	0.41	0.42	0.42	0.43	0.44	0.44				
76	0.42	0.42	0.43	0.44	0.44	0.45	0.45			
77	0.43	0.43	0.44	0.44	0.45	0.45	0.46	0.47		
78	0.43	0.44	0.44	0.45	0.45	0.46	0.47	0.47	0.48	
79	0.44	0.44	0.45	0.45	0.46	0.47	0.47	0.48	0.48	0.49
80	0.44	0.45	0.45	0.46	0.47	0.47	0.48	0.48	0.49	0.50
81	0.45	0.46	0.46	0.47	0.47	0.48	0.48	0.49	0.50	0.50
82	0.46	0.46	0.47	0.47	0.48	0.48	0.49	0.50	0.50	0.51
83	0.46	0.47	0.47	0.48	0.49	0.49	0.50	0.50	0.51	0.52
84	0.47	0.48	0.48	0.49	0.49	0.50	0.50	0.51	0.52	0.52
85	0.48	0.48	0.49	0.49	0.50	0.50	0.51	0.52	0.52	0.53
86	0.48	0.49	0.49	0.50	0.51	0.51	0.52	0.52	0.53	0.54
87	0.49	0.50	0.50	0.51	0.51	0.52	0.52	0.53	0.54	0.54
88	0.50	0.50	0.51	0.51	0.52	0.52	0.53	0.54	0.54	0.55
89	0.50	0.51	0.51	0.52	0.53	0.53	0.54	0.54	0.55	0.56
90	0.51	0.52	0.52	0.53	0.53	0.54	0.54	0.55	0.56	0.56
91	0.52	0.52	0.53	0.53	0.54	0.55	0.55	0.56	0.56	0.57
92	0.52	0.53	0.54	0.54	0.55	0.55	0.56	0.57	0.57	0.58
93	0.53	0.54	0.54	0.55	0.55	0.56	0.57	0.57	0.58	0.58
94	0.54	0.54	0.55	0.56	0.56	0.57	0.57	0.58	0.59	0.59
95	0.55	0.55	0.56	0.56	0.57	0.58	0.58	0.59	0.59	0.60
96	0.55	0.56	0.57	0.57	0.58	0.58	0.59	0.59	0.60	0.61
97	0.56	0.57	0.57	0.58	0.58	0.59	0.60	0.60	0.61	0.61
98	0.57	0.58	0.58	0.59	0.59	0.60	0.60	0.61	0.62	0.62
99	0.58	0.58	0.59	0.59	0.60	0.61	0.61	0.62	0.62	0.63
100	0.59	0.59	0.60	0.60	0.61	0.61	0.62	0.63	0.63	0.64
101	0.59	0.60	0.60	0.61	0.62	0.62	0.63	0.63	0.64	0.65
102	0.60	0.61	0.61	0.62	0.62	0.63	0.64	0.64	0.65	0.65
103	0.61	0.61	0.62	0.63	0.63	0.64	0.64	0.65	0.66	0.66
104	0.62	0.62	0.63	0.63	0.64	0.65	0.65	0.66	0.66	0.67
105	0.63	0.63	0.64	0.64	0.65	0.65	0.66	0.67	0.67	0.68
106	0.63	0.64	0.64	0.65	0.66	0.66	0.67	0.67	0.68	0.69
107	0.64	0.65	0.65	0.66	0.66	0.67	0.68	0.68	0.69	0.69
108	0.65	0.66	0.66	0.67	0.67	0.68	0.68	0.69	0.70	0.70
109	0.66	0.66	0.67	0.68	0.68	0.69	0.69	0.70	0.71	0.71
110	0.67	0.67	0.68	0.68	0.69	0.70	0.70	0.71	0.71	0.72
111	0.68	0.68	0.69	0.69	0.70	0.70	0.71	0.72	0.72	0.73
112	0.69	0.69	0.70	0.70	0.71	0.71	0.72	0.73	0.73	0.74
113	0.69	0.70	0.70	0.71	0.72	0.72	0.73	0.73	0.74	0.75
114	0.70	0.71	0.71	0.72	0.73	0.73	0.74	0.74	0.75	0.76
115	0.71	0.72	0.72	0.73	0.73	0.74	0.75	0.75	0.76	0.76
116	0.72	0.73	0.73	0.74	0.74	0.75	0.76	0.76	0.77	0.77
117	0.73	0.74	0.74	0.75	0.75	0.76	0.76	0.77	0.78	0.78
118	0.74	0.74	0.75	0.76	0.76	0.77	0.77	0.78	0.79	0.79
119	0.75	0.75	0.76	0.77	0.77	0.78	0.78	0.79	0.80	0.80
120	0.76	0.76	0.77	0.77	0.78	0.79	0.79	0.80	0.80	0.81
121	0.77	0.77	0.78	0.78	0.79	0.80	0.80	0.81	0.81	0.82
122	0.78	0.78	0.79	0.79	0.80	0.81	0.81	0.82	0.82	0.83
123	0.79	0.79	0.80	0.80	0.81	0.81	0.82	0.83	0.83	0.84
124	0.80	0.80	0.81	0.81	0.82	0.82	0.83	0.84	0.84	0.85
125	0.81	0.81	0.82	0.82	0.83	0.83	0.84	0.85	0.85	0.86
126	0.82	0.82	0.83	0.83	0.84	0.84	0.85	0.86	0.86	0.87
127	0.83	0.83	0.84	0.84	0.85	0.85	0.86	0.87	0.87	0.88
128	0.84	0.84	0.85	0.85	0.86	0.86	0.87	0.88	0.88	0.89
129	0.85	0.85	0.86	0.86	0.87	0.87	0.88	0.89	0.89	0.90
130	0.86	0.86	0.87	0.87	0.88	0.88	0.89	0.90	0.90	0.91

Table volumes are for one metre bole length. To calculate total volume, multiply table figure by actual length in metres.

Small end: 80-89 cm
Large end: 70-130 cm
Average small end diameter dt

Average large end diameter db

70										
71										
72										
73										
74										
75										
76										
77										
78										
79										
80	0.50									
81	0.51	0.52								
82	0.52	0.52	0.53							
83	0.52	0.53	0.53	0.54						
84	0.53	0.53	0.54	0.55	0.55					
85	0.54	0.54	0.55	0.55	0.56	0.57				
86	0.54	0.55	0.55	0.56	0.57	0.57	0.58			
87	0.55	0.55	0.56	0.57	0.57	0.58	0.59	0.59		
88	0.56	0.56	0.57	0.57	0.58	0.59	0.59	0.60	0.61	
89	0.56	0.57	0.58	0.58	0.59	0.59	0.60	0.61	0.62	0.62
90	0.57	0.58	0.58	0.59	0.60	0.60	0.61	0.62	0.62	0.63
91	0.58	0.58	0.59	0.60	0.60	0.61	0.62	0.62	0.63	0.64
92	0.58	0.59	0.60	0.60	0.61	0.62	0.62	0.63	0.64	0.64
93	0.59	0.60	0.60	0.61	0.62	0.62	0.63	0.64	0.64	0.65
94	0.60	0.60	0.61	0.62	0.62	0.63	0.64	0.64	0.65	0.66
95	0.61	0.61	0.62	0.62	0.63	0.64	0.64	0.65	0.66	0.67
96	0.61	0.62	0.63	0.63	0.64	0.65	0.65	0.66	0.67	0.67
97	0.62	0.63	0.63	0.64	0.65	0.65	0.66	0.67	0.67	0.68
98	0.63	0.63	0.64	0.65	0.65	0.66	0.67	0.67	0.68	0.69
99	0.64	0.64	0.65	0.66	0.66	0.67	0.68	0.68	0.69	0.70
100	0.64	0.65	0.66	0.66	0.67	0.68	0.68	0.69	0.70	0.70
101	0.65	0.66	0.66	0.67	0.68	0.68	0.69	0.70	0.70	0.71
102	0.66	0.67	0.67	0.68	0.69	0.69	0.70	0.71	0.71	0.72
103	0.67	0.67	0.68	0.69	0.69	0.70	0.71	0.71	0.72	0.73
104	0.68	0.68	0.69	0.70	0.70	0.71	0.72	0.72	0.73	0.74
105	0.68	0.69	0.70	0.70	0.71	0.72	0.72	0.73	0.74	0.74
106	0.69	0.70	0.71	0.71	0.72	0.72	0.73	0.74	0.75	0.75
107	0.70	0.71	0.71	0.72	0.73	0.73	0.74	0.75	0.75	0.76
108	0.71	0.72	0.72	0.73	0.74	0.74	0.75	0.76	0.76	0.77
109	0.72	0.72	0.73	0.74	0.74	0.75	0.76	0.76	0.77	0.78
110	0.73	0.73	0.74	0.75	0.75	0.76	0.77	0.77	0.78	0.79
111	0.74	0.74	0.75	0.75	0.76	0.77	0.77	0.78	0.79	0.79
112	0.74	0.75	0.76	0.76	0.77	0.78	0.78	0.79	0.80	0.80
113	0.75	0.76	0.76	0.77	0.78	0.79	0.79	0.80	0.81	0.81
114	0.76	0.77	0.77	0.78	0.79	0.79	0.80	0.81	0.81	0.82
115	0.77	0.78	0.78	0.79	0.80	0.80	0.81	0.82	0.82	0.83
116	0.78	0.79	0.79	0.80	0.81	0.81	0.82	0.83	0.83	0.84
117	0.79	0.80	0.80	0.81	0.81	0.82	0.83	0.83	0.84	0.85
118	0.80	0.80	0.81	0.82	0.82	0.83	0.84	0.84	0.85	0.85
119	0.81	0.81	0.82	0.83	0.83	0.84	0.85	0.85	0.86	0.87
120	0.82	0.82	0.83	0.84	0.84	0.85	0.86	0.86	0.87	0.88
121	0.83	0.83	0.84	0.85	0.85	0.86	0.87	0.87	0.88	0.89
122	0.84	0.84	0.85	0.86	0.86	0.87	0.87	0.88	0.89	0.90
123	0.85	0.85	0.86	0.86	0.87	0.88	0.88	0.89	0.90	0.91
124	0.86	0.86	0.87	0.87	0.88	0.89	0.89	0.90	0.91	0.91
125	0.86	0.87	0.88	0.88	0.89	0.90	0.90	0.91	0.92	0.92
126	0.87	0.88	0.89	0.89	0.90	0.91	0.91	0.92	0.93	0.93
127	0.88	0.89	0.90	0.90	0.91	0.92	0.92	0.93	0.94	0.94
128	0.89	0.90	0.91	0.91	0.92	0.93	0.93	0.94	0.95	0.95
129	0.90	0.91	0.92	0.92	0.93	0.94	0.94	0.95	0.96	0.96
130	0.91	0.92	0.93	0.93	0.94	0.95	0.95	0.96	0.97	0.97

Table volumes are for one metre bole length. To calculate total volume, multiply table figure by actual length in metres.

Small end: 90-99 cm
Large end: 90-150 cm
Average small end diameter dt

Average large end diameter db										
	90	91	92	93	94	95	96	97	98	99
90	0.64									
91	0.64	0.65								
92	0.65	0.66	0.66							
93	0.66	0.66	0.67	0.67						
94	0.67	0.67	0.68	0.68	0.69					
95	0.67	0.68	0.69	0.69	0.70	0.71				
96	0.68	0.69	0.69	0.70	0.71	0.72	0.72			
97	0.69	0.69	0.70	0.71	0.72	0.72	0.73	0.74		
98	0.70	0.70	0.71	0.72	0.72	0.73	0.74	0.75	0.75	
99	0.70	0.71	0.72	0.72	0.73	0.74	0.75	0.75	0.76	0.77
100	0.71	0.72	0.73	0.73	0.74	0.75	0.75	0.76	0.77	0.78
101	0.72	0.73	0.73	0.74	0.75	0.75	0.76	0.77	0.78	0.79
102	0.73	0.73	0.74	0.75	0.76	0.76	0.77	0.78	0.79	0.79
103	0.73	0.74	0.75	0.76	0.76	0.77	0.78	0.79	0.79	0.80
104	0.74	0.75	0.76	0.76	0.77	0.78	0.79	0.79	0.80	0.81
105	0.75	0.76	0.77	0.77	0.78	0.79	0.79	0.80	0.81	0.82
106	0.76	0.77	0.77	0.78	0.79	0.80	0.80	0.81	0.82	0.83
107	0.77	0.77	0.78	0.79	0.80	0.80	0.81	0.82	0.83	0.83
108	0.78	0.78	0.79	0.80	0.81	0.81	0.82	0.83	0.84	0.84
109	0.78	0.79	0.80	0.81	0.81	0.82	0.83	0.84	0.84	0.85
110	0.79	0.80	0.81	0.81	0.82	0.83	0.84	0.84	0.85	0.86
111	0.80	0.81	0.82	0.82	0.83	0.84	0.85	0.85	0.86	0.87
112	0.81	0.82	0.82	0.83	0.84	0.85	0.85	0.86	0.87	0.88
113	0.82	0.82	0.83	0.84	0.85	0.86	0.86	0.87	0.88	0.89
114	0.83	0.84	0.84	0.85	0.86	0.86	0.87	0.88	0.89	0.90
115	0.84	0.84	0.85	0.86	0.87	0.87	0.88	0.89	0.90	0.90
116	0.85	0.85	0.86	0.87	0.88	0.88	0.89	0.90	0.91	0.91
117	0.86	0.86	0.87	0.88	0.88	0.89	0.90	0.91	0.91	0.92
118	0.86	0.87	0.88	0.89	0.89	0.90	0.91	0.92	0.92	0.93
119	0.87	0.88	0.89	0.90	0.90	0.91	0.92	0.93	0.93	0.94
120	0.88	0.89	0.90	0.91	0.91	0.92	0.93	0.93	0.94	0.95
121	0.89	0.90	0.91	0.91	0.92	0.93	0.94	0.94	0.95	0.96
122	0.90	0.91	0.92	0.92	0.93	0.94	0.95	0.95	0.96	0.97
123	0.91	0.92	0.93	0.93	0.94	0.95	0.96	0.96	0.97	0.98
124	0.92	0.93	0.94	0.94	0.95	0.96	0.97	0.97	0.98	0.99
125	0.93	0.94	0.95	0.95	0.96	0.97	0.98	0.98	0.99	1.00
126	0.94	0.95	0.96	0.96	0.97	0.98	0.99	0.99	1.00	1.01
127	0.95	0.96	0.97	0.97	0.98	0.99	1.00	1.00	1.01	1.02
128	0.96	0.97	0.98	0.98	0.99	1.00	1.01	1.01	1.02	1.03
129	0.97	0.98	0.99	0.99	1.00	1.01	1.02	1.02	1.03	1.04
130	0.98	0.99	1.00	1.00	1.01	1.02	1.03	1.03	1.04	1.05
131	0.99	1.00	1.01	1.01	1.02	1.03	1.04	1.04	1.05	1.06
132	1.00	1.01	1.02	1.02	1.03	1.04	1.05	1.05	1.06	1.07
133	1.01	1.02	1.03	1.03	1.04	1.05	1.06	1.06	1.07	1.08
134	1.02	1.03	1.04	1.04	1.05	1.06	1.07	1.07	1.08	1.09
135	1.03	1.04	1.05	1.06	1.06	1.07	1.08	1.09	1.09	1.10
136	1.04	1.05	1.06	1.07	1.07	1.08	1.09	1.10	1.10	1.11
137	1.06	1.06	1.07	1.08	1.08	1.09	1.10	1.11	1.11	1.12
138	1.07	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.12	1.13
139	1.08	1.08	1.09	1.10	1.11	1.11	1.12	1.13	1.14	1.14
140	1.09	1.09	1.10	1.11	1.12	1.12	1.13	1.14	1.15	1.15
141	1.10	1.11	1.11	1.12	1.13	1.14	1.14	1.15	1.16	1.17
142	1.11	1.12	1.12	1.13	1.14	1.15	1.15	1.16	1.17	1.18
143	1.12	1.13	1.14	1.14	1.15	1.16	1.16	1.17	1.18	1.19
144	1.13	1.14	1.15	1.15	1.16	1.17	1.18	1.18	1.19	1.20
145	1.14	1.15	1.16	1.17	1.17	1.18	1.19	1.20	1.20	1.21
146	1.16	1.16	1.17	1.18	1.18	1.19	1.20	1.21	1.21	1.22
147	1.17	1.17	1.18	1.19	1.20	1.20	1.21	1.22	1.23	1.23
148	1.18	1.19	1.19	1.20	1.21	1.21	1.22	1.23	1.24	1.25
149	1.19	1.20	1.20	1.21	1.22	1.23	1.23	1.24	1.25	1.26
150	1.20	1.21	1.22	1.23	1.23	1.24	1.25	1.25	1.26	1.27

Table volumes are for one metre bole length. To calculate total volume, multiply table figure by actual length in metres.

Small end: 100-109 cm
Large end: 90-150 cm
Average small end diameter dt

Average large end diameter db										
	100	101	102	103	104	105	106	107	108	109
90										
91										
92										
93										
94										
95										
96										
97										
98										
99										
100	0.79									
101	0.79	0.80								
102	0.80	0.81	0.82							
103	0.81	0.82	0.83	0.83						
104	0.82	0.83	0.83	0.84	0.85					
105	0.83	0.83	0.84	0.85	0.86	0.87				
106	0.83	0.84	0.85	0.86	0.87	0.87	0.88			
107	0.84	0.85	0.86	0.87	0.87	0.88	0.89	0.90		
108	0.85	0.86	0.87	0.87	0.88	0.89	0.90	0.91	0.92	
109	0.86	0.87	0.88	0.88	0.89	0.90	0.91	0.92	0.92	0.93
110	0.87	0.88	0.88	0.89	0.90	0.91	0.92	0.92	0.93	0.94
111	0.88	0.88	0.89	0.90	0.91	0.92	0.93	0.93	0.94	0.95
112	0.89	0.89	0.90	0.91	0.92	0.93	0.93	0.93	0.94	0.95
113	0.89	0.90	0.91	0.92	0.93	0.93	0.94	0.95	0.96	0.97
114	0.90	0.91	0.92	0.93	0.94	0.94	0.95	0.96	0.97	0.98
115	0.91	0.92	0.93	0.94	0.94	0.95	0.96	0.97	0.98	0.99
116	0.92	0.93	0.94	0.95	0.95	0.96	0.97	0.98	0.99	0.99
117	0.93	0.94	0.95	0.95	0.96	0.97	0.98	0.99	1.00	1.00
118	0.94	0.95	0.96	0.96	0.97	0.98	0.99	1.00	1.00	1.01
119	0.95	0.96	0.96	0.97	0.98	0.99	1.00	1.01	1.01	1.02
120	0.96	0.97	0.97	0.98	0.99	1.00	1.01	1.02	1.02	1.03
121	0.97	0.98	0.98	0.99	1.00	1.01	1.02	1.02	1.03	1.04
122	0.98	0.99	0.99	1.00	1.01	1.02	1.03	1.03	1.04	1.05
123	0.99	0.99	1.00	1.01	1.02	1.03	1.04	1.04	1.05	1.06
124	1.00	1.00	1.01	1.02	1.03	1.04	1.05	1.05	1.06	1.07
125	1.01	1.01	1.02	1.03	1.04	1.05	1.05	1.06	1.07	1.08
126	1.02	1.02	1.03	1.04	1.05	1.06	1.06	1.07	1.08	1.09
127	1.03	1.03	1.04	1.05	1.06	1.07	1.07	1.08	1.09	1.10
128	1.04	1.04	1.05	1.06	1.07	1.08	1.08	1.09	1.10	1.11
129	1.05	1.05	1.06	1.07	1.08	1.09	1.09	1.10	1.11	1.12
130	1.06	1.06	1.07	1.08	1.09	1.10	1.10	1.11	1.12	1.13
131	1.07	1.07	1.08	1.09	1.10	1.11	1.12	1.12	1.13	1.14
132	1.08	1.08	1.09	1.10	1.11	1.12	1.13	1.13	1.14	1.15
133	1.09	1.10	1.10	1.11	1.12	1.13	1.14	1.14	1.15	1.16
134	1.10	1.11	1.11	1.12	1.13	1.14	1.15	1.15	1.16	1.17
135	1.11	1.12	1.12	1.13	1.14	1.15	1.16	1.17	1.17	1.18
136	1.12	1.13	1.13	1.14	1.15	1.16	1.17	1.18	1.18	1.19
137	1.13	1.14	1.15	1.15	1.16	1.17	1.18	1.19	1.20	1.20
138	1.14	1.15	1.16	1.16	1.17	1.18	1.19	1.20	1.21	1.21
139	1.15	1.16	1.17	1.18	1.18	1.19	1.20	1.21	1.22	1.23
140	1.16	1.17	1.18	1.19	1.19	1.20	1.21	1.22	1.23	1.24
141	1.17	1.18	1.19	1.20	1.21	1.21	1.22	1.23	1.24	1.25
142	1.18	1.19	1.20	1.21	1.22	1.22	1.23	1.24	1.25	1.26
143	1.20	1.20	1.21	1.22	1.23	1.24	1.24	1.25	1.26	1.27
144	1.21	1.21	1.22	1.23	1.24	1.25	1.26	1.26	1.27	1.28
145	1.22	1.23	1.23	1.24	1.25	1.26	1.27	1.28	1.28	1.29
146	1.23	1.24	1.25	1.25	1.26	1.27	1.28	1.29	1.29	1.30
147	1.24	1.25	1.26	1.27	1.27	1.28	1.29	1.30	1.31	1.32
148	1.25	1.26	1.27	1.28	1.28	1.29	1.30	1.31	1.32	1.33
149	1.26	1.27	1.28	1.29	1.30	1.30	1.31	1.32	1.33	1.34
150	1.28	1.28	1.29	1.30	1.31	1.32	1.32	1.33	1.34	1.35

Table volumes are for one metre bole length. To calculate total volume, multiply table figure by actual length in metres.

Small end: 110-119 cm
Large end: 110-170 cm
Average small end diameter dt

db										
	0.95									
	0.96	0.97								
	0.97	0.98	0.99							
	0.98	0.99	0.99	1.00						
	0.99	0.99	1.00	1.01	1.02					
	0.99	1.00	1.01	1.02	1.03	1.04				
	1.00	1.01	1.02	1.03	1.04	1.05	1.06			
	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08		
	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.08	1.09	
	1.03	1.04	1.05	1.06	1.07	1.08	1.08	1.09	1.10	1.11
	1.04	1.05	1.06	1.07	1.08	1.08	1.09	1.10	1.11	1.12
	1.05	1.06	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.13
	1.06	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.13	1.14
	1.07	1.08	1.09	1.10	1.10	1.11	1.12	1.13	1.14	1.15
	1.08	1.09	1.10	1.11	1.11	1.12	1.13	1.14	1.15	1.16
	1.09	1.10	1.11	1.12	1.12	1.13	1.14	1.15	1.16	1.17
	1.10	1.11	1.12	1.12	1.13	1.14	1.15	1.16	1.17	1.18
	1.11	1.12	1.13	1.13	1.14	1.15	1.16	1.17	1.18	1.19
	1.12	1.13	1.14	1.14	1.15	1.16	1.17	1.18	1.19	1.20
	1.13	1.14	1.15	1.15	1.16	1.17	1.18	1.19	1.20	1.21
	1.14	1.15	1.16	1.17	1.17	1.18	1.19	1.20	1.21	1.22
	1.15	1.16	1.17	1.18	1.18	1.19	1.20	1.21	1.22	1.23
	1.16	1.17	1.18	1.19	1.19	1.20	1.21	1.22	1.23	1.24
	1.17	1.18	1.19	1.20	1.20	1.21	1.22	1.23	1.24	1.25
	1.18	1.19	1.20	1.21	1.22	1.22	1.23	1.24	1.25	1.26
	1.19	1.20	1.21	1.22	1.23	1.24	1.24	1.25	1.26	1.27
	1.20	1.21	1.22	1.23	1.24	1.25	1.25	1.26	1.27	1.28
	1.21	1.22	1.23	1.24	1.25	1.26	1.27	1.27	1.28	1.29
	1.22	1.23	1.24	1.25	1.26	1.27	1.28	1.29	1.29	1.30
	1.23	1.24	1.25	1.26	1.27	1.28	1.29	1.30	1.31	1.31
	1.24	1.25	1.26	1.27	1.28	1.29	1.30	1.31	1.32	1.33
	1.26	1.26	1.27	1.28	1.29	1.30	1.31	1.32	1.33	1.34
	1.27	1.28	1.28	1.29	1.30	1.31	1.32	1.33	1.34	1.35
	1.28	1.29	1.30	1.30	1.31	1.32	1.33	1.34	1.35	1.36
	1.29	1.30	1.31	1.32	1.32	1.33	1.34	1.35	1.36	1.37
	1.30	1.31	1.32	1.33	1.34	1.34	1.35	1.36	1.37	1.38
	1.31	1.32	1.33	1.34	1.35	1.36	1.37	1.37	1.38	1.39
	1.32	1.33	1.34	1.35	1.36	1.37	1.38	1.39	1.40	1.40
	1.34	1.34	1.35	1.36	1.37	1.38	1.39	1.40	1.41	1.42
	1.35	1.36	1.36	1.37	1.38	1.39	1.40	1.41	1.42	1.43
	1.36	1.37	1.38	1.38	1.39	1.40	1.41	1.42	1.43	1.44
	1.37	1.38	1.39	1.40	1.41	1.41	1.42	1.43	1.44	1.45
	1.38	1.39	1.40	1.41	1.42	1.43	1.44	1.44	1.45	1.46
	1.39	1.40	1.41	1.42	1.43	1.44	1.45	1.46	1.47	1.48
	1.41	1.42	1.42	1.43	1.44	1.45	1.46	1.47	1.48	1.49
	1.42	1.43	1.44	1.44	1.45	1.46	1.47	1.48	1.49	1.50
	1.43	1.44	1.45	1.46	1.47	1.47	1.48	1.49	1.50	1.51
	1.44	1.45	1.46	1.47	1.48	1.49	1.50	1.51	1.51	1.52
	1.46	1.46	1.47	1.48	1.49	1.50	1.51	1.52	1.53	1.54
	1.47	1.48	1.49	1.49	1.50	1.51	1.52	1.53	1.54	1.55
	1.48	1.49	1.50	1.51	1.52	1.52	1.53	1.54	1.55	1.56
	1.49	1.50	1.51	1.52	1.53	1.54	1.55	1.56	1.56	1.57
	1.51	1.51	1.52	1.53	1.54	1.55	1.56	1.57	1.58	1.59
	1.52	1.53	1.54	1.54	1.55	1.56	1.57	1.58	1.59	1.60
	1.53	1.54	1.55	1.56	1.57	1.58	1.58	1.59	1.60	1.61
	1.54	1.55	1.56	1.57	1.58	1.59	1.60	1.61	1.62	1.63
	1.56	1.57	1.57	1.58	1.59	1.60	1.61	1.62	1.63	1.64
	1.57	1.58	1.59	1.60	1.61	1.61	1.62	1.63	1.64	1.65
	1.58	1.59	1.60	1.61	1.62	1.63	1.64	1.65	1.66	1.66
	1.60	1.61	1.61	1.62	1.63	1.64	1.65	1.66	1.67	1.68
	1.61	1.62	1.63	1.64	1.65	1.65	1.66	1.67	1.68	1.69

Table volumes are for one metre bole length. To calculate total volume, multiply table figure by actual length in metres.