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ABSTRACT

Depletion of natural resources is a major problem facing many developing countries. Ghana, a developing tropical country is especially faced with the problem of a rapid destruction of her forests. The use-maintenance ratio is so imbalanced that the forests may be completely extinct within a generation if present conservation programmes are not overhauled and made more productive. Limitations including finance, personnel, silvicultural infrastructure, equipment and support services, legislation, local support and an absence of a conservation strategy have rendered present conservation programmes less successful.

An ecosystematic approach to forest conservation can help maintain the resources for development and for protecting the natural environment. Increased central government support, research and development, education, managerial innovation, land reform, co-operation of the general population and international assistance will be helpful.

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LIST OF ABBREVIATIONS

CEP .	Commission on Environmental Planning
CIDA	Canadian International Development Agency
ICEF	International Conference on Environment Future
IDRC	International Development and Research Centre
INTECOL	International Association of Ecology
IUCN	International Union for Conservation of Nature and Natural Resources
MAB	Man and the Biosphere Project
UNDP	United Nations Development Programme
WCS	World Conservation Strategy
WERC	World Environment and Resources Council
WWF	World Wildlife Fund

CHAPTER I. INTRODUCTION

1.1 A BACKGROUND TO CONSERVATION

Until our human ancestors developed complex cultures, they could be regarded as part of the natural environment. They hunted game, fished in the waters, gathered wild fruits, nuts and seeds, used the tree branches and caves as home as present wild animals do. There could be nothing like an absolute control over other components of the environment. All could be subjected to the same raw functionings of the natural environment - rain, sunshine, winds, floods, predation and diseases.

The agricultural revolution which can be said to be capable of causing a significant alteration of the natural ecosystem where human numbers concentrated, did not occur until about 8,000 BC. Even when it did it was for a long time, too rudimentary an activity to cause any major alterations. A long period of such primitive existence may have seen very small human numbers in most places. Numbers may have been kept down also principally through negative processes in the environment such as cold, flooding, predation, epidemics to which people were directly exposed. By 1650 AD, the world population stood at 500 million, up from

5 million in 8,000 BC (Table I and Fig. I). The rate of increase was very insignificant in these times. It would seem that, pressures on resources and consequent effects in the environment may have generally been absent until recent ages.

Ironically, the benefits of the environment - soils, rocks, vegetation, wildlife, waterbodies - provided opportunities for the cultural and material development of human ancestors. The possibility of effective control of human circumstances resulted in modifications in the environment to suit immediate needs. Populations began to increase accordingly while technologies also grew complex. Technological complexity as well as a rapid development in human material cultures resulted in a wider appraisal and use of the environment. Natural resources (which could only mean tangible useful objects) such as the trees, animals, water bodies, fruit and stones that helped to nurture primitive humans took an extensive definition.

They (natural resources) now encompass a multitude of both tangible and intangible, living and non living objects offered by the deeper and lifeless part of the earth's crust, the biosphere and possibly outerspace and other celestial bodies. The concept of a resource is charac-

terised by an atmosphere of dynamism. Randall (1981:14) has noted that ... "the possibility always exists that changes in information technology and relative scarcity may make a valuable resource out of that which previously had no value".

Throughout history, availability of natural resources both in quantity and quality at the needed place, at the right time and the technology to exploit these, have determined the cause of human development in various parts of the earth. Areas that have been poorly endowed with natural resources or have not been able to develop appropriate means of appraisal and exploitation have had to concentrate on what exists or what is known to be useful. In other environments, abundant resources have been recklessly used. In both cases the ultimate result is a heavy pressure on limited resources which usually led to ecosystem destruction and human suffering. A rapid increase in world population after 1650 (Table I) has resulted in an increased demand on resources for support. A critical imbalance of person-resource relationship has engendered the perception and the real problem of resource scarcity in most parts of the world. Scarcity of resources has untold disadvantages for people and the natural environment since it may lead to over use.

TABLE I: World Population Since 8,000 BC

Date	Estimated Population	Time for Population to Double.
8,000 BC	5 million	
1,650 AD	500 million	1,500 years
1,850 AD	1,000 million (1 billion)	200 years
1,930 AD	2,000 million (2 billion)	80 years
1,975 AD	4,000 million (4 billion)	45 years
	computed doubling time around 1970	
¹ 1,980 AD	4.5 thousand million (4.5 billion)	
1,990 AD	5.8 thousand million (5.8 billion)	35-37 years
2,000 AD	7.5 thousand million (7.5 billion)	

After Ehrlich and Ehrlich (1970: 6)

¹ U.S. Department of State (cited in Souza and Foust, 1979: 76)

FIGURE I

Figure I: Logarithmic growth curve for world population from 1,000,000 years ago.
Source: Edward S. Deevey, Jr., 1960, "The Human Population", Scientific American, September, p.52 (adapted from Souza and Foust 1979: 74)

Evidence of effects of overuse of resources in various parts of the world are many and age old. Present desolated areas between the Tigris and Euphrates rivers had supported the prosperous and powerful civilization of Mesopotamia. A viable agriculture, built on elaborate irrigation facilities in the attempt to increase yields to meet growing numbers may have led to huge salt accumulation (under the semi arid environment) that rendered the soils sterile. Similarly, overgrazing by livestock on limited and unsuitable terrain and removal of wood for direct use or to make farming possible may have exposed the surface to erosional agents and therefore hastening the process of desertification and a possible destruction of the population.

Plato had commented on serious socio-economic and environmental effects of resource abuse in ancient Greece.

There are mountains in Attica which can now keep nothing more than bees, but which were clothed not so very long ago with fine trees, producing timber suitable for roofing the largest buildings. There were also many lofty cultivated trees, while the country produced bountiful pastures for cattle. The annual rainfall was not then lost, as it is at present,

through being allowed to flow over a denuded surface to sea... The shrines that survive to the present day on the sites of extinct water supplies are evidence for the correctness of my present hypothesis

(Plato in the Critias about 400 BC cited in World Bank Sector policy paper, February 1978, p.17).

Overuse of the land resources in Europe with the inception of the modern agricultural revolution, voyages of discovery and the industrial revolution brought the problem of resource scarcity to national prominence. For instance, an alarming rate of timber depletion in England led to the institution of a commission in 1548 to inquire into the destruction of wood in the iron making area of the Weald. In neighbouring France, the "Ordonnance des eaux et forêts" in 1669 provided that no wood be cleared without authority (Heichelheim, 1955: 200).

Evidence of misuse of natural resources persists to the present. A few examples are summarised as follows: (1) Due to overfishing at least 25 of the world's most valuable fisheries are seriously depleted while a large number more, may face the same fate in the near future; (2) over-exploitation threatens almost 40% of all vertebrate wildlife

species with extinction; (3) between 5 and 10 million hectares of forests are being felled each year for agriculture alone. In the tropical forests, felling and burning for agriculture proceed at a rate of 110,000 km² per year giving the forests an average lifespan of 85 years (source: IUCN, 1980); and (4) through reckless human activities such as overgrazing, poor agricultural practices and deforestation, deserts are known to be advancing between 10 km and 50 km a year in some areas threatening between 500 and 600 million people bordering arid and semi arid areas (UNEP: 1976). In Africa it is believed that an area of 650,000km² of arable land has been engulfed by the Sahara in the past 50 years (Env. Conserv., 1982).

1.2 HUMAN-RESOURCE RELATIONSHIPS - VIEWS

Views on resources and development have been central in most writings on resource analysis. House and William (1976: 21) have observed that both Aquinas in the "City of God" and Plato in his "Republic" concerned themselves with the man-land ratio. The work of Rev. T.R. Malthus provided one of the boldest and comprehensive attempts in the modern era to provide a conceptual basis and practical means of solving natural resource related problems. The malthusian theory expounded a population growth model that relates

human numbers to given resources of an area. Resources have to balance with population growth in order to avoid undue pressures and to maintain human quality. This model which can be represented by the exponential equation

$$N_t = N_0 e^{rt} \text{ where: -}$$

N_0 = Population at time 0

N_t = Population at time t

r = growth rate

t = time in years

e = 2.718 (The base of natural log)

later influenced such workers as range ecologists who helped to develop the popular concept of carrying capacity. This concept, like the Malthusian hypothesis attempts to estimate an upper limit of a population which a given ecosystem can support (Fig. II). It provides a major tool in range management as well as a major consideration for resource planning in a general environment to benefit human and the ecosystem.

To Malthus, human numbers may increase only when there are adequate resources to support them. A strict control of populations through various means may be necessary to maintain such a balance since human growth generally outstrips resource capacities. To the Malthusian theory then, resource scarcities may have accounted a great deal for the

FIGURE II: Population Growth and Carrying Capacity

Adapted from Smith Robert L. 1980

extinction of most ancient civilizations. The original Malthusian hypothesis persists through a school of Neo-Malthusians who basically follow the underlying principles of the theory.

Malthusian theory has been disputed because it did not consider certain possible factors that can reduce or eliminate the effects of resource scarcity in an area. Technological changes, substitution of products, recycling, trade, migrations, changes in taste, preferences, attitudes and overall human expectations over time and an interrelated and closer world among a number of factors makes it unnecessary for a population to be tailored to the extent of resources in a given environment. People may not have to practice infanticide, commit mass suicide, resort to cannibalism or stop breeding completely (as have been done in some environments in the past) so that they can continue living within available resources. With a single decision, thousands of tons of grain may be shipped from North America to help drought starved Sahelian populations in West Africa or to refugees in South-East Asia. In a similar manner, through trade, tropical raw materials and foods like cocoa, coffee, hardwoods may be shipped to the temperate lands where these cannot be normally raised under the existing climatic conditions.

There appeared to be so many inconsistencies in the Malthusian theory that a new school that believes in the perfection of science and technology as a means of solving all resource problems apparently offered a most dynamic alternative. Human numbers can no longer offer threats to existence. They may rather provide the basis for greater perfection of production and distribution techniques. Examples are given by the vast increases in human material production and development despite huge increases in population since the 1650s. It is also contended that the natural resources realm may be extended to the deepest sea bottoms, the core of the earth and other non conventional sources such as raising foodstuffs mainly through an aquatic medium (hydroponics) or mass desalination of ocean waters. There is therefore no possibility of shortages now or in the future. The ability to respond to such emergencies has been basic to human development.

As summed up by Abelson and Hammond in 1976, "it is impossible to run out of anything in economic terms. All that happens is that the price goes up which encourages greater efforts to produce the goods in question and the use of substitutes (cited in House and Williams, 1976: 18). The first law of thermodynamics even tends to allay human fears of a possible future shortage of certain natural resources

such as the metals or even energy. (Simply stated, it gives that matter cannot be made or destroyed. The implication is that when any of these are used, changes are simply caused in form, distribution and local concentration. Everything else remains intact. Thus, "...it is incorrect to talk about finite resources in such a way as to simply imply exhaustion" observed (Slessor 1980: 42) in an analysis of natural resource classification.

The technocentric theorists provide every hope for humankind and appear to render the Malthusian school obsolete and illogical. Most writings on natural resources have fallen under these two poles (Neo-Malthusian and technocentric) that the committee on Mineral Resources and the Environment of the United States of America Academy of Sciences (COMRATE) has classified them into two groups - the Doomsters and Cornucopians (House and Williams, 1976: 15).

The "doomsters" represent the Malthusian (Neo-Malthusian) camp that sees the supply of natural resources as fixed and do not believe technology has an unlimited capability to solve ultimately, all resource problems. The "Cornucopians" represent those views that believe in a limitless technological ability and the market mechanism as a means of building the needed support for human's continued existence and development (Table II).

While one may assail the weaknesses and dangers of a wholesale pessimistic explanation of the Malthusian school and considering the fact that technology has actually great potentials for human development, one cannot accept in entirety the simplistic and complacent views of the technological school. Despite the giant leaps in technology, human misery and suffering continues. A recent report in the "Globe and Mail" indicated that about 50 million deaths a year are attributed to hunger (Regina Hickl-Szabo, June, 1984). Most of present day technologies are tied to petroleum-based inputs whose lifespan may be limited due to their exhaustive characteristics and no new major finding to meet escalating demands.

Modern machines and synthetic products still need to be built by using natural resources and these are also needed in order to use machines to produce goods and services in the form that meet human satisfaction. Technologies therefore have serious limitations in solving long term human needs. In addition, technologies have resulted in greater social and environmental costs that appear to have been overshadowed in the past probably by "giant" contributions to development. Atmospheric pollution, destruction of sources of water, soils and species are all but a few of the costs that have to be paid for technological advancement.

TABLE II: Viewpoints in Resource Development

<u>Viewpoints</u>		
Issue	Neo-Malthusian	Post Industrial
Basic Model	Fixed resource base	Variable size; function of technology
Growth in technology and capital	Diminishing returns: use of poor grade resources	Absolutely necessary for survival
Management and decision making	World too complex to manage	Market mechanisms mean that amount necessary is small and possible
Resources	Rapid depletion	Ample, given techno- logy and substitution possibilities
Current growth	Exponential or cancerous	Towards and eventual stability
Innovation and discovery	Based on luck - not predictable	Opens new opportuni- ties
Income gaps and poverty	Increasing	Diminution of poverty
Industrial development	Disaster for the Third World	Must continue
Quality of Life	Trade-off with growth	Eventually high for all
Long-range outlook	In crisis	All is going well

SOURCE: Herman Kahn, 1975-76 (cited in House and Williams 1977: 15)

If it is to benefit long term human development, then it may have limits. Technologies can also not be applied in an unlimited range in the natural ecosystem since this cannot be overstretched forever. For the needs of a healthy environment too technological advancement may have serious limitations.

Such an analysis appears to vindicate the Malthusian school. However, in the search for solutions for a healthy person-resource relationship, there is no wisdom in dismissing any theory in a wholesale manner. These diverse views reflect the complex nature of human and the natural environment. A balanced consideration of these controversies may help arrive at fruitful solutions. Both schools of thought may therefore be relevant. It is the ability to recognise the contribution of each in relation to a particular problem that appears to matter.

1.3 CONSERVATION: WHAT IS IT?

A recognition of the dangers of natural resource scarcity to long term human and ecosystem needs provides the necessity to attempt to reverse these. In various environments, a number of measures both short and long term aimed at maintaining limited resources to benefit continued human

existence have been carried out over the years. These measures have collectively been termed Conservation. Due to different directions that can be taken to effect "Conservation", the multiplicity of groups (with various objectives) that can be involved and its time dimension, a clear cut definition has not been possible.

Like all human efforts to solve problems in the environment, appropriate definition of the means to achieve this is necessary. This may help to work out proper plans and strategies, the assembling of necessary tools, personnel and the confidence to tackle them. In the midst of resource scarcity, nebulous concepts cannot be afforded. A level of precision, worthiness and practicability may guide all attempts to solve problems. A proper definition is therefore needed for the concept of conservation.

In line with the age long debate on resource relationship, two major orientations underlie all attempts that have been made to give conservation a proper working definition. One orientation sees conservation as restoring the balance of nature which humans are apt to destroy. Human technology and consumption habits have fouled nature and the possibility of a total destruction of all its beautiful works is

high. This will deny future generations the rightful opportunities of enjoying such resources. Use of the natural resources are a privilege and not an absolute right. When privileges are abused, they are lost completely. People are considered outside all conservation measures. To save the natural resources, the optimal approach is considered to be a complete cessation of economic use to ensure their unimpaired state. To this school, conservation may be defined as the preservation of natural resources to ensure their unimpairedness to benefit posterity. Anything outside this may not be considered as constituting conservation .

A logical inference from such a definition can be stated that the world already has a large chunk of natural resources under use. There can be an efficient concentration on these so that all others may be left to themselves to ensure their healthy existence. In the absence of such an inference, advocates of this line of resource maintenance may be calling for a possible liquidation of the human race. The natural resources still contribute its major support for development. In environments where high population growth has resulted in large scale resource requirements, shutting these off completely from use may be impractical and unwise. People may question the wisdom of human misery in the face

of resource abundance. The Bible may be quoted to show the precedence of human needs over nature (Genesis 1: 26-29).

In the midst of such considerations, an opposing orientation believes the economic use of resources can be perpetual through "wise use". Technological and managerial ability can help to retain natural resources in a reasonable quantity and quality to benefit mankind at all times. Humans cannot be considered outside any conservation measure by being part of the environment. Conservation is actually centred on their interests. This school believes that changes can occur in the natural environment independent of human intervention. Human ability to build, improve, prevent wastes and protect can be used efficiently to achieve a wise use of resources. Conservation may therefore be viewed as a rational use of resources over time. The modus operandi of this school has been described as "the application of a rational and 'value free' scientific and managerial techniques by a professional elite who regarded the natural environment as a neutral stuff from which man could profitably shape his destiny (T. O'Riordan 1976: 1)". Such an activity is actually a source of worry to the preservationists. Human greed and the insatiable urge for development may cause irreparable damage in the environment whatever

rational actions are taken to avoid these. An absence of a moral recognition of the right to existence of other species render all human actions potentially dangerous. A "wise use" may therefore be so vague that it cannot offer any meaningful relief to the concerns of the preservationist school.

These extreme viewpoints provide some valid points that cannot be ignored in any working definition of conservation. A ban on resource use may not be feasible at all places at the same time. On the other hand some resources that are rare and or threatened by extinction may have to be preserved to ensure their existence at all times. A notion of human unlimited control over the environment is self-defeating. It is the judgement and the capacity to identify what activity to be carried out at the right place and at the right time that seem to be crucial.

Several attempts to give conservation an inclusive definition to marry these viewpoints have been made by politicians, administrators, fieldworkers, intellectuals and international agencies concerned with resource issues. For example, President John F. Kennedy interpreted the term as "the wise use of our natural environment: it is in the final analysis, the highest form of national thrift - the

prevention of waste and despoilment while preserving, improving and renewing the quality and usefulness of all our resources (Owen, 1971: 10)". Scott (1972: 30)⁴ defined conservation as "a public policy which seeks to increase future usable supplies of a natural resource by present actions (also cited in Howe 1972: 54)". Allan (1971: 235) saw conservation as being "synonymous with the socially optimal allocation of natural resources over time". Finally, the International Union for Conservation of Nature and Natural Resources (IUCN) sees it as ..." the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of the future generations".

Despite the different wordings of these definitions, there are some common characteristics. Conservation is seen as a reaction to resource shortages. Conservation can be incorporated in all human development endeavours. Conservation involves a complex of activities linking current needs to the future. It is dynamic so that tools, concepts and goals may alter over the years to reflect changes in human and environmental demands. Conservation is seen basically as a public activity to regulate negative effects of short term ~~private~~ interests. Conservation involves both "preservation" and a "wise use".

Some shortcomings in these definitions however call for comments. An over-emphasis on human socio-economic well being as an ultimate goal may lead to the avoidance of crucial activities that can protect the environment. For instance, programmes regarded as vital for human existence may not necessarily be in the interest of natural processes. A purely utilitarian interpretation such as that of Scott is even more controversial. It appears that only resources deemed useful may be given attention at a particular time. Having recognised that a "resource" is a dynamic concept that keeps changing with human growth and development, a complete destruction of species that are regarded as uneconomic at present, may amount to a destruction of possible future stock of resources. The economic interpreters may also match the usefulness of a resource with some current value such as a market price. In environments where technological advancement and cultural sophistication are low, such potentially useful land resources as coastal flats and marshes, wetlands, stony and steep terrain, some wildlife and fauna may be regarded as liabilities because under existing conditions there are no demands for them so that no price values can be assigned.

What constitutes socially optimal allocation or a rational use is very difficult to reduce to operational

terms. Definitions that also put most emphasis on government action provide a weakness. No single government may possess all the resources and powers to carry out conservation activities successfully. Most sources of resource degradation may be traced to individual action so that the involvement of people at the grassroots becomes important.

The emotions, conflicts and political machines that underlie the concept, rule out a dogmatic definition. For its flexibility and relative ease of interpretation, the IUCN definition however offers the most attractive option. By concerning itself with the whole biosphere, it is not restricted to problems related to resource scarcities alone but all processes that can make for a sound environment which in turn may ensure continued human existence. Thus, pollution, watershed destruction, species extinction among others are considered as crucial in all conservation activities just as activities that make for direct human consumptive needs. The phrase "management of human use" resolves to some extent, the underlying conflict between the "preservationists" and the "rational users". If humans can be irresponsible some of the times, then their activities may be restrained wherever possible by such means as complete protection, legislations, education and other forms of social control to safeguard a healthy environment. If they

have the capability to maintain, then they can also build upon, protect, replace and use efficiently all benefits that the environment provides. This satisfies both extreme viewpoints in conservation - preservation and rational use.

An important point to notice in the IUCN definition is that it still leaves the environment as a weak factor in the power relationship in conservation; human versus the environment. If humans decide to unleash their destructive tendencies without an appropriate check (which is usually absent) damage in the environment may be uncontrolled. An appropriate definition of the status of natural factors appears to be crucial in all conservation goals. It is more important that, a balanced view of conservation, taking into consideration both human and ecosystem development should provide the best approach to any definition. Recent activities of the IUCN have however shed greater light on what lies behind its definition of conservation. It becomes more revealing that a balance of the two power considerations are sought for as much as possible and thus provides a very good basis for any considerations.

The commissioning of a World Conservation strategy prepared by the IUCN with the advice, co-operation and financial assistance of the United Nations Environment

Programme (UNEP) and the World Wildlife Fund (WWF) in March, 1980, provided a better focus for worldwide conservation practices. The aim of the World Conservation Strategy (WCS) according to the document setting out its preamble is to help advance the achievement of sustainable development through the conservation of living resources. To attain this, the document sets out three main objectives:-

- (1) to maintain essential ecological processes and life support systems;
- (2) to preserve genetic diversity; and
- (3) to ensure sustainable utilization of species. (Source IUCN: WCS preamble and Guide 1980; WCS, Executive Summary, 1980).

The objectives of the WCS appear comprehensive enough to cater for both the natural ecosystem and human development. It rightly sees conservation as necessary for all present and future human development needs. To achieve this, it recommends a proper recognition of social, economic and ecological factors. The strategy provides a framework streamlining conservation activities on a worldwide scale. This makes it possible for a global comparison, evaluation and promotion of all activities that come under conservation.

Some possible defects of the strategy have attracted attention. The document itself admits the dangers of gross generalizations in dealing with global analysis. Certain local problems may be omitted or oversimplified while others may be magnified. It has been regarded by some observers as a highly idealised document and that its objectives may be unattainable in most environments. Another major defect of the document appears to be the absence of a role for the general population. The users of the strategy are supposed to be; (1) government policy makers and their advisers; (2) conservationists and others directly concerned with living resources; and (3) development practitioners, including aid agencies, industry and commerce and trade unions (IUCN: Preamble and Guide, 1980). These appear to be the most reasonable groups to use but as has already been noted a role for the general public cannot be overlooked.

Many countries, particularly the developing nations, may not have adequate resources to undertake the magnitude of activities needed to achieve the international objectives of the strategy. It is believed also that the strategy assumed a uniform resource endowment and problems in all environments alike so that sacrificing a great deal of these resources to achieve the set objectives may be a

matter of routine. The possibility of unwarranted sacrifices in local needs and preferences appear high in the attempt to achieve such lofty objectives.

The WCS may not be held as a final blueprint for all environments alike. It mainly attempts to provide a tentative focus of action to assist those involved in the planning and execution of conservation programmes. A guideline put forward by the Commission on Environment (CEP) of the IUCN in March, 1981 attempts to resolve much of the deficiencies in the original WCS in terms of planning and actions that follow. Presented in a schematic form, (Appendix I) the guideline is made up of three complex interrelated stages:- (1) initiation of action (2) implementation of study (3) implementation of project (IUCN, 1982: 13). The CEP advises a consideration of such external factors as local support, the support of political leaders, scientists, Non-Governmental Organisations (NGO's), community and business leaders in the formulation of all projects to ensure success. It provides opportunities for various countries to adapt the WCS to suit local capabilities and needs while attempting to achieve international goals.

Striving to achieve a balance in conservation activities, various world organisations have provided support to

FIGURE III. ~ Average Annual Rainfall

Reproduced from GHANA, 1977.

the IUCN or moved in their own direction to help put resource conservation in a better perspective. Among some of the notable organisations that are conservation oriented are the World Wildlife Fund (WWF), United Nations Educational and Scientific Organisation (UNESCO). The United Nations Environmental Programme (UNEP), International Association of Ecology (INTECOL), World Environment and Resources Council (WERC) and the International Conference on Environment Future (ICEF). Various organisations related to conservation of resources also exist within countries. World leaders are being made more responsible to the need of incorporating environmental considerations in development. The Stockholm Conference on man and the environment in June 1972 (UNEP, 1982) and attended by representatives from over 113 countries became the eye-opener. The enthusiasm with which world governments received the WCS launched in 1980, is another proof of the acceptance of conservation as a standard practice all over the world.

Choosing the IUCN definition as the best start, one may define conservation, operationally as, all those activities both public and private that aim at maintaining the biosphere in a perpetual healthy state. The sustenance of man can provide an immediate motivation for conservation but an absence of a recognition (to some extent) of an independent

existence of natural species may render all such efforts futile. It is difficult to resolve this dilemma in a single definition. The WCS has provided the way to show that it is the spirit and action that lie beyond the semantics of a definition that matter since in most cases definitions may not be perfect to suit all conflicting considerations. Conservation may involve such activities as preservation, protection from destruction and extending the base of the resources. It may also involve wise use. Using resources wisely may involve operationally, such practices as number or volumetric restrictions, efficient extraction and processing, re-usage, substitution and curtailment of uses in certain cases. It may involve importation, from abundant sources or stockpiling in times of plenty to spread over longer time. It also covers all practices that seek to protect the natural ecosystem - water, atmosphere, soils, flora and fauna. These activities may be both short and long term as may be appropriate. It may also depend upon the characteristic of the resource, whether renewable or non-renewable and the nature of its exhaustibility (Table III). A sustained development of human may be attained through a perpetual healthy biosphere.

1.4 THE TOPIC

Different countries may be faced with different perceptions of conservation priorities. In countries where industrialization and development have reached such a level that atmospheric pollution, waste disposal, water pollution and absence of open space provide major problems, emphasis on environmental protection may dominate conservation programmes. In most developing countries, rapid extraction of the primary resources to satisfy human development needs may lead to depletion. Conservation may be viewed as a means of maintaining the numbers and volumes of those resources that provide immediate sustenance so that use can be made perpetual. Environmental considerations become secondary. At best they may be regarded as a past-time of an affluent society or a few privileged citizens. The average resource user may not even perceive the negative consequences of resource abuse since these may happen in another generation. Meanwhile, people must eat. The means to assure this is the most important goal.

Forests and agricultural soils are among the most degraded natural resources in the developing countries especially in the tropical world due to overuse and lack of maintenance. Forests, however provide the highest cause of

TABLE III: A Generalised Classification of Natural Resources

TYPE	DESCRIPTION	EXAMPLES
RENEWABLE	These are mainly biological. They have the ability of continuous self-regeneration with a level of human management (or through total abstinence of human use).	plants, animals soils
NON-RENEWABLE	These are resources that cannot be replaced after use (a) they are highly exemplified by non-living resources particularly minerals; (b) some living resources can also be destroyed beyond a level where their original form cannot be attained or lost completely so that they also become non-renewable in that sense.	(a) oil, gas, uranium (b) agricultural soils, forests, wildlife species.
EXHAUSTIBLE	These are resources which by their original nature are fixed in quantity so that they can be used up completely. They can both be biological and non-biological.	minerals limited forests, water and agricultural lands etc.
INEXHAUSTIBLE	Naturally their existence is continuous independent of human activities.	water in the hydrologic circle, wind power solar energy.

concern. From development and environmental point of view, they are very important in tropical ecosystems. While they may be removed faster, they cannot be replaced easily or at all due to a rapid destruction of the surface through exposure to high rainfall amounts when they are cut. They may also be destroyed with all the components within them including rich soils. Destruction of tropical forests has been estimated at the frightening rate of 110,000 km² per year (IUCN, 1980: 16).

The IUCN, FAO, UNESCO, WWF, governments, conservation agencies and concerned individuals have recognised forest conservation as a major priority activity in tropical countries in the interest of long term human production needs and environmental balance. Ghana, also a tropical country, can never be left out in such considerations.

Ghana is situated within the low tropics of Africa between latitudes 4½°N and 11°N. It has an east-west extent between longitudes 1½°E and 3½°E. This gives her a total area of about 239,460 km². True to its tropical location, it enjoys uniformly, high temperatures averaging between 26°C and 29°C. Rainfall amounts are also fairly high. A north rainfall zone lying above latitude 8°N enjoys mean annual totals of (summer concentration) up to 1,250 mm

while a south rainfall belt below this latitude to the coast (Fig. III) experiences the equatorial type of rainfall with a double maxima. Mean annual totals range between 1,250-2100 mm (there is an anomalous narrow climatic stretch along the coast east of Cape Coast where even though the regime is a double maxima mean totals fall below 1000 mm - Fig. III). High rainfall amounts and temperatures create humid conditions especially below latitude 8°N that promote greater microbial activity. Once the forests remain unimpaired, natural processes are promoted in a balance state and they provide a healthy environment for a multitude of species.

The population of the country, estimated at 11,450,000 in mid-1980 is growing at a rate of 2.7 percent per annum (E.A. Boateng: 1983). More than 50% of the total population is concentrated in the tropical rainforest belt which constitutes just about 30% of the country (Fig. IV). In the main therefore, conditions that give rise to a mass destruction of tropical forest ecosystems elsewhere, exist in the country. While increasing populations may lead to a rapid utilisation of the forests for development needs, high rainfall amounts may degrade the cut over areas to inhibit natural restoration. Like other tropical areas, environmental needs may not be considered as a necessary partner of

resource development and use. Poverty in the rural areas and a low performance of the economy may further put major stresses on the forest ecosystem to sustain human development.

Since destruction of the forest ecosystem may lead to serious consequences, a study into forest conservation in the country is very necessary in order to expose possible deficiencies of present attempts in light of standard practices elsewhere and also in relation to present and future national needs and aspirations. This will enable necessary suggestions and readjustments to be made so that the forests may be maintained perpetually.

The main focus for this study therefore is that balanced conservation of the forest ecosystem in Ghana, may promote an overall rapid and continuous national development. Balanced conservation is considered as all those activities that give priority to both environmental and development requirements in resource management. Forest conservation may not stand for total environmental conservation. Such activities as pollution abatement, urban waste disposal and land restoration may clearly lie outside its limits. However, forest conservation forms a necessary part of any effective environmental conservation programme. In

FIGURE IV. Ghana - Vegetation Types

the text, it (Forest Conservation) may concern activities or group of activities and services that relate to or originate in the forest ecosystem.

An ecosystematic approach to conservation provides the major basis for analysis: this approach recognises that the forests are made up of a number of organisms that live in a dynamic interrelationship so that composite measures are needed if they can be managed efficiently. Smith (1974) sums up this viewpoint as involving total systems approach to resource management because single purpose strategies seem to treat natural resources as discrete commodities.

The ecosystematic approach may not be misinterpreted to mean what O'Riordan (1981) has termed ecocentric mode of conservation which invariably implies ecological dominance in conservation. In a sense, the approach recognises a technological dilemma of humans in the ecosystem that can both build and destroy. A recognition of humans as part of the wider ecosystem is also made which gives that they may actually be part of all interrelationships that exist (in the ecosystem). Such functional interdependence requires a balanced co-existence between humans and the natural environment. It is no longer the environment having controls over human development neither can humans regard the natural

ecosystem as an arena for unlimited manipulations to cater for their welfare. The approach accordingly, stresses the welfare of both (human and nature) in all aspects of forest conservation planning.

The ecosystematic approach is important to the extent that it enables a number of related activities to be carried out to benefit many aspects of the forest ecosystem and even the wider environment lying beyond it. The flora, fauna, soils, watersheds and the environment can benefit at a time. The approach as presented here also recognises the impact of external factors such as research, technology, education, industrialization, legislation and development in other sectors of the economy on field programmes. Absence of these considerations in conservation planning may render all programmes less successful since the natural environment does not exist in isolation from those of humans (Fig. V).

It is of interest to note that workers such as Holling and Chambers (cited by Park, 1980) have argued that it may be more expedient to seek narrow solutions for specific problems because interdisciplinary approaches can suffer from a proper communication of ideas and concepts between disciplines, between research scientists and decision makers. They also noted that problems within resource management are global and on long-term dimensions.

Logical as the above assertions may sound they are no longer tenable in the wider sense in the modern conservation scene. Generally, there are no problems about concepts and ideas (in conservation) now. It is no longer a disorganised activity. It is built upon laid down procedures. It is planned. The planning stage brings actors of varied background together. This clears all doubts and prepares the way for smooth field programmes. The observation that resource problems are global and or long term so that they should be solved in single narrow programmes is even more distressing. Such biases in forest conservation in the past have not been able to halt wide-scale degradation in most environments due perhaps to the convincing fact that the forests are not composed of single lives only. When problems are long term, they need to be solved in a decisive manner once they show up so that they do not escalate into uncontrolled dimensions. Yes, some programmes may have to be emphasized, however this must not be the rule. All programmes have to consider the wider forest environment. The ecosystematic approach can stand the test of all times.

To be able to convince a development minded and not so affluent people as Ghanaians that balanced conservation involving both consumptive and non-consumptive considerations in the ecosystem are vital for survival provides a

FIGURE V: Necessary Considerations for Balanced Forest Conservation

Modified from Soerianegara, 1982

major task. To achieve this, an objective and indepth analysis is needed to expose possible vulnerabilities of existing use trends. Such an objective analysis is also necessary to provide insight into various attempts that have been made in the past in terms of conservation. This will help to expose all possible shortcomings that may warrant new considerations. In line with such a requirement, the study sets out to examine the characteristics, extent, use and possible problems arising out of use of the forests and the nature, rate, extent, source and possible implications arising out of the problems identified (Chapter two).

In chapter three, responses to problems (as well as other resource management issues) both in the past and present are examined. Two bases of evaluation are employed. The first is the extent and effectiveness of strategies in solving short and long term requirements for food, protein, raw materials, employment and income needs in a healthy environment. The second basis is provided by the three objectives that form the framework of the WCS: (a) to maintain essential ecological processes and life support systems; (b) to prepare genetic diversity; and (c) to ensure the sustainable utilization of species and ecosystems. Aspects of these that can be realised through forest conservation, may be used. Both criteria are ingrained in the ecosystematic approach.

Presented in chapter four are several measures which can help make for successful conservation. Most of these measures arise from local considerations and experiences, practices from other sectors of the economy, innovations from other societies and suggested practices from conservation related agencies.

Finally, presented in chapter five are a summary and conclusion to the study.

CHAPTER 2. THE FORESTS

2.1 WHAT THEY ARE

So many variations occur in natural vegetation over the earth's surface that it is extremely difficult to categorize them into standards that can be discerned easily everywhere. Forests for one, are the most nebulous. What constitutes forest in a semi-arid or an arid region may be so different from the point of view of moist-wet environments. Within a single country, what may be regarded as forest in one locality may be termed differently in another. Factors such as climate, landform, soils, human and historical among others may help account for such lack of uniformity in vegetation distribution.

No organised analysis of vegetation however, can be made without a good basis of classification to make comparison possible either within or between countries. One of such best classification methods is offered by the UNESCO's International classification and mapping of vegetation prepared in Paris in 1973. The system uses physiognomic - structural characteristics with supplementary ecological

information integrated into its various categories and applicable to natural and semi natural vegetation (UNESCO, 1973).

According to the UNESCO system (of classification) Ghana can broadly be categorized into two main vegetation zones - forests and savanna. Forests are characterised by a high percentage of tree cover. Heights of trees may be at least 5 metres with interlocking crowns. There is also a virtual absence of a continuous grass layer. Savanna vegetation on the other hand, may have a tree density ranging from high to nothing. Generally, crowns may not touch as trees are dispersed. It is dominated by a grass layer.

Strictly by the above definition, true forests in Ghana are restricted to the closed forest region, an area of about 82,000 km² (Table IV). The rest of the country is covered by savanna (Fig. IV). However, a broad intermediate vegetation zone between forest and savanna conspicuously occurs to merit a third type. This is the woodland also recognised by the UNESCO classification. Tree population in this zone is relatively high, with a coverage of at least 40%. Crown does not usually touch but tree heights may reach 5 metres or more. Grass layer is relatively sparse. This area has been estimated to cover 90,617.8 km² of the total savanna.

zone (Ghana, 1979). For purposes of forest conservation, the woodland is considered with the closed forest zone.

(i) A Brief Profile of the Forests

The closed forest zone of Ghana occupies much of the southern parts of the country below latitude 7° 45' N. It is broken towards the coast by a narrow savanna belt running east of Sekondi, widening in the extreme east of the country (Fig. VI). Mean annual rainfall amounts total up to 2,100 mm (Fig. III). Temperatures are uniformly high (between a mean of 26°C and 29°C) with relative humidities of at least 77%. Relief is generally low. No point reaches 1,000 metres above sea level.

Based upon physiognomic-environmental characteristics, Hall and Swaine (1981) have identified four major types of forests. These are the evergreen, semi-deciduous, southern marginal and the south-east outlier. Several subtypes occur within the evergreen and semi-deciduous types (Table IV).

The evergreen forests occupy the south western part of the country covering about 29.3% of the total

FIGURE VI. Distribution of Forest Types -
Closed Forest Region

TABLE IV: Areas Occupied by Various Forest-Types in Ghana

Types and Subtypes	Area (km ²)	Percentage of Total Forest Area
Wet evergreen	6,570	8.1
Moist evergreen	17,770	21.9
Upland Evergreen	292	0.3
Moist semi-deciduous	21,990	40.4
South-east ¹	(18,460)	
North-west ¹	(14,430)	
Dry semi-deciduous	32,890	26.4
Inner zone ¹	8,630	
Fire zone ¹	(12,810)	
Southern marginal	2,360	2.9
South-east outlier	20	0.03
Total Forest Area ²	81,342	100.03

¹ Forest Subtypes

² Total forest area omitting figures for subtypes

SOURCE: Hall and Swaine (1981)

FIGURE VII. Major Soil Groups

Reproduced from GHANA, 1977

closed forest area (Table IV). Rainfall is equitably distributed throughout the year with average annual totals between 1,525 mm and 2,100 mm. Relative humidities are over 85% with no marked dry season. The soils are mainly oxysols. These are highly leached under the humid conditions. The vegetation is generally evergreen. Where rainfall amounts are over 1,780 mm the wet evergreen type exists. Away from the core of the wet zone northwards is the moist evergreen type. This is a transition between the typical evergreen forest and the true semi-deciduous forest. Some trees in this ecotone, exhibit characteristics of either zone. Lowering rainfall amounts and increase in the period of dryness as well as decreasing soil nutrient loss may account for this zone (Fig. VI).

The evergreen forest is marked by a high diversity of species. Up to 200 species to a sample area of about .0625 ha were noted by Hall and Swaine (1981). Mean height of trees are estimated to be about 32 metres. Common species of trees include Dacryodes klaineanna (odoka), Strombosia glaucescens (Afina) Diospyros sansa-minka (Kisibiri) Lophira alata (Kaku/Ekki). Quality of trees in terms of

height and girth are relatively poorer compared to the semi-deciduous zone.

The semi-deciduous zone is made up of moist and dry zones. Together they take up about 60% of the closed forest zone (Table IV). The zone enjoys rainfall amounts of between 1,250 and 1,800 mm per annum. There is a period between 3 to 4 months of dry season. Humidities are high, about 80%. It is mostly covered by the forest ochrosols which are relatively richer in base minerals. pH values may be up to 6. Like the evergreen forest, it shows stratification. There is a ground layer of shrubs of up to 5 metres. This is followed by a lower canopy species in which trees with heavy crowns and low branches may reach up to 15 metres. A middle continuous canopy species may stand as high as 40 metres. The topmost layer is taken by the emergents which may reach heights of over 60 metres. A vertical layer of giant lianes, epiphytes and other-climbers link the ground layer to the upper-storey.

Some of the trees shed their leaves but at different times within the dry season. This is

particularly so with the upper canopy trees and those at the northern and south eastern boundaries. Many of the lower canopy trees and shrubs are however evergreen. Species per unit area is relatively lower than that of the evergreen. 170 species per a sample plot of .0625 ha have been noted (Hall and Swaine (1981). It carries most of the common and important timber species. Trees grow to greater heights than any of the forest types. Heights exceeding 60 metres are common and girth of 2 metres can also be found.

Some of the common species of trees are Celtis mildbraedii (Esalkutus), Nesogordonia papaverifera (Danta), Triplochiton scleroxylon (Wawa/ obeche), Khaya ivorensis (Mahogany-African Mahogany) Terminalia ivorensis (Emire/Idigbo), Khaya anthrotheca (anthrotheca) and the Etandrophragma utile (utile). Together with the coastal belt, the zone carries the highest density of population. It is also the most economically exploited.

The southern marginal belt covers about 2.9% of the forest zone (Table IV). It runs as a narrow belt immediate north of the coastal savanna zone and

providing the southern boundary to the true semi-deciduous (Fig. VI). It is a poorer type of forest in terms of tree quality and species diversity. Height of trees rarely exceed 35 metres. The Nesogordonia papaverifera (Danta) species, the only species of some quality for timber has an average diameter, at breast height (dbh) of 10 cm or less. Single species density is greater, a contrast to the other types of forests noted. Hall and Swaine recorded densities of 200 trees (≥ 10 cm dbh) for four major species on a sample plot of 0.0625 ha. Among these, the Talbotiella gentii is the most gregarious. Others are the Hildegardia barteri, Hymenostegia afzelii, the Manilkara obovata and the Nesogordonia papaverifera.

The forest is poorly structured and has a dense undergrowth. Several reasons may account for such a low quality forest just within 5.5° N. Rainfall amounts are low - between 1,000 and 1,250 mm. The soils are generally developed over rocks of poorer base materials. The southwestern part is underlain by a granitic association of the Birrimian system of rocks while rocks of the Togo series, composed principally of quartzites and shales underlie the

north eastern section (Fig. VII). Soils are mainly shallow and therefore deficient in natural nutrients. Also lying near the coast and adjacent to centres of high population concentration, this forest type may have been over exploited for a long period of time. Fetish growths and isolated hilly stands provide much of the remnants.

Finally, the south east outlier presents the smallest forest type covering just about 0.03% of the total closed forest zone. It occurs in discontinuous patches basically on the shai hills (Fig. VI). Rainfall amounts are the lowest in all the forest types - 750 mm to 1,250 mm per annum. Soils are developed over basic gneiss. Even though they are mostly shallow as a result of steep slopes, there is a negligible amount of leaching under the dry environment. The soils are therefore rich in natural minerals and are able to support a drier type of forest as an island in a mainly savanna zone.

Trees are shorter, averaging up to 15 metres. Floristically, it contains the least number of species. This low number of species probably account for the high degree of gregariousness. It is also

noted that basal sprouting and profuse epicormis are a feature of many of the species. Notable trees species include Vepris heterophylla, Ochna ovata and Crossandra nilotica. No known timber species exist.

(ii) The Woodland

This is very extensive zone bounding the closed forests and the pure savanna (Fig. IV). The area receives mean annual rainfall of between 1,000 and 1,250 mm but is of single peak (May-October). Soil moisture deficiency, compact soils (particularly during the dry season) and low relative humidities (50% in the dry season) have affected tree growth. Human activities, particularly in northern Brong Ahafo, Ashanti and the southern parts of the northern region have also helped to add to the otherwise, climate climax vegetation.

Towards the closed forests, tree quality and percentage coverage is high. Trees may be up to 20 metres or more in height. Forests do occur along water courses (riverain or fringing forests), a result of available moisture in the soil. Towards the true savanna vegetation, tree population

decreases and quality also deteriorates. There is a high percentage of grass cover. Most of the trees are drought and fire resistant. They develop thick woody outer barks, may be short statured and deciduous in nature.

Common species found include the Antiaris-Chlorophora association in the southern boundary. The savanna mahogany (Khaya senegalensis) a riverain type; the Anogeissus leiocarpus, Azelia africana Smith, Parkia clappertonia na keay (dawadawa) and the acacia species towards the north. It is a poor timber area.

2.2 USES OF THE FORESTS: GENERAL ROLES

Forests make up over 30% of the land area of the earth. They are therefore prominent environmental components and offer uncountable amounts of benefits. These can be summarised under environmental and socio-economic (Appendix 2).

It is difficult to mention with a high degree of certainty, the actual effects of forests in environmental processes, however, various studies have indicated basic influences a forest may have in the environment.

Forests, may help to control flooding and regulate stream flow. Tree roots may help stabilise soils. Closed canopies help break the full impact action of raindrops on forest floors to reduce soil detachment and removal effects. A surface cover of trees and forest litter may help check surface run-off and accelerated erosion.

A thick forest litter may impede deep freezing in the soil profile and may help to maintain appreciable temperature balance between surface and indepth (soils). They may increase the organic matter content of soils. It has a great hydrologic role by helping to improve the infiltration capacity of soils. Groundwater budgets are thus kept increased and forests provide one of the most efficient means of watershed protection.

Siltation of water bodies has been a menace in most countries. For example, it is estimated that it costs Argentina about \$10 million a year to dredge silt from the estuary of the River Plate so that Buenos Aires can be opened to shipping (IUCN, 1980). Forests, by covering the surface help to reduce silting. Joseph Kitredge (1973: 6) noted that "the silting of the lagoons near Venice as a result of deforestation in mountain headwaters of the Po and other rivers was an early cause of recognition of forest influences".

Climates may also be modified by forests. Even though the amounts of solar energy reaching any point on the earth's surface may be affected by factors such as latitude, season, altitude, aspect and cloudiness to mention a few, less solar radiation may reach the floor of a dense multi-structured forest. In close-canopied broad-leaved forests as the tropical evergreen, lower layers receive negligible light. The tops of some shiny leaves may reflect a fair proportion of incoming solar radiation. Much may be withdrawn for photosynthesis and evapo-transpiration. Most of the leaves may also be opaque to light. Thus, much energy is lost to the surface.

The effects of forests on light intensities have been reported by Burns (Kittredge, 1973) from his study of Jack Pine plantations. (Table V). He used four plantations all between 3.7 and 4.3 metres (12ft and 14ft) high. They differed only in the spacing between the trees which was 0.6, 1.2, 1.8 and 2.4 metres. The Crowns of the plantations spaced 1.8 and 2.4 metres, had not yet closed. He measured light intensities with a Coblentz thermophile at a height of 0.89 metres above the ground. The result of his work showed that with a high canopy density, closeness of trees, tolerance of species and progression of natural succession toward the climax, the intensity of solar radiation may be reduced.

TABLE V: Effects of Forests on Solar Energy

SPACING	TREES PER .4047 ha (acre)	% AVERAGE SOLAR RADIATION
0.6 m x 0.6 m (2' x 2')	10,890	15.9
1.2 m x 1.2 m (4' x 4')	2,722	36.0
1.8 m x 1.8 m (6' x 6')	1,210	46.6
2.4 m x 2.4 m (8' x 8')	680	55.4

After (Burns (1927) Adapted from Kitredge (1973)

TABLE VI: Oxygen Release of the Forests on Earth (from Hansen) 1975

Author	10 ⁹ t O ₂ /year	In % of all land plants
Bruenig, 1971	55	-
Leith, 1972	85	60
Reichle, 1970	94	67
Whittaker, 1970	102	74

SOURCE: Bernatzky, A(1978)

TABLE VII: Increase of Carbon Dioxide Concentration in the Atmosphere since 1860 (after Anon; 1971 Umschau)

1860	293 ppm
1950	306 ppm
1960	313 ppm
1970	321 ppm
Estimated	
1980	334 ppm
1990	353 ppm
2000	379 ppm

Adapted from Bernatzky (1978)

Thus, a closed forest may receive less solar energy near the surface than in more open forests or treeless areas. Being the 'main engine' (solar energy) for weather processes, this may help to determine differences in temperature, humidity, evapo-transpiration and even precipitation (rainfall) between forested and non-forested areas either directly or indirectly.

Independent studies by Bruenig, Leith, Reichle and Whittaker (Bernatzky, 1978) have concluded that forests produce 2/3 of the oxygen of all land plants (Table VI). The increase in carbon dioxide concentration in the atmosphere at alarming proportions (Table VII) in recent years put oxygen release by vegetation, particularly forests in a more important position to counter this threat.

Forests provide shelter from destructive winds and may also help to check soil loss in arid environments through wind erosion.

Forests may provide a buffer, helping to thwart the spread of diseases both to man, plant and animals from one environment to another. They sometimes check or at least slow down uncontrolled bush fires.

Forest trees have been found to have pollution reducing characteristics. Large stands of trees or forests may reduce radioactivity in the air by altering its dispersion (Herbst, 1975). James Schmid (1975) has reported that, plants can take up appreciable concentration of pollutants actively at rates influenced by an individual's life history, its genotype, species and other current environmental factors. Smith (1972) has also demonstrated that tree vegetation collects heavy metals such as lead. In the urban environment, forests may help absorb particulates, smoke emissions from industrial plants and automobiles and help abate noise. Urban ventilation may be enhanced by trees through their cooling and purifying of air and the absorption of carbondioxide and release of oxygen (Bernatzky, 1978). Urban forestry may also help to screen unpleasant sights, like car graveyards.

There is no doubt forests exercise some positive influence in the human environment. It is however much more difficult to monitor this due to the complexity of processes in the environmental flux and the interrelationship of factors in the ecosystem. As much as some effects have been identified, closer and a more sustaining and co-ordinated research may yield conclusive and probably startling results.

Human uses of the forests are many (Appendix 2). Since pre-agricultural eras, they have been a major source of food. Forest environments still are important food source. Notable examples are coffee (Coffea) tea (Camellia sinensis), cocoa (Theobroma cacao), a host of edible fruits including bananas (Musa sapientum) and cola nuts (Cola nitida).

Most fibre and industrial materials also have forest origin. Among these are natural rubber and wood.

Natural rubber made the automobile revolution a success. Together with synthetic rubber, it provides much of today's automobile and aircraft tyres and other numerous related products.

Wood is the single most important forest product in terms of volume and multiplicity of use. It generates considerable incomes for both developed and less developed countries. The value of the annual world production of forest products, mainly wood is estimated to exceed \$115.5 billion with about \$40 billion entering into international trade (FAO, 1968 cited in IUCN 1980). It is a convenient component in every aspect of construction ranging from large-scale engineering works to simple farm fencing. It is

estimated that current world consumption of industrial wood stands at 1,233 million m³ in raw material equivalent per annum (FAO (World Wood), Feb. 1983). It is also a major source of fuel for a large percentage of the world's population. In the developing countries, fuelwood is estimated to take about 80% of all total wood use; providing as high as 58% of total energy requirements in Africa, 42% in South-east Asia and 20% in Latin America (IUCN 1980: 4).

There are other numerous minor fibres such as the Abaca or Manila hemp and piassava (Raphia vinifera). Tanning and dye materials can be produced from the bark and leaves of trees such as the hemlock, oak, mangrove, chestnut, myrobalan and the sumaco. The genus Cinchona provided the most singular combat medicine - quinine - against malaria fever. Medicinal plants are widely utilised in developing countries where modern health care is unable to reach a mass of the population, particularly in the rural areas.

There is widespread use of the forests for non-consumptive purposes. Forests have been utilised to beautify urban landscape and to give diversity to otherwise monotonous and artificial environments. Most of the present day agitations for forest protection have not come from economic users but the recreationists and the naturalists. Scientific and educational uses of forests are also increasing.

2.3 THE USE OF FORESTS IN GHANA

(i) Major Uses - Timber and the Wood-Based Industries

Virtually all of Ghana's timber produce comes from the closed forest region. The greater proportion about 60% comes from the forest reserves on an annual allowable cut of about 2.1 million m³ (FAO, Worldwood, 1982). Timber is among the traditional and earliest export products from the country. Foggie and Piasecki (1962) have noted that logs of Lophila alata were exported in Elisabethan times to be used for the keels of wooden ships. Exports began officially however, in 1888. For a long period of time they consisted of only rough wood. Currently, wood exports include both industrial roundwood and processed wood including veneers and plywood. Wood also provided the earliest base for local industrialization drives.

The forest industries employ about 70,000 people, 15% of the estimated labour force (Friar, 1982). Most of this labour force is employed at or near timber source - the forests. Thus, it brings

the rural population into the regular employment sector helping to arrest the perennial problem of rural - urban, migration.

It is estimated that the forestry sector contributed 5.5% to the Gross Domestic Product in 1978 (FAO, Worldwood, 1982). Wood products provide the third major export item by value in the country's external trade (Central Bureau of Statistics, December 1981). In 1978, it accounted for 6.6% of all exports (UN, 1982). Between 1970 and 1980, the forestry sector contributed 8.622% of the total exports amounting to \$689.564 million (Table VIII).

A number of local wood industries depend upon large volumes of wood feedstocks. Table IX gives a list of these industries and their wood requirements in 1981. These were wholly supplied from within the country. Ghana maintains a self-sufficiency in sawnwood, veneer, plywood and blockboard unlike 34 African countries importing sawnwood and 36 others importing plywood and blockboard (FAO, 1981).

Local wood-utilising industries including building, general construction and furniture to

TABLE VIII: Ghana's Forest Exports Compared with Total Exports, 1970-1980 (millions of US dollars in current prices)

YEAR	FOREST PRODUCTS ¹	TOTAL EXPORT ITEMS
1970	39.286	427.0
1971	36.730	334.6
1972	51.095	384.3
1973	123.938	585.0
1974	34.121	679.0
1975	74.620	801.0
1976	70.978	779.1
1977	72.355	889.6
1978	58.790	892.8
1979	42.038	1066.0
1980	35.613	1159.4
TOTAL	689.564	7997.8

¹ FAO, 1981 Yearbook of Forest Products

² UN, International Trade and Development Statistics, 1982.

TABLE IX: Local Wood Industries (Wood) Demands in 1981

INDUSTRY TYPE	NUMBER	VOLUME(M3)
Sawnmills	157	218,000
Veneer	11	20,000
Plywood and Blockboard	13	67,000
Particle Board	1	6,000
TOTAL	182	311,000

SOURCE: FAO (Worldwood Review), August 1982

TABLE X: Sawnwood Production, 1970-81
Quantity 1,000 Cum.

YEAR	PRODUCTION	EXPORTS	SURPLUS FOR LOCAL USE
1970	359	241	118
1971	340	186	154
1972	348	250	98
1973	370	305	65
1974	453	169	284
1975	398	165	233
1976	316F	139	177
1977	316F	103	213
1978	316F	84	232
1979	316F	80	236
1980	316F	70	246

TABLE XI: Plywood and Blockboard Production, 1970-80
Quantity 1,000 Cum.

YEAR	PRODUCTION	EXPORTS	DIFFERENCE
1970	33	22	11
1971	41	12	29
1972	49	17	32
1973	53	47	6
1974	59	16	43
1975	40	18	22
1976	59	17	42
1977	47	2	45
1978	40	1	39
1979	40F	2	38
1980	40F	1	39

F: FAO Estimate

SOURCE: FAO, 1981

mention a few, are adequately supplied with processed wood after export demands have been met. Tables X and XI show that progressively a larger proportion of wood products have been retained in the local economy. One major cause is a booming local market for processed timber particularly sawn lumber and plywood so that producers prefer to sell most of their products on the local market. This was also aided by the official exchange rate of the Cedi which made the export prices very low compared with local prices in the wake of an export duty up to 30% to be paid (Central Bureau of Statistics, 1981).

The furniture industry, a major wood user, after satisfying home demand, made US 1,629,000 dollars in foreign exchange - about 0.17% of total exports - in 1978 (UN 1982). The Kade match Factory also uses considerable amount of wood for its match sticks and boxes.

(ii) Optimal Environment for Crop Farming

As a primary producer and a net exporter of agricultural products, Ghana relies on her forests for the optimal environmental conditions needed for

cultivating such tropical crops as cocoa, coffee, kola nuts, rubber, bananas, palm oil and palm kernels. Kola nuts may still be collected wild in the forests in addition to cultivated ones. The tree Funtumia elastica and the Landolphia vine which grow wild and found in Ghana's forests provided a major export item in rubber since the 1880s until the *Hevea brasiliensis* or para rubber was introduced as an exotic from Brazil to be grown in plantations on a wider scale.

The present economy is mainly based on cocoa. It contributes about 12 percent to the Gross Domestic Product, employs about 17% of the country's labour force and yields over 60% of foreign trade receipts (Central Bureau of Statistics, 1981). In 1978 cocoa alone earned 739.387 million US dollars (about 75.56%) out of a total export of US 978.607 million dollars (UN, 1982), cocoa and the other crops noted above grow only in the forest region.

Similarly, much of the subsistence crops come from the forest. This zone has less variable climate and a relatively nutrient - rich soils, a result of decomposition and mineralisation of a high and constant volume of forest litter.

(iii) Energy Source

Woodfuel is the cheapest and commonest source of domestic energy. The country lacks coal or any large petroleum deposits. Electricity serves mainly the major urban centres, constituting less than 29% of the population. With a limited generating capacity of 1,160,000 kw and a per capita of 289 kw in 1982 (US State Department, 1983) the bulk of the nation's energy needs lie on wood energy.

Fuelwood provides almost all the energy for cooking and heating in the rural areas. In the urban centres, charcoal is predominantly used because it is easier to transport, cleaner to use and takes less storage space.

Several cottage industries depend upon wood energy. Fish curing, a major means of fish preservation in the country, depends upon fuelwood. Local distilleries, brickworks, potteries and tobacco curing also derive their main energy source from it. Charcoal making is now a lucrative business in the middle belt of Ghana, principally occupied by the woodland (Fig. IV).

The mines used wood as a source of energy in their early operations to power machines. The railways also used wood energy. The Opon Mansi iron and steel complex to be operational soon may be utilising a projected 120,000 tons of charcoal per annum for energy.

It is estimated that wood is consumed as energy at a per capita rate of 1 m³ of fuelwood and 0.2 m³ of charcoal (FAO, 1982). Use of wood for energy purposes is estimated to be greater by far in volume than for timber purposes (Table XI). However, it is difficult in the Ghanaian context, to arrive at precise values of wood used as fuel. Admittedly, there is no machinery in existence to keep records of use. Even if this were so, it would be difficult to monitor. In the rural areas much of woodfuel does not enter into the monetary economy and the rate of illiteracy is relatively high (to keep documentary records). Thus, data on wood energy may be imprecise as it may be based upon some arbitrary criteria. Despite this fact, various estimates provide an insight to the dimension of use of woodfuel. Foggie and Piaseki (1962) estimated an annual woodfuel consumption of about 6 million m³ - 4.5 million m³ as

firewood and 1.5 million m³ as charcoal. UN (1983) estimates between 1969 and 1980 show the magnitude of use of fuelwood and charcoal (Table XII).

Fuelwood is produced throughout the closed forest region but is a speciality in the southern marginal and south-east types. These zones are nearer large centres of population concentration. The trees are generally not suitable for timber use. Considerable firewood and charcoal are also produced in the woodland belt. Here, the hard and coarse-grained trees produce quality charcoal which are distributed to the main urban centres as far as the Accra-Tema Metropolitan area. Woodfuel is a relatively reliable source of energy which is easily obtainable and can be produced on a renewable basis.

(iv) Other Uses: Poles Production

The mining industry depends upon the forest sector for all its pit-prop needs. It is estimated that 306,000 m³ of pit-props were produced between 1969 and 1981 (FAO, 1981). Posts for building and fencing, for utility transmissions principally electricity and telephone, are all derived from the

TABLE XII: Fuelwood and Charcoal Production, Compared with
Production of Industrial Roundwood, 1969-81¹
(1,000 m³)

YEAR	FUELWOOD AND CHARCOAL ¹	INDUSTRIAL ROUNDWOOD ²
1969	5,085	1,922
1970	5,206	1,920
1971	5,345	1,691
1972	5,502	1,979
1973	5,672	2,476
1974	5,352	1,841
1975	6,038	1,708
1976	6,229	2,519
1977	6,425	2,519F
1978	6,630	2,519F
1979	6,840	2,519F
1980	7,085	2,519F

- ¹ 1981 Yearbook of World Energy Statistics, UN New York, 1983
² FAO Yearbook of Forest Products, Rome 1981
 F FAO estimate

TABLE XIII: Bushmeat record for the Kantamanto Market,
Accra, Ghana (December 1968-June 1970)

SPECIES	WEIGHT (KG)	WEIGHT PER SPECIMEN (KG)
Grasscutter (<i>Thryonomys</i> spp.)	117.226	4.8
Grey duicker (<i>Sylvicapra grimmia</i>)	26.406	6.7
Bush buick (<i>Tragelaphus scriptus</i>)	4.225	22.5
Royal antelope (<i>Neotragus pygmaeus</i>)	3.682	2.4
Black duiker (<i>Cephalophus niger</i>)	3.498	15.8
Green Monkey (<i>Cercopithecus aethiops</i>)	1.055	3.2
Bay duiker (<i>Cephalopius dorsalis</i>)	701	4.2
Bush pig (<i>Potamochoerus porcus</i>)	561	26.7
bush-tailed porcupine (<i>Atherurus africanus</i>)	357	3.6
Giant Rat (<i>Cricetomys gambianus</i>)	121	1.6
Monitor lizards (<i>Varanus</i> spp.)	92	4.2
Two-spotted palm-gvet (<i>Nandinia binotata</i>)	47	3.1
Togo hare (<i>Lepus capensis</i>)	8	1.7

SOURCE: Asibey (1974)

FIGURE IX: Christian's Stress Hypotheses

SOURCE: Robert Leo Smith (1980)

- Palm wine, a local beer of immense attraction is tapped from the palm tree, a forest product. Chewing stick is used as a tooth cleaning device. It is generically termed "tweapea". The most popular source comes from the wood of the Garcinia spp. Several other species can be used.

(vi) Game and Wildlife for Food

Ghana is not a noted meat producing country. Overall protein per capita per day in 1977 was estimated at 45.1 grams (U.S. State Department, 1983). Foreign exchange constraints and poor fishing and livestock industries make game, a major protein source. Antoon de Vos (1977) has noted that wild animals provide the greater proportion of locally produced meat; in some localities as much as 73% of all meat produced may come from this source. Asibey (1974) has also observed the importance of wildlife as a major protein source for about 75% of the population. His studies showed that in only one market in Accra, a total of 157,809 kg of bushmeat from 13 species of animals was sold between December 1968 and June 1970 (Table XIII)./

Game meat is commonly termed "bushmeat" in the country. A number of them that can be produced both in the forest and the woodland are utilised as food.

There is also a modest receipt of foreign exchange. Exports of 14,400 parrots (80% of birds and animals exported) between July, 1973 and June 1974 were valued at 10,800 pounds sterling (Ghana, 1977).

(vii) Tourism, Recreation and Others

Wildlife as a major forest resource may act as a tourist attraction. Sport-hunting, bird and animal watching attract large number of tourists to wildlife parks especially the Mole Game Reserve (Fig. VIII). Wildlife reserves were originally located mainly in the woodland belt. A number of them are now springing up in the forest region. Scenic attractions like waterfalls, scarp-faces, botanical gardens and spectacular rivers are mostly in the forest region or the boundary with the other vegetation zones.

Overall use of forests for recreation purposes are very limited. It is expected that with possible

FIGURE VIII. National Parks, Game and Wildlife Sanctuaries

future increase in disposable incomes, leisure time, education and population, demand for forest space for recreation purposes may increase.

Minor uses of the forests such as source of bathing sponges, ropes and strings, kapoks, medicinal plants, edible wild fruits and nuts provide a major help to the rural populations.

• It is almost impossible to catalogue or estimate the benefits of the forests. Ranging from religion to economics, they are central to the nation's independence, identity and existence.

2.4 ANALYSIS OF PROBLEMS ARISING OUT OF THE USE OF THE FORESTS

Changes in the environment may be brought either through natural or human causes.

Natural fires, volcanic eruptions, earthquakes, flooding, pests and diseases, violent climatic changes are examples of natural factors that may cause environmental change. These factors, however, have been part of the processes in the natural environment since evolutionary

history. Organisms have developed adaptive mechanisms to counter their effects. Sometimes too negative natural factors may act as (natural) regulatory measures to avoid crowding on a limited carrying space and food resources. There have been oscillations in the population of organisms and where human intervention has been absent, a balance is usually maintained in the long run. Christian's stress hypothesis of population regulation (Fig. IX) expresses such a mechanism.

, Both plant and animal populations may react to stress in the environment. When natural fires devastate a forest stand, a new succession of plants may develop and if left undisturbed may attain the original form. A living example is provided on the island of Krakatoa.

There is no doubt certain extreme negative impacts may be left in the environment through natural processes. In most cases however, changes through these means have not been continuous or widespread. Large scale use of the environment by people has hastened destruction. Since people cannot be divorced from the environment, changes become real and alarming. An FAO report in 1968 stated that the disappearance of forests since the last ice age has not been due to any climatic phenomenon but caused mainly by the

FIGURE IX: Christian's Stress Hypotheses

SOURCE: Robert Leo Smith (1980)

action of humans. (FAO, 1968) In Ghana, most of the major alterations that have occurred in the forest environment can be traced to human use either directly or indirectly.

Even though historical sources put the peopling of the country by present ethnic groups to periods between 700 and 1,000 years past (Boateng EA, 1966), evidence from archaeological sources indicate that the forest zone has been occupied and used for many thousands of years. Carbonised remains of foodplants such as cowpeas (Vigna unguiculata), hackberry (Celtis spp) and oil palm (Elaeis guineensis) have been found at Kintampo (now in the ecotone of the semi-deciduous and the woodland - Fig. Vi) with radio carbon date to around the early to the middle part of the second millennium B.C. (Anquandah, 1982). There are strong indications that these may be cultivated crops. Anquandah (1982) has also reported that a number of sites, mostly in the Akan inhabited areas (the forest region) have produced evidence of large concentrations of what has been described as stone hoes dating to the later stages of the stone age used probably as farming tools. The same source also contends that archaeological records have shown proto-urban development in the forest region particularly in the Brong Ahafo by 11th Century A.D. It should also be noted that, before the

arrival of the first Europeans (Portuguese) in the 15th Century, powerful forest kingdoms including Adanse, Asante, Akim, Wassaw-Aowin and Fante had come into existence. These states became principal trading partners of the early European traders. What a period of long occupation means is that these people may have used the forests for their existence. Through use they may have caused or set the pattern for the degradation of the forests by future generations.

(i) Destruction (Degradation) Agents: Agriculture

Agriculture is by far the single most important source of destruction of the forests of Ghana. During the long era of low population densities and a subsistence economy based on collection and rudimentary cultivation, very little impact was left on the forest ecosystem.

With shifting cultivation system, primitive tools were used. Only small patches of forest could be cleared at a time usually below 0.4 hectares. Simple tools like the digging stick, the hoe or the cutlass, scarcely disturbed the top soil. Surrounding uncleared forests and mixed cropping protected the soil from accelerated erosion. Large trees were

usually left standing because tools could not fell them or that they provided shade for some crops. With very minimal pressure on land both settlement and farms shifted according to the dictates of soil fertility. Farmed land could be left fallow for periods exceeding twenty years in certain locations for natural regeneration. Considering the fact that even by the 1960 population census parts of the south-western forest region (Fig. X) had densities of less than 20 persons per 2.6 km² the system may have operated for a long time. Forests could have time to regenerate and it is possible most of the present primary forests may actually be secondary forests.

Rapid increase in population and the introduction of a monetary economy, has led to a breakdown in the shifting cultivation system. Foreign advanced technology has replaced simple means of cultivation.

It is difficult to give any accurate population figure for the country until 1891 when the first official census was taken (Table XIV). But it is believed that poor sanitary and health facilities, frequent and deadly inter-tribal wars and the slave trade may have kept populations down considerably.

FIGURE X. Ghana-Distribution of Population - 1960

Adapted from E.A. Boateng : 1966

In 1853, the population of southern Ghana was estimated to be 253,000 (Hall and Swaine, 1981). The greatest increase in population occurred between 1891 and 1960 when the population jumped from 764,185 to 6,726,800. The forest region, by 1960, recorded densities of up to 400 persons to 2.6 km² (square miles) in several areas (Fig. X). Increasing populations mean high demand for food and fibre and this invariably puts a stress on the land - the forests.

Forest subsistence farming in Ghana is mainly of the bush-fallowing system. Unlike shifting cultivation, settlements are fixed with farmlands rotating. Because of increasing population and increasing pressures on land, fallow periods have been cut considerably low to less than 7 years in such heavily farmed areas as Swedru-Bawjiasi-Nsawam, Kwahu plateau, Asesewa-Bisa (Fig. VI) and several other areas in the forest region. The bush fallowing system employs very little or no soil improving facilities like chemical fertilisers. Other farm inputs like herbicides, irrigation facilities or farm machinery like tractors are also scarcely used in the forest region. Productivity is based on the inherent fertility of the soils, the mercy of the weather, the size

of the farm and the skills of the farmer. High frequency of use of same lands have led to serious soil deterioration since natural fertility regeneration has been undermined. Secondary regrowths in most of the heavily farmed areas are unable to support new forest vegetation. In the dry semi-deciduous zone, vegetation deterioration has resulted in a derived savanna replacing the original forests in areas like Mampong Ashanti-Ejura-Wenchi, Asesewa-Bisa, Swedru-Nsawam. A few fire resistant trees stand as relics of the original forests.

Another direct threat of subsistence farming is the perception or belief that new forests are inherently rich. There is therefore continued pressures on remaining forests even those in reservations. Forests in the present reserves are in the most precarious situation. They are mostly on hilly sites with shallow soils that deteriorate fast after two or three years of use under the high tropical rainfall. This fact was confirmed after the government released large tracts to farmers between 1973 and 1977. A survey by the cocoa division of the Department of Agriculture (now ministry) estimated that 4.8% of the forest lands were under food crops in 1955. This did

not take account of lands under fallow. It is believed that the area actually cultivated at any one time is usually less than 10 percent of the total fallow area (Foggie, 1962). Dickson (1969) estimates that food farming has destroyed 30044.9 km² of forest since 1894.

An absence of quantitative evidence and a purposeful scientific study together with the complexity of environmental processes make any objective analysis of the effects of subsistence farming on the forest ecosystem, difficult to make. It is an accepted fact however, that it is the fastest destroyer of forest stands. It is also believed that the regimes of forest streams have been altered. Several perennial streams are now seasonal or have had their beds run dry for several years. The fact that most of the rivers in Ghana have their headwaters in the forest region means that a destruction of watersheds may have a long term country-wide effect. The effects of water shortages began to be markedly felt in 1982-83 when increasing low level of most rivers and the great Volta Lake affected power production and industrial and urban water supply. Food crop farming is

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by their canopies. However, they carry other environmental effects. They have altered the habitats of wildlife, particularly the browsing animals that need a dense herbage. The use of insecticides, herbicides and pesticides have also affected non-targeted organisms and have resulted in the extinction or migration of delicate wildlife.

The role of agriculture as a destructive element to forest ecosystems in Ghana is proved by the fact that of the total area of 82,576 km² of the closed forest region, cocoa food farms and bush fallows had taken up 62,587.2 km² by 1977 (Ghana, 1977).

(ii) Logging

Dickson (1969) observed that timber logging did not itself cause any alteration in the appearance of the forest since exploitation was confined to a few species which are scattered. Recent studies have shown that logging has both direct and indirect effects on forests. Hall and Swaine (1981) have noted that even though selection felling seldom extracts more than 2 trees per hectare, many trees are destroyed in the process of tree fall. In

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another study by Mensah (1966) it was found out that 10% of established trees were damaged after selection felling in a 77 hectare area of forest. Young trees and saplings are generally damaged. With total annual timber production averaging about 1.85 million m³ since 1958 such direct losses may be considerable.

Indirect causes may also have untold effects. Timber access routes directly lead to a destruction of considerable forest stand. The access routes have been followed by farmers to previously inaccessible areas. Timber camps with an assemblage of haulage trucks and workers have resulted in mass trampling right in the middle of forests. Trampling leads to soil compaction and its associated effects of poor water infiltration, damage to micro flora and fauna. Large stands of forest space are also cleared for the camp and usually camp activities may extend beyond marked boundaries for further damage to the forest ecosystem.

Logging may create gaps in a previously well structured tropical rainforest with adequate surface cover. Such poorly-covered spaces in the forests are

exposed to erosion from torrential rainfall sources. With much leaching and subsequent nutrient loss, these areas may support lower quality vegetation in an otherwise rich forested area.

Run-off from logged areas may result in the sedimentation and eutrophication of water bodies. A careless disposal of logging wastes in water channels may disturb their normal flow, add more organic matter and disturb aquatic life. Logging wastes that are not disposed of efficiently may pose a fire hazard when dried. Such negative impacts associated with logging are common in most areas of the forest region.

(iii) Woodfuel

As the major source of energy for the majority of the rural population (about 71% of the total population), the use of woodfuel has a major effect on forest status. FAO estimates for 1980 alone gave a production figure of 11.5 million m³ of fuelwood and 950,000 m³ of charcoal. The effects of wood energy may have been more damaging if the forests constituted the only source.

Fuelwood can be derived from several sources in addition to direct cutting of live forest trees. Pieces of wood from wood mills, old wood fences and other wood structures may supplement urban needs. It is also collected on cleared farms. Traditionally, in the forests, it is the deadwood that is taken. All other non-forested vegetation types also yield large amount of wood for fuel.

Increasing demand for wood is however directly affecting forest stands of late. Prices of kerosene, an alternative home energy source continue to escalate while woods surrounding large centres appear to have been over-exploited. Wood contractors (a recent innovation) mostly from the urban centres, have entered into the supply scene to supplement the informal supply sector. Such contractors pay high prices for live trees and process them for the urban market. Their sphere of activity has extended to greater distances into the rich forests. They are more mechanised and have the necessary transport facilities to reach the product and the far away markets. From the forest reserves alone, the Forestry Department has estimated an amount of 5,000 m³ are being taken annually.

Woodfuel scarcity particularly holds a dangerous threat for the forests. As most settlement fringes including rural have been so degraded, the normal range of fuel gathering by women and children (main wood gatherers) is widening to distances of over 12 kilometres from settlements. Thus, while wood contractors are pushing fast into greater distances within the forest, the traditional collectors are also moving away from the normal range of wood harvesting which usually did not extend beyond 10 kilometres from settlements due to the high cost of transporting wood from longer distances (a result of low recoverable energy in relation to bulk). In a desperate attempt to collect wood to keep the household running, women and children take anything including very young growing trees or sometimes remove whole branches from standing trees to leave them dying. This may be done several times in a week.

(iv) Transportation and Utility Transmission

As the hub of extractive activities - mining agriculture and logging, the forest region, has the highest density of road and rail systems. More than

50% of the country's 32,000 kilometers of roads are found in this zone. Damage to forests are therefore considerable.

It is reported that in 1907, about, 1,500 trees were felled along a distance of 14.4 km on the railway line between Kumasi and Eduadin. Near Obuasi (Fig. XI) alone, 760 trees are estimated to have been cut. There is a total of 953 kilometres of railroad almost all in the forest region. Each side of the track is cleared at least to 10 metres away. Dickson (1969) has noted that fuel supply to railways required estimated forest area of about 10360.3 km².

Rights-of-way for utilities also take a considerable amount of forest space. Power from the Volta Hydro-electric project sited at Akosombo (Fig. XI) alone serves southern Ghana (mainly the forest region) on a grid totalling 808 kilometers. This is estimated to cover about 41047 hectares mainly of forests. A network of telephone lines, watermains and underground cables have all aided in destroying prime forests. As a major area of population concentration and centre of economic activities, the forest region benefits to a greater extent from such utilities.

FIGURE XI. Ghana, Major Mining Centres
and Lines of Transportation

(v) Mining, Other Development Projects and Urbanisation

Ghana is rich in several mineral resources. These are actively exploited in several parts of the country virtually all in the closed forest region (Fig. XI). Mine sites, camps, dumps and infrastructure have caused a destruction of forests. Strip mining of manganese, bauxite and diamonds has left irreparable scars on the forest landscape. Mine fuel and pit-prop needs are estimated to have accounted for about 906.5 km² of forest loss (Dickson, 1969).

Large development projects notably the Volta River Project have also altered the forests. The artificial Volta Lake covering an area of about 8,502 km² has flooded valuable forests and woodlands. Six forest reserves are reported to have been lost to flooding in the Afram and pawnpawn valleys (Fig. VI) in the southern section. It displaced about 80,000 people and these have been resettled in 52 new townships mostly in the closed forest zone. Here, they are expected to continue their agricultural and other activities on the land. Other dams like the Barekese near Kumasi (Fig. VII), have also flooded forest lands.

Urbanisation also takes a major toll on the forests. Apart from the narrow coastal belt in the south of the country, the forest region is the most urbanised. Such a high degree of urbanisation has resulted in uncontrolled encroachment on rich forest stands to serve housing and other urban-related needs. Large centres including Kumasi (second largest city), Sunyani, Obuasi, Akim-oda and Koforidua (Fig. XI) are growing at alarming rates. Even though urbanisation does not constitute much of the total closed forest region, any comprehensive study will reveal a distressing rate at which prime forests are being converted into urban landscapes. Once they come under concrete and asphalt, they are lost forever. Low density housing both in the rural and the urban centre also contribute to a great deal of degradation of the forests.

(vi) Fire and Others.

Recently, uncontrolled fires have been a major source of forest destruction. Reports indicate that most of these fires are caused through human activities. Camping, hunting, roadside burning by highway workers (a means of weed clearance), live

cigarettes left carelessly on flammable materials, farming and isolated cases of pure arson to mention a few have caused indiscriminate burning of forests. Ghana experienced her worst bush fires in history between November, 1982 and April, 1983. It is estimated that about 121,140 hectares of land including primary forests were destroyed by fires (Ghana News, 1983). Such fires were again reported in early 1984.

Fire has long been an environmental factor. However, with present increases in pressure on limited forests, they may not be allowed a healthy period of regrowth to maintain their ecological balance. In addition, importation of exotic tree seedstocks has resulted in diseases adding to endemic pests and disease problems.

2.5 THE SCENARIO

There is every indication that Ghana's prime forests are disappearing. A total deforestation rate of about 45,000 hectares per annum for the period before 1976 and 22,000 hectares per annum for the period 1981-1985 has been estimated by FAO (FAO, 1981). The bare fact is that of the

TABLE XIV: Ghana-Population 1891 to 1970

<u>YEAR</u>	<u>POPULATION</u>
1891 ¹	764,185
1901	1,548,945
1901	1,502,286
1921	2,296,400
1931	3,160,386
1948	4,119,450
1960	6,726,800
1970 ²	8,559,313

¹ Does not include Ashanti and Northern Region

² Population Census, 1970

SOURCE: Boateng, 1966

TABLE XV: National Parks (NP), Game Production Reserves (GPR) and Wildlife Sanctuaries (WS) Within the Forest Zone Administered by the Department of Game and Wildlife

	<u>RESERVE</u>	<u>AREA (km²)</u>	<u>DATE OF FIRST ASSIGNATION TO DEPARTMENT OF GAME AND WILDLIFE</u>
1	Ankasa GPR	348.7	1976
2	Bia NP	227.9	1974
3	Bia NP	77.7	1974
4	Bomfobiri WS	50.0	1976
5	Nini-Suhien NP	174.5	1976
6	Owabi WS	14.5	1971
7	Shai Hills GPR	54.4	1971

SOURCE: Hall and Swaine, Geo Botany, 1981, 328.

illusory total closed forest zone of about 82,756 km² in area, only 19,988 km² remained as true forests by 1977 (Ghana, 1977). Out of this, only 3,135.6 km² was unreserved land which could be utilised for farming and other purposes. Assuming the estimated deforestation rate of 22,000 ha per annum could be applicable by 1978, Ghana has only $\frac{3135.6}{22,000/100}$ years or 14.25 years (1992) to finish with her unreserved forests if such use trends continue.

Once the unreserved forests have been completely destroyed, those in reservations may come under extreme pressure. The discrepancy in the rate of utilisation between the period before 1976 and the 1981-85 estimate above can be explained in part by the non-availability of large areas of free forests by that period. It means that increasingly, a relatively smaller area of land is available for individual use. If the reserves are declared free, use may escalate to the pre 1976 levels considering the rapid increase in population (2.7 to 3.0 per annum) and the teeming demand for forest-based products. The forests could be historical facts by the second decade of the 21st century.

By 1981, Ghana had a commercial forest volume of only 4.4 million m³ with a per capita annual wood consumption of

purpose. It should be remembered that any one type of reserve can serve most or all the purposes mentioned.

The department has managed to meet its original target of putting about 15,540 km² (approx. 6,000 sq miles) of the closed forest zone under reserves. By 1977, reserves covered an area of about 16,853.2 km², constituting approximately 84% of total remaining closed forests and 20.36% of the closed forest zone (Ghana, 1977). They contribute an average annual log output of not less than 60%. In 1977 and 1978 combined, log output from the reserves amounted to 80% of (Central Bureau of Statistics December, 1981) total output.

In the savanna woodland, an area of 8,840 km² were under reserves by 1977 also providing protection and production requirement. Major contributions from the forest reserves underscore the importance of the strategy for resource protection.

Other Reserves

A new system of reserves where economic exploitation may be excluded has been a later development.

rapid depletion of merchantable timber. Lack of machinery did not prevent the country from producing one of her highest records of timber exports as far back as 1913.

Complete deforestation will make Ghana vulnerable to the spread southwards of the Sahara desert. With an equally frightening rate of destruction of the woodland belt, estimated at between 20,000 and 30,000 ha per annum for the period 1981-85 (FAO, 1981) desertification may provide a great threat in a matter of decades.

Pressures on the existing forests may cause considerable damage to the natural ecosystem. Certain changes in the pattern of rainfall has been observed. Since it takes a long period of time for climatological data to be assembled, the effects of deforestation on rainfall patterns are not certain yet. However, droughts and long periods of dry season which were unknown in the forest region are becoming a matter of fact in recent years. Some wildlife and organisms may also go completely extinct with the destruction of their forest habitats.

2.6 SUMMARY

The chapter provided an examination of the forests including their extent, species composition and utilisation potentials. A general role of forests for both environmental and human requirements was also presented. In addition a comprehensive analysis of their uses (in Ghana) and problems arising out of their uses was made.

In the main, the chapter provided evidence that the forests are disappearing fast. Ironically, it also established that they (forests) are very important to all spheres of life in the country. Rapid loss of the forests requires that in the interest of a harmonious environment, the present human population and generations unborn, measures have to be devised to arrest the situation. In chapter three, various attempts that have been designed to meet the threat of forest loss are examined and evaluated.

CHAPTER 3. MANAGING THE FOREST RESOURCES

3.1 HISTORICAL INTRODUCTION

In the past, conditions did not exist in Ghana to call for a rational use of the land resources particularly, the forests. Populations were small and a vast expanse of the country remained uninhabited even to the end of the 19th century. There were no real pressures on resources to aggravate a feeling of scarcity. At best, the dense forests were one of the marks of the "primitiveness" of the people and when opportunities became available for their large scale exploitation, they were to be cut without regard to natural processes to provide for rapid development. Such feelings may have accounted for the virtual absence of indigenous naturalists or conservationists amongst the early educated elite to help create the necessary awareness for the consequences of resource abuse. To the contrary, the elite were to spearhead vehement opposition to central government conservation drives in its formative years and to shape the course for a poor public reception to resource management in the country.

(i) Traditional Contributions

Despite poor local efforts, ancient traditional customs and practices helped to maintain forests. As a traditional practice in most Akan societies in Ghana, burial grounds for chiefs and royalty which are mainly wooded are strictly out of bounds to the general public. Sacred Fetish groves for religious worships were also strictly out of bounds except to the appropriate priests and immediate assistants. Most fetish groves were usually strategically sited on common sources of water, hill summits or on steep slopes providing "accidentally", beneficial ecological protection as well. Severe sanctions, sometimes death penalties accompanied the violation of entry restrictions. Through such means, the forest ecosystem was little disturbed.

Other means of traditional protection of forests also stemmed from the use of specified areas to bury people who died through unnatural causes - accidents, suicides and childbirth. No traditional rules barred entry into these areas but superstition and fear served that purpose.

Traditional practices that benefited forest protection, were not meant originally for that purpose. They however helped to prevent a complete loss in the most heavily populated and long settled areas of the country particularly near the coast west of Accra and the Central and South Eastern forest zone. In the Savanna region of the north, fetish groves have persisted as "islands" of dry forests, a factor that helps to identify the original vegetation cover and the extent of degradation. Most of the traditional reserves provided a basis for the government reservation programmes in the 20th century.

Traditional customs and practices could scarcely have maintained a larger area of the nation's forests if organised and purposeful management had not been instituted. Traditional "reserves" were unscientifically selected, objectives were limited and their persistence depended upon the existence of a tribe and the extent to which rules could be enforced. Most of the traditional religious "reserves" were also undermined by the advent of Christianity which declared practices leading to their creation, satanic.

(ii) Central Government

By the 1880's gold mining, timber cutting and agriculture had become major economic activities. Private land speculators from Great Britain (mostly) and Ghana (Gold Coast) were acquiring with relative ease, lands from chiefs, the traditional custodians. A series of disputes over concession lands and the expansion of the timber trade in the 1890s, necessitated some level of control. The first attempt to regulate forest exploitation was made in 1883 through the Native Jurisdiction Ordinance. This empowered chiefs to make bye-laws to preserve forests in their areas but unfortunately none of them did so (Kimble 1963).

By 1894, the need for forest protection had become so acute that governor Brandford Griffith proposed a bill "that would prevent the lands ... falling into the hands of concession mongers for a bottle of rum or a case of gin" (Kimble, 1963: 334). This was the famous Crown Lands Bill of 1894 which was "to vest wastelands, forest lands and minerals in the Queen". The bill also had the objectives of

controlling further exploitation of timber and mineral resources and safeguarding existing grants and concessions.

The lands bill was fiercely fought by the Gold Coast (Ghana) intelligentsia manipulating the support of the chiefs and backed by the Chambers of Commerce in London, Liverpool and Manchester. It was dropped in 1895 and a subsequent one drafted in 1897 was also "killed". One can understand the great concern raised in local circles since it was thought that the government wanted to take forcibly, all lands belonging to the chiefs and the people. Similar problems had arisen in East Africa and the natives (in Ghana) were in no compromising mood to let this happen.

Governor Maxwell (Governor of Ghana in 1897) believed that the opposition was mainly to safeguard the interests of Ghanaian land speculators. A source cites Jacob Wilson Sey, the President of the Aborigines Rights Protection Society (the group formed to oppose the lands bill) and Brew, another leading member, as having had interests in the Gold Coast Native Concession Co. Ltd. of 1882. The same source cites J.P. Brown, Vice President, as one of the

leading Africans who had helped to negotiate the Adansi Concession which later came under the Ashanti Goldfields Corporation (Kimble, 1963). The chambers of commerce of England also had members who held most of the lucrative concessions and thus may have supported the local opposition basically to protect their economic interests. One cannot agree in entirety with Governor Maxwell's view or other similar views on Ghanaian opposition to the lands bill. Whatever the economic interests, there were genuine fears that the lands may be lost to the natives. The average citizen did not foresee any reckless destruction that necessitated government controls. Whatever it stood for, conservation, like the colonial government, was alien and was not to be forced on the people; so went the reasoning.

Opposition to the government's attempt to manage the forests did not dampen efforts to meet this goal. In 1907, a timber protection ordinance prohibiting the cutting of immature trees was passed. In 1908, H.N. Thompson the conservator of forests in southern Nigeria was invited to assess the forests and make recommendations about their management. He proposed the passing of a forest legislation, the establishment of forest reserves and the issue of property

marks to timber operators. He also recommended that a forestry department functioning with an appropriate forest policy be created (Forestry Department of Ghana, 1982). A forestry department was accordingly established in 1909 with a Mr. Mcleod as the first head.

A forestry bill in 1911 which would enable the governor to set up forest reserves over lands unoccupied and uncultivated, was again fought and killed subsequently by the local people led by the Aborigines Rights Protection Society. The forestry department closed down at the outbreak of the First World War and reopened again in 1919. In the interim, Nana Ofori Atta Chief of Akim Abuakwa took the most unprecedented move of being the first chief to publish bye-laws in 1915 to control deforestation in his traditional area. They prohibited cultivation of cocoa and food crops on all outstanding hills and a list of forest trees that might not be felled without permission was also compiled (Dickson, 1969). When the forestry department re-opened in 1919, more appeals went to the chiefs to voluntarily put lands under reservations. The department itself embarked upon extensive surveys to select, demarcate and

constitute reserves. The slow rate of voluntary reservation and the rapid rate of forest destruction particularly through cocoa cultivation made a reservation bill a matter of urgency. This happened in 1927 when a forest ordinance was passed. A forest policy which has scarcely changed over the years came into being to help check forest degradation.

The forest ordinance of 1927 made the forestry department the main manager of the country's resources. The game and wildlife department at this stage remained an integral part of the forestry department. (The game and wildlife department attained an independent departmental status in 1965). In March 1980, an act of Parliament established a Ghana Forestry Commission "with the responsibility for the regulation and management of the utilization of all forestry and wildlife resources (Forestry Department, 1982). The forestry department, game and wildlife department, the Ghana Timber Marketing Board and Forests Products Research Institute came under its jurisdiction.

No meaningful analysis of conservation in Ghana can be made without such historical traces since it

3

may help give a clue to what exists now, what should have existed and what should be done.

3 . 2 CONSERVATION IN ACTION

Any comprehensive analysis of conservation in the country has to consider the complexity of the forest ecosystem which invariably demands complex activities usually going beyond the forest environment for good results to be attained.

To be expected, several departments may be connected in one way or the other with forest conservation in Ghana but the major institutions are supposed to be the four components of the Forestry Commission. Practically however, the forestry department is the single most important agency charged with forest conservation in the country whilst the department of game and wildlife complements its activities. These two public agencies seem conspicuous in the conservation process perhaps because of a narrow emphasis on the land-base aspect of forest management. The Forest Commission is yet to organise itself to break this characteristic.

3.2.1 Conservation - Land Based

There is no doubt that any mention of Forest Conservation falls into the domain of the Forestry Department. It is the department directly charged with the management of the forest environment. Its functions are performed through its general secretariat (headed by the chief conservator of forests), General Forestry Conservation Services, Training Branch, Planning Branch, Utilization, Research and Extension Branch and the Public Relations Unit. The department operates under the Government forest policy which requires:

- (a) the creation of sufficient permanent forest resources by reservation to supply direct and indirect benefits necessary for the welfare of the people of Ghana;
- (b) the management of these resources by methods that will achieve sustained maximum productivity and value;
- (c) research necessary to achieve management objectives;
- (d) effective public relations and public education aimed at creating a rapport as the basis for improving the understanding of the populace of the necessity for and value of the nation's forests;

- (e) maximum utilization of forest resources not dedicated to permanent forestry;
- (f) manpower development;
- (g) cooperation with all agencies interested in optimum usage; and
- (h) the provision of technical advice (Forestry Department, 1982).
- (i) Reservations

Apparently, the most important conservation mechanism to be applied has been reservations. This is a major tool for resource protection in a situation of rapid loss. Certain areas may be declared legally protected either from absolute use or for certain limited purposes to guarantee the existence of needed resources for perpetual use.

An alternative objective for reserves has been reported by Shawki (1964) for the semi-arid regions of Sudan. Here, reserves may be selected where

FIGURE XII. Ghana - Forest Reserves

Sources: Forestry Department, 1958, 1960; Dickson, 1969; Survey of Ghana, 1973.

regeneration is possible while all non-reserved areas will be protected and completely freed from biotic interference.

Apart from the fundamental goal of managing resources from reckless use, a good reservation policy may be manipulated to serve several purposes. Traditionally, the reserves in Ghana have been managed for multiple benefits providing a wider range of environmental and economic functions. Environmental use of the forest reserves include the role of barriers to the spread of the savannas, shelterbelts for the production of humid tropical crops and for watershed and surface protection. Economically, the reserves provide timber, protein, fuel and agricultural needs.

There are no strict distinctions between the reserves as to particular functions. Timber for instance, may be harvested anywhere it is found including lands outside the reserves. Game and wildlife may be produced in any type of reserve. Basically however, location and terrain characteristics appear to give particular reserves or sets of reserves certain functions. The hill tops and steep

slopes have generally been maintained to protect watersheds and to check soil erosion. Logging may be excluded from this area partly because the removal of trees may result in the reduction of surface cover; hill tops are covered with thin soils and once the primary trees are removed, secondary growth may be impaired; due to poor site conditions, timber quality may be sub-standard and the steep slopes and rugged hill summits may generally be inaccessible to logging facilities.

The forest-savanna ecotone (Fig. IV) a dynamic area of landuse change provides threats for forest loss. Cultivation is intense, it is heavily populated, annual rainfall amounts are below 1,450 mm and increasingly unreliable and dry season wild fires provide a menace. This necessitates barrier reserves to protect the main rainforest region. A series of forest reserves have therefore been established to ring the closed forest zone (Fig. XII). Such important crops as cocoa, coffee, kola nuts, timber, plantain and cocoa yam need humid conditions to grow. Shelterbelt reserves have been established strategically throughout the closed forest region for this

purpose. It should be remembered that any one type of reserve can serve most or all the purposes mentioned.

The department has managed to meet its original target of putting about 15,540 km² (approx. 6,000 sq miles) of the closed forest zone under reserves. By 1977, reserves covered an area of about 16,853.2 km², constituting approximately 84% of total remaining closed forests and 20.36% of the closed forest zone (Ghana, 1977). They contribute an average annual log output of not less than 60%. In 1977 and 1978 combined, log output from the reserves amounted to 80% of (Central Bureau of Statistics December, 1981) total output.

In the savanna woodland, an area of 8,840 km² were under reserves by 1977 also providing protection and production requirement. Major contributions from the forest reserves underscore the importance of the strategy for resource protection.

Other Reserves

A new system of reserves where economic exploitation may be excluded has been a later development.

Under the multiple use concept of forest management the danger of certain species becoming extinct is real. There is also an increasing conflict in demands for forestry space and resources which makes multiple use unworkable under different circumstances.

In Ghana, the fear of a possible disappearance of certain ecotypes brought the need to preserve representative areas to ensure a genetic diversity on a permanent basis. Such preservations may have several long term benefits both to human and the environment.

They may serve as a store of potential resources from which future scientific research and technology may profit to serve human needs. It is of interest to note that the timber species, Afrormosia elata became important only after 1945 when it was realised that it could provide a good substitute for teak in furniture making. Ghana made her first exports in 1948 and by the 1960's it was the nation's best selling timber on the world market.

Preserving representative areas may provide a reference base for comparing and analysing changes

and direction of change of different ecosystems at different stages of time. Preserved areas may ensure the existence of vital species needed for the proper functioning of environmental processes. They may provide ideal conditions for educational or scientific studies requiring particular natural characteristics. For example, the study of animal behaviour can best be made in their natural setting than under captive or laboratory conditions. Areas may be preserved to serve for heritage purposes. Depending upon the level of protection envisaged, preserved areas may be used for recreation purposes to help ensure their perpetual existence.

The national parks are managed for recreation purposes while ensuring the protection of their natural state as much as feasible to benefit posterity. There are five major parks covering an area of over 10,381.21 km². The largest the mole reserve, covers about 4,929.6 km². The Digya (3,120 km²) and Bui (2,080 km²) like the Mole park are all situated in the woodland belt. The Bia and Nini-Suhien covering an area of about 252.2 km² are the only important representative areas of the closed forest region (Fig. VIII).

Even though the national parks are intended for recreational use, impacts of tourist visitations may be negligible for a long period of time. This is because almost all the parks are removed from heavily populated areas, are poorly served by access routes and are less advertised to attract potential users (perhaps with the minor exception of the Mole National Park). In addition to this, outdoor recreation is a poorly developed leisure activity among the average Ghanaian. Barring other uses, several of these national parks may maintain their natural state for a long time.

There is only one reserve under the strict nature preservation category: This is the Kogyae (strict nature) reserve near Ejura (Fig. XII). Human influence of any kind is excluded. It is maintained as a research reserve.

In addition to the non-exploited reserves, a new concept of game production reserves and wildlife sanctuaries has entered the conservation scene. The game production reserves are intended to provide meat. Within the forest zone, game production reserves are located in the Ankasa, Bia and Shai Hills reserves (Table XV).

Almost all the reserves covered by the National parks and the game and wildlife preserves were originally under the jurisdiction of the forestry department which later transferred them to the department of Game and Wildlife (Table XV). Thus, the department (of Game and Wildlife) even though not primarily responsible for forest management, by maintaining and protecting a natural habitat for game and wildlife for various purposes helps to preserve the forests as well.

All reserves are created by appropriate procedures. A suitable site or area is chosen with an objective or a set of objectives in mind. The area is demarcated, surveyed and mapped. After all claims to ownership have been settled by a Reserve Settlement Commissioner, the area is legally constituted as a reserve and gazzeted. It then comes under the forestry department or any appropriate agency like the Game and Wildlife department becoming protected by various state enactments.

(ii) Forest Restoration and Expansion

Reservations in whatever form provide a positive strategy for holding back a mass depletion of forest

resources. It is however a deficient tool if it is not combined with other strategies. Reserves are fixed once established while demand for forestry products may keep increasing. Where they are established after other land use practices have taken over much of the land, their extent may be restricted, vital sites may be lost and certain objectives cannot be met satisfactorily. Furthermore, where reserves are open to some form of extraction, some level of restoration may have to be done to ensure a sustained use.

Ghana's reserves are so limited in extent and under such pressure that forestry expansion and restoration work through reforestation and afforestation become crucial. Reforestation involves the planting of trees in a forest area which has been logged over or degraded through agriculture or other means. Afforestation is undertaken in an area that was not previously forested. Like the reserves, forest plantations are mainly carried out by the forestry department.

Plantations have several advantages. Fast growing and high quality trees may be used to reduce

the long period of time needed under natural regeneration whereby trees may take up to 120 years or more (depending upon site and ecological conditions) to attain a merchantable girth. Where trees can be grown on a shorter rotation, less pressure may be put on the natural forests and they may be allowed a healthy period to develop. Plantations can be specialised for specific use objectives. To this end, the forestry department began converting cutover areas of the Subri Forest Reserve (Fig. XII) into plantations of Gmeliona arborea since 1972 to meet the requirements of a proposed 60,000 ton a year pulp and paper mill (Earl, December 1982). Plantations may ensure a regular supply of standard wood to meet market demands.

The natural forests, including the reserves are poorly stocked with economic trees. The forestry department has estimated that a reforestation rate of 11,000 hectares per annum is needed to supplement the natural forests if the country can meet her future wood demands by the minimum rotation period of 50 years (Forestry Department, 1982). Plantations may also be sited on favourable terrain and near means of communication to assist efficient management, easy harvesting and transportation of produce.

Reforestation programmes began in the closed forest region as early as 1928. Two major approaches were adopted. These were, using farmers and the adoption of organised large scale mechanised planting.

Planting by farmers in forest reserves under the "Taungya" system was the earliest approach.

Farmers were supposed to plant industrial trees in return for the use of the land for their food crops. The system later proved to be slow and inefficient. Plots were small and less accessible. Abundant land for farming existed (before the 1970s) elsewhere and so there was a general lack of motivation to adopt the system. Even with this background, the system had contributed 4,771 hectares by 1961 and taken up about 15% of all man-made forests in current existence (FAO, 1981).

Large scale mechanised planting was adopted to speed up plantations from 1948. It involved scientific silvicultural techniques including land demarcations, soil surveys, mechanical site clearance and preparations and establishments of nurseries.

TABLE XVI: Afforestation Programme: Principal Trees Used

LOCAL SPECIES	EXOTIC SPECIES
<u>Terminalia ivorensis</u>	<u>Tectona grandis</u>
<u>Khaya ivorensis</u>	<u>Cedrela odorata</u>
<u>Etandrophragma</u>	<u>Gmelina arborea</u>
<u>Mansonia altissima</u>	<u>Eucalyptus spp.</u>
<u>Tarrietia utilis</u>	<u>Pinus spp.</u>
<u>Triplochiton scleroxylon</u>	
<u>Pieghlemella heckelii</u>	
<u>Pericopsis elata</u>	
<u>Nauclea diderrichii</u>	

SOURCE: (1) Forestry Department, Ghana, 1982 pp.3
 (2) FAO, 1981 pp.198

TABLE XVII: Areas of Established Plantations
Estimated at end of 1980 (1,000 ha)

SPECIES	1976-80	71-75	66-70	61-65	51-60	41-50	Before 41	Total
Hardwood species other than fast growing	11.70	17.74	12.86	8.50	6.57	2.30	0.80	60.17
Fast growing hardwood species	4.10	6.80	3.00					13.90
Sub total hardwood species	15.80	24.54	15.86	8.50	6.57	2.30	0.80	74.07
Sub total softwood species	1.20							1.20
Total All Plantations	17.00	24.54	15.86	8.50	6.57	2.30	0.80	75.27

SOURCE: FAO, 1981 pp.199

The programme was suspended briefly between 1961 and 1966. By 1970 an area of about 19,739.35 hectares had been planted. A major re-organisation programme for reforestation began in 1970/71. A target of 10,900 ha of plantations per annum was earmarked. By 1976 a total of 51,555 hectares had been planted (T.D. Amarkye, 1978).

Both exotic and local trees have been used (Table XVI). Hardwood species dominate with softwoods (mainly exotic) making in-roads after the mid-1970s (Table XVII). Most of the plantations are made up of intermingled homogeneous blocks of species.

Afforestation programmes have also been given widespread attention. These are mainly located in the savanna woodland belt. According to long term plans of the forestry department, they are intended as barriers along the northern borders of the country to check desertification, to serve as shelter belts around farms and to provide wood for building poles and firewood. The department, as an interim measure, is concentrating its work around educational institutions, parks, avenues, approaches to towns and

villages and around dams and other waterbodies to minimize evaporation and normalise temperatures (Forestry Department, 1982). Admittedly, planting programmes have not been as massive as the forest region and figures for coverage are difficult to come by.

Government and international efforts to promote tree planting increased after 1975. The World Food Programme (WFP) of FAO donated food aid, worth 19 million dollars to help two phases of tree planting in thirty different forest reserves begun in 1978. The second phase of the programme ended in June 1984. The WFP has again committed a total of 14.2 million dollars for the next phase of the programme to begin after June, 1984 (Embassy of Ghana, Washington, DC, September 1983).

FAO and the UNDP Forestry Department are also involved in a project with the government of Ghana at the Subri Forest Reserve (Fig. XII). This project began in 1976. Among other things, it is intended to establish a supply of wood suitable for a pulp and paper mill, to establish a supply of wood from the area for charcoal production for both industrial and

domestic use while ensuring that the flow of timber to the existing mills for export or damage to the environment is not compromised. The programme has so far succeeded in establishing 1,000 ha of forest plantations. Techniques of forest harvesting, charcoal production and kiln construction have also been established.

The government made an allocation of 25.4 million cedis (about US \$9,236,363.6 - 1978 equivalent) between 1977 and 1980 to the forestry sector. Most of this went into plantation programmes. A recent report from Accra has indicated that the forestry department is to launch a three-year programme covering 1984-86 in three regions - Volta, Ashanti and Western getting educational institutions involved for a start (Embassy of Ghana, New York, Feb. 1984).

Reforestation and afforestation programmes have been generally slower than expected. By the end of 1980, an estimated area of established plantations amounted to only 75,270 hectares (Table XVII).

(i) Maintaining Essential Ecological Processes and
Life Support System

To achieve this objective, forest conservation must ensure soil protection and regeneration, nutrient cycling, protection of watersheds and water systems.

In a limited sense, Ghana's conservation attempts meet this objective. The earliest concern for conservation of the forest ecosystem stemmed from the need to protect the environment. It was meant to prevent the forests from being altered into savannas, to protect the source of the major rivers in the forest region and to preserve a congenial environment for tropical food and cash crops. As feasible as possible, forests have been managed intact at some appropriate sites to play these environmental roles.

As much as the need to meet the above objective was basic to forest conservation in the country, attempts in that direction have been limited. Very crucial areas and sites needed to achieve much of the objective have been greatly abused or never came under protection reserves. For example a great deal of the forest reserve covering the southern Voltaian

To assist extensive management work, inventory of wood volume is taken. An inventory project was established by the department in May, 1980 to train staff for modern inventory taking. UNDP/FAO Technical Co-operation Programme offered assistance in the training phase with a grant of US \$81,900 (Forestry Department, 1982). The first phase covered an area of about 100,000 ha in the Subri forest reserve while the second phase is expected to cover the whole country.

Stands are protected from such destructive agents as fire, pests and diseases. Early burning in the dry season is carried out along the forest-savanna ecotone to avoid spread of uncontrolled fires. Many studies have been undertaken on pests and diseases particularly on the Ambrosia beetle species that attacks both felled logs and growing trees. Various chemicals including dioxin-based kinds like the Gammalin 'A' powder have been employed. Salvaging of diseased trees and rapid extraction of logs from forest to processing and exporting centres have also been encouraged.

With increased productivity in the natural forests and a rapid establishment of man-made plantations, benefits from Ghana's forests may increase tremendously.

3.2.2 Conservation: Non-Land Emphasis

(i) Research and Forestry Education

Research is basic to forestry development. It may be employed to combat losses through pests, diseases and fires. It may be employed to develop species of high genetic quality to speed up growth, to give superior wood strains, to be self sufficient in nutrients, to be drought resistant and to provide species with multipurpose uses as well as to achieve efficiency in use.

Research may also help to monitor dynamics in the forest ecosystem. It may help to determine the effects of forestry practices in the environment and help devise means to combat negative aspects. It may also be employed to determine an optimal relationship between forestry and other land use demands.

Research in various fields, particularly, agriculture, profits forestry in the country. However, some attempts have been made to create special institutions for forestry research. As early as 1953, the West African Timber Borer Research Unit was established at Kumasi to deal with problems of insect pests. Currently, most of forestry research is carried out by the Forest Products Institute. This institute was under the Council for scientific and Industrial Research of Ghana (CSIR) until the inauguration of the Forestry Commission in 1980. It carries out research into wood properties, seed viability provenance trials, entomology and pathology.

Forestry education at various levels has been established to train manpower for management, technical and research work. A department of Horticulture at the University of Science and Technology (UST) at Kumasi offers a post-graduate course in wood technology. This course is intended to train top level management for wood industries. A 2-year diploma course is also run at the same department to train middle level forest technicians. Professional foresters at the Bachelor and Graduate levels receive overseas training. An Institute of Natural resources

was established at the UST in 1982 with a degree and diploma in forestry as well as forestry research as part of its programme. It is expected that this institute may help turn out several foresters with local experience to assist research and development in the sector. At the lowest level, a forestry training school offering a three-year certificate course to train technical staff for the Forestry and Wildlife departments is located at Sunyami (Fig. XI). With increased turnout of qualified forestry personnel, management activities may be enhanced.

(ii) Controls and Efficiency in Forest Resources
Utilisation

A major conservation tool may be found in controls of forest products utilisation. To achieve maximum efficiency at the primary resources level, controls may apply in varying degrees to areas both under protection and outside. This is necessary in Ghana because the reserves are utilised for production purposes. In particular, timber cutting needs controls since a reckless exploitation and subsequent exhaustion on unreserved lands implies an

uncontrolled pressure on protected areas. Unrestricted hunting of game outside the preserves may also lead to the same problem.

Timber from any location, is accordingly controlled by various enactments. Rights to logging companies are controlled by the Lands Act, 1962 (Act 123). The forest ordinance, cap 157, the forest protection Decree, NRC Decree 243, 1974 and the Trees and Timber Decree, 1974, NRCD 237 protect the forests against destruction and govern appropriate utilisation of wood resources (Ghana, 1976). The land commission makes grants of concessions (outside the forest reserves) on behalf of the landowners including stools, families or individuals (where applicable). This is done with a clearance from the Forestry Department with regard to the stocking of the area, yield prescriptions (allowable cut) or the appropriateness of logging on particular concessions to the public good. Exploitation in the reserves are strictly under the authority of the Forestry Department. It collects royalties and grant licences.

A minimum girth of between 210 and 330 cm sets the limits of trees to be cut. This regulation helps to check reckless cutting.

A ban on the export of logs from fourteen primary species (Appendix IV) of timber trees came into force, for three months in 1972 and has remained in force since January, 1979. The ban is aimed at conserving the trees which have been overexploited and face possible extinction due to lack of replanting. This ban may however be viewed as a means of increasing the market value for lumber products since cutting was not abolished. Rather, logs from these species went to local lumber mills to be processed into such high cost products as, veneers, plywood and sawn lumber. These products fetched higher prices on the world market than raw logs. To illustrate this; in 1979, the price of a log per metre was \$93.80 while sawn wood cost \$264.2 and plywood \$536.4 at the same unit (Central Bureau of Statistics, December, 1981). This ban may have an impact since it is perceived in forest industry circles as a cause for decreasing volumes of timber output (Tables X and XI).

The Ghana Timber Marketing Board controls the marketing of all lumber products. The Timber Association embracing loggers, millowners and exporting companies helps to control its members to abide by

regulations affecting the industry. Rationalisation of wood usage in industries may be enhanced with the availability of more wood technologists.

The various controls in the lumber industry and increased efficiency with the use of wood products may help minimise the rate of tree exploitation. Massive replanting of forests and management may help to increase forest resources for continuous use.

Wildlife, a major protein source is also controlled both in reserves and outside by various regulations enforced by the Department of Game and Wildlife and the Police. Hunters and trappers need game licences. Dangerous and wasteful methods of hunting such as using poisonous chemicals are prohibited and there is also a closed season from the 1st of August to the 1st of December each year when hunting of most animals is banned. The wildlife society also helps to draw attention of the general public to the benefits of rational harvest of wildlife resources.

With increased research being undertaken by the Department of Game and Wildlife into wildlife

management and habitat controls, this aspect of the forest ecosystem may be greatly improved.

Summary

The analysis so far made, appears to portray forest conservation as a high priority activity in Ghana. Admittedly, some efforts and successes have been made. However, an objective assessment of the situation cannot be made without first, a critical evaluation of various strategies used including their effectiveness and adequacy and secondly, comparing conservation in Ghana to standard practices set by the International Union of Conservation of Nature and Natural Resources through the framework of the World Conservation strategy.

3.3 EVALUATION

3.3.1 The Other Side of the Strategies

A balanced examination of conservation strategies is necessary in order to find out possible deficiencies and areas of overemphasis or otherwise to help formulate and execute effective conservation plans. Mechanisms and positive contributions have been presented. A look at their

TABLE XVIII: Changes in Area Coverage of Unreserved and Reserved Forests in the Closed Forest Region - 1940-1975 (km²)

YEAR	PRODUCTION	RESERVED	TOTAL
1940	46629.00	12493.279	59113.279
1945	33670.00	12582.22	46252.22
1950	26604.48	15016.82	41621.3
1955	13095.04	15187.76	28282.8
1960	9282.56	15185.17	24467.73
1965	8205.00	15185.17	23390.17
1970	5786.06	15571.08	21357.14
1975	2654.00	16788.00	19442.00

SOURCE: Forestry Department: Accra, 1982

TABLE XIX: Shares of Various Species in Volume of Exports Logs and Lumber (1976-78)

	1976	1977	1978
	%	%	%
<u>Logs</u>			
Wawa	44	40.5	41.8
Utile	11.8	9.8	16.6
Mahogany	10.3	11.0	8.5
Sapele	3.6	8.5	7.7
Edinam	6.5	7.4	6.3
Makere	6.8	7.0	6.9
Others	12.0	15.8	12.2
Total	100.0	100.0	100.0
<u>Lumber</u>			
Odum	25.4	10.9	7.6
Utile	19.2	21.2	60.7
Wawa	14.8	19.3	5.3
Sapele	9.3	16.1	6.2
Krokodua	4.4	4.6	4.6
Mahogany	8.1	7.7	6.0
Others	18.8	19.7	9.6
Total	100.0	100.0	100.0

SOURCE: Central Bureau of Statistics, Accra, December 1981: 66

Refer Appendix IV for botanical names.

effectiveness and comprehensiveness in relation to both short term and long term societal and environmental needs is crucial.

(i) Protection/Preservation

Protection (and or preservation) of forest resources in reserves may be a negative tool if it is over-emphasized in relation to other mechanisms. Reserves may create a belief that any form of land use can be practised on other lands irrespective of natural characteristics since the most vulnerable have been withdrawn from use. They also carry an impression of a "bank" for possible future shortages of forest resources so that they may serve as a disincentive for wise management and use of resources. In other words, they may encourage reckless use of resources.

In Ghana, there have not been any attempts to incorporate forest development in any general land use planning. Hill slopes have been over-farmed and in areas like the Kwahu plateau (Fig. VI), the original forests have been lost. Again, the forest-savanna boundary has been so much abused that most of

began to increase in the 1970s especially in the densely populated areas of the forest region. In parts of these areas, cocoa and coffee have taken over most of the available land outside the reserves. Land for food cropping has become so scarce and impoverished that they have become food deficit areas. In most situations, the government has had to bow to demands for land because it is the most logical thing to do to avoid the possibility of mass starvations. In addition to this, the reserves are increasingly being used for firewood, ropes, poles and for game hunting because they are becoming the only source - a process that undermines the very purpose of the reserves.

When reservation is the main conservation tool and reserves are constituted under local opposition, any means of resource management may be looked upon with suspicion and may never receive popular support among the general populace. Since its official inception, forest reserves have been regarded as symbols of central government usurpation of local rights. They are said to have been made without local approval and are therefore meant to deprive the local population of their livelihood. Such ill-feelings may not be a characteristic of the Ghanaian

FIGURE XIII. Changes in Areal Coverage of Reserved and Unreserved Forests, 1940-45
(Based on Table XVII)

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FIGURE XIV. A Generalised Relationship Between Distance and Rate of Approval of Reserve Projects

K = Project area

Approval rate $[R]$ is a function of distance $[D]$

$$R = f[D]$$

alone. It should be appreciated that, reserve policies imply some sacrifices especially by the immediate local population. If an area is to be reserved for watershed protection or any other purpose to benefit a regional or a national area, the local people may be deprived of their normal range of economic activity while the larger area and the distant population gain. Some form of opposition as a reaction to this perceived loss of territory and resources may be expected in the immediate vicinity while general approval may be received from the distant population (Fig. XIV). It is the responsibility of resource managers and project authorities to help ensure local interest to allay fears, suspicions and unwarranted opposition through public education, fair compensation and means of improving the livelihood and incomes of the affected people.

Unfortunately, most of the early reserves were demarcated under the assumption that they were unoccupied, underdeveloped and therefore had no owners. Local satisfaction never received adequate consideration in their creation. The reality of the situation however, is that, all types of land had rightful owners - the stools, extended families and

individuals. Use of land had been extensive - shifting cultivation, collection and hunting. Therefore, much area remained unoccupied by the time reservation became a major policy. Even by then, their unoccupation did not mean they were not used. After the second decade of the 20th Century, there have been increased demands for land due to increased populations and cultivation of cash crops principally, cocoa. Local opposition to reserves had therefore been age old and continuous.

Illegal cultivation and hunting as protests are common in reserves. Court prosecution for such illegal offences abound in the reports of the forestry department. As late as 1972, 525 illegal farmers were prosecuted in the courts (Hall and Swaine, 1981). Illegal farming continues undetected in most reserves because the forestry department does not have adequate manpower resources to patrol all areas at a time, boundaries have never been recognised by adjacent landowners, most reserves lack access routes and the local people are not ready to report such crimes to the authorities because of a common contempt and local solidarity. Were the local people involved in the decision to create reserves

and their management, their commitment may have ensured labour to fight fires, detect violation of reserve regulations or even provided land and money to promote wider reserves. A complete lack of co-operation of local people, continues to plague the reserves of Ghana.

Over protection assumes a static nature to the forest ecosystem. However, there are dynamic natural processes of species regulation and development. Throughout evolutionary history, certain species have gone extinct while new ones have developed. The long existence of people in the forests of Ghana may also imply that species development might have been affected in some way and the present nature of the forest ecosystem may carry part of their influence. Where strict protection is enforced without any given level of management, there may be an over production of dangerous species that may be detrimental to adjacent areas and may cost taxpayers money to regulate. In the Mole Game reserve, lions attacked livestock and people. Elephants from the Bui and Ankasa reserves also cause perennial damage to crops and there have been instances of human deaths. In most of these cases, scout rangers are called upon to

eliminate them. Over production of browsing animals such as the grasscutter and the deer may also lead to a shortage of food. In the same instance, overproduction of predators like the lion or leopard and other flesh eating mammals may lead to an extinction of certain smaller species.

(ii) Regeneration

Man-made plantations may carry several drawbacks that need to be considered. The closed forests are made up of complex ecosystems that cannot simply be replicated by planting single species of economic trees that are common with most plantations. The local forests also yield a variety of materials for use by the rural people and these may be denied under the plantation system particularly, those using unproven exotic species. The natural forests thrive on soils that are easily impoverished when the surface is exposed to high rainfall conditions and attendant leaching. Forest renewal programmes therefore may require large soil fertility treatment facilities to ensure optimal growth rates if objectives are to be achieved. Under current economic circumstances, limited imported fertilisers may not

be diverted for silvicultural use since food production receives a higher priority. Planting a large area with trees is just a preliminary process of afforestation. Maintenance and survival rates determine how successful the project may be.

A survey of plantations established between 1970-75 indicated that only 55% had been successful due to poor maintenance work (Baerg, Feb. 1983). It may be misleading therefore to depend solely on statistics of acreage of reforested or afforested areas as a means of evaluating the success of conservation programmes. Forest renewal programmes have never kept pace with destruction. While a target of 10,900 ha per annum of planting was set for 1976-80, a mere average of under 4,000 ha or 36.7% was actually attained (Central Bureau of Statistics, 1981). Meanwhile, FAO estimates of destruction for the period were not less than 22,000 ha per annum.

International aid, principally food aid from the WFP aimed at assisting forest renewal projects has not made much impact. Any food aid to assist forestry work particularly between 1977 and 1980 when the WFP began its involvement in the forestry sector of

Ghana had restricted results. There are fewer workers involved in forestry work (mainly in the Forestry Department) and it may therefore amount to a total disregard for human suffering if large quantities of food meant for forestry are held for the small number of workers alone while the larger population perishes. In principle, the aid should go strictly to forestry work but the reality of the situation makes this impossible. Were a comprehensive tree planting programme involving a larger mass of the population (not necessarily in paid employment) designed, this bottleneck might have been avoided. Also, pilot projects such as those in the Subri Forest Reserve have not been extended to other forests nor have they made any significant impacts in the broader sense.

(iii) Non-Land Based

Beyond the land-base, forestry has received very minimal attention in terms of conservation. Research is very fundamental compared to agriculture. Little has been developed from the local species to increase their economic viabilities. Out of over 300 species of trees that can grow to timber size, less than 50 may be commercially utilised. Out of this only six

species provide over 80% in volume of all log and lumber exports (Table XIX and Appendix 4). Diseases, pests and uncontrolled fires continue to destroy valuable timber trees in the absence of minimum research work to counter these problems.

Technology for monitoring forest productivity and surveillance for destructive agents such as up-to-date aerial photographs and more recent satellite imageries are out of reach (some of these facilities may exist but they may be many years behind use). Data on forest volumes are mostly lacking. If there are any, estimates may be misleading and far behind schedule. Techniques and equipment for collecting and analysing data on forest resources on shorter period basis are absent. In light of these shortcomings efficient planning and management are bedevilled and any talks of successes in conservation are illusionary.

Harvesting technology also remains obsolete. The hand-axe and the draw saw may still be seen in certain localities. Wastage, estimated to be anything from 10% to 80% of tree volume is not an exaggeration. In the processing sector, inefficiency

is also the rule. Plants lack any modernisation. They are wood demanding and have never strived to reach the point where industrial wastes like edgings, slabs, trimmings and saw dust can be integrated into the raw material base to increase efficiency and profits and reduce demands on the tree base.

Discussions on alternative sources of energy have never been translated into realities. What have been achieved most are the rationing of petroleum products and the attempt to increase prices of petroleum products to their full market value to curtail demand and imports. These policies have however driven most marginal income urban workers into the ranks of wood energy users to accelerate the rate of forest destruction. Granted that wood provides the major potential energy source, it is expected that attempts may be made to make their use efficient. The age-old traditional stoves and cooking habits still dominate and the wastage continues.

The non-land aspect of conservation normally ensures success at the field level in terms of protection, quality, productivity and sustainable volumes of resources. Where this has been down-

played or not given the attention it deserves, results are very poor. In essence, forest conservation in Ghana has made minimal advances.

3.2.2. Evaluation: Conservation and the IUCN Guidelines

The WCS (IUCN, 1980) offers an ideal basis for evaluating conservation since its three major objectives make an invaluable framework for all assessment work. A precautionary note is that it does not limit itself to forest conservation alone. However, whilst some of its requirements may be specific to other fields such as marine life, coastal and wetlands, its guidelines are comprehensive enough to cater adequately for the conservation of all natural resources.

Forest conservation in particular, takes a major consideration under the strategy since the protection and sustenance of the forest ecosystem ensures to a greater extent much of the set objectives. An evaluation of forest conservation in Ghana under the WCS framework provides objective way for assessing the performance of attempts made so far.

(i) Maintaining Essential Ecological Processes and
Life Support System

To achieve this objective, forest conservation must ensure soil protection and regeneration, nutrient cycling, protection of watersheds and water systems.

In a limited sense, Ghana's conservation attempts meet this objective. The earliest concern for conservation of the forest ecosystem stemmed from the need to protect the environment. It was meant to prevent the forests from being altered into savannas, to protect the source of the major rivers in the forest region and to preserve a congenial environment for tropical food and cash crops. As feasible as possible, forests have been managed intact at some appropriate sites to play these environmental roles.

As much as the need to meet the above objective was basic to forest conservation in the country, attempts in that direction have been limited. Very crucial areas and sites needed to achieve much of the objective have been greatly abused or never came under protection reserves. For example a great deal of the forest reserve covering the southern Voltaian

plateau between Begoro and Jumapo (Fig. VI) that serve as watershed for many streams have been cut down for farming purposes. A major part of the hill slopes of the southeastern forest region, particularly Akwapim and Krobo Hills also never came under protection. Important protective reserves are currently under threats of destruction due to demands for farmlands. The forest policy which provides guidelines for conservation is wholly exploitative-based. The danger of a loss of the forests and their ecological role may be hastened unless there is rational planning and allocation of uses and a high degree of management of these uses. This is yet to be done in the country.

(ii) Preserving Genetic Diversity

The WCS suggests three main approaches: On site; in which the stock is preserved by protecting the ecosystem in which it naturally occurs; offsite, part of organism; in which the seed, semen or other element from which the organism concerned can be reproduced is preserved; and offsite, whole organism; in which a stock of individuals of the organism

concerned is kept outside its natural habitat in a plantation, botanical garden, zoo, aquarium, ranch or culture collection.

On site preservation provides the most important approach for preservation of genetic diversity under forest conservation practices. The National Parks system and the Kogyae strict nature reserve are specifically meant for this purpose. The utility of these areas to serve as long term ecological reserves is however doubtful.

The National parks have not been classified into use intensities to meet their long term preservatory objectives. An indiscriminate use of preserved area whatever the level can result in the extinction of certain fragile fauna and flora. It may be possible that certain ecosystems that provide a potential for protection may also possess high tourist attractivity. Thus the possibility of a visitor-concentration in certain restricted but fragile areas in parks calls for zoning to control and monitor human use.

Any areas intended for genetic preservation must be large enough to encompass diverse ecosystems to

cater for optimal habitats, food needs and free movements of species. Such areas must be well defined with boundaries protected by appropriate legislation.

With the exception of the parks in the savanna belt (which are even inadequate in size), none of those in the high forest covers an area of about 200 km². The Bia National Park established in 1974 with an area of about 305 km² has been reduced to under 80 km² due to a government directive in 1976 (Table XV). Apart from the role of serving as a representative area of high forest, it is intended to provide a natural preserved habitat for such animals as elephants and the colobus species. Most of the remaining area of the park is mainly on steep sites that may not be suitable for large animals such as elephants. Of the 184 species of recorded mammals in Ghana, about 52% are estimated to be found in the forest zone (Asibey, 1982). With the rapid disappearance of the forests, only the 252.2 km² or 0.3% (Table XV) left between the two parks (Bia and Nini-Suhien) can be said to be safe enough (at least in the short-term) to provide a refuge for most of these.

Evidence from studies in island biogeography provides a good basis for assessing the ecological contributions of the reserves. Even though none of the reserves is insular, reserves in general may be regarded as "islands" in the sense that they may create and retain special ecosystem areas significantly different from larger surrounding environments (example - a protected forest surrounded by derived savanna or cultivated area). The persistence of these "special" areas imply that species may be adapted to conditions within them while surrounding areas become unfavourable or limiting environments. This may permit an analogy to be drawn from insular situations for study and explanatory purposes with regard to parallel land situations.

From biogeographic investigations, it has been estimated that the number of species on a given island or isolated area is approximately related to the equation $S = CA^z$ where;

- S = number of species
- A = given area
- C = a constant; related to number of species of one unit area
- Z = a parameter that depends upon the degree of isolation (most z values have been estimated to cluster between 0.18-0.35. Within continents the z value may fall within 0.12 and 0.17 (MacArthur and Wilson, 1967)).

From this equation, it has been determined that there is a relationship between species numbers and area of islands. The larger the island, the greater the number of species (Fig. XV). Even though large areal coverage alone may not as a matter of reality provide sufficient conditions for species abundance, the probability of habitat diversity and resource abundance for particular species needs is high compared to small island situations in terms of support for large numbers.

It has also been established that, the greater the degree of isolation of an island or reserve the lesser the number of species it holds. This can be deduced from the fact that if reserves or islands are highly dispersed, intervening areas may act as barriers for certain species that could have immigrated or dispersed to similar reserves or islands for recolonisation purposes. A low recolonisation implies that an island ecological reserve may not be capable of receiving as many diverse species as possible to ensure its role (Fig. XVI) since dispersal ability over great distances varies with species.

Diamond (1975) has also observed that when a reserve is created in an area where most of the

habitat has been destroyed, it will initially contain more species than it can hold at equilibrium. Then, the excess will gradually go extinct. Finally, the smaller the reserve, the higher the extinction rates (Fig. XVI).

These experiences show that the reserves in Ghana can barely meet the objective of preserving ecological diversity if the insular conditions may approximate such situations created on land in the form of reserves. The ecological reserves are all small in extent. This means that they cannot hold many species and most (species) which may be beneficial in the future may go extinct. The reserves are fragmented and isolated by large distances of degraded environments. The implication here too is that species exchanges cannot be promoted adequately so that diversity (of species) cannot be attained. Fragmented and small reserves may also not provide for a healthy species development since habitats, food and ease of movement may be restricted.

As expected, offsite preservation has not developed much. Most of the existing facilities for that purpose are run by departments independent of

FIGURE XV. Species Numbers in Relationship to Area

Example of the relation between species number and island area in an archipelago. The ordinate is the number of resident, non-marine, lowland bird species (S) on the islands of Vitiaz and Dampier Straits near New Guinea in the south-west Pacific Ocean, plotted as a function of island area (A , in km^2) on a double logarithmic scale. The points $\bullet$ represent relatively undisturbed islands. The straight line $S = 18.9A^{0.18}$ was fitted by least mean squares through the points for these islands. Note that species number increases regularly with island area. The two points $\circ$ refer to Long and Ritter Islands, whose faunas were recently destroyed by volcanic explosions and which have not yet regained their equilibrium species number. Reproduced from

Diamond, J.M. ; 1975.

FIGURE XVI. Distance, Immigration and Extinction Rates of Species

Adapted from Smith Robert L. 1980.

the forestry unit. Within the Forestry Department the use of exotic species in plantations provide the most significant example. A few botanical gardens are maintained by the Department of Parks and Gardens mainly for ornamental and recreation purposes. Such limited ends may serve to exclude greater numbers of species. There are two zoological gardens managed by the Department of Game and Wildlife in Accra and Kumasi (Fig. VI). These zoos are however woefully inadequate and do not represent a greater proportion of the faunal composition of the country's diverse ecosystem several of which are threatened with extinction.

Preservation in the form of seed or semen banks or forms of genetic development has not made any headway in forestry development and management in the country.

(iii) Sustained Use of Species and Ecosystems

Among other things the WCS recommends: a determination of the productive capacities of exploited species and ecosystems ensuring that utilisation does not exceed those capacities; ensuring that access to a resource does not exceed the resource's capacity to

sustain exploitation; reduction of excessive yields to sustainable levels; equipment of subsistence communities to utilize resources sustainably; maintenance of the habitats of resource species and above all limiting firewood consumption to sustainable levels as a step towards a sustained use of species and ecosystems.

Using the forest resources on a sustained basis has been a cornerstone of Ghana's forest policy. However, strategies that can make for these are lacking. Very little is known of the stock of resources that exists so that use cannot be appropriately regulated to meet supply. There has also not been any proper mechanism except perhaps in some reserves to restrict uses of overexploited species. Rural communities continue to put increased pressures on the forest ecosystem for their existence. Much has not been done to increase available resources, use them rationally or protect them. This aspect of conservation objective is as lacking as the two others. Its limited success can be seen in most of the earlier analysis on strategies (of conservation)-

3.4 WHY LOW PERFORMANCE OF FOREST CONSERVATION

Forest management has been run on an independent and sectoral basis with different aims and objectives. Various agencies strive to protect their own interests and therefore there are duplications, conflicts and lack of coordination. The forestry commission was established to bring such co-ordination but it is yet to reorganise existing structures to effect that. Within the wood sector, tree production and management is totally dependent on the Forestry Department (Government responsibilities) while forest industries are mainly dominated by private firms. No meaningful attempts have been made to make industries responsible for replacing the tree crops they remove from their concessions. No attempts have also been made to provide comprehensive guidelines for efficient extraction and processing.

There is a lack of forestry personnel at all levels. In 1977-78, out of 1,946 established positions in the Forestry Department, 732 were vacant. There was a 44% vacancy at the professional level (the vacancy rate increasing with distance from Accra) and 20% at the senior technical level. 535 forest guard positions were also vacant. (Forestry Department, cited by Baerg, 1983). Several reasons may account for this. Among them are unattractive conditions of

service. Highly qualified workers who are not professional foresters but can assist in forestry research and management are attracted to competitive areas of employment mostly in the urban centres and there is an undersupply of professional foresters. Training for this group is mainly undertaken in overseas institutions. The poor economic situation of the country and openings in appropriate institutions, restrict the numbers that can be trained at a time. In the same manner, it is expensive to engage overseas personnel. Even where workers are available, vital equipments may be absent to make their services profitable. In 1980, an estimated 78% of the vehicles belonging to the Forestry Department were out of use (Baerg, 1983).

Lack of personnel may affect general silvicultural programmes including establishment, protection and improvement of plantations. It may also affect research and technical capacity to bring about a rapid development and modernisation in the forestry sector. A lack of personnel may therefore provide a reflection of the overall gloomy nature of conservation results.

Conservation has not benefited from scientific and technological innovation (whether from local or external sources) that have improved productivity dramatically in the forestry sector of most countries including Sweden, Finland,

the United States of America, Canada and even the Philippines. Tree growth, protection, processing and supportive data for planning and management purposes continue to suffer. Ghana cannot put her developmental levels on the same basis with these countries but a modest attempt can be made to draw from modern innovations that are necessary for forestry development. Most forestry technology can be transferable and a local technological capability can adapt these to suit the environment.

The present system of land ownership militates against an effective conservation. Most of the lands are owned by stools, skins, families, and individuals. The government can acquire land for any purpose only through negotiations and appropriate compensation. There are limits to which reserves can be acquired and afforestation programmes can be embarked upon. In the forest zone, potential areas are all almost under cash crop farming (principally cocoa) and any acquisition may involve substantial sums of money for compensatory purposes. In the short term, these cash crops provide the mainstay of the economy and even if government can provide money to acquire those lands for forestry purposes, it may be ill-advised.

For various reasons, forestry has a low profile in terms of government investment priorities. Trees are deemed to grow by themselves and therefore need minimum attention to yield profits. Furthermore, a shortage of trees seems distant. They are seen everywhere and even if they were to run out of supply, they may not arouse social and political upheavels that food shortages or even urban service cuts may bring. Budgetary allocations have been inadequate and irregular. An allocation of about US \$9,236,363 (at 1978 exchange rate) or £25.4 million made to the forestry sector for the period 1977-80 is believed to be unprecedented. Insufficient financial resources may hamper any meaningful programmes.

The scattered and disjointed nature of the reserves provide a major problem to effective management. Meagre resources may have to be stretched to cover about 200 scattered forest reserves. It has not been feasible to provide access routes to most of them thereby cutting them from mainstream conservation activities.

Mounting pressures for forest land for various uses particularly agriculture, exposes the dangers of not incorporating forestry in any land use plans for the country. It also makes clear the disadvantages of not integrating forest

conservation with rural or national development as a matter of policy. As at now, it appears the major means of estimating the success of conservation in the country have been the extent of area that have been taken away from public use, volume of economic trees that have been maintained and the stock of wildlife that can roam freely in the reserves. The pressures for forestry space and resources may continue to mount. The forestry department has been able to withstand most of these in the past but it is becoming clearer that if people's needs are not considered in planning for conservation projects, millions of trees may be successfully planted or protected but they may be lost in a matter of a few years to cater for the livelihood of galloping populations.

There has been little or no public education to help create the awareness of benefits of conservation and the need to support it.

Environmental effects of various activities particularly the use of chemicals to protect and improve stands have generally not been built into conservation strategies. There is generally an absence of strong and definite legislation to give forest conservation the attention it deserves.

in the society. In addition to this, severe foreign exchange constraints seriously affect conservation at all levels.

3.5 SUMMARY

The chapter reviewed various strategies, both past and present that have been employed to help maintain the forests. Strategies used were evaluated to help assess the performances of forest conservation in the country and also provide an insight to possible limitations to conservation.

Results of such objective evaluation indicated that forest conservation in the country, has a long way to go. In its present form, it is not comprehensive enough to meet present and future national development and environmental demands nor can it meet adequately, international objectives set by the WCS. The analysis however projects a high possibility of success if proper review, planning and redirection of conservation programmes can be made to sustain a good start already made. There is a hopeful sign that problems enumerated as among possible causes of conservation failures in the country are not insurmountable. Chapter four examines some possible means that can help increase the performance of conservation activities in the country.

CHAPTER 4. A BALANCED CONSERVATION: WHAT CAN BE DONE

4.1 INTRODUCTION

In the previous chapters a number of forest resource problems were identified and analysed. A critical examination of strategies meant to resolve such problems revealed that they were inadequate and or less successful. This chapter attempts to present several positive measures which the writer believes can lead to a balanced conservation in the country. Beginning with a conservation framework, various approaches ranging from the field to consumer efficiency are described and analysed. Effective means of making them operational are also suggested.

4.2 A CONSERVATION FRAMEWORK

No number of strategies and inputs can put forest conservation on a sound footing without a framework setting out goals and the means to achieve these in the country. Such a blueprint can help effective planning, promotion and monitoring of all activities. It can provide a basis for soliciting needed support both internal and external for all

FIGURE XVII: Suggested Conservation Guideline for Ghana

LEVEL	GOAL	OBJECTIVE
A: NATIONAL		
(i) Local	Satisfaction of immediate human and environmental needs. (To vary according to location and/or time)	Energy Poles (buildings) Fodder Game Protection of obscure species Minor watersheds
↑ ↓		
(ii) Nation-wide	National resource sufficiency and a balanced environment	Timber Poles (utility) Watershed management Soil building and protection Ecological Parks (for recreation etc.)
↑ ↓		
B: INTERNATIONAL		
	IUCN OBJECTIVES:	
	(a) to maintain essential ecological processes and life support systems.	
	(b) Preservation of genetic diversity.	
	(c) Sustainable utilization of species and ecosystem.	
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	↑	
	↓	
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field hands and local support. A scheme to involve the mass of the people in a comprehensive programme based on the suggested Framework (Fig. XVII) can help overcome a great deal if not all of such problems. In this direction, a major area of forestry that requires greater (people's) participation is regeneration of the resources. This is needed to build the primary resources to sustainable levels.

By involving the larger population, abundant and cheap labour can be mobilised near or at the site of projects. Private investment (individual or groups) may be tapped so that limited central government efforts may be strengthened. Through such means the forests can be expanded without undue strain on government resources.

The foremost group to be considered is the rural population. This group is directly in contact with the forest ecosystem. It makes the most immediate demands on forestry space and resources for food, protection, energy and various other uses. Agriculture, the single most important agent of forest destruction is the main occupation involving up to 95% of the population in certain localities. Low productivity, low incomes and general poverty warrants the reckless use of the forests to ensure a continued livelihood and existence.

Modern agricultural inputs such as chemical fertilizers, pesticides and machinery are not imported in sufficient quantities to meet the requirements of all farmers. In most cases even if they can be made available, they may be priced beyond the reach of the small scale farmers who constitute the bulk of the rural population. It may also not be economical to apply such high-cost technologies on tiny and usually scattered holdings. It appears farming may continue to provide the most formidable threat to the forests unless means of improving the standard of living in the rural areas through viable rural development programmes are found.

It may be wishful thinking however, for forest managers to wait for rural development as an ultimate solution of degradation. Experience from the country's development scene, since independence proves that it is a complex process and may be unattainable within the near future. On the other hand, destruction of the forest ecosystem is continuous and effects may become cumulative. This will require vast amounts of resources to correct in the future if no major attempts are made at present. Tree production is also a long term activity and to meet future requirements immediate attention is needed.

Recent examples from various countries have shown that farming can be made to co-exist with tree development. Organisations such as the World Bank and the FAO have identified tree farming as a major means of development. Forestry for promoting rural development has received World Bank loans and technical assistance in a number of countries including Finland, the Republic of Korea and the Philippines (World Bank, February 1978). The Eighth World Forestry Congress held in Jakarta, Indonesia also recognised the role of forestry "for food ... for employment promotion ... for industrial development and ... for improving quality of life" (Journal of Forestry, February, 1979).

4 . 4 AGRO-FORESTRY

The importance of agriculture in the national as well as rural economies of Ghana and its role as a degradation agent gives it an important role in conservation programmes. A system of production whereby agriculture and silviculture can be combined on the same unit of land, may provide an ideal solution. Such a production system integrating food (including animal) and tree farming may be referred to as agro-forestry (agri-silviculture, farm forestry, agri-forestry can variously be used to refer to the same system).

With regard to forest conservation, two basic forms of agro-forestry can be used. These are the Taungya System and general agro-forestry or farm forestry.

(i) Taungya System - A Historical Precedence
of Agro-Forestry

The most basic form of agro-forestry to be widely practised is the Taungya system. This system of forest production using shifting cultivators originated in Burma in the 1860's. Farmers were allowed the use of public land (in the reserves) to plant their food crops while they plant industrial trees like the teak and the eucalyptus for the Central Forestry Authority. The main objective of the scheme was to establish industrial plantations. The importance of using farmers particularly those involved in inefficient land rotating agriculture was that it utilised the known system hitherto regarded as wasteful (in terms of land degradation) in the interest of forest development.

By involving a large number of farmers at a time, forest development progressed at a rapid rate and at lower costs. The meagre staff and resources

of the Central Forestry Department would be utilised on other important field programmes required to improve and to protect stands. The landless, the small holders and sharecroppers were assured adequate land for farming. An allocation of new forest plots annually helped increase yields in food production. This ensured adequate nutrition needs while excess was sold to improve incomes and thereby living standards. The purest form of the Taungya approach merely used farmers to replant forests without much legal commitment of the Central Forestry Authority to the farmers future welfare.

Various adaptations of the Taungya have been devised. Among the most successful are the Forest village approach. Under this, villages may be established for the sole purpose of forestry development (under the control of the Central Forestry Agency). Services and future welfare are properly incorporated in all arrangements under the scheme.

A number of countries including Kenya, Thailand, Burma and the Phillipines have derived benefits from the village approach. In Kenya, it provided employment for about 5,000 persons living in 100 villages.

Plantations from this system are estimated to be supporting more than 80% of current wood demands and secondary employment is said to have been generated in logging, sawmilling, pulp and paper and furniture industries (Spears, 1980). In Thailand and Burma, it has provided sedentary communities for otherwise nomadic cultivators, helping to improve considerably, their way of living while helping to halt forest degradation and assisting forest expansion and restoration (FAO, 1980).

Several of the positive benefits of the system in similar tropical environments make it an attractive approach in Ghana. Actually, the extensive form which merely uses farmers to replant the forests in return for the use of the land has been tried. It has generally however failed to generate the type of labour commitment needed to make the Taungya approach successful. As the writer was made to understand during a field survey in 1979 (Osei, 1979), in most instances farmers did not feel bound to plant and protect seedlings because they were made to pay token administrative fees which some erroneously regarded as the true value of the land. They also did not see the need to plant trees that were not going to benefit them in the long run. If properly taken care of

such trees could oust their food crops within a short period of time. Seedlings were therefore burnt, trash piled on them or pruned prematurely to make way for their food crops. An absence of good supervision from the forestry department also accounted for the low success rate.

If Ghana adopts the forest village approach most of these problems can be eliminated. Basic agreements may assure farmers regular access to land, appropriate remuneration (both in cash and in kind) and a guarantee for all future employment opportunities to be generated out of projects (to farmers and their offsprings). The forestry department may help farmers to market their food produce since most forest areas are poorly linked by roads or may enjoy very irregular transport services to market centres. Once farmers perceive greater benefits, they may be highly committed. L

The forest village system can enhance supervision and increase field activities. A series of nurseries may be established at central locations under the control of a few forestry personnel who may also offer planting and tending educational programmes. In peak planting seasons, personnel from

the department may work among farmers on rotational basis to ensure that trees are planted at appropriate times.

Forest villages can ensure that remoteness of reserves and forestry projects from centres of administration may no longer provide hinderances. Bush fires, unauthorized encroachment and exploitation may be checked. Farmers may help monitor the occurrence of diseases and pests and general plantation performances, alerting the authorities promptly, when problems do occur.

Under the village system, labour supply can be assured on a continuous basis. The quality of labour can also be maintained through regular medical checks and nutrition care.

Beneficial as the village system may sound, the country cannot embark upon a formal establishment of forest settlements under existing conditions. A budget for this may be astronomical since services to accompany such projects may outweigh the actual field programmes. The most convenient and economic approach may be to adopt a number of existing villages within

a practical walking distance from areas to be reforested (such distance may among other things depend upon terrain characteristics of a locality. Distances of up to 5 kilometres in hilly areas and about 8 kilometres in lowland areas may be regarded as normal). If villages are adopted, basic requirements such as housing, water, food and services such as roads and schools may already be in existence. Very little may be spent to improve these while scarce resources can be fully emphasized on the actual regeneration projects.

On the whole however, the Taungya system may provide limited results in forestry development if it is practised as the only form of agro-forestry. It requires a large expanse of area to ensure that farmers may be guaranteed a minimum amount of land per annum for several years in order to provide the needed attraction. In Thailand, an estimated 96,000 hectares of land was envisaged for 100 families only to meet the requirements of an estimated 60 years rotation period (Samapuddhi, 1965). The reserves which may offer land for this purpose are limited in extent (covering a total area of just about 16,853.2 km²). A possible complete reforestation

within the shortest possible time may bring back the old question of land scarcity. The motivation to move elsewhere or into some new activity might have been discouraged by the promising benefits at the start of the scheme. Thus, the landless, small holders, and other poor socio-economic groups may again be caught in a poverty trap and it may require extreme legislation and patrols to save the plantations from exploitation.

The Taungya forest village system may not benefit all communities alike. Most settlements may lie away from the villages to be adopted. Within project areas, future benefits to farmers may be limited because plantations belong to the sponsoring agency - the forestry department. Plantations may also be established without regard to local needs. Furthermore, the extent to which the Taungya system promotes the agro-forestry idea is limited. Food-stuffs are planted only at the beginning of plantations. Within a limited period of time, they are overtaken by tree monocultures.

Such limitations of the Taungya system call for a more appropriate and general type of agro forestry

as a complement to present efforts to maintain the forests while the normal range of economic activities are pursued in a more promising form. There should not be any doubts however that it provides one of the best strategies.

(ii) General Agro-Forestry

A true agro-forestry strategy may seek a balance between tree and food cropping. As much as possible each of these production needs may not be subordinated to the other. Production may be held to be long term and a number of tree and crop-mix can be used for various purposes. A pure agro-forestry strategy may not be government controlled for it to benefit the rural areas. Production may be designed to reflect local needs and capabilities which may sometimes run counter to the objectives of most government agencies. It may therefore aim at both forest production and the raising of nutrition and living standards on a sustained basis.

When agricultural crops and trees co-exist on a permanent basis, food, protein and energy may be provided. In addition, trees may provide for housing

and other wood needs and protect the environment. Trees may now exist in a symbiotic relationship with food crops instead of being regarded as competitors for a scarce land resource base. Individual farmers and private groups of all types can adopt the system successfully in varied environments. It has wider advantages.

General agro-forestry may help provide for a self reliant, sustained and productive agriculture. Natural nutrients to improve the chemical and physical characteristics of soils can be derived from composite sources. Leaf litter, organic matter derived from pruning and thinning deliberately done to increase light penetration to the ground, or to improve tree quality or to supply green manure (or any combinations of these) and harvested crop wastes may decompose and mineralise to supply nutrients to the soil. An enriched soil from natural processes will help improve productivity and cut the reliance on artificial fertilisers for this purpose. There has been a frantic search for a production system that may be devoid of synthetic inputs noting increased concentration of fertiliser and other chemical residues in food products of late in almost all

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parts of the world. Thus, the organic farming concept may be successfully carried out under this scheme.

Other physical benefits to be derived are protection of soil surfaces from dessication, prevention of crop destruction by strong winds, a reduction of risks of uncontrolled fires in a humid food crop and tree environment and the prevention of accelerated erosion. All these may benefit productive agriculture.

Carefully selected trees may provide cheap fodder for livestock to help raise family protein and income levels. By simulating the natural environment, certain wildlife, particularly, the grasscutter (Thryonomys spp) can be successfully raised for meat. Grasscutters may destroy such crops as corn and cassava but do practically no harm to cocoyam, plantains and yams of all kinds. These ~~are~~ crops that are ironically shade tolerant. Wood may be produced in abundance for energy. Agro-forestry therefore has the capacity of increasing efficiency in the overall food system and may provide effective means for reducing pressures on the limited forests.

General agro-forestry together with the Taungya derivate can provide broader work and income alternatives. Employment may be promoted both in the tree and food sectors from the primary production stage to the distribution end (Fig. XVIII). Employment in the secondary and tertiary sectors in the rural areas may help cater for varied socio-economic groups especially those that cannot meet their daily needs through agricultural sources alone. With wider income opportunities, the rural population may enjoy a higher standard of living. Increasingly, they may resort to the use of manufactured products instead of relying directly on the forests for most of their immediate needs. This in the long run may help to save the forests.

(iii) Putting General Agro-Forestry into Action

Agro-forestry can take various forms in the field depending upon land availability, soil characteristics, climate, terrain, labour, local needs and several other considerations. It can be undertaken as a simultaneous system which exemplifies the typical form of the technique. With this, food crops and trees may be mixed on the same piece of land,

FIGURE XVIII: Agro-Forestry: Employment Web

growing at the same time. Several modifications can be made. On prime agricultural lands, the density of food crops may be higher while trees with lower Crown surface areas may be planted in large spacings. Trees can also be used to mark the margins of such holdings with no deliberate plantings within the farm itself. On cash crop plantations (cocoa and coffee mainly), multi-purpose middle canopy trees can be planted to provide shade particularly in the drier forests while valuable timber trees are planted sporadically to top them. Tree fruit plantations such as coconuts and oranges can be interspersed with shorter growing trees for firewood. They can also have plants such as pineapples and pepper at the ground layer.

Agro-forestry can also take a sectional form. On a given piece of land, a part or parts may be given solely to food crops while others may be given to tree production. Strictly, there is no mixture but each crop is given all the necessary attention and both may be found on the same land unit. An example can be the use of hill slopes of a farmland to trees whilst the valley bottoms (assuming they are

not marshy or do not have general production deficiencies) may be used for agricultural crops. Trees, apart from other intended uses such as energy, poles and lumber, may protect the surface to ensure efficient crop production at the valley bottoms and also save the watersheds.

A rotational system, when a whole holding may be used to plant either food or tree crops in a sequence, can also be adopted. An adaptation of this form, may be found in the successional polyculture type in which a varied number of food crops and trees may be used in a sequence until a climax stage of cultivation marked by a dominant and or several co-dominants in association with suppressed lower crops can be attained. An example in Costa Rica given by Holdridge indicated that the final stage under the system had Cordia alliodora and Pejibaye palm as dominant vegetation, cocoa was suppressed while tubers were scattered across the ground (cited by Weaver, 1979: 5). Four stages of cropping as suggested by Hart and cited by Weaver (1970: 5) are as follows: (a) a leafy stem and root plants (b) bananas and plantains (c) palms (d) productive system.

These approaches may not exhaust the various forms which the system can take. Whatever form it takes in the field there are certain major prerequisites to be considered.

Appropriate species to be used to make the system successful are important. Examples from various tropical environments where the system is operated in some form show that crops (both food and trees) should be shade tolerant, be moisture efficient so that competition may not be fatal, be less demanding on nutrients and should not have large crown surface areas. There can be variation of the species mix in different environments to meet production requirements.

Maize, beans and potatoes are successfully planted with pines and Mexican Cypress under the Taungya system in Kenya (Spears, 1980). In Thailand, rice, maize, beans and cotton are interplanted with teak (Samapuddhi, 1975). Budowski (1982) has reported a high productive milk venture in the highlands of Costa Rica where alder species (Alnus acuminata) and fodder are intermixed. Weaver (1979) also mentions that in Ecuador the timber species

Cordia alliodora is planted with cocoa, plantains and pasture near San Lorenzo. While in Columbia the tree species Cordia cedrela and Juglans are found with cocoa, coffee and plantains near Tumaco.

In Ghana, plantains, cocoyam, bananas and several tubers do well in association with natural growing trees under the traditional farming system. Plantations of cocoa, coffee and oil palm also benefit from the shade of trees. Several of the trees mentioned in the examples above are planted as exotics in the country in monocultural tree plantations. If these can be made available to individual farmers and if they are given the required planting techniques, agro-forestry may be given a great boost.

Species have to be chosen to meet to a greater extent, local needs. Trees to be selected may be multipurpose to provide food (fruits, seeds nuts) building poles, herbs and medicines, fuelwood fodder, craft materials, lumber and a host of other uses. These may meet the immediate requirements of rural populations and help attract them to the production idea (agro forestry). Trees to be used may

therefore vary from localities to take into account needs and preferences. A number of trees can provide for such multi-purpose ends. Appendix 7 sets out a range of useful species from lumber to vegetable trees that can be selected for local use.

A good choice can be made from Appendix 7 or any other sources when soils, topography, climatic variations, labour and financial resources are considered as well.

Appendix 8 also gives a summary list of species by climatic types which may provide useful selection options to suit the dry forests, the woodland and the savanna belts in addition to other important local ones such as the Khaya senegalensis or the accacias.

A proper use of the leguminosae most of which are provided in Appendix 7 can cater for moisture and soil nutrient demands. The use of household refuse, urban organic wastes and green manure may help improve soil fertility and water retention. Where synthetic fertilisers are available, they can be

applied to promote growth. Farms lying near streams or any other fresh water bodies may benefit from limited irrigation especially during moisture demanding periods of growth. A good choice of food crops and sequence of cropping to meet moisture and nutrient requirements is also crucial.

In considering trees for energy, those that have coppicing ability and or can be established simply through seeds or stem cuttings must be preferable. This may help avoid high costs of farm re-establishment after harvests. Such trees may also possess high calorific values and be small stemmed to assist easy harvesting and transportation. Trees that develop multiple branches in which recoverable volumes can be high may be useful. They may also be fast growing and demoisture rapidly after harvesting. All such trees must meet local preferences in terms of customs and taboos, health and environmental considerations. The forestry department may establish extensive seed orchards with the co-operation of farmers and benefits from such sponsoring agencies as the World Bank and the FAO. Seedlings may be supplied to farmers at no cost or that they may be highly subsidized to encourage patronage.

A labour pool of the unemployed in the urban centres may be set up in the planting season. Arrangement of such type is already in existence to service the cocoa industry. The scheme can be expanded to help the additional demands of tree planting. Village labour co-operatives or the "Nnoboia system" can also be used at all stages of production. A scheme to avoid planting conflicts between tree and food crops can be worked out whereby food crops may be planted at the commencement of the rainy season in March/April, while tree seedlings may be planted from mid-May onwards, taking advantage of the prolific rains.

(iv) Some Organisational Problems to Watch

There are some problems to be solved in order to make the system highly successful. While some of these can be predicted and can therefore be discussed, others may arise in the course of the scheme. Problems may also vary from one locality to another and over time. Planning for such foreseen and unforeseen difficulties may help promote the scheme successfully. They do not invalidate it.

Among several problems to discuss, land is prominent. Land may be scarce in a locality. If there is a high incidence of land scarcity, food and cash crops may offer the highest priority to meet nutrition and income requirements. Planting of trees may provide "risks" which most farmers may not be prepared to face. Land under the system may also have to be in secured and permanent hands due to long-term nature of tree planting. Under the traditional land tenure system certain types of perennial crops cannot be planted in some areas since the land may be communally owned either by a family (extended) or a clan. Most of the lands may also be parcelled into tiny holdings for inheritance purposes. This is well exemplified under the "Huza" system of the Krobos where holdings are divided equally among surviving sons of a deceased father. Tiny holdings as has been observed, may not be sacrificed for "unproven" production systems.

In most rural areas, the bulk of the land may be owned by a few landlords. The final decision as to what type of crops must be planted may be their sole responsibility. In a situation where the owners decide contrary to the scheme, the farmers who work

on various tenural arrangements on the land and, who may have liked to adopt the system may be powerless.

In a rush to adopt the system, appropriate scientific and organisational capability may not be developed fast enough to assist productivity. There is a danger of low productivity since the question of competition between trees and food crops for moisture, nutrients and light is real. The potential of food shortages occurring is high. When this happens, trees may be eliminated to promote food production and the system may collapse. Again, where a compatible mix of trees and food crops can be matched, food-stuffs may not necessarily be the right types that feature prominently in the diet of the local people.

A multiple mix of trees and agricultural crops may carry pests and diseases that may affect some species. For example, the humid conditions created may promote fungal diseases that can destroy both crops and trees. The simulated natural environment may attract browsing wildlife. Projects near settlements may equally be affected by domesticated browsing animals that may destroy food crops, tree seedlings and barks. Ill-selected species may

secrete noxious chemical compounds to inhibit the growth of others in order to reduce competition (allelopathy). Low energy levels on floors of heavy-canopied systems may retard the growth and development of some crops, particularly, corn.

Damage to crops can result from weed clearance, harvesting or accidental falls (either tree branches or heavy stemmed food crops). The buttresses of trees may take up large planting spaces and may sometimes destroy tubers and other growing plants. By using every available space both vertical and horizontal mechanization may be made difficult. The use of chemicals for protection may become complex. Chemical levels for trees and food crops may differ assuming certain pesticides can effectively be applied for both. Where a type of pesticide needed for either may be noxious to the other, it becomes extremely difficult for such applications. Food-stuffs may store large amounts of pesticide residues.

The long term nature of tree production may alienate a number of poverty-stricken rural dwellers who may be pre-occupied with immediate needs.

If farmers produce large amounts of trees, markets for wood products should be available to them. It may happen that farms may be off transportation routes and lumber may not be produced in large quantities within a minimum economic radius (in terms of transportation costs) to attract forest industries either to site milling plants or to help open up routes to harvest and transport them to existing milling or demand centres. In the absence of this, most farmers may not readily adopt the system.

Some of the problems elaborated, may not be peculiar to agro-forestry. They exist even under pure cropping systems. However, since the approach may be new and somewhat complex compared to existing systems of cultivation, many studies may be needed in the scientific, technological and cultural spheres to help its widespread adoption and success. Most of the recommendations made at the end of the chapter can help solve many of these problems. In the interim, they may be established on small plots alongside the traditional system of farming. Emphasis on early maturing trees particularly for energy may also help. It is expected that resource managers may set up experimental plots in varied environments

to improve on its viability. This will help evolve a more practical and easy approach guided by institutional, production resources and legislative facilities to make it a national production scheme.

4.5 ALTERNATIVE ISSUES

Agro-forestry as a lone strategy, cannot meet all the quests for rapid development of the forestry sector. Several alternative but closely related approaches can offer increased help.

(i) Private and Community Woodlots

Like agro-forestry, these may help shift most of the responsibilities of forestry development from central government to the general population. Private or community investment may be directed at growing trees for a variety of purposes.

Private woodlots can be undertaken as a full time activity by a farmer or an investor. It can also be undertaken as a part-time activity. It differs from general agro-forestry as discussed because trees form the only crop for consideration. Lumber, ornamental, fodder or energy trees can be

raised. In all cases since emphasis is on trees only, every attempt may be made to ensure high productivity so that returns to investment may be high. They may be more accessible for efficient protection and development. They may be close to markets and labour sources, they can be specialised for both domestic and local purposes. A proliferation of private woodlots may increase the rate of afforestation.

Community woodlots may be owned by a whole village or town as a unit. Community emphasis may provide several advantages. Labour can easily be mobilised by chiefs and their elders. In most of rural Ghana, weekly communal labour is obligatory to all citizens irrespective of employment status. The main custodians of the land, the chiefs and their elders who are expected to offer leadership to such projects may provide abundant land. The community can pool its resources together to solve problems relating to finance, seedstocks, development, protection and maintenance. The large scale nature which some of these projects can take may help attract external help both from within the country and outside, governmental and non-governmental.

Community forests may go beyond traditional rural organisation. Urban areas with large expanses of degraded land at their fringes can adopt it. Local government authorities can also establish their own woodlots independent of traditionally-led projects.

Community woodlots can be planned for a variety of purposes. They can be used for energy production. Regular harvests of fuelwood can give rise to charcoal making ventures. Critical energy needs may be catered for and community incomes may be improved. It is possible by this means to undertake more socio-economic development programmes. An absence of any pressures to plant certain type of crops to meet immediate needs of an individual makes it possible for long term lumber tree growing. In addition to this, availability of land elsewhere can offer a variety of choices of trees to meet specific local as well as external industrial needs. Increased exports and local wood-based industries may offer employment to the people.

Community forests may be established to protect common watersheds and to provide a check to desertification or destructive winds. They can also be used

to develop large scale grazing facilities. A large area within settlements and fringes, transport corridors or water courses can be planted to trees for recreation uses. Community forestry can also be developed for wildlife purposes.

The forestry department may successfully exploit community forests to achieve many of its objectives. Professional foresters and technicians may be attached on a zonal basis to help develop the projects. Through this, appropriate management plans can be built to direct such projects in line with the national framework of forest development. If communities become self-sufficient in their forestry requirements, demand on the national forests may be reduced and conservation activities may now expand and improve rapidly.

Private and community woodlots may be faced with problems related to land, ecological, technical and economic characteristics noted with the agro-forestry approach in various forms. In the case of private forests, particularly those that may be run as pure business ventures, investors may exploit various sources to solve them as decisively as possible.

for game and wildlife development. The present game production reserves that are potentially meant for such a purpose are inadequate and have remained virtually unoperational. Large scale wildlife farms can help maintain the forest ecosystem while helping to improve the protein needs of the people. A self sufficiency in protein requirements may help keep the Game Reserves (National Parks) from poachers.

Wildlife farming can be suitable in all parts of the country due to the fact that most game can adapt to large terrain and environmental ranges. Various localities also abound in a number of game and wildlife that can be used. It has been determined that most wild African ungulates generally have lesser development of their digestive tracts (Bourlière, 1963). They can therefore subsist on a smaller per capita food resources compared to those of domestic ungulates. It is also possible for a number of wild animals to co-exist in an environment without any significant destruction of habitats since they may have different food requirements. In addition to these positive characteristics, they are generally resistant to disease that may afflict domesticated animals. Furthermore Surujbally (1977) has observed

arrangement may help avoid future misunderstanding. Solutions to these problems lie partly with local consideration and arrangements on one hand and an ultimate development of public forestry structures and resources on the other.

(ii) Institutional Attraction

With good leadership the forestry authorities can draw various public institutions into forestry activities. A massive planting scheme can be carried out through such means under the direct auspices and or management responsibility of the forestry department.

Several measures can be undertaken in the high forest for land. Regeneration programmes can be designed to correspond with harvesting. Due to the fact that the main harvesting technique is selection felling, this may not provide enough land. Hence, deliberate cutting may be done at appropriate sites as an additional means of freeing land for quality replanting.

Plantations outside the reserves can be established in various parts of the Afram plains and the Middle Belt zone (Fig. VI) where population densities are very low. The southern stretches of this zone which adjoins the closed forest region can be used for lumber plantations. The Khaya and the Pinus spp. that are not so much moisture demanding can be successful. The northern portions may specialize in energy plantations, pole production and grazing woods. Tectona grandis, eucalyptus and several of the acacias with any other appropriate drought resistant species can be used.

Together with its own staff and resources, the forestry department can draw support from various institutions and agencies for all planned projects. In any case, plantation sizes may be controlled at a time to measure with available resources. This may ensure a high success rate of trees because appropriate and feasible management techniques can be worked out to protect stands. Practices such as soil surveys may also be carried out to help devise planting schemes for different soils so that success rate can be improved. While emphasizing lumber production, the department may also help establish

plantations for watershed management, energy and poles. Communities must be assisted to develop grazing forests.

Institutional labour can be drawn from several sources. Among the potential sources are personnel undertaking the 2-year national service scheme, mainly graduates from the universities and colleges. Engineers, scientists and other general workers who can help to run a successful forestry work can easily be recruited from their ranks. Experience from the Dahwenya Irrigation project in early to the mid-1970s and the recent Cocoa Evacuation programme in 1982 indicate that with minimum motivation, such students are modest in their demands for facilities such as accommodation, food or monetary remuneration whilst embarking upon national assignments in the field.

Other potential groups to tap include members of the Trades Union Congress, Peoples Defence Committees, Civil Servants Association, the Voluntary Workscamp Association and a number of non-governmental organisation including churches.

The Department of Game and Wildlife may enter into such projects to provide required environments.

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that carcasses of wild ungulates contain a much higher percentage of lean meat than domesticated ungulates while at the same time achieving the same dressing percentages as fat domestic stock.

It appears that the major requirement for achieving a sound wildlife development in the country rests on habitat maintenance. The mass planting schemes may help to achieve this objective.

(iii) Other Institutions

Forest industries, which are mostly privately owned, may be encouraged to set up their own plantations and assist in general planting programmes. Concession licences may contain a clause demanding the replacement of trees removed and their maintenance to periods of not less than 5 years. Examples from Sweden indicate that companies own as much as 25% of the total forest with the Central Forestry Authority owning just about an equivalent percentage (Bengt-Olof Danielsson, 1982).

Wood industries may enter into joint ownerships with the forestry department in some of the

afforestation projects. They can also sponsor some of the community as well as the private woodlots. Where industries become involved in planting programmes, they may help produce specific trees to meet their own demands. This will help maintain the natural forests from where the bulk of present produce is derived.

2
Educational institutions must also be greatly used. Tree planting may be made mandatory in all government assisted schools and colleges. Residential institutions may be required to provide about 25% of their energy needs through woodfuel sources in a situation where electricity or other forms of energy can be made available. In other institutions, particularly those in the rural areas where wood may provide the only source of energy, up to about 80% must be supplied from energy plantations established by such schools. While this may help reduce school expenditures, it may also help to preserve the natural vegetation. The Ministry of Education may provide special budgetary allocations for this purpose. Prizes and competitions established among schools may provide a means of motivation.

Agricultural and forestry colleges may set up experimental plots to develop agro-forestry farms using all facilities available.

All correctional institutions may also be required to develop energy farms to supplement energy for cooking and heating from other sources. It may also raise incomes for such institutions.

4.6 PLANNING FOR PROTECTION AND EFFICIENCY

A massive build up of the primary resources of the forest ecosystem may not necessarily lead to balanced conservation if appropriate measures are not taken to protect the resources from destruction and to increase efficiency in all aspects of conservation activities.

(i) Protecting the Field Resources

As much as possible the use of various chemicals particularly pesticides and fire retardants may be necessary to protect stands. Light planes may be acquired for fire-fighting and monitoring work especially in the remote forests. A non-technological and chemical emphasis may however go a long way to help the country.

While a high technological orientation such as the use of air planes cannot be met adequately due to foreign exchange constraints and an absence of a local forestry technological base, chemical emphasis especially through aerial spraying may be less attractive not only because of high cost of acquisition but serious damage it is capable of causing in the environment. In most advanced countries where intensive use of chemicals has been made in forestry, studies have indicated serious environmental destruction. This is mainly due to the fact that most chemicals are toxic to a wide range of organisms in the forest ecosystem most of which chemicals may not be intended originally but may be destroyed along with targeted ones. In addition, most chemicals are mobile and some persistent in the ecosystem. They may contaminate water bodies, pollute the air and concentrate in food chains far away from sites of application and long periods after application if they are inappropriately used.

A large spectrum of non-chemical methods including a number of cultural practices to eliminate pests and diseases and to improve species quality; large clearance and ploughing of fire lanes; biological

controls using live organisms such as animal and insect predators, parasites and a host of pathogens; genetic manipulations to develop disease and pest resistant species and many others are increasingly being adopted in place of chemical approaches.

The non-chemical approach may be cheaper, free from supply constraints as most chemicals do and may be safer for environmental protection. Intensive research and development into the non-chemical emphasis in forestry development may help the country maintain her forests at minimum costs. In the interim however, all known non-chemical practices may be applied in conjunction with proven chemicals until they become effective alternatives. A screening of chemicals to avoid a continued importation of dangerous ones may help. Also, a guideline has to be set to regulate dosage, time of application and venues of application. It is hoped that an effective means of protecting the field resources may be found so that productivity may increase.

Protection of the forest ecosystem cannot be complete without a major emphasis on the reserves, both productive and non-consumptive.

The forestry department may concentrate on the improvements of existing production reserves under its care incorporating some important replanted areas to achieve set objectives. To go with this, a management plan setting out functions and nature of exploitation of reserves may be provided. This is necessary because most of the present reserves are managed for production purposes even though they are expected to serve protection functions as well. Such a conflict may be resolved by a guiding plan. The reserves may be classified into four main types on the basis of the afore-mentioned criteria:

- (1) Watershed Reserves
- (2) Buffer Reserves
- (3) Wood Production Reserves
- (4) Grazing Reserves

Watershed reserves may cover not only the most important areas such as the Kwahu plateau but all hilly sites and or steep slopes to offer surface protection as well. No logging or forest roads may be allowed into any of these sites.

The Buffer reserves may protect the main forests from the encroachment of degraded environments

including that of desertification in the north. Such forests can also be maintained to provide shelter within the agricultural areas of the forests. Extraction for industrial purposes may be by strict selection method. Local use for ropes, canes, medicinal herbs, fruit collection, limited wildlife (such as harvesting of snails) may be allowed. Only dead wood may be allowed to be collected for fuel purposes.

Wood production reserves may be classified into timber and other wood. On timber reserves a further sub-classification into prime and moderate lands may be necessary. Prime timber lands may cover artificial plantations and highly improved original reserves. A limited clear-cut method with prompt regeneration may be adopted. On the moderate timber lands, because of slope and stocking characteristics, the selection system followed by both artificial and natural regeneration will be necessary. The other wood land may be reserved for pole and fuelwood production. They may be the type of reserves near settlements. A grazing reserve may be maintained by the department alongside this type of forest. Harvesting regulations in all the reserves may also guide that on non-reserved lands in private property.

Reserves intended for non-consumption ends also need wider attention. This is more important in the case of those for ecological protection. They are woefully inadequate. They may have to be extended in area to cover vital sites to give them as much diverse internal variations as possible. Attempts may also be made to alter their present fragmented state. Figure XIX, presents an important model that can be used to design such reserves. The model stresses that, reserves be large, contiguous and as nearly circular in shape as possible to promote good development and protection of species (Diamond, 1975).

The model presented may not be held rigidly at all locations alike. Tidsell (1982: 4) has suggested that:

there may be cases in which separation increases the probability of survival of species provided each separated reserve is above some critical size ... the risk of a particular species being wiped out by occurrences such as new predator or disease, drought etc. could be lower than for one large reserve.

FIGURE XIX. Suggested Model for the Development of Ecological Reserves

In each case Labelled A to F, species extinction rates will be lower for the reserve design on the left.
 Reproduced from Diamond, J.M., 1975.

He cites the case of Australia where it is believed, her relative isolation from other continents may have been a probable factor in ensuring the survival of most of her unique flora and fauna.

A criteria of ecological value for nature reserves used by Great Britain's Nature Conservancy may also provide a guideline for selection and developing the reserves. Among other things the system considers extent, naturalness, richness, diversity, fragility, representatives, research and educational value, recorded and potential value (Goldsmith, Feb. 1975: 90). The present system of selecting wildlife parks (which are also intended for protective purposes) by vegetational consideration may be followed alongside most of the recommendations made.

Whatever guidelines are taken to redesign the reserves, additional areas may be required. Corridors of land between some reserves to provide a link is needed so that the needs of migratory species can be met. Afforestation may also be needed at vantage points between the highly dispersed reserves and around smaller ones which are enclosed by a wide expanse of degraded environments. A number of man-made vegetation enclaves between the highly dispersed

natural ones may serve as stepping stones for migratory species trying to reach them. Similarly, an artificial plantation around a reserve may serve as a buffer zone helping to fence-off or minimise the effects of destructive elements. In the long run, with a careful manipulation of the buffer vegetation, it may catch up with the natural one. This may help increase the size of reserves and help to make for species diversity.

The watershed reserves which may not be exploited can also be used for ecological reserves. The importance of the ecological reserves require that a legislative instrument guaranteeing their continued existence be passed as early as possible so that they may be protected from exploitation.

The recreation use of the forest parks also need consideration since with the exception of the Kogyae Strict Nature reserve all ecological parks can be used for recreation purposes. A management plan setting out goals, objectives and means to achieve these can ensure their ecological roles even with recreation use.

For the purpose of ecological considerations the parks (only five of them) can be classified into two main management types. These are Natural Ecosystem Parks and Semi-Natural Ecosystem Parks.

The Natural Ecosystem Parks may be used for extensive activities only. The Digya, due to its relatively large expanse, location between the forest and savanna woodland and its remoteness may be appropriate. In the high forest, both the Nini-Suhien and the Bia Parks may be selected. They may be too small in extent for this purpose but they may be the only true representative areas (of the high forest). They also run adjacent to similar forests across the border in the Ivory Coast so that there can be species exchanges.

The Bui and Mole reserves may be selected under the second type. There can be a minimum manipulation of species to keep them in a healthy state. For instance protection from fire in the dry season, provision of water and increasing food sources may be necessary because the savanna environment in which they are situated are affected by the seasonal nature of rainfall which invariably affects all these requirements.

It is necessary for more forest parks to be created particularly in the southern parts of the country. Man-made plantations can also be used to establish parks especially around the urban centres. For the purpose that they protect the natural environment and help to maintain the forest vegetation positively, Forest National Parks are a necessity for the country.

(i i) Other Important Considerations

Conservation can be effectively promoted through the application of efficient planning techniques and science and technology to the forestry industry at all levels. The renewable character of most forest resources also makes it possible wherever appropriate techniques can be adopted to manipulate them for efficiency.

Fertilisation, chemical and biological protection, irrigation and all other known techniques that can increase crop productivity can be applied to increase the quality of forests whether man-made or natural. In forest plantations, it may be possible to monitor and analyse growth rates, keep record on

volumes of species both by type and age and manipulation of rotation periods. If these can be done in the country future requirements both for domestic and export purposes can be predicted and plantation size and input mix can be adjusted to achieve highest efficiency without destroying the forest ecosystem.

A wide scale use of logging residues both by industries and direct consumers can also help to reduce pressures on the forests. Tree stumps, tops, branches and defective stems which usually take up a high percentage of harvested volumes are usually left in the field as wastes. A recovery of these may amount to an increase in wood volumes to feed mills and provide for other direct uses such as energy. An increased demand for wood and the consequent pressures on limited forests has resulted in a series of practices aimed at an efficient use of trees in several countries.

Among these are the practice of Whole Tree Use. This practice aims at a full utilization of a harvested tree crop from roots to tops for various purposes. Stems and bigger branches may be used to feed logging and pulp and paper mills. Smaller

branches, stumps, defective stems and tops apart from the possibility of being used in some mills can generally provide feedstock for energy conversion plants or used directly as woodfuel. Machinery for whole tree harvesting has been developed and is in use in such countries as Sweden, Denmark, Canada and the United States of America. Residue harvesting equipment that can collect ground logging wastes or harvest stumps is also available.

Whole tree utilisation should be adopted with caution. Technologies may be expensive to maintain by such a relatively poor country as Ghana. They have not been fully developed to meet the ecological needs of such fragile environments as the tropical forests. Removal of a whole tree amounts to a wholesale export of natural nutrients from the forest environment. Whole tree harvest without regeneration may lead to a widespread destruction of soils and watersheds and may give rise to mass movement on steep slopes. Transporting whole trees to mills and other demand centres may be expensive partly because of bulk density in relation to economic use (stones, earth, leaves and other foreign elements may take a large proportion of transported volumes).

On the other hand, if technologies can be made applicable at cheaper costs (economic and environmental) a controlled whole tree harvest may be beneficial to the country. Already, the main harvesting system (select-felling) is estimated to remove only about two trees per km² (Hall and Swaine, 1981). This is a result of the multi-species and age-mixture of trees and more important the preponderance of a large volume of uneconomic species. Hence, there may be no serious exposure of the surface to degradational agents. This will rather make for a maximum benefit of the limited trees that are harvested at a time. Transportation problems can be solved by applying the technique of chipping whereby the stumps and other non-conventional parts can be blown into chips to reduce their bulk density and transported by any ordinary haulage trucks (tipper trucks especially) to areas of use. Another alternative is the direct conversion of these residues into charcoal at logging sites to increase their economic return for transportation to demand centres that are further from logging sites.

Another important practice is the increased use of industrial wastes. Large volumes of barks, slabs,

core-chipping and other milling wastes are now being used by modern mills to increase their feedstocks. An increased use of logging industrial wastes may help to reduce the rate of forest destruction. They can help the planning of tree removals from forests and assist other management activities aimed at increasing forest productivity and general maintenance.

Several economic practices can also help achieve efficient planning in the development and use of forests. The technique of cost-benefit analysis is one such efficient planning tools. It may help provide one of the many approaches by which allocation of forestry space for various objectives can be made. It may also be used to determine feasible alternatives for conservation activities such as the best stand establishment and protecting techniques. A cost-benefit analysis may attempt to value the costs and benefits of all forestry projects on a common denominator usually, monetary value. This will help project managers to select an alternative that appears to be the most efficient so that waste may be avoided.

As has been noted, this approach may provide only one of many tools for consideration in forestry work. Alternatives that may provide the highest monetary remuneration may not necessarily be the best in terms of environmental and socio-political goals of a locality. In a similar manner, many intangible benefits associated with forests cannot be efficiently priced. A balance of economic, social and environmental considerations may therefore be needed in forestry planning and development. Under present circumstances a business outlook of conservation cannot be ignored in certain areas. All modern techniques that help to plan for efficiency in business outfits including computerization that can be applicable to forestry situations may be applied.

The question of integrating forestry with national development becomes important here. This will put forestry among major priority sectors of the national economy to be given immediate attention. As a major part of a national development strategy, any negative forces that tend to erode its viability may be checked. In turn, the forests will provide a greater impetus for the government's industrialisation plans. A large number of wood-related

industries can help lift the country from its over-dependence on the primary sector. With minimum efforts all the primary raw materials for wood industries can be raised within the country. This cannot be done easily for other existing industries that are foreign raw material-oriented.

When forestry is considered as an important part of national planning, overall use of the (national) land resources can be rationalised through a national land use plan. This will allocate various land areas to activity types that they may have the capability of holding efficiently and "permanently". Soil surveys and mapping, terrain and vegetation characteristics, situation of land in relation to population centres, local, national and international demands for certain products and services can all help to classify the land for particular uses. Thus, all prime agricultural soils may be protected for that purpose. Forests may also be held efficiently in their own domain. Land use may no longer refer only to those immediate or quick-return uses of land such as agriculture, mining, urbanisation or transport and communication corridors.

By putting activities on lands that are suitable for them, it is envisaged that productivity may increase. Once productivity is increased particularly in agriculture, the question of a reckless cutting of the forests may be out since these may not be necessary in order to maximise yields. Another important contribution of land use plan to forestry development is that designated zones may remain protected by requisite legislation as long as the plan persists. Through a land use plan, environmental considerations can be required in all use types and means to check this can be efficiently worked out.

A rational planning of the land resources may also require some land reforms. The government must have the power to expropriate all important areas that are needed for national schemes. Forestry particularly, may be blessed with new acquisitions of land to enhance national objectives. Rural land-ownership may need critical reviews. Farmers must be made to have control over the lands they occupy. There has to be some redistribution of land in critical farming communities where a few landlords own the land. A review of tenural arrangements is

also necessary to enable farmers adopt new techniques such as the agro-forestry idea which can help improve their socio-economic circumstances.

The search for efficiency may also consider the consuming end. In the long term, a great deal of substitution may help to reduce demands on direct forest resources. An important consideration here is energy. A reliance on wood sources alone to meet increasing energy demands, principally in the rural areas will not be possible in the long term.

With escalating demands for wood for purposes other than energy, it will soon become uneconomic to use it for energy purposes. Again, even if it will always be feasible to use wood for energy, escalating populations will further increase demands which will in turn require large expanses of land to be devoted to energy farms. Since this cannot be possible due to the fact that other human needs may be critical as well, a new energy policy to consider alternative sources of rural energy may help. Cheaper sources, such as windpower and solar energy can be developed. The country's hydro-electricity potential should be fully harnessed. Power from such sources must be extended to the rural areas to supplement all other

sources of energy. Present attempts to prospect for more oil deposits must continue. Abundant petroleum energy can help reduce pressures on wood sources even if for a short-term. To achieve efficiency in the use of wood energy until viable alternatives become available, appropriate technology for charcoal making, increasing energy value of woodfuel, gasification and liquefaction of wood and energy stoves and cooking utensils are necessary.

Substitution can also be achieved in various areas. Aluminium, cheap steel and concrete facilities may feature prominently in all construction works instead of wood products both as supports and direct components. An increase in local manufacturing together with increased imports may provide such high demand items in the rural areas as synthetic ropes and strings, safer and cheaper drugs, plastic and tin containers, seating facilities, tools and implement parts, varied food and protein sources.

Practices such as paper recycling, conversion of old wood products like furniture into new forms, collection of municipal wood wastes can all help to reduce direct pressures on the forests.

With increased efficiency in production, protection and use techniques, it may not be necessary for the whole population to be directly involved in tree planting in order to maintain the forest ecosystem. Whatever the rate of regeneration, these aspects of forest management are crucial. Forests may never be the only users of the land. Neither will all the country's financial and labour resources be committed to their welfare alone. To make for other equally important land use demands, an efficient management of whatever exists and whatever can be added is very important. Plantings may be necessary in order to build up the existing depleted forests but they cannot be made to cover the whole country and as a replacement to the natural forests. This will result in inestimable costs in socio-economic and environmental processes. A balance of all the management activities supported by available facilities may help put forest conservation on a higher level in the country.

4.7. SUMMARY

The chapter presented among other things the role of the public, leadership, efficiency on the field and external

factors in balanced conservation activities. For successful and balanced conservation to be achieved however, several requirements may be necessary.

Finance and investment in forestry research and development are among the most important factors. These are needed to make the major schemes discussed possible. A new forest policy and legislation is required to meet changes in demand, objectives, forestry practices and problems that have considerably changed since 1927, the source of most provisions under the existing forest policy. A stronger forestry support services is also needed to help modernize conservation activities and to make them more productive. A strong Central Forestry Institution with the power, effectiveness and resources for quick action is needed to provide efficient co-ordinating role for the complex activities that come under forest conservation. Public education, provision of resources that can make for mass participation and incentive structures have to be built to attract the general population to conservation programmes.

Successful conservation in the country must also require increased international co-operation and assistance (from such agencies as UNESCO, FAO, the World Bank, UNDP, CIDA and IDRC of Canada and a number of other conservation

related agencies international or national). Research, technical and financial resources may be obtained from this source to help supplement local efforts. The country must strive to belong and adhere to most world conventions that are aimed at protecting forest resources. These must include the Convention on International trade and Endangered Species of Wild Fauna and Flora (CITES), the Convention concerning the protection of the World Cultural and Natural Heritage and the Convention on conservation of migratory species of wild animals among others). This will help conservation activities come in line with international practices. The country must enter into joint conservation programmes with neighbouring countries especially the Ivory Coast. National parks and ecological reserves can be planned to link each country so that they can be extensive to help promote species development. Journals, newsletters and most periodicals produced by foreign national and international resource conservation agencies must be subscribed. This will help resource managers and decision makers keep abreast with new developments in the international conservation scene.

CHAPTER 5. SUMMARY AND CONCLUSION

Conservation of forest resources is a necessary requirement for their continued enjoyment and for the benefit of a sound natural ecosystem. Appropriate means of conserving the resources have however eluded many environments and therefore destruction continues unchecked. The crux of the problem is that an effective working definition of forest conservation has not been possible. This is a result of differences in training, beliefs, cultural and ideological orientations of conservation practitioners and above all development levels within and between countries. In light of these problems it becomes extremely difficult if not impossible to design effective strategies that can help to maintain the resources.

In most developing countries, there can be no waiting time for a complete grasp of what is needed for sound forest conservation. Destruction of the forest ecosystem is continuing at such a pace that the whole human race is threatened. Evidence of such imminent dangers is already in existence. Desertification is engulfing rich agricultural lands. Watersheds are being destroyed and species are disappearing fast. People need to provide for their current requirements but if all the forests may be destroyed at one

point in time everything else would be lost forever. In matters concerning the natural ecosystem, inaction, apathy and ignorance do not help anybody.

The case of Ghana, which provides the theme for this work, is clear. The forests contribute immensely to socio-economic development. Their contributions are becoming more important with the rapid increase in populations. In the rural areas, they provide the single most important means of sustenance. These areas of the country have been highly underprivileged in the distribution of the nation's resources so that they stand in stark contrast to the urban centres in terms of incomes, employment and basic facilities such as power (energy), roads and access to manufactured products. The forests are the main assurances to basic development. However, inefficient and unrestrained use threaten their extinction. This threat looms high since a recognition of the dangerous factor of a relationship between rural poverty and forest destruction appears not to have been made by resource managers.

In addition to threats arising from rural needs, forest resources are demanded in large quantities for national development. Modern extraction technologies remove faster and reach sites that have been inaccessible previously.

This has to be done in order to meet increasing demands. The result is a rapid loss of the resources and considerable damage to the forest ecosystem. The extent of the problem is perhaps not known since resource managers may not have had any clear idea of what stock of resources existed, how much should be removed at a time and how this should be done in order to avoid negative consequences both now and in the future.

One can safely notice (the weaknesses in conservation attempts with a close examination of all past and existing strategies that have stood for it. Apart from being inadequate, they have mainly been sectoral and poorly co-ordinated.

Tree production and maintenance seemed to have been given a central focus. Even though this does not constitute a balanced approach, there is no doubt its proper running can contribute immensely in all forest conservation schemes. Measures intended to increase wood production have however been restricted because resources needed to make this possible have been non-existent. In some manner, one can assert that resource restrictions appear to have been exaggerated due to the inefficient manner of project designs. The role of the general public has not been recognised.

If there is an activity which requires mass participation, forest conservation comes to the fore. Forest resources reach every home. The protection they offer ensures a good environment for all. The action of every individual can destroy or maintain them. If technology is dismal, if transportation is poor and if financial resources from central authorities are meagre, mass labour of the larger population can make the difference. People's participation seems to be absent partly because the general public has not been educated on what conservation stands for. Instead of seeking their support for regeneration projects, certain schemes rather tend to heighten their fears and suspicions of what conservation is meant to be. At best, they have meant a loss of one's right to existence. The emphasis on reservations as the main conservation tool and the failure to consult and involve local populations in conservation planning and activities partly account for such poor public reception.

Tree maintenance also suffers because appropriate techniques and measures have not been designed to ensure their survival or quality development. This is more applicable to the man-made plantations. While grandiose plans are designed to achieve relatively large planting hectareage per annum, survival rates have been discouragingly low.

Probably, documentary evidence of planted areas per unit time provide a criteria for measuring success of regeneration activities. Such an action can only benefit public relation ends and not silvicultural excellence. Weed control, attack on pests and diseases, cleaning and thinning are all left undone to the detriment of productivity.

In the natural forests, economic trees are usually left to the forces of nature to develop. Most of them become defective or sometimes over mature for most uses because they may remain unreached and therefore unattended at earlier stages of growth. Logging and related activities also cause considerable damage to the standing forests.

A large-scale use of locally improved trees has not gained root. A greater proportion of all genetically improved tree species are exotic. These are usually single purpose (lumber, pulp and paper) and their impact on the environment is not well understood. For example, most of the broad-leaved local species can offer surface protection, help improve the soils and offer multi-layer habitats for a number of fauna. Species such as the pine or the eucalyptus can scarcely offer such advantages.

Ecological and general environmental perspectives of conservation are absent. There are a number of species that

may vanish because they are deemed not to be useful under present economic and technological circumstances. Areas that have been set aside for ecological purposes are inadequate and small in extent. They are surrounded by degraded environments. They are constantly under threats of exploitation because there has been an absence of a purposeful legislation to keep them for that purpose for all times. Traditionally, all the reserves have been subjected to a form of exploitation. Availability of rich resources in the ecological ones, may constantly offer attraction especially when the resource situation becomes critical in some places unless a proper legislative instrument protects them.

Absence of ecological consideration is marked by unwanton destruction by users. Watersheds and steep slopes are logged over or released to farmers. Chemicals are freely used irrespective of dosage requirements, fatality, expiry or proximity to water bodies and settlements. A reconciliation of ecological and development considerations in resource management has not been achieved. Strategies in existence so far fail to meet this. International practices, particularly those set by the WCS have not been achieved in any proportion.

Forest conservation has also mainly been restricted to the high forests proper. This area cannot meet all future

demands because it is smaller in extent. Desert encroachment from the north of the country demands that afforestation be taken seriously in that section as in the south. Conservation activities in the country have been imperilled with a lack of innovations in science and technology. There are limited markets for the large number of tree species that exist in the natural forests. Forest industries remain small, fragmented and inefficient. Most of these are privately owned and have done very little to help maintain the forests or modernise the forest industries sector. Conservation and for that matter forest conservation has never been a major political contention in Ghana as in some countries in North America and Europe. Political leaders have least interested themselves in conservation issues. Their support is crucial for the provision of needed resources.

Compared with tree maintenance, the wildlife aspect of forest protection has not been popular. In times, past, wild animals are said to have mauled humans and destroyed domesticated animals. They still destroy crops in parts of the country. Antagonistic feeling towards the wild animals is fundamental in most human thinking. In addition to this, wildlife provides a major protein source to most Ghanaians. Rules banning their use appear to cut the protein source of

most of the people. Game and wildlife authorities in the country have generally failed to project a good image for wildlife protection. Thus, while rapid destruction of the forest ecosystem deny habitats to them, poaching (in reserves) and reckless hunting are reducing their numbers.

It is difficult to arrive at definite estimates for wildlife for a big country as Ghana. However, a scarcity and correspondingly the high cost of game meat in recent times is an indication of their shortage. In the past, it was common to encounter wild game just outside settlement fringes. Currently the few that remain vanish at the sight or voice of humans. Prowling for household refuse in the night in the remotest villages is even ceasing. There is no doubt that most of the wildlife are endangered. A comprehensive study will probably reveal a sorry situation.

Most of the failures of forest conservation in Ghana stem from a narrow concept of conservation, an absence of solid working plans and a strong coordinating body. As has been observed throughout the text, conservation involves a complex of dynamic activities that range from the field to the consumer. Problems in the natural ecosystem are complex. Their solutions lie in solid programmes both within and outside the natural ecosystem. Isolated prescriptions

that have been the lot in Ghana, may not work satisfactorily or at all. Programmes can also not be haphazard. They have to be based on local realities, available resources and accepted guidelines. They need planning, monitoring controls and readjustments. Regular changes in the forest ecosystem and human needs over time requires that dynamism becomes the hallmark of conservation activities. For, no prescription can satisfy all times or all environments alike. Constant adaptations with time and new challenges may help ensure success. It may involve a political will, a support of the masses, the direction of skilled personnel and managers and sacrifice by all.

Forest destruction must be recognised as a worldwide problem. However, in the advanced countries, pressures from the grassroots and worldwide scarcities are awakening political leaders and resource managers to their tasks. More important, vast amounts of resources can be committed to restoration and protection activities. Countries such as Canada, United States of America, Finland and Sweden abound in so much forests that revenue from that source alone can help all regeneration activities. They may not be said to have performed better in the past but present commitments are commendable.

In the developing countries of the tropical areas, much still needs to be done. Current forest resources are scant

but the destruction rates frightening. The forests are needed most but they are disappearing fast. The tropical climate exacts a high price for mismanagement. It does not allow long periods of exposure. This should have spurred on the populations to be responsible to the natural vegetation. This has not been so and their recklessness is greatly exposed to the world in the form of environmental degradation and resource loss.

Conservation in tropical countries is bedevilled with confusions; confusions that unfortunately equate conservation with non-development. This outlook has to change. Timely and relieving enough, most agencies have sustained their campaigns for sound conservation of resources the world over. The IUCN framework provides a guide to all nations irrespective of development levels and the type of environment. It has shown that conservation can function with development and it is actually a necessary condition for its attainment.

The activities of UNESCO particularly the MAB programme should help tropical countries to design appropriate strategies to protect the natural environment. The great watchdog role of the WWF can also help direct all countries in line with worldwide practices of species protection. Societies

such as the Sierra Club, the Natural Resources Defence Council, Friends of the Earth and many others have their influences extending beyond their national borders. It is hoped that developing countries can benefit from most of these.

International co-operation and help for sound conservation, is needed in developing countries. There is no doubt that poor economic situations and general poverty put them at the lower end of the conservation scale. Authorities in these countries have by now identified most of such problems but remain helpless in the absence of means to combat them. With all the input disadvantages, several of the developing countries have made modest and encouraging attempts. Ghana is an example. Co-operation from the richer and advanced countries can help more. No part of the world can remain aloof to destruction in another part. The world is now closer and highly integrated. There is nothing like an "African problem" or "North American problem" in terms of destruction of the biosphere. Increased co-operation amongst all may save all.

Developing countries can also do much to help themselves. Problems have to be grappled with at the onset so that they do not grow out of proportion to the means to solve them. They can make use of human resources to achieve

many results in conservation schemes. Conservation education must increase and be ongoing. Many resources have to be committed to it. A composite view of conservation must require a varied professional background. Land use planners, field ecologists, biogeographers, environmental engineers, business managers and analysts among others may be as equally important on the conservation team as the professional forester if a balanced conservation is to be attained.

Many studies have to be done. This is necessary to assess resource situations and the means to contain them. The ecosystematic approach to forest conservation can provide a guide to all. Suggestions made elsewhere in the text can suit the needs of most developing countries. A proper adoption of these and any other viable programmes in existence can help raise conservation activities to higher levels and save the biosphere.

APPENDIX 2: The Role of Forests

Adapted from World Bank 1978

APPENDIX 3: Time Series Regression of Export Earnings by 2000
From Table VIII

YEAR	Y (EARNINGS IN MILLION US DOLLARS)	X	XY	X ²
1970	39.286	-5	-196.43	25
1971	36.730	-4	-146.92	16
1972	51.095	-3	-153.285	9
1973	123.938	-2	-247.875	4
1974	84.121	-1	-84.121	1
1975	74.620	0	0	0
1976	70.978	+1	+70.978	1
1977	72.355	+2	+144.71	4
1978	58.790	+3	+176.37	9
1979	42.038	+4	+168.152	16
1980	35.613	+5	+178.065	25
∑	689.564	∑	-90.356	∑X ² =110
2000		+25		

Y (required earning)
or

$$= a + bx \dots (1)$$

$$= \bar{y} + \left(\frac{\sum xy}{\sum x^2} \right) x \dots (2)$$

Y

$$= \left(\frac{689.564}{11} + \frac{(-90.356)}{110} x \right)$$

$$= 62.68736 - 0.8214182x$$

$$= 62.68736 - 0.8214182 \times 25$$

$$= 62.68736 - 20.535455$$

$$= \$42.151905 \text{ million}$$

Earning (y) for the year 2000

APPENDIX 4: A List of Species Banned from Exportation in Log Forms

LOCAL NAME	TRADE NAME	SCIENTIFIC NAME
Odum	Iroko	<u>Machlura excelsa</u>
Edinam	Gyedu Nohor	<u>Etandrophragma angolense</u>
Penkwa	Sapele	<u>Etandrophragma cylindricum</u>
Candollei	Omu	<u>Etandrophragma candollei</u>
Efuobrodedwo	Utile	<u>Etandrophragma utile</u>
Baku	Makore	<u>Tieghemella heckelii</u>
Dubini	African Mahogany	<u>Khaya spp.</u>
Dubinbiri	African walnut	<u>Lovoa trichilioides</u>
Krokodua	Afromosia	<u>Pericopsis elata</u>
Nyankon	Niagon	<u>Tarrieta utilis</u>
Wansenwa	Avodire	<u>Terraeanthus africanus</u>
Prono	Mansonia	<u>Mansonia altissima</u>
Hyeduanini	Ovangkol	<u>Guibourtia ehie</u>
Teak	Teak	<u>Tectona grandis</u>

SOURCE: Forestry Department, 1982.

APPENDIX 5: Relationship Between Changes in Unreserved
and Reserved Areas (Based on Table XVIII)

X (UNRESERVED/ 1,000)	X ²	Y (RESERVED/ 1,000)	Y ²	XY
46.63	2174.3569	12.49	156.0001	582.4087
33.67	1133.6689	12.58	158.2564	423.5686
26.60	707.56	15.02	225.6004	399.532
13.10	171.61	15.19	230.7361	198.989
9.28	86.1184	15.18	230.4324	140.8704
8.21	67.4041	15.18	230.4324	124.6270
5.79	33.5241	15.57	242.4249	90.1503
2.65	7.0225	16.79	281.9041	44.4935
$\Sigma x = 145.93$	$\Sigma x^2 = 4381.2649$	$\Sigma y = 118.00$	$\Sigma y^2 = 1755.7868$	$\Sigma xy = 2004.6395$

$$\begin{aligned}
 r &= \frac{\Sigma xy - \frac{(\Sigma x)(\Sigma y)}{n}}{\sqrt{[\Sigma x^2 - \frac{(\Sigma x)^2}{n}][\Sigma y^2 - \frac{(\Sigma y)^2}{n}]}} \\
 &= \frac{2004.6395 - \frac{(145.93)(118.00)}{8}}{\sqrt{[4381.2649 - \frac{(145.93)^2}{8}][1755.7868 - \frac{(118)^2}{8}]}} \\
 &= \frac{-147.828}{\sqrt{(1719.31929)(15.2868)}} \\
 &= -0.9118431
 \end{aligned}$$

approx. -0.9 Answer

APPENDIX 6: Classification of Ghanaian Timbers

Timber Classification used by Department of Forestry,
Government of Ghana, 1977

Class & subclass	Species	Local trade name*	Standard trade name*
1a	<u>Chlorophora</u> spp. <u>Entandrophragma angolense</u> <u>E. cylindricum</u> <u>E. utile</u> <u>Khaya anthotheca</u> <u>K. grandifoliola</u> <u>K. ivorensis</u> <u>Tieghemella heckelii</u> <u>Nuclea diderrichii</u>	Odum Edinam Sapele Utile Anthotheca Odupon Mahogany Baku Kusia	Iroko Gedu nohor Sapele Utile Anthotheca African mahogany African Mahogany Makore Opepe
1b	<u>Pericopsis elata</u> <u>Lourea trichilioides</u> <u>Terminalia ivorensis</u> <u>Triplachiton scleroxylon</u>	Kokrodua African walnut Emire Wawa	Afrormosia African walnut Idigbo Obeche
1c	<u>Heritiera utilis</u>	Nyankom	Niangon
2a	<u>Entandrophragma candollei</u> <u>Guarea cedrata</u> <u>G. thompsonii</u> <u>Lophira alata</u> <u>Piptadeniastrum africanum</u>	Candollei Kwabohoro Kwadwuma Kaku Dahoma	Omu Scented guarea Black guarea Ekki Dahoma
2b	<u>Antiaris toxicaria</u> <u>Gurubourtia ehie</u> <u>Mansonia altissima</u> <u>Mitragyna ciliata</u> <u>Mesogordonia papaverifera</u> <u>Lurreanthus africanus</u>	Kyenkyen Shedua Opron Subaha Danta Avodire	Antiaris Mansonia Abura Danta Avodire
3	<u>Azelia</u> spp. <u>Albizia andianthifolia</u> <u>A. ferruginea</u> <u>A. zygia</u> <u>Anoxyris klaineana</u> <u>Canarium schweinfurthii</u> <u>Celtis adolfi-friderici</u> <u>C. mildbraedii</u> <u>C. zankari</u> <u>Cylicodiscus gabunensis</u> <u>Cynometra ananta</u> <u>Diospyros sanza-minika</u> <u>Distemonanthus benthamianus</u> <u>Erythrophloeum ivorense</u> <u>Holoptelea grandis</u> <u>Lammas africana</u> <u>Morus mesozygia</u> <u>Peterianthus macrocarpus</u> <u>Pyonanthus angolensis</u> <u>Scottellia klaineana</u> <u>Sterculia chinopetala</u> <u>Strombosia glaucescens</u> <u>Terminalia superba</u>	Papao Pampena Awiemfo-samina Okuro Kokoti Bediunua Esabiri Esa Esakoko Denya Ananta Kisibiri Bonsamdua Potrodom Onakwa Bompeggya Wonton Esia Otie Koroko Wawabima Afina Ofram	Azelia Albizzia Albizzia Okuro Kokoti Canarium Celtis Celtis Celtis Okan Apome Kusibiri Ayan Missanda Mumuli African apple Difou Essia Ilomba Odoko Sterculia brown Afina Afara

* Names from Pergusson (1970) and Taylor (1960) (cited from Hall and Swaine (1981))

APPENDIX 7: Trees for Timber, Firewood, Fencing, and Forage

SCIENTIFIC NAME	COMMON NAME	SPECIAL VALUES, HABITAT
<u>Ainus spp.</u>	Alder	Timber, fixes N; cool, moist montane
<u>Anthocephalus chinensis</u> A. Fich. ex Walp.	Kadam	Timber, veneer, cabinetwood; fast growing; moist to wet lowlands and foothills
<u>Bombacopsis quinatum</u> Dug.	False cedar	
<u>Casuarina equisetifolia</u> L.	Australian beefwood	Construction timber, fast growing; dry to wet lowlands
<u>Cedrela odorata</u> L.	Spanish cedar	Windbreak, hedge, fuel (dense wood); propagated from cuttings, fixes N; dry to moist lowlands and foothills
<u>Ceiba pentandra</u>	Kapok	Boxwood, fibre, edible leaves, fast growing; dry to wet lowlands or foothills
<u>Colubrina arborescens</u> Sarg.	Coffee colubrina	Water resistant construction timber, coffee shade; dry to wet lowlands and foothills
<u>Cordia alliodora</u> Oken	Capa	Timber, furniture, posts, coffee shade; dry to wet lowlands and foothills
<u>Cupressus lusitanica</u> Mill.	Mexican cyprus	Timber, pulp; summer rains, foothills to montane
<u>Eucalyptus spp.</u>	Eucalypt	Timber, fuel, rapid growth; individual species adapted to variety of climates
<u>Gmelina arborea</u> Roxb.	Gmelina	Pulp, posts, fast growing; moist to wet lowlands and foothills
<u>Ochroma spp.</u>	Balsa	Light wood for construction, fast growing; moist to wet lowlands or foothills
<u>Pinus caribaea</u> Morelet	Caribbean pine	Timber, pulp; summer rainfall, low elevations
<u>Pinus oocarpa</u>	Ocote pine	Timber, pulp; summer rainfall, intermediate elevations
<u>Pinus radiata</u> Don.	Monterrey pine	Timber, pulp, winter rain and dry summer; low to high elevation

APPENDIX 7: Trees for Timber, Firewood, Fencing, and Forage (cont'd)

SCIENTIFIC NAME	COMMON NAME	SPECIAL VALUES, HABITAT
<u>Sumaruba glauca</u>	Paradise tree	"Living fencepost," fuel, oil for soap; monsoon to rain forest in lowlands
<u>Syzyetia macrophylla</u> King	Honduras mahogany	Timber, furniture, durable, wood resistant to termites; dry to wet lowlands
<u>Syzzygium jambos</u> Alston	Rose apple	Fuelwood, charcoal, heavy yield, fruit; dry to moist lowlands and foothills
<u>Tectona grandis</u> L.f.	Teak	Timber, furniture; deep soils at low elevations, dry to moist
<u>Teona ciliata</u> Roem.	Burma toon	Furniture; moist to wet foothills at mid-altitudes
	Leguminosae	
<u>Acacia albida</u> and other spp.	Tibet tree	Forage; drought resistance
<u>Albizia lebbek</u> Benth. and other spp.	Bauhinia	Fuel, construction wood, leaves and pods as forage; drought resistance
<u>Cassia</u> spp.	Cassia	Forage, fuel
<u>Erythrina berteroana</u> Urban and other spp.	Machette	Forage, green manure
<u>Gleditsia</u> spp.		Shade, forage, hedges
<u>Gliricidia sepium</u> Steud.	Mother of coca	Forage, fencing, hedge, sprouts from stakes, edible flowers; widely adapted
<u>Inga</u> spp.	Spanish oak	Coffee shade, fuel, edible pulp; wet tropics
<u>Leucaena leucocephala</u> de Wit.	Tantan	Forage, fuelwood, timber, windbreak, shade, fast growing high density wood, young pods and leaves as human food, dye from pods, mainly dry tropics
<u>Pithecellobium dulce</u> Benth.	Blackhead	Forage, hedges, edible pulp, construction wood, tannin, dye; drought resistant
<u>Prosopis juliflora</u> (Sw.) DC. and other spp.	Mesquite	Fuel, leaves and pods as forage; very drought resistant
<u>Sesbania grandiflora</u> Pers.	Sesban	Forage or green manure, pods, young leaves and flowers parts edible, bark yields fibre, dye from sap, fuel, pulp; common in dry areas
<u>Tamarindus indica</u> L.	Tamarind	Excellent fuel, fruit and vegetable source; widely adapted

SOURCES: Golfari, 1963; Little and Wadsworth, 1964; Lamb, 1966; Critchfield and Little, 1966; Grijsa, 1969; Kadambi, 1972; Salazar and Albertin, 1973, 1974; National Academy of Sciences, 1977; Wadsworth 1943; Rosevears, 1948; Whyte, Nilsson-Lessner and Trumble, 1953. Cited from Weaver, 1979.

APPENDIX 8: Summary List of Species by Climatic Types

CLIMATIC TYPE	SPECIES ¹	METHOD OF ESTABLISHMENT ²
2. SUBDESERT (Annual rainfall 200-400 mm, 8-11 dry months in the year) Dependent on rainfall alone Dependent on irrigation, annual flooding or extraneous subsoil mixture	<u>Acacia senegal</u> <u>Prosopis chilensis</u> <u>Acacia alba</u> <u>Acacia nilotica</u> <u>Azadirachta indica</u> <u>Conocarpus lancifolius</u> <u>Dalbergia sissoo</u> <u>Eucalyptus camaldulensis</u> <u>Eucalyptus microtheca</u> <u>Eucalyptus tereticornis</u>	DS DS (PP) PP (DS) DS St or PP St St PP PP PP
3. DRY TROPICAL (Annual rainfall 400-1,200 mm but generally below 1,000 mm. Dry season 6-8 months)	<u>Anacardium occidentale</u> (<u>Callitris</u> spp.) (<u>Cassia siamea</u>) (<u>Dalbergia sissoo</u>) <u>Eucalyptus camaldulensis</u> (<u>Eucalyptus citriodora</u>) <u>Eucalyptus microtheca</u> <u>Eucalyptus tereticornis</u>	DS PP St St PP PP PP PP
4. SEMIHUMID TROPICAL (Annual rainfall 1,000-1,500 mm Dry season 4-5 months)	(<u>Acrocarpus fraxinifolius</u>) <u>Araucaria cunninghamii</u> <u>Callitris calcarata</u> <u>Callitris glauca</u> <u>Callitris intratropica</u> <u>Callitris robusta</u> <u>Cassia siamea</u> <u>Eucalyptus camaldulensis</u> <u>Eucalyptus</u> sp. 12 APL <u>Eucalyptus citriodora</u> <u>Eucalyptus cloesiiana</u> <u>Eucalyptus propinqua</u> <u>Pinus caribaea</u> <u>Pinus kesiya</u> <u>Pinus merkusii</u> <u>Pinus oocarpa</u>	St or large PP PP DS or PP DS or PP DS or PP DS or PP St (DS) PP PP PP PP PP PP PP PP PP PP
5. HUMID TROPICAL (Rainfall over 1,500 mm, 0-3 dry months)	<u>Acrocarpus fraxinifolius</u> <u>Araucaria cunninghamii</u> <u>Chlorophora excelsa</u> <u>Chlorophora regia</u> <u>Eucalyptus deglupta</u> <u>Gmelina arborea</u> <u>P. caribaea</u> <u>P. kesiya</u> <u>P. merkusii</u> <u>P. oocarpa</u> <u>Tectona grandis</u>	Large St or large PP PP St St PP St PP PP PP PP PP PP St

1 Species in parenthesis are occasionally used on specially favourable sites but more generally in the next moister climatic type.

2 DS = Direct sowing. St = Stump planting. PP = Pot planting.

Adapted from FAO, 1974: 72

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