The United Republic of Tanzania
Ministry of Natural Resources and Tourism

INTEGRATED FIRE MANAGEMENT
GUIDELINES FOR COMMERCIAL FORESTRY

Forestry and Beekeeping Division
April 2019

FOREWORD

Forests and woodlands cover about 48.1 million hectares (ha) equivalent to 55% of total land surface area of Tanzania Mainland. It is estimated that forests through wood products contribute up to 3.5% to gross domestic product (GDP) and over 20% to subsistence economy and employs 3 million people in rural and urban areas. Contribution of forest resources to the GDP is mainly through tourism, hydropower generation and supply of wood energy while for livelihoods is through supply of employment, domestic water, timber and non-timber forest products and creation of microclimate for other productive activities including agriculture. In Tanzania commercial forestry is gaining prominence to meet the growing economy and population demands. Thus, in addition to other benefits, it helps to reduce importation of sawn timber and poles which is predicted to be sustained over the coming decades.

Despite the appreciated importance of forests, fire is one of the major threats to sustainable forest management and commercial forestry. Fire has indeed significant negative impacts on forest resources and biodiversity, and has sometimes caused loss of life particularly where fire escaped the control in Tanzania. Major commercial forestry stakeholders affected negatively by fire are large scale forest plantation operators, local forest plantations' investors and small-scale tree growers. There have been efforts by these and other stakeholders to manage fire but because of lack of coordination, clearly defined roles and responsibilities and activities combined with limited mitigation and response capability, high frequency and severity of fire outbreaks have continued causing significant impact on forest resources. Thus, the Ministry of Natural Resources and Tourism (MNRT) which is mandated to oversee natural, cultural and tourism resources through Forestry and Beekeeping Division (FBD) has developed Integrated Fire Management (IFM) guidelines to provide systematic leadership and intervention options to prevent, control and suppress fire in commercial forestry.

The IFM guidelines have been prepared based on current forest fire trends, existing national policies including the recently reviewed forest policy, Food and Agriculture Organisation (FAO) recommendations and the increasing investments in small, medium and large-scale commercial forestry in the country. It also considers cumulative traditional and scientific knowledge, experience, past successful efforts in the forestry and other related sectors on enhanced fire management in different landscapes. Therefore, these guidelines are prepared to provide simple, practical and applied coordinated instructions, activities and principles to be used by any person working on management of fire using integrated approaches. It is hoped that the guidelines will contribute to reduce the negative impacts of fire on forest resources, livelihoods and the economy.

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ACKNOWLEDGEMENTS

These Integrated Fire Management (IFM) guidelines are a result of consultative process and various contributions from many individuals, communities, organisations, leaders and governments both local and central without which development, production and dissemination would be impossible to make. Experienced commercial woodlot and plantation owners, forest managers in public and private sectors, plantation operators, members of Tree Growers' Associations (TGAs), policy makers, planners, support organisations, implementing agents, contractors and forestry investors contributed by providing on ground and field experiences and expertise that added value to the IFM guidelines.

I would like to extend my appreciation to Working on Fire Africa Limited (WoFA) for preparatory work on IFM guidelines for plantation forests in Tanzania, which formed the base for the development of present guidelines. These guidelines benefitted greatly from their synthesized and articulated information and experience on IFM from elsewhere in the world.

I am indebted to Dr Samora A. Macrice and Mr Paulo J. Lyimo from the Department of Ecosystems and Conservation, Sokoine University of Agriculture for leading the process and collating important and relevant information to guide the development of IFM guidelines to foster development of commercial forestry in Tanzania.

On behalf of the MNRT and the FBD I would like to thank Forestry Development Trust (FDT) for financial assistance, technical guidance and logistical arrangements levelled in the development and production of the IFM guidelines.

I urge that all stakeholders in commercial forestry at small, medium and large scales and in private and public institutions use effectively these guidelines to enhance productivity and meet increasing demand for wood raw materials in the country.

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ABBREVIATIONS and ACRONYMS

CBFiM	Community Based Fire Management
Cm	Centimetre
FAO	Food and Agriculture Organisation of the United Nations
FOs	Farmers organisations
FBD	Forestry and Beekeeping Division
FDI	Fire Danger Index
FDT	Forestry Development Trust
FFO	Forest Fire Officer
FTI	Forestry Training institute
GDP	Gross Domestic Product
GRL	Green Resources Limited
KVTC	Kilombero Valley Teak Company
Ha	Hectare
IC	Incident Commander
ICS	Incident Command System
IFM	Integrated Fire Management
Kg	Kilogramme
m	Meter
m.a.s.l	Meters above sea level
Mngt	Management
MNRT	Ministry of Natural Resources and Tourism
MODIS	Moderate Resolution Imaging Spectroradiometer
NFC	The New Forests Company
NGO	Non-governmental Organization
PA	Protected area
PIO	Public Information Officer
PFM	Participatory Forest Management
PFP	Private Forestry Programme
PPE	Personal Protective Equipment
RH	Relative humidity
SHI	Sao Hill Industries
SHFP	Sao Hill Forest Plantations
SUA	Sokoine University of Agriculture
TANWAT	Tanganyika Wattle Company Limited
TFS	Tanzania Forest Services
TGAs	Tree Growers' Associations
TZS	Tanzania Shilling
TFRF	Tanzania Fire and Rescue Force
Yr	Year
VC	Village council
VEC	Village Environmental Committee
VFMT	Village Fire Management Team
VG	Village Government
VNRC	Village Natural Resource Committee
WDC	Ward Development Committee
WOFA	Working on Fire Africa Limited

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

SCOPE AND TARGET AUDIENCE

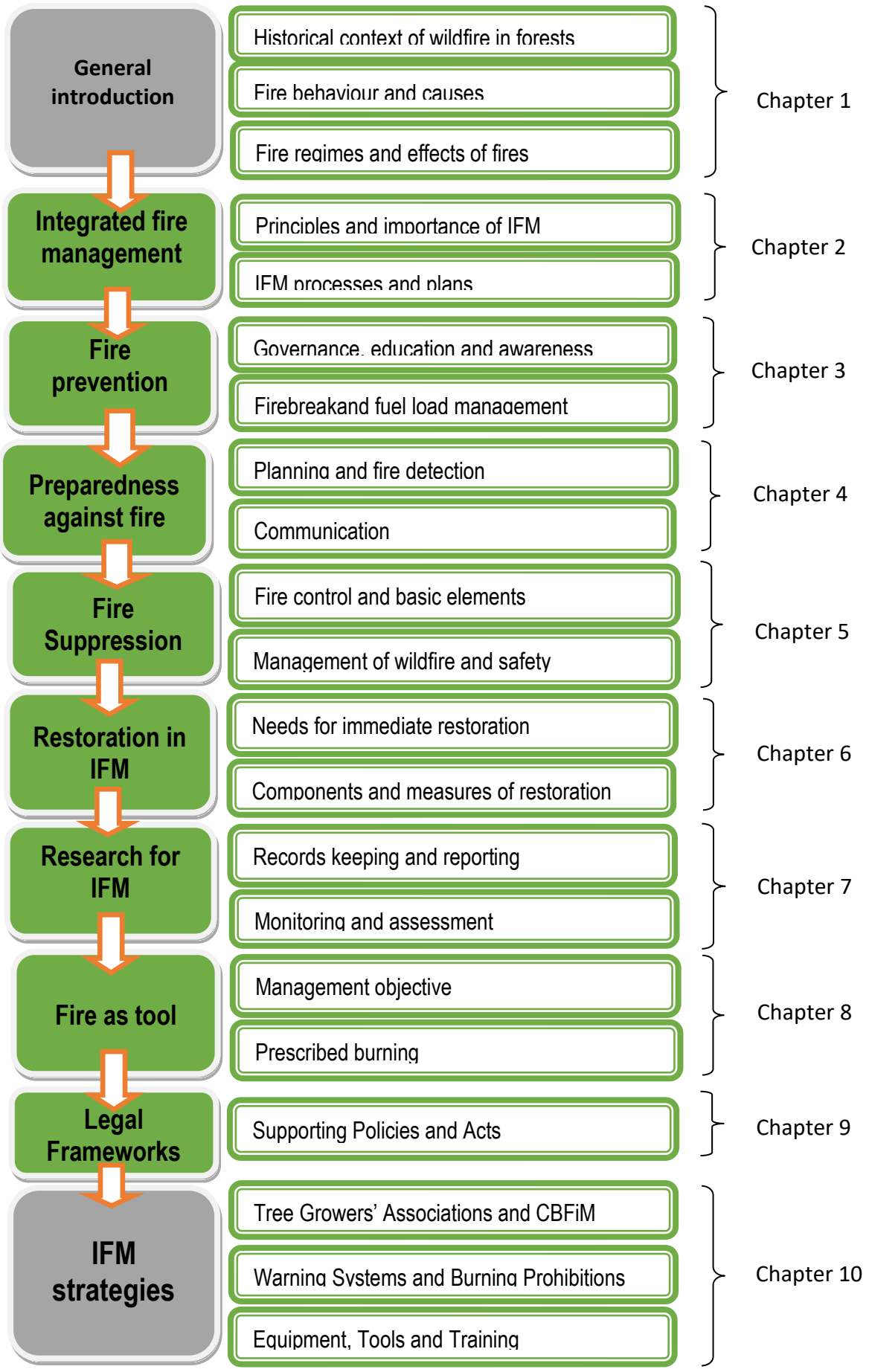
These technical guidelines aim to provide relevant information and procedures based on the best available science, to develop key strategies and implement actions that reduce the number of unplanned ignitions from human causes. Also, the guidelines support timely and effective risk-based decisions to prepare an effective response to all plantation and woodlot fires. The guidelines should be followed to avoid damages and impacts caused by fire and ensure well-managed plantations and woodlots contribute to poverty reduction, economic development and environmental stability of Tanzania.

The intended audiences for the guidelines are forest plantation managers from the public and private sectors, village authorities managing fire funds, forestry extension staff, TGAs and all those involved in developing learning and teaching materials for forest management particularly fire management. In this way, the guidelines are intended to be used as the technical basis for developing other tailor-made materials, such as teaching, education and extension materials (e.g. videos, leaflets, posters and trainer guides) and specific fire management strategic actions.

It should be noted that responsible management of forest/woodlot fires should also consider institutional, policy, legal, economic, social and cultural aspects as are principles of integrated fire management.

Reference guide

The diagram over the page provides easy reference to using these guidelines:


General introduction
Historical context of wildfire in forests
Fire behaviour and causes
Fire regimes and effects of fires
Chapter 1
Integrated fire management
Principles and importance of IFM
IFM processes and plans
Chapter 2
Fire prevention
Governance, education and awareness
Firebreakand fuel load management
Chapter 3
Preparedness against fire
Planning and fire detection
Communication
Chapter 4
Fire Suppression
Fire control and basic elements
Management of wildfire and safety
Chapter 5
Restoration in IFM
Needs for immediate restoration
Components and measures of restoration
Chapter 6
Research for IFM
Records keeping and reporting
Monitoring and assessment
Chapter 7
Fire as tool
Management objective
Prescribed burning
Chapter 8
Legal Frameworks
Supporting Policies and Acts
Chapter 9
IFM strategies
Tree Growers' Associations and CBFiM
Warning Systems and Burning Prohibitions
Equipment, Tools and Training
Chapter 10

1. GENERAL INTRODUCTION

1.1 History of fire in forest plantations and woodlots

Tanzania has a total forest area of 48.1 million hectares (ha), which is 55% of the total land area of Tanzania main land. Woodlands occupy 44.7 million ha which is 92% of the total forest area and forest plantations cover a total area of 554 500ha which is 1.2% of the total forest area of Tanzania mainland. Out of this, government owns about 95 000 ha, private industrial plantations 40 000 ha and the total area of private woodlots is about 419 500 ha (MNRT, 2015). Main species planted in woodlots and forest plantations throughout the country include *Pinus patula, P. elliottii, P. caribaea, P. kesiya, Eucalyptus* species, *Cupressus lusitanica,Tectona grandis, Acacia mearnsii*, C*edrela odorata, Grevillea robusta* and *Juniperus procera*. Pines are the dominant species in most of the government, private plantations and woodlots with about 78% of the total area planted and the remaining 22% is shared among hardwoods and other softwood species (PFP, 2017). A survey in many places show that, tree species planted include those for timber, building poles, firewood, tanning, charcoal production and water sources protection and conservation (Ngaga, 2011).

Most of the forest plantations and woodlots planted areas are situated in the Southern Highlands of Tanzania. This is because of favourable altitudes ranging from 1,300 to 2,000 meters above sea level (m.a.s.l.), annual rainfall exceeding 1,000 mm p.a. and mild temperatures. Most of forestry companies are invested too in Southern Highlands of Tanzania including Sao Hill Industries (SHI), Green Resources Limited (GRL), Mufindi Paper Mill (MPM) and New Forestry Company (NFC). These forest companies, woodlot owners and government forest plantations experience forest fire, which causes great economic losses.

Fire has been used in Tanzania for hundreds of years for preparing land for agriculture and pasture management as well as for hunting, pest control and other land management reasons. Fire is a tool to achieve wildlife and conservation management targets. For rural people fire is a viable economical tool for the attainment of various land management objectives. Local communities often have traditional knowledge on how to manage and prevent fire. However, the intricate balance between people, fire and the natural environment has been difficult to attain due to the changing demographics, land management practices and a breakdown in relay channels of indigenous knowledge used in natural resource management. There is growing concern over the fate of the perceived rise in the number of fires and associated negative impacts on forests and woodlands resources, and human livelihoods under the ongoing climate change.

The satellite image data (MODIS) reveal that an average of 11 million ha burns annually in Tanzania. Most of the burning occurs in the west and southern highland regions particularly Rukwa, Tabora, Kigoma and Mbeya, as well as the south-eastern part Lindi region. The land cover types most affected are woodland and shrub land comprising of about 70 % of Tanzania's average annual burned area or 7.7 million ha. Most burning occurs in protected areas, with an annual average of 3.7 million ha in forest reserves, 3.3 million ha in Game Reserves and 1.5 million ha in National Parks, totalling close to 8.5 million ha or 77% % of the annual average burned area of Tanzania.

According to Lulandala et al. (1995) between 1985 and 1987 at Southern Highlands Forest Plantations (SHFP) there were 105 incidences of forest fires destroying 5,665 ha of plantation forests. Between 1999 and 2001, MNRT (2001) reported that a total of 7,644 ha of forest plantations were destroyed by forest fires at SHFP alone. Like in other places, fires at SHFP are mainly caused by human activities. Fire destroyed more than 1,600 ha of compartments of Pine spp. in SHFP of age between 3–20 years, worth about TZS 876 million in 2009. The cause of this fire was from neighbouring villages or communities during farm preparation, assisted by strong winds. In 2010 GRL operating in the Mufindi District lost about 1,900ha of young Pine and Eucalyptus plantations (1–12 years) with an estimated loss of about 10million US$ or about 10 billion TZS. The cause was considered to be arson and the entire area was re-established.

In 2016, GRL lost 536 ha of forest plantation because of wildfire from village land south-east of Ukami plantation. Between 2008 and 2016, about 988 ha of Wattle, Pine and Eucalyptus plantations were completely burned at TANWAT. The main cause of fire was agricultural farm preparation adjacent to TANWAT plantations. About 605 ha were completely burned in Wino, Ifinga and Mkongotema forest plantations of Ruvuma in 2017. The source of fire was agricultural farm preparations. The fire return period in Tanzania is about 8 years. However, most of the landscape is fire-dependent with return periods of 1-5 years. In addition, the burned areas are most probably 2-3 times over-estimated by remote sensing technology (TerrAfrica, 2016). Most burned areas are recorded in the months from May to October, with the peak fire activity in July and August. The number of fires per year is reasonably consistent.

Though forest fires have become of much concern in recent times due to their direct negative impacts on the environment and human livelihoods, the impact of fires have not been uniformly negative, because not all fires are destructive. Thus, sustaining and maintaining ecosystems and the related land management and livelihoods goals through appropriate fire management practices need to consider both the beneficial and damaging (Figure 1) effects of fires.

1.2 Forest plantation/woodlot fire behaviour

Fire behaviour refers to the dynamic properties such as rate of spread, the energy profile and the rate of energy release (intensity).To understand the way in which fire burns, we first need to understand the phenomenon of fire: what causes fire? why and how does it burn? And why are there flames? This knowledge will enable fire fighters and forest managers to: (i) develop more effective and efficient fire management plans;(ii) work safely; and (iii) train more efficiently.

Fire, or process of combustion, is a chemical reaction called rapid oxidation, and is accompanied by production of heat and light. Compare with rusting or rotting of wood. Combustion is similar to photosynthesis in reverse order.

Figure 1: Damaging/negative impact of forest fire

Principles of Combustion:

Fire triangle

Sufficient fuel, heat, and air (oxygen) must be present for fire to persist. This interrelationship is called fire triangle (Figure 2).

Figure 2: Fire triangle

Eliminating or reducing any of the three, the fire goes out and is a means of fire control.

Fuel is a vegetative matter that will burn. Dry dead vegetation is a primary fuel while green/live vegetation is a secondary fuel. Heat is a form of energy produced by mechanical means, electrical, chemical and lightning. As you increase heat to any fuel, molecules break and vapour bursts to flames. In order to start fire, fuel must be brought to the ignition temperature (varies from between 220-250^{0}C depending on the fuel). If the heat drops below the ignition temperature, fire goes out.

Ignition is the beginning of flame propagation or burning; the starting of fire and the ignition temperature refers to the temperature at which a fuel ignites, and a flame is self-propagating. About 21% of the air is oxygen (O_2) and reduction of O_2 below 15% in air, fire will stop. Wind which contains O_2 also carries away moisture-laden air and speeds up the drying of fuels consequently increasing flammability. The direction of spread of fire is determined mostly by wind.

1.3 Factors influencing fire behaviour

Fire behaviour knowledge could be used in controlling burns and in firefighting. There are three main factors influencing fire behaviour: fuel, topography and weather.

(i) Fuel

Fuel is any organic material either dead or living that will ignite and burn. The intensity of fire will be determined by size of fuel, arrangement/compactness, continuity, volume, condition, location and kind. Fine fuels comprise twigs, leaves, grass and small branches and ignite easily, burn for short period, easy to extinguish, and loose moisture fairly quickly. Conversely heavy fuels such as logs, snags, stumps behave the opposite of above. They also need much more heat to reach ignition temperature than a light fuel. Loosely packed fuel ignites easily and burn readily, due to easy air supply. They also loose moisture fairly fast. Tightly packed fuel ignites slowly due to less air supply and is slowly in losing their moisture. In forest plantations and woodlots, especially with even age form continuous fuel in the floor and crown. Fire intensity is directly proportional to the amount of fuel available

for combustion at any given rate of spread of fire front. Volume determines total heat generated and the total heat volume plays a big part in fire spread. Fire behaviour is greatly influenced by the vertical distribution of fuels namely, ground, surface and aerial fuels. High moisture content fuel burns slowly while low moisture content fuel burns quickly. Flammability is determined by burning characteristics of individual materials. Pine needles will burn faster than Teak leaves due to resins contained in the former trees.

(ii) Topography

Topography refers to the physical features of the earth's surface and is a result of slope, shape, and aspect. Slope significantly influences the forward rate of spread of fire burning up-slope by increasing the degree of preheating of unburnt fuel immediately in front of the flames. Conversely, a down-slope decreases the rate of spread of surface fires and at low wind speeds has the effect of converting a head fire into a back fire. Speed of air movements depends on degree of slope. Under same conditions, fire will burn more rapidly on steep slopes than they will on more gradual slopes. Fire could move up slope during daytime, since air rises when heated by sun. The cycle is reversed at night; as cool air moves downhill. Speed increases with narrow valley and decreases with wide valley. The occurrence of fire and the rate of spread will vary according to the aspect, with more and fierce fires on south and southeast slopes.

(iii) Weather

Time of the day and seasonal changes influences the weather which in turn influences fire behaviour. The basic weather elements which should be considered in wildfires are: precipitation, temperature, wind and relative humidity. Each of these elements contributes to the atmospheric stability of a given forest plantation or woodlot. They are also important in firefighting. The heavy fuels are more likely to hold their moisture content longer. Air temperature directly influences the temperature of the fuel and therefore the quantity of heat energy required to raise it to its ignition point. Air temperatures also reduce efficiency of fire fighters. Wind affects the rate at which fuel dries, increase supply of Oxygen to the fuel, influences direction of spread, and rate of spread. Wind can also carry burning ambers across a narrow fuel break, thereby causing the fire to jump the fuel break. It is difficult to work against wind during firefighting. High Relative Humidity (RH) reduces the intensity of fire and low RH increases it. Practical experience shows that the intensity of a fire is potentially high when the RH is around 30%.

1.4 Causes of forest plantation/woodlot fires

Forest/woodlot fire ignition sources are similar to those found elsewhere in the world basically lightning or caused by man. Ignition by lightning is rare in Tanzania because thunderstorms usually occur in the rainy season when vegetation is too wet to support ignition. Most wildfires are caused by human activities particularly farm preparation, game hunting, honey hunting, grazing, charcoal making, prescribed burning, arson, and others including smokers, mining and pit sawing.

(i) Farm preparation

The use of fire to clean farms (slash and burn) is considered to be the principal cause agents of wildfire in Tanzania. Most fire outbreaks in forest plantations and woodlots originate from surrounding village lands during farm preparation for crop cultivation. There should be good relations among communities and between communities and large plantation owners. Communities should be educated on fire danger and good fire management and should seek assistance from forest extension officers or forest plantation management before setting fires. Communities should also develop by-laws on fire prevention and control.

(ii) Game hunting

Game hunters set fire on biomass deliberately in order to drive wild animals to intended destiny or to attract them later to the re-growing grass on burnt areas for an easy catch. Sometime, game hunters forced to burn the bush to in order to open up the area and increase visibility.

(iii) Honey collection

Most of the local beekeepers use fire during harvesting honeybee. In the process of harvesting honey, beekeepers use smoke to drive away bees but often do not extinguish the fires, which lead to accidental or unwanted fires. Honey hunters should be encouraged to seek assistance from forest plantation staff during honey collection.

(iv) Grazing

Some of livestock keepers setting deliberate fires in grasslands is meant to improve pasture quality and, in some areas, to eradicate parasites such as ticks or tsetse flies.

(v) Charcoal making

Charcoal making is among serious human activities which cause uncontrolled wildfire in forest plantations and woodlots in Tanzania.

(vi) Prescribe burning

Prescribed burning is controlled application of fire to wildland fuels in either their natural or modified state, under specified environmental conditions which allow the fire to be confined to a predetermined area and at the same time to produce the intensity of heat and rate of spread to attain planned resource management objectives. Prescribed biomass burning especially in forest plantations and woodlots, at the beginning of the dry season, is done to reduce amount of biomass and therefore, maintain conditions that could not lead to uncontrolled wildfires. Unfortunately, poorly planned prescribed burning sometimes leads to uncontrolled fire and causes damage.

(vii) Arsonism

Thismaybecausedbyworkersorneighbours.Unhappyworkersandneighboursmay set fires to vent their anger. Fair and timely payments to workers according to government regulations and resolving disputes amicably with workers and communities are ways to prevent arsonism.

(viii) Others

From pedestrian (smokers) induced fires, mining and pit sawing. Cigarettes thrown from car windows can cause fires. In essence, the basic underlying cause of frequent smokers is the problem of lacking knowledge on the effects of disposing a piece of cigarette in the forest/woodlot. There should be warning signs on major roads passing through forest plantations and woodlots.

1.5 The anatomical parts of a forest fire

Forest fires can be distinguished in the following parts (Figure3). Detailed explanations on parts of forest fire are provided on Table 1.

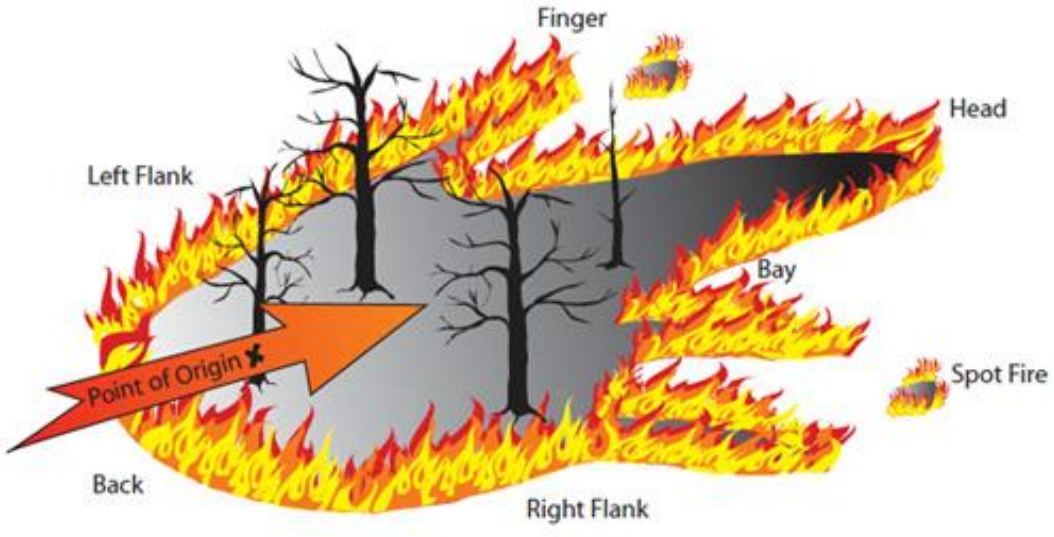


Figure 3: The anatomical parts of a forest fire

1.6 Types of forest fire

Three types of fire are recognized according to the layers in which the vegetation burns, namely ground, surface, and crown fires.

(i) Ground fire

It is the fire that burns below the surface of the ground in deep layers of organic material and plant debris. It follows surface fire. Slow moving but very destructive.

(ii) Surface fire

It burns the surface vegetation, the most common form being a grass fire either in grassland or in the understorey in wooded communities. Most common fire in tree and shrub vegetation and can develop into crown fire when foliage ignites and carries the fire above the surface of the ground.

(ii) Crown fire

Advances from top to top of trees and shrubs and can be more or less independent of surface fire. In practice all three types of fire may occur simultaneously or in all possible combinations (Figure 4).Fires can be further subdivided into those burning with or

against the wind. These are referred to as head fires and back fires respectively and they could have significantly different effects in open plant communities. Crown fires occur only as head fires but surface fires occur as either head or back fires. These two types of surface fire (head and back fires) have different fire behaviour characteristics that are very pertinent to an understanding of the effect of fire and its use in management of ecosystems for livestock, wildlife and water catchment purposes.

Table 1: Anatomical part of typical forest fire

Part	Explanations
Head	The most rapidly spreading part of a fire's perimeter. It often burns intensely and may move forward at a dangerously fast rate.
Finger	Long narrow tongue of fire projecting from the main fire body. Each finger has an individual "head" and "flanks".
Flanks	Those portions of the fire perimeter that are between the head and the back of the fire which are roughly parallel to the main direction of spread. (Synonym: Sides.)
Bay	A marked indentation in the fire perimeter, usually located between two fingers. (Synonym: Pocket).
Back	That portion of the fire perimeter opposite the head; the slowest spreading part of the fire. (Synonyms: Base, Heel, and Rear.)
The edge	The boundary of fire at any given moment. It can be active burning with varying intensities, or completely extinguished.
Jump fire or spot fires	Occur in advance of the main fire and are started by burning sparks or embers carried from the main fire by air currents.
Pockets	The indentations in the fire edge formed by fingers or slow burning areas.
Island	Area of unburned fuels located within the fire perimeter.
Point of Origin	The location within the fire perimeter where ignition first occurred.

1.7 Classification of forest plantation/woodlot fires

Basically, there are three classifications of forest/woodlot fires namely;

(i) Small fires

A small fire is one that has not yet built up to serious proportions of intensity and spread. It can be controlled with the forces of hand by initial direct attack.

(ii) Medium fires

Medium fires are of serious intensity, depending on the fire fuel and weather conditions. They can burn both as a surface and a crown fire.

Figure 4: Unburned (left) and burned (right) forest plantation

(iii) Large fires

Large fires are fires which do the most damage, often reaching catastrophic proportions. Many large fires are a result of adverse conditions of weather and topography. Fighting is normally indirect.

1.8 Fire regimes

Fire regimes are factors which collectively are important in determining the effects of fire on the biota. These features include the following components; fire intensity, fire frequency, season of burning, the extent (or patchiness) of a fire and type of fire. Basic tropical and sub-tropical fire regimes are determined by ecological and anthropogenic (socio-cultural) gradients.

Factors affecting the components of the fire regime

Several factors affect the components of fire regime; however, the ultimate regulating factor for any fire regime is climate.

(i) Intensity

The intensity of fire once ignited, will be influenced by climate, topography (slope and aspect), fuel load, fuel type and chemistry, and vertical and horizontal distribution of fuel. The fire history of the site can have a marked effect on the intensity of a fire, via fuel availability. A site that was burnt recently will have been unable to accumulate adequate fuel to support an intense fire. Thus, there is close link between fire intensity and fire frequency.

(ii) Season

The over-riding determinant of fire season will be climate, because this determines the season of occurrence of man-made and natural ignition sources such as lightning. Fire season can be measured easily for a given location and related to the timing of plant growth and drying out. In the savannah, fire season is usually during dry season and particularly when people are preparing their agricultural fields and/or when they burn to stimulate grass growth.

(iii) Extent

The extent of fire is influenced by many features of fire behaviour, particularly the landscape because natural topographic features such as ridges, gullies and lakes can provide natural fire breaks. Vegetation heterogeneity associated with soils or topography is also important.

(iv) Type

The type of fire, whether it burns the organic soil layers and/or the vegetation and litter, must ultimately be determined by the presence of an organic soil layer. This will depend upon the past vegetation and climate.

(v) Frequency

This will depend on; the time required building up a load of available fuel since the past fire, and the frequency of ignition. Fires are more frequent in the Miombo than in dry savannahs due to high fuel loads and high frequency of ignition. In dry savannahs, there is low fuel load after any fire and building up could take longer period and consequently low fire frequency.

1.9 Conclusion

Tanzania has a significant portion of forests and woodlands which cover 55% of total land surface area of Tanzania Mainland. There are also undeniable increasing trends in investments on small, medium and large scales commercial forestry in Tanzania. On the other hand, fire has traditionally been used to meet different land management objectives in Tanzania. However, increased annual burnt area poses a real challenge to sustainable forest management and commercial forestry. This calls for attention of natural resource managers, forest investors and contractors, and policy makers. Knowledge of fire history, behaviour, trends, causes and regimes in forest plantations and woodlots facilitate better understanding and opens a door for integrated fire management design and implementation.

2. INTEGRATED FIRE MANAGEMENT

2.1 Introduction

The world is becoming more integrated, and “integration” is increasingly surfacing as the most important concept in modern society. In the field of natural resource management, ‘integration’ emerged as an important concept (CGIAR 2004), owing to the numerous complex systems involved including fire management in natural and plantation forests. The concept of integrated fire management (IFM) offers a holistic framework for managing fires in fire-dependent ecosystems such as the savannah ecosystems while providing associated co-benefits for local communities as well as sustaining ecosystem services. IFM consists of five elements namely Prevention (Risk Reduction), Preparedness (Readiness), and Suppression (Response), Restoration (Rehabilitation) and Data collection and Analysis (Research). These elements entail various subthemes and activities considering environmental, social, economic and political-administrative aspects.

Traditionally fire management is rooted in forestry and thus had until recently mostly considered firefighting as a top priority to protect forest resources. However, fire management is not only a technical aspect of fighting (forest) fires, but rather a socio-economic, cultural and political challenge, which requires an effective network of partners, agreements and cooperation strategies to achieve the balance between economic development, environmental protection and conservation. Technology transfer and training in fire management is only one aspect of the fire problem. It is the complexity of socio-economic, cultural as well as land-use policies and conditions that lead to a fire problem. Drivers and supporting policies behind the use of fire make it necessary to have a closer look at the design of the interventions to achieve long term impact.

Therefore, fire management is a cross sectoral issue, thus equally important is involving the various relevant stakeholders comprising of government agencies, private sector and local communities on the basis of (inter-agency) cooperation for the implementation of the necessary technical, logistical, operational and social programmes striving to balance between developing and conserving natural resources and managing unwanted fires while at the same time promoting the safe use of beneficial fires.

The integrated approach to fire management is set out comprehensively in the Fire Management Voluntary Guidelines (FAO, 2006), and involves:

- Integrating all activities related to fire management, such as prevention, preparedness, suppression and restoration, into one coordinated process of fire management policy, planning and implementation;
- Integrating the use of fire as a land-management tool and the management of devastating wildfires into one process, which involves the acceptance of fire use in certain situations;
- Integrating all actors and sectors involved into the same process; and

- Integrating all actors involved in fire suppression, through the use of the Incident Command System (ICS), in the case of wildfires.

2.2 Integrated fire management principles

(i) Economic

Take cognisance of the likelihood and consequence of wildfire. Use fire as a cost-effective management tool to protect assets, including fire-sensitive land use (e.g. forest plantations and woodlots) and lives.

(ii) Environment

Understand the relationships between adjacent fire-dependant and fire-sensitive land uses. A change in natural fire regime can result in severe fires with negative consequence for ecosystem services.

(iii) Social

Sustain livelihoods by the appropriate use of fire to maintain traditional agricultural practices and water quality/quantity. Invest in community-based fire prevention activities to protect lives.

(iv) Legal framework

An overarching national fire management policy that recognises the requirements of fire-dependent and fire-sensitive environments is required to support IFM guidelines and harmonise policies, acts and regulations of related sectors.

(v) Institutional framework

A clear institutional framework is in place to address IFM in the related sectors. Effective implementation will require good collaboration with multi-stakeholders.

(vi) Enhanced capacity

Fires respect no boundaries; collaboration and pooling of resources are of the outmost importance for early warning, instant detection, and fast reaction. Involve adjacent land-users and invest in IFM training and local recruitment. People start almost all wildfires, and people are also the most effective resource to put out fires.

2.3 Importance of integrated fire management

An integrated approach seeks to secure the maximum benefit from the available resources and to help communities find cost-effective approaches to maintain desirable wildland fire programmes while limiting fire damage. When wildfires do occur, IFM provides a framework for:

(i) Weighing the relative benefits and risks of different wildfire scenarios;

(ii) Evaluating whether the effects of a wildfire will be detrimental, beneficial, or benign; and

(iii) Responding appropriately, based on stated objectives.

IFM addresses the problems and issues posed by damaging and beneficial wildfires within the context of the natural environment and the socio-economic systems in

which they occur. It evaluates and balances the relative risks posed by fire with the beneficial or necessary ecological and economic roles that fire may play in a given area. As a result, IFM integrates the following:

(i) The entire fire cycle and its different components of prevention, protection, suppression and rehabilitation;

(ii) The fire management efforts of all land managers whether in respect of public or private land;

(iii) The actions of regulatory agencies with the management measures on the ground; and

(iv) The funding and resource allocation to optimise its benefits and impacts.

IFM assists in the development and implementation of mitigation measures, standards and prescriptions based on comprehensive risk assessment, and aimed at reducing the negative impacts of forest fires on social, economic and environmental assets. It is a process of continual improvement, involving recordkeeping, monitoring, measurement and modification. IFM also implies co-operation and coordination between all role players in the fire prone environment.

2.4 The continual process of integrated fire management

Effective IFM is a continual process that involves a number of steps including planning for fire safety, implementing these plans, checking that what was planned has been done and was effective and reviewing and, where necessary, checking these plans (Figure 5).

Figure 5: Continual process of integrated fire management

This continual process occurs both at a property scale and at a larger public scale. Both scales are important to secure fire safety across the landscape. At a public scale, government authorities should undertake fire management planning as part of the responsibility for public safety and to support communities and forest companies.

This includes developing and implementing fire management approaches and ensuring that IFM strategies are part of the forest management plan.

At a property level, fire management may range from developing and undertaking simple unwritten plans to more complex documented plans. Wherever possible, TGAs are encouraged to have a written plan so that it is easier for them to consider fire risk issues on their property and to communicate these issues to others. As part of this process TGAs need to:

- Identify key assets and key fire safety risks, including those from adjacent properties and features;
- Consider other risks such as economic, environmental, and legal risks;
- Assess whether the risks identified are relevant and/or significant to the property, by considering the likelihood and consequences of these risks happening;
    (i) select interventions that minimise the identified risks; and
    (ii) consult and work with adjacent public and private landowners, managers, and land users to achieve fire safety benefits for all involved.

2.5 Integrated fire management plan

Public and private forest plantations, woodlots owners and TGAs are required to prepare IFM plans which should be recognized by forest management plans. An IFM plan should contain strategic and operational information to support informed decision-making and to assist management. The IFM plan provides a framework to facilitate cooperation among stakeholders towards fire control in commercial forestry. Thus, in actual sense it will have different levels of details depending on the area of operation, size of investments and objectives of the stakeholders. It also contains strategic and operational elements that describe how to manage and respond to unplanned ignitions, hazardous fuel load, vegetation and rehabilitation**,** prevention, community interactions and collaborative partnerships roles, and monitoring and evaluation programmes. The level of detail and quality of IFM plans will vary across the forest plantation, woodlots, TGAs and forest companies. Reviewing of IFM plans is important to improve challenges arising during its implementation. A period of 5 years reviewing of each IFM plan is recommended to capture new experiences and technologies. For TGAs, Village Fire Management Team (VFMT) and/ or VNRCs in collaboration with District Natural Resources and Land Department will be responsible to develop Integrated Fire Management Plan (IFMP), review and redevelop. Similarly, each public and private forest plantation will also be required to develop IFMP using their wildfire expertise to be adopted and reviewed after quarter period and redeveloped for the next quarter. The format of IFMP is provided in Appendix 1 while IFM review guide is in Appendix 2. Each developed IFM plan should compose of year activities plan in order to facilitate timely deliverables and smooth monitoring and evaluation for any commercial forest plantation and woodlot. Table 2 is an example of IFM year activities plan. Detailed explanations and breakdown of activities are given elsewhere in the guidelines.

Table 2: IFM year activities plan for commercial forest plantations and woodlots

Activities – complete before end of month	J	F	M	A	M	J	J	A	S	O	N	D
Update institution framework												
Education and Awareness												
Complete Training Analysis												
Establishment/Maintenance of Firebreak												
Establishment/Maintenance of Fuelbreak												
Fuel Load Management												
Planning												
Fire detection												
Communication												
Training												
Field Preparation Prior to the Fire Season												
Equipment and Supplies												
Records and Reports												
Monitoring and Assessment												
Review and Update Integrated Fire Management Plan												
Prepare Annual Wildfire Preparedness Report												

2.6 Conclusion

Integration has become a popular approach as a result of increasing complexity in managing natural resources under isolation but also because of its co-benefits for local communities as well as sustaining ecosystem services. IFM offers holistic framework to manage commercial forests using 5 key elements namely prevention, preparedness, suppression, restoration and research. These elements should be implemented, monitored and evaluated in a continuous fashion in commercial forestry.

3. FIRE PREVENTION

3.1 Introduction

Forest fire prevention is a set of activities directed at reducing the number of fires that start. In other ways, it is a set of activities developed to mitigate and manage the start and spread of forest fires as well as navigation of legislation during implementation. Prevention is certainly better than cure and for that reason a proactive approach to control fire through IFM is advocated. This includes helping with putting the right legislation in place to govern how fires are managed, creating community awareness and educating communities on fire safety, advocating and implementing prescribed fires and fuel load reduction. The following detail measures should be considered to reduce wildfire occurrence in forest plantations and woodlots in Tanzania.

3.2 Governance

There is a need of well-known governance structures specifically on wildfire management from national to local level. These structures should have a mandate to communicate and coordinate projects and programmes related to wildfire management. Where there are already these structures, there is a need to strengthen them for efficient management of wildfires. The formal governance structures of IFM include Village Government (VG), Village Council (VC), Village Natural Resource Committee (VNRC) or Village Environmental Committee (VEC), Ward Development Committee (WDC) (Table 3) and Primary court. All structures have been established in accordance with formal laws such as Local Government Act No. 167 of 1982, Forest Act No. 14 of 2002 and Environmental Management Act No. 20 of 2004.Table 3 presents roles of aforementioned formal governance structures. Roles of VG/VC and VEC/VNRC are originated from forest management plans, Participatory Forest Management (PFM) guidelines and bylaws, Forest Act No. 4 of 2002, Local Government Act No. 167 of 1982 and Environmental Management Act of 2004. The roles of WDC with regard to forest protection have been extracted from section 32 of the Local Government Act No 167 of 1982.

Table 3: Roles of formal governance structures in integrated fire management

Governance structure	Roles
VG (village assembly)	-Discuss and approve draft of management plan and by-laws including those prohibiting wildfires; and -Participate in forest management activities including making fire breaks.
VC (Village council)	-Discuss and provide suggestions of forest management by-laws; -Dislodge VEC/VNRC if proved failure in performing its duties including failure to reduce incidences of wildfires; -Awareness creation on forest protection including matters related to wildfires; and -Enforce by-laws.
VEC/VNRC	-Plan and supervise everyday forest activities including doing forest patrols; -Propose draft of by-laws that govern management of the forest reserve; and -Enforce by-laws including fining any person caught committing illegal activities and take criminals to the court including those caught starting wildfires.
WDC	-formulation, and submission to VC or to the district council proposals for formulating by-laws in relation to the affairs of the ward.

3.3 Education and awareness

Education and awareness form a bridge between research or technical knowledge and the effective application of policy and procedures. They are needed within organizations and for external partners and members of the community. An effective programme of community engagement in fire management and safety can help prevent unwanted fires, build the trust of the community in the fire management programme and inform citizens of their responsibilities in using fire wisely and carefully. Wildfire education and awareness should aim at changing people's behaviour through awareness and knowledge. Wildfire education fundamentals should include: signs, mass media, volunteers, public education, educational programmes, public contacts, school programmes, fairs, parades, sports exhibits, poster contests, high visibility patrols and printed materials of wildfire prevention.

There is a need to offer education and create awareness on wildfire prevention more frequently especially to areas of high risk. The community should be aware of wildfire detection, suppression and notification systems. The MNRT should develop and deliver fire prevention and safety education programmes in partnership with other stakeholders particularly private forest companies and TGAs. The public and private institutions should promote and improve fire prevention and life safety through research, testing and evaluation in forest plantations and woodlots. To be able to achieve this goal, budget for education and awareness should be in place annually. The existing local wildfire group should be assigned this task of educating and

creating awareness of wildfires to the surrounding communities. Posters can be used to raise awareness (Figure 6).

Figure 6: Posters are effective in raising awareness

3.4 Firebreak

A firebreak is strip of land5 to 10m wide (or more) in which all vegetation is removed down to bare each year prior to fire season. It is a gap in vegetation or other combustible materials that acts as a barrier to slow or stop the progress of a wildfire. A firebreak may occur naturally where there is a lack of vegetation or fuel, such as a river or lake. Firebreaks may also be man-made, and many of these also serve as roads, such as a logging road, four-wheel drive trail, secondary road, or a highway (Figure 7). The purpose of a firebreak is to provide an area of reduced fuel load which will reduce the intensity of a wildfire and therefore allow for more effective combating and to also serve as a line from which a back burn can be started. Firebreaks can be prepared in a number of ways, for example, by grading, ploughing, disking, hoeing or burning.

Figure 7: A man made firebreak

Firebreak should be of sufficient width and length to contain the wildfire. To reduce wildfire risk, forest plantation and woodlot should have wide enough (minimum width of 10m) external firebreaks on the outer side of the forest. Internal firebreaks (i.e. those made within the plantations) are narrower than the external ones (Figure 8) to reduce wildfire risk within the forest or woodlots when outbreak occurs. They should have a width of 5 to 10 m depending on slope. For conservation zones, a firebreak width of 60 m is recommended.

Figure 8: A plantation of *P. patula* with internal and external firebreaks

Firebreak network

It is possible for forest plantations or group of woodlot owners to establish strategically located fire break that take into account the topography, accessibility, vegetation type, fuel load and predominant wind direction during the dry season. This could be more efficient and effective if tree growers work together and establish joint fire breaks located at strategically important locations. The network depends on the most probable type of fires in the area. It is recommended to divide forest plantations into blocks (50 - 75 ha), using open or green firebreak, then each block divided by fire lines in small blocks up to 20 ha. The intensity of the network is determined by the value of the protected tree species, risks in the area and site characteristics. Locate firebreak network along entire boundary and internally where topography favours stop of fire; consider accessibility and natural features e.g. rivers; consider areas where construction is easier, fire-hazard areas e.g. sawmills, camps should have a fire line, construct from an "anchor" e.g. road, keep it as straight as possible and run them parallel to contours of the area and to minimize the visual impact. Table 4 shows the various terrains or land types, the width and method to create firebreaks.

Maintenance should be regular, however, adjusted with money available, risks and nature of ground cover. Outer firebreaks must be cleaned more frequently. Controlled burning of the fire lines could be used inside the forest. Keep a clean strip along both sides of main roads to avoid by passers risks. Normally, access, and high pruning removes fire-risks. Branches should be piled along rows. Use hand tools or tractors in construction. Every land owner where a wildfire may start or burn or from whose land it may spread must prepare and maintain a firebreak on his or her side of the boundary between his or her land and any adjoining land. The IFM plan's strategic firebreaks may require that some of firebreaks width will differ from what has been set out here.

Table 4: Various land types, the width and methods to create firebreaks

Land type	Prescribed width (m)	Recommended method
Fallow land	5 m	Cultivate (Crop)
Natural grassland Agricultural land interface	Width = 2.5 x height (minimum = 5 m)	Crop; Brush cut; hoeing allowed on slopes less than 30 degrees only.
Road edge	3 m on either side	Crop; brush cut, hoe, burn.
Alien infestations	Width = 2.5 x height (minimum = 5 m)	Crop; brush cut; hoe
Labour camp, farm infrastructure and homesteads	10 m	Crop; brush cut; hoe

3.5 Fuelbreak

A fuelbreak is closely related to firebreaks; however, they are wide and could keep part of the burnable materials. These are generally wide (20-300 m) strips of land on which the flammable vegetation has been permanently modified or replaced by

introduced vegetation, referred to as green fuelbreak, so that fire burning into them can be more readily controlled. Fuelbreaks provide quick access for wildfire suppression. Control activities can be conducted more safely due to low fuel volumes. Strategically located, they break up large, continuous tracts of dense timber, thus limiting uncontrolled spread of wildfire. Fuelbreaks can aid fire fighters greatly by slowing fire spread under normal burning conditions. Keeping 2-3 m wide clean strips along each side of fuelbreak is recommended.

Fuelbreak can be maintained economically by the following practices:

- Agricultural and pastoral land uses where most of the woody, above-ground biomass is removed and substituted with agricultural crops and livestock grazing;
- Shaded, agroforestry-style fuelbreaks where trees are widely spaced and livestock grazing reduces the abundance of surface and aerial fuels; and
- Fuelbreaks that are maintained as forest but where aerial fuels are mechanically shredded or chipped.

The selection and planting of tree species as fuelbreaks should follow the following general characteristics; less inflammable leaves in dry period; forming dense and deep canopy; producing mildly inflammable litter in small scale, and growth usually fast than screened trees. In Tanzania, trees widely used in fuelbreaks include: *Cinnamomum camphora* and *Ficus* spp. Fuelbreaks have four other main advantages: preventing soil erosion, offering a safe place for fire fighters to work, low maintenance costs and pleasing appearance.

Constructing the fuelbreak (width and slope adjustments)

Since road systems are so important to fuelbreak construction, the following measurements are from the toe of the fill for down slope distances, and above the edge of the cut for uphill distances. The minimum recommended fuelbreak width is approximately 91m for level ground. Since fire activity intensifies as slope increases, the overall fuelbreak width must also increase. However, to minimize aesthetic impacts and to maximize fire crew safety, the majority of the increases should be made at the bottom of the fuelbreak, below the road cut. Widths are also increased when severe topographic conditions are encountered. Guidelines for fuelbreak widths on slopes are given below in Table 5:

Table 5: Fuelbreak width/slope adjustments

Percent slope (%)	Minimum uphill distance (m)	Minimum downhill distance (m)	Total width of modified fuels (m)
0	45	45	90
10	42	50	92
20	39	54	93
30	36	59	95
40	33	64	97
50	30	68	98
60	30	73	103

*As slope increases total distance for cut-and-fill for road construction rapidly increases improving effective width.

3.6 Fuel load management

Managing fuel loads is an essential part of managing wildfire risk(Figure9). The reduction of fuel loads is desirable in terms of reducing immediate risk or can pose a threat to a forest plantation or woodlot. The most common and applicable management of fuel loads in Tanzania is by means of prescribed burning. There is a need to put clear understanding between prescribed burning and wildfire. Prescribed burning is conducted during the cooler months to reduce fuel build-up and decrease the likelihood of serious hotter wildfires. Prescribed burns are fires that are planned to reduce fuel load in the forest. They are deliberately ignited with the intention of burning at predetermined time and specified area.

Figure 9: Only a minimum amount of fuel load should be left in forests and woodlots

Wildfires are accidental and uncontrolled. They can threaten lives and properties and can do great economic damage to forest plantations and woodlots. There are many factors that influence decision making about the timing, frequency and need for prescribed burning in and around forests, including; the location of forest, surrounding communities, target plant communities and current vegetation.

In order for prescribed burning to be successful, a wide variety of equipment and tools is needed including drip torches for ignition, nomex fire suites, leather boots and gloves, hard hats with face shield and nomex ear/neck protection, first aid kit, radios, drinking water for crews, backpack pumps, slip-on water pump and truck, fuel cans, replacement parts and took kit, grass/thatch rakes. There is a need to develop prescribed burning plan, to guide the whole burning operation. A prescribed burn plan should be developed that outlines the environmental conditions appropriate for the burn as well as details about how the burn will be conducted.

3.7 Conclusion

Fire prevention forms the first part of IFM and helps to reduce risks emanating from fire incidences. The advantage of IFM is that it uses existing governance structures, and therefore, to prevent fire and associated negative impacts emphasis should be put on strengthening those structures. Provision of education and awareness raising (to change people's behaviour) together with firebreak establishment and maintenance, fuelbreak construction and fuel load management are also effective interventions against fire in forest plantations and woodlots.

4. PREPAREDNESS AGAINST FIRE

4.1 Introduction

Preparedness is activities needed to be undertaken prior to the beginning of the fire season. Preparedness include all the actions that are required in firefighting for the successful suppression of a fire, with exception of fire prevention. This includes all kinds of preparations, such as development of the organisation, maintenance of equipment, planning, cooperation and mutual aid arrangements with other authorities, personnel recruitment, and training. Important checks and preparations to be done before the start of the fire season include: forest roads, maintain dense and accessible road network; reliable water supply - natural or supplied; fire lookout towers, warning signs and boards, firebreaks and hazard reduction. Delay some forest operations e.g. road repair to coincide with fire season, in-order to use the manpower more efficiently and cheaply in case of fire. Fire suppression will only be as effective as the quality and the continuity of the preparedness operations. A lot of work is needed in the area of preparedness. In this work it is well to remember an old proverb; "good planning is the work half done". The main activities are summarized in the following sections.

4.2 Planning

Planning should be done at local, regional and government level, however, most details must be included in regional and local fire plans and should include all the recruitment of personnel, the purchase of equipment, and all activities needed in forest fire suppression. The list of fire crew, tools, equipment, machines and transport should be well known and recorded. The crew must be supplied with water, food and first aid facilities. Similarly, all machines should get fuel and regular maintenance. Also, cooperation with other authorities including Fire and Rescue Force, police, army, air force and Red Cross Society is necessary.

4.3 Fire detection

Fire detection is an important part of an effective fire management programme. The occurrence of a wildfire must be observed and reported as soon as possible in order to start the suppression activities while the fire is small. Fire detection could be done by general public or forest workers. Large plantations e.g. Sao Hill; have permanent fire service during fire season and the crew works on shifts. Similar arrangements on large plantation could be maintained in small plantations when there are very high fire risks. The main methods of organized fire detection activities are:

(i) Ground patrolling;
(ii) Fire lookout towers, points and stations;
(iii) Air patrols; and
(iv) A combination of these methods may be the most appropriate.

(i) Ground patrolling

All forest staff and public should be alert during fire season. Patrolmen or rangers can travel in the forest on foot, bicycles, motorcycles or vehicles, and should be equipped to take instant action against any small fire that may be found. Forest fire patrols are often combined with general forest patrolling. Ground patrols must have

some kind of communication or alarm system and good maps to report the location of the fire.

(ii) Fire lookout tower

Fire lookout tower can be a lookout point which is the same as vantage point selected for fire detection and is normally built on the top of high hills. Lookout towers are appropriate on flat terrain (Figure 10). The effective detection range of the lookouts is approximately 30-40 km around the tower or point. Lookout towers are normally built of wood or steel and the height usually depends on the height of the surrounding forest and any visual obstructions. Record of daily fire communication or incidences is important.

Figure 10: A fire tower built of wood materials

Basic fire lookout tower equipment include map of the area - mark blind areas (i.e. those areas not easily seen from the lookouts) and their distance from tower, compass or fire finder, pair of binoculars, sunglasses, communication equipment: telephones or radio-telephones, radio-call and fire watcher record book.

(iii) Air patrols

Air patrolling is an appropriate method of fire detection in extensive, sparsely populated areas. It gives prompt and reliable information, and accurate location of the fire. It is possible that large investment is done to employ unmanned aerial vehicles commonly known as drones to conduct air patrols in place of conventional aircrafts.

4.4 Communication

Adequate and reliable communication will mean less damage since different activities could be quick and effective. Common communication systems with all role players are: cell phone, radio, visual or sound signals e.g. siren or bell, (pipe or

electric) messengers should be used to alert people on fire occurrences. Primary communication needs in fire attack operation are:

(i) Between the fire chief and the site of fire, division heads, and sector heads in large fire;

(ii) Between the fire chief and headquarters, or the alarm centre;

(iii) Between the fire chief and heads of other authorities if they are used; and

(iv) Between the first-on-scene and woodlots owner/managers/supervisor/

All fires should be reported to fire control centre and fire location should be precise and speedy. The following components will facilitate easy and correct communication:

Fire reporting and alarm systems

Essentially it includes: reporting and analysis of smoke and fire; regional fire and alarm centre system; methods to alert fire crews and other units e.g. the use of appropriate communication system.

Location and maps

Basically, you could have regional or local maps. The primary uses for regional maps are basically: fire location and guiding the units to the fire site. It should contain information about main roads, forest roads, natural water supplies, contour of the forest areas, and boundaries.

The appropriate scale (large) of these maps is between 1:100,000 and 1:500,000. Local maps are more detailed with the primary objective of management of fire suppression by the fire chief and the rest of the fire crew. A good scale is between 1:10,000 and 1:50,000. A local map is very important tool for the fire chief especially in large fires.

4.5 Conclusion

Preparedness is a state of being ready against fire. It is an important activity as fire incidences come without prior information, and if adequate preparations are not made fire causes large negative impact to forests and woodlots. Therefore, give high priority making adequate planning, putting detection and communication systems in place, and be ready at all times particularly during dry season against fire.

5. FIRE SUPPRESSION

5.1 Introduction

Fire suppression (or response to fire) means all the procedures which start on or after the fire alarm. The main aim of the suppression is to extinguish the fire. Most modern firefighting technologies have been designed in developed countries. However, with the increase in infrastructure and trained personnel modern technologies are being imported and adopted especially in large forest plantations in Tanzania. For efficient action in firefighting the following is important:

(i) People must know what to do;

(ii) People should be available on need; the crew should be engaged in other forest activities during none-fire season period;

(iii) Available reliable labourers to reinforce the crew; and

(iv) Equipment should be available and operational (Section 10.5).

5.2 Mode of action for sizing-up

Size-up is the evaluation and estimation of the fire by the fire boss to determine a course of action for suppression of fire. Sizing-up usually starts as soon as the smoke is seen and the location is determined:

(i) Fire crew should leave promptly once informed on fire incidence, carrying all necessary equipment e.g. beaters, hoes, saws and axes. Mechanical equipment is included if it is a large fire;

(ii) The Incident Commander (or Fire Chief or Plantation Manager) should advice the crew on the most convenient route to the fire area;

(iii) Speed is important;

(iv) On arrival at the scene, the fire officer has to size-up the fire;

(v) In the control room a few stand-by crews are left;

(vi) Coordination to remove confusion is important when you have many people and equipment; and

(vii) Ready-made recipes for fire-fighting cannot be made; therefore, the fire boss should be a skilful person.

5.3 Phases of fire suppression

During wildfire there are generally five phases of suppression action, especially large fires. In small fires, these phases could go on simultaneously. These are initial attack, fire containment, control, mop-up and patrol.

(i) Initial attack

The initial attack is the first phase of fire suppression. The success of the entire fire management programme may be reflected in the success or failure of this phase of any fire. If the initial attack is successful, most other programme elements will also be successful. The objective is to cut-off and/or restricts the fire spread. There is a need ofwell-trained crew, to put the fire out while they are small. The size of crew will

depend on fire conditions. Basic equipment includes: car with two-way communications with headquarters, and hand tools. A mix of hand and tanker crews could increase efficiency. The crew should be healthy and well-motivated.

(ii) Containment

Containment indicates that the spread of the fire has been stopped through construction of control line. However, suppression work has not been completed.

(iii) Control

At this stage of the fire suppression action, the control lines have been completed and work has begun along the edges of the fire to fully extinguish it. Fire is said to be controlled if the "fire boss" is satisfied that there is no chance for the fire to spread further.

(iv) Mopping-up

Mop-up is the action of making the fire safe after it is controlled such as extinguishing or removing burning material along or near the control line, felling snags and trenching logs to prevent rolling. In large areas it does not include whole burnt area, only specific spots. Construct fire lines around unburned green areas inside the fire area. Green unburned patches could otherwise be burnt if they are at risk. You could use water to extinguish these areas. Extinguish the outside perimeter of the fire for some specified distance inside the fire lines. Burning stumps, logs and large splinters should be extinguished to remove rekindling.

(v) Patrol

Mobilize several crews depending on the area to ascertain fire suppression. The crew move in fire areas and extinguish any isolated fire that has been missed during mop-up. This could take several days, emphasis being given to areas along fire lines. After this exercise, the area could be given another visit, 24 hours afterwards.

5.4 Methods of fire attack

There are two basic methods of fire attack namely: Direct and Indirect attack as described below.

(i) Direct attack

Attack made directly on or adjacent to the fire edges using a water spray, throwing soil, using beaters or building fire lines at the edges. The objective is to get as close as possible to the fire. It is applicable for light fires or late stages of large fires. It is also used in grass fires, of any size, where pumps can be applied directly. After the head is cut off, and most of the spreading is stopped on the flanks, a secure line must be prepared along the flanks. When the control line is established, mopping-up, spot fire control and patrolling must be started in order to complete the operation.

Advantages of direct attack

- Easier for crew to escape;
- Full advantages taken of burned-out areas, and
- No additional area is intentionally set on fire.

Disadvantages of direct attack

- Fire fighters can be hampered by heat, smoke or flames;
- Control line can be long or irregular;
- Natural barriers may not be taken advantage of;
- Hot spots may cause breakover and spot fires; and
- More mop-up and patrol may be necessary.

(ii) Indirect attack

This is building a line some distance from the edge of the fire when fire is too hot. Utilized where:

a) Fire is too hot to work close to it (Parallel attack)

Construction of straight fire line is difficult due to fire fingers and running out from the main body of the fire. In such areas, burning-out, firing out or clean burning should be carried out. This entails construction of fire lines at short distances (5-50 m) from fire's edge, then start a fire along the inside edge of the control line so that the fuel in the area between the fire line and the fire edge will be burnt. Pockets and islands should be burnt-out after the line is built so that they do not pose a threat of spreading at a later time. On the hillsides, the burn-out should start from the top and work downwards. Burn out makes the fire lines wider and thus safer.

b) Large and rapidly spreading fires

In such circumstances, backfiring is usually carried out. This is intentionally setting of fire to eliminate the fuel between the inside of the control line and the fire head. Control line is located at great distance, about 1-2 km from the fire edge.
Backfiring widen the control line, change the direction of fire, or slow the progress of fire in order to gain enough time for line construction. Backfiring is a tactic that makes possible a strategy of locating control lines at places where fire can be fought on the fire fighter's terms. Timing is very important in backfiring. The right time to start backfire will depend on the fuel; weather; resources of the crew; speed of spread of the main fire; and topography. Indirect methods usually considered as desperate measure and are rarely used in forest fire suppression.

Advantages of indirect attack

- Easier for the crew,
- Team work and coordination easier,
- Maximize use of natural barriers,
- It develops shortest lines,
- It takes advantage of the easiest location for line construction.

Disadvantages of indirect attack

- Larger area burnt,
- Burning out fires may explode and consume larger area,
- Careful watch to be maintained along entire line,
- Weather changes could change direction of spread,

- Crew can be outflanked.

(iii) Managing multiple incidents

Some of the most difficult and complicated situations occur when multiple fires start simultaneously or when additional fires are discovered before the initial ones are brought under control. This situation is further complicated when the fires occur across several authorities with different legislative or institutional management objectives. These cross-boundary incidents can impact local authorities as well as national boundaries. During periods of multiple fires, fire suppression resources may be depleted, requiring managers to allocate resources based on priorities and potential threats. Often the priorities for protection are widely varied, which makes it difficult to determine where fire suppression resources should be deployed.

Moreover, these decisions are often made without access to adequate information. Setting up procedures in advance reduces the risks to health and safety and the potential damage to resources and communities. In addition to preplanning these actions, an effective way to manage priority setting during multiple incidents is to have established a coordinating group beforehand composed of senior managers from the agencies and organizations involved, including community groups. This group will meet during the emergency to set priorities and agree on critical areas of concern. However, it should also meet throughout the year to confer on all aspects of interagency or international concerns, such as standards, objectives, priorities and procedures for coordination and mutual assistance during emergencies

Another important factor would be agreement to use Incident Command System (ICS) and to expand its scope as the number of fires increases and the impact expands to more authorities. The ability to continue the same management structure at any level of complexity is important in critical periods.

Prior to the start of the fire season, plans should be developed that provide for the management, resource-allocation, prioritization and other transboundary actions required during multiple incidents. Through the use of ICS in all authorities and in response to any type of fire or other emergency, the companies, Tanzania Forest Services (TFS), TGAs, groups and other organizations involved will acquire the experience to effectively use the system in transboundary and multiple fire situations.

5.5 Other important initiatives for wildfire control

(i) National level

Government can deal with fire in three ways:

(i) Promote investigation and research on problems related to bush-fires.

There is a lot of knowledge on how wood-land and savannah can be cleared for particular purposes. Very little is, however, known on the effect of fire on the biodiversity in these areas. Long term effects on soils and evolution of the herbaceous vegetation is less studied. In this respect speculation should be avoided by getting facts through conducting research;

(ii) Create public awareness through education on fire problems and control. Public awareness is brought through education from school to village level;

(iii) Enact and promulgate legislation aiming at limiting occurrence of bush fires, also to ensure enforcement of such legislation. Specification of what people should do and what they should not do is very important to be indicated at national level as for example:

- Don't burn during fire season;
- Compulsory fire lines around houses and industrial areas;
- Burning pasture land should not be permissible unless one obtains written permission;
- Compulsory for any able person to extinguish fire; and
- Should also outline penalties.

On the other hand, Forest Officers should have some authority and legal protection including:

- Arrest law breakers;
- Issue summons to appear in court;
- Order removal of fire-hazards;
- Enter premises for the purpose of inspection factors relating to fire spread and control e.g. brewing local alcohol;
- The officers should be protected by law against interference with their work.

(ii) At local level

Local measures to control fire focuses on: protective measures aiming at preventing fire spread are properly observed; steps to ensure that laws aiming at fire control are enforced and penalties which could reduce deliberate fires should be emphasized.

5.6 Organization and management of wildfires

The principles of fire management are the same for all fires, regardless of size. Firefighting is an emergency operation, and to achieve success, good organisation is needed. In any organisation there is only one Incident Commander (IC or in forest plantations called Plantation Manager), who should take all decisions (Figure 11).
The basic requirements for the Incident Commander are:

(i) Should have an excellent knowledge of forest fire behaviour, and all the factors affecting fire control;

(ii) Sufficient knowledge of fire suppression strategy, tactics, and techniques, and also be able to set up fire suppression objectives;

(iii) Familiar in the practical use of equipment;

(iv) Able to organize, and plan objectively under stress;

(v) Have full management experience of forest fire suppression;

(vi) Be able to plan for the safety and welfare of staff;

(vii) Accept the authority and carry out duties assigned to a fire chief; and

(viii) Be able to make decisions and give commands.

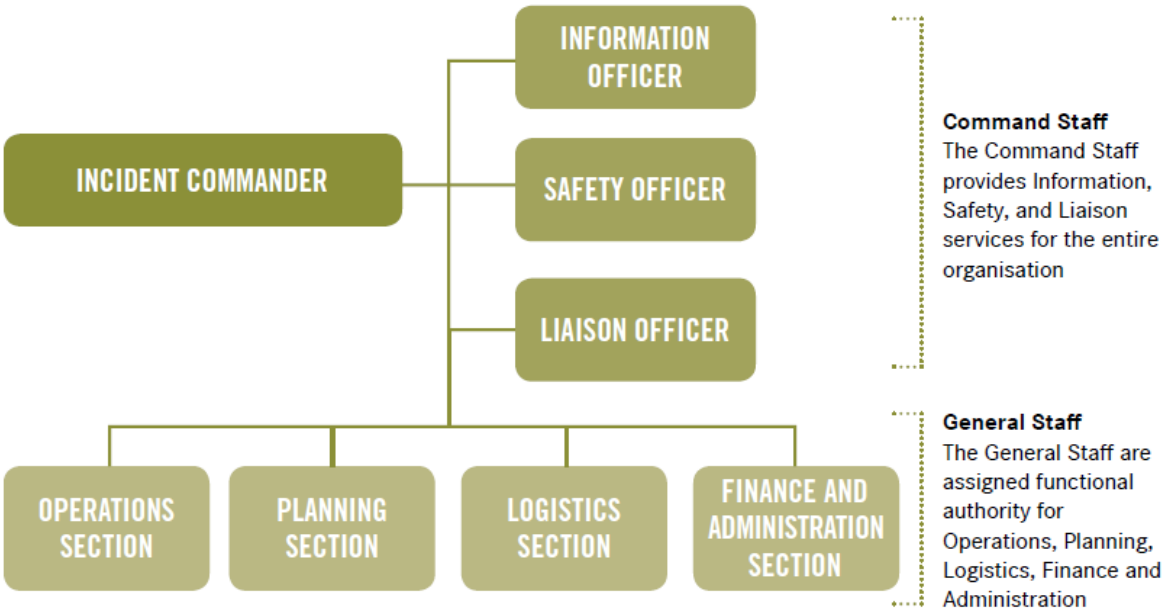


Figure 11: Structure of ICS in integrated fire management (FEMA, 2011)

ICS can be used by all levels of government - national, regional, district, and local - as well as by many nongovernmental organisations and the private sector. ICS is also applicable across disciplines. It is typically structured to facilitate activities in five major functional areas: Command, Operations, Planning, Logistics, and Finance and Administration. As a system, ICS is extremely useful, providing an organisational structure for incident management and guiding the process for planning, building, and adapting that structure. Using ICS for every incident or planned event helps hone and maintain the skills needed for the large-scale incidents. For ICS to work, each participant must be committed to working together to solve a common problem. Each responding agency will have individual objectives to carry out. In addition, the primary objectives of each responding agency are established under the unified command concept and focus on these common response priorities, which state:

- Preserve the safety of human life;
- Stabilise the situation to prevent the event from worsening;
- Use all necessary containment and removal tactics in a coordinated manner to ensure a timely, effective response that minimises adverse impacts to the environment; and
- Address all three of these priorities concurrently.

The Incident Commander

The IC is responsible for the request, use, and release of resources at an incident. Support agency resources are sought through a process that must be outlined in the TGA or National/Regional/District or Forest Management plans. Fire services are a key support along with working on fire ground. The person who arrives first at the fire is the IC until the fire is put out, or a more experienced person or the Fire Brigade arrives on the scene. Once the fire has been put out and the fire brigade and the

more experienced persons leave (to be available for other incidents), the landowner on whose land the fire was, will become the IC and monitor the area for a few days for flare-ups.

The Safety Officer

A Command Staff position consisting of a single person who has responsibility for monitoring on-scene safety conditions and developing measures to ensure the safety of all assigned personnel. A Safety Officer may designate one or more assistants from either the same or another assisting agency or jurisdiction.

Liaison Officer

In the case of mobilisation of resources from multiple stakeholders, there will also need to be a person designated to coordinate partners, freeing the IC to manage the fire. The Liaison Officer's role is to serve as the primary point of contact for assisting and coordinating activities between the IC and various agencies and groups. How incidents are communicated to the public and media are important. This requires each incident to have a public information point person who can provide information to the concerned public, the media and any other interested parties.

Public information officer (PIO)

The public has a right to know about forest fire and emergency incidents, what they can do to protect themselves, and what the agencies responsible for managing these events are doing to mitigate the crisis. The officer can help an organisation to convey its message, facilitate better interaction among the media, response agencies, and the public, and help put other response officials at ease when dealing with the media. The PIO should possess the following:

- Must be an effective verbal communicator.
- Must be able to clarify technical information so that the media and the public easily understand it.
- Must be knowledgeable about firefighting operations. This is critical to gain credibility with the media and the public.

5.7 Safety

For firefighters and fire managers, safety is a core value and cannot be compromised. It is a critical part of all activities, from planning through restoration. In fact, one of the most common reasons for developing these IFM guidelines is to protect firefighters and communities from unwanted fires. Public safety is very important, but the safety of the firefighter must be given the highest priority in the policies, bylaws, procedures, plans and management philosophy of any agency or organization. Firefighter safety begins with the provision of the proper safety equipment and training to each individual in fire suppression and prescribed burning operations. Safety training includes education in the local weather and terrain, as well as in the flammability of fuels. Firefighters must also be trained to recognize the characteristics of fire behaviour, such as intensities, spread rates and when a smouldering fire can re-ignite and begin to spread. Crews need to understand how

to monitor fires and to estimate potential changes in order to avoid becoming trapped by an unanticipated change in spread or intensity.

General safety measures

Firefighting is always hazardous activity. In many countries, several deaths and injuries occur during firefighting. It is therefore important to adhere to safety procedures. The IC is responsible for the crew safety. On the other hand, the fire fighters must work safely and take heed of the firefighting safety instructions. Safety activities should also include welfare and first aid services in the field. Safety is a matter of common sense. Use it, and you will keep yourself and others out of trouble. Ensure that foot, head, hands and entire body is protected to avoid injuries. Wear and use personal protective safety equipment, clothes (cotton not synthetic),gloves and shoes as a precautionary measure during firefighting operations. Choose a safe route away from fire hazards. Watch at all times for changes in the speed and direction of fire and smoke.

5.8 Conclusion

Fire suppression is all procedures which start on or after the fire alarm. Efforts to increase effectiveness of suppression and safety must go hand to hand with using modern technologies and trained personnel. Experience shows that use of ICS has been effective and efficient in fire suppression in other parts of the world as it integrates facilities, equipment, personnel, procedures, and communications operating within a common organizational structure. It is recommended to be adopted particularly when dealing with multiple fire incidences or prolonged large fires in forest plantations.

6. RESTORATION IN INTEGRATED FIRE MANAGEMENT

6.1 Introduction

It is important to implement a programme that will facilitate the speedy rehabilitation and restoration of forest plantations and woodlots, including both timber stands and conservation areas (wetlands and grasslands within the forest plantation) that have been damaged as a result of fire. The aftermath of a fire, requires rehabilitation of the burnt area. Immediate dangers include soil erosion and longer-term damage by invasion of exotic and invasive plant species. In commercial forest plantations or woodlots, there can be a need to remove burnt materials and re-plant with the same or other commercial tree species.

6.2 Needs for immediate restoration

There are immediate rehabilitation actions that can be undertaken in conjunction with fire suppression actions. A fire line constructed along a steep slope may be very prone to erosion and further damage if immediate steps to interrupt the flow of water are delayed. Fire suppression actions may damage the environment and may need to be avoided. Many actions that are effective in stopping a fire can severely impact other resources, such as soils, wetlands, habitats and vegetation. The impacts are often long term or can promote the spread of disease, weeds and other exotic pests.

Replanting and reseeding of sensitive areas can stop an invasion by exotic and invasive species that would take advantage of a large expanse of exposed soil. In this case, the presence of the exotic species in the ecosystem may require actions that are unnecessary in areas without this species. Engaging suppression crews in rehabilitation activities can have the advantage of teaching them which suppression techniques are most damaging to the ecosystem and, in some cases, make possible the implementation of mitigation measures in conjunction with suppression actions. For example, a crew using hand tools to construct fire lines can construct water bars along the fire line at the time of initial construction, which will reduce the potential for erosion.

In planted or natural forests in which commercial activities are planned, economic considerations may dictate an aggressive salvage and removal programme for damaged timber or other products and an extensive reforestation plan. In the context of the management plan for the area, economics may be the overriding consideration when communities are dependent on forests as a source of revenue and livelihoods.

6.3 Components of restoration after fire

Major components for burned area restoration and rehabilitation include:

(i) Every burned-area rehabilitation and restoration plan should be based on the planned or natural fire regime for the area and should include actions that facilitate a restored, healthy sustainable ecosystem or cultural area;

(ii) Every fire suppression plan should consider the need for immediate corrective action that will mitigate further damage resulting from the suppression, such

as constructing fire breaks or other disturbance activity;

(iii) Where natural processes are not expected to provide adequate generation, rehabilitation plans should be developed that use plants, trees and grasses native to the ecosystem and that will not cause damage or unexpected consequences; and

(iv) Care should be taken to ensure that seed sources are reasonably free from contaminants such as seeds of invasive species.

6.4 Measures for restoration of burned areas

Natural restoration will be considered as well as non-interventionist methods, taking benefit of natural regeneration, mainly when fires were part of the ecosystem processes. When active methods are necessary, a programme for the specific burned area will be approved specifying the measures to be adopted for restoration, the timeline for execution, species to be used for reforestation, time of the year for the work, use of burned wood, as well as any other action that allows restoration of the burned area.

6.5 Conclusion

It is important that restoration is done immediately on the burnt area to avoid exacerbated impacts including soil erosion and invasion of alien plant species. Efforts and financial resources needed to restore will depend on the impact of fire, tree species and the area affected. It is common to find that the same species are planted as a restoration strategy after fire incidence in forest plantations and woodlots. This is the case where natural regeneration is not possible and where it could delay the recovery of plantation/woodlot. Pinus species are a good example as they do not regenerate and therefore they may be a need to replant after fire. In other cases natural regeneration is possible for example with Eucalyptus species and there may not be a need to replant the affected plantation/woodlot. There is a need to emphasize effective restoration strategies to ensure optimal production of forest products and services in commercial forestry.

7. RESEARCH FOR INTEGRATED FIRE MANAGEMENT

7.1 Introduction

In order to be better prepared in the future, research should be done to determine how the fire started, what contributed to the spreading thereof and how best to prevent similar occurrences in the future. Research is essential to find out which strategies work better for fire prevention, preparedness, suppression and control. It also plays an important role in discovering new strategies, and making sure that existing strategies are used in the best possible ways.

7.2 Records keeping and reporting

The Forest Officer/ Plantation Manager will complete fire reports (Appendix 3) for all wildland and prescribed fires. Records of all fires will be consecutively numbered and entered into the computer system for safety. In case of forests under the central government fire account numbers will be requested from the TFS fire program management assistant as soon as fire costs are incurred. Each report will include a brief narrative stating the cause of the fire, the action taken, and fire location. A permanent record of all fires will be kept in the TFS headquarters. The TFS will prepare an annual fire summary report which will contain the number of fires by type, acres burned by fuel type; costs, personnel utilized, hours of fire brigade used, and fire effects. All fire related activities should be reported on the TFS website. Similarly, fire records should be kept and reports be prepared and shared among stakeholders even for private forest plantations and woodlots. Similarly, for small and medium growers, keeping accurate and up-to-date records on fire occurrences and associated impacts should be maintained at all times.

7.3 Monitoring and assessment

The fire records and reports will assist in monitoring and assessment. Monitoring and assessment are important at several levels. Monitoring of the effects of both fires and suppression activities is needed in order to achieve a balance between stopping the fire and protecting the resource. Monitoring the effectiveness of the fire organization will help managers determine if the programme is working. Cost/benefit assessments are useful in assessing the effectiveness of various types of resources. Effective monitoring and assessment of the prevention programme can reduce the occurrence of specifically identified types of fires and the costs of suppression. Major important actions for monitoring and assessment include but are not limited to:

- A comprehensive plan for monitoring and assessing all aspects of the fire management programme should be implemented;
- A safety programme, including analysis of near-miss incidents, accident reports and a review of lessons learned, should be implemented and monitored to reduce the risk to firefighters, fire managers and the public;
- Information and data from the fire prevention programme should be used to develop a monitoring system that measures the effectiveness of fire prevention efforts; and

- A programme should be implemented to monitor the ecological effects of fire and of suppression methods and it should include cooperation with universities, other research organizations and local communities.

7.4 Conclusion

Research is important to know how fire started, how effective was the suppression operation and how it could be prevented in the future. It is also important to facilitate knowing which restoration measures worked and where, and monitor trajectory of change. Implementation of all major components of IFM should be annually monitored. Performance assessment by means of contracted second party monitoring audit is recommended. The audit will be performance-based, covering predetermined indicators and criteria, and will make provision for coaching during field assessment.

8. FIRE AS A MANAGEMENT TOOL

8.1 Introduction

The use of fire will always be controversial, since it renders both good and bad services, and the definitions of 'good' and 'bad' may often be ones perspective. In spite of that, fire is widely accepted as being a valuable tool in the management of natural vegetation. It is a resource modifier and can be used to change the composition of vegetation and its cover or to maintain plant communities in a certain stage of succession. The use of fire as a management tool will be detected by:

(i) Desired objectives;

(ii) Known reaction of the plant communities to burning;

(iii) The management systems into which it is to be incorporated; and

(iv) The local legislation pertaining to the use of fire (Chapter 9).

8.2 Management objectives

The objectives and consequences of the burn should be evaluated before including fire in the management system. In the tropics fire could be used in different management systems: rangelands, game parks/reserves, agricultural fields, and forests.

(i) Rangelands

Fire is used to control livestock parasites e.g. tick and tsetse flies. Burning can improve the acceptability and nutritional value of grass. It can be used to facilitate the introduction of exotic species into the vegetation (e.g. the introduction of improved forage species); and control of noxious weed species.

(ii) Game parks/reserves

Here fire aims to promote grass regrowth. It creates habitats suitable to certain game species and to assist in inducing the movement of large game. Maintain balance between desired and undesired vegetation which is important in tourism. Increase visibility for both tourists and workers.

(iii) Agricultural fields

Land clearing and removal of surplus vegetation and facilitate access by man. Controlled burning will reduce the fuel load and thus the intensity and frequency of accidental fires. Fire is applied to make firebreaks which protect valuable agricultural areas. It is also used to control insect and vertebrate pests and helps to remove noxious weeds.

(iv) Forests

Sometimes Foresters use fire during land preparation as cost effective means. To maintain or achieve a plant composition which is optimal for specific management objectives e.g. induced germination of some Miombo species: Occasionally fire is used in early burning. To maintain or develop the plant cover needed to conserve soil or water in a particular catchment. It affects both canopy and basal cover of vegetation and thus the infiltration and runoff of precipitation.

8.3 Prescribed burning

Prescribed burning is intended to reduce highly flammable fine fuels (e.g. humus, leaves and litter) on the forest floor, and provides low hazard barriers that reduce the frequency, rate of spread and intensity of wildfires and their associated damage to forest ecosystems. Low-intensity prescribed fires also speed up the recycling of nutrients into a form usable by the trees. The interval between fuel reduction burns depends on: species, rate of fuel accumulation, values at risk, and the risk of wildfire. In Tanzania prescribed fire is practised in National parks and pastoral-agricultural fields and occasionally in conifer plantations. It is seldom practised in savannah woodlands. In spite its wide use in other places like Australia, there is considerable concern that such practice induces adverse side-effects on the physical, biotic and aesthetic attributes of forest ecosystems, an important issue that forest managers must address and, if necessary, ameliorate.

8.4 Prescribed burning plans

Prescribed burning plans are not yet available for the tropical forests, however, principles from industrial pines and eucalyptus plantations can be used. A successful plan should be in a confined area, burns with the desired intensity, accomplishes the prescribed treatment and is compatible with resources management objectives. Such plans should be based on the following factors.

a) Physical and biological characteristics of the site to be treated;
b) Land and resources management objectives for the site to be treated;
c) Known relationships between pre-burn environmental factors, expected fire behaviour and probable fire effects;
d) The existing art and science of applying fire to a site;
e) Previous experience from similar treatments on similar sites; and
f) Smoke impact from health and safety standpoint.

8.5 Practice of prescribed burning

The practice entails the following:

- Burn when the fuel volume is small and moisture content of fuel is not too low;
- Consider the type of species, time of burning-low breeze and afternoon preferred most; and
- Construct narrow (1- 2 m) fire lines around the burning areas.

8.6 Conclusion

Fire is important and can be effectively used to meet management objectives in different landscapes. It can be used to improve rangelands, reserves, agricultural fields and forests conditions. Therefore, if fire should be used then care should be taken to ensure that only the intended objectives are met and no undesirable impacts are realized.

9. INTEGRATED FIRE MANAGEMENT AND LEGAL FRAMEWORKS

9.1 Introduction

Organization of fire control service, laws, regulations and duties of the responsible authorities may vary from location to location depending on: the organization of the government, local laws, culture and traditions. The responsibility and authority for all duties must be clearly outlined to all responsible bodies, from village/local level to the highest level of the government (i.e. Ministry). The following review seeks to identify entry points which can be exploited for forest fire control in Tanzania, notably in the forest plantations and woodlots. On the question of past and current prevention and intervention practices used elsewhere, in the light of current field instructions in use, it is amply clear that Tanzania's position is not enviable. There is also a possibility of getting negative results from improper adherence of the aforementioned measures and practices such as those promoting excessive litter accumulations under woodlands. Biodiversity considerations, steep topography, and fragmentation also evoke special wildfire management considerations. It is imperative to take stock of the options available in anticipation that wildfire control prescriptions will be built from current practices since initiating sophisticated approaches may in the long-term, be unsustainable. The following are major legal frameworks related to fire control in Tanzania.

(i) The National Forest Policy of 1998

The National Forest Policy (URT, 1998a) mentions fires as one of the threats to public lands leading to their degradation. It is clearly stated in the policy that wildfires are taking place annually affecting both natural forests and plantations. Uncontrolled wildfires are hampering natural regeneration resulting in eventual deforestation. However, forests lack systematic management, unclear boundaries and inadequate resources for control. The policy therefore emphasizes clear ownership on land and trees, allocation of forests and their management responsibilities to villages, private individuals or to the government as a way to curb forest degradation caused by among others, forest fires (URT, 1998a: Policy Statement 5). Wildfire management in the Forest Policy is not separately stipulated, but mentioned in a group of threats and appropriate interventions such as developing forest management plans and co-management approaches.

(ii) Forest Act No. 14 (2002)

The Forest Act No. 14 (2002) has Sections 70–76 devoted to wildfire issues and provide restrictions on burning of vegetation. It is clearly stated that, unless otherwise exempted by an order made by the Minister and published in the Gazette, no person shall subject to provisions of Section 70(1) within any area of Tanzania Mainland; (a) burn any vegetation on any land outside the cartilage of his own house or compound and (b) wilfully or negligently kindle or cause to be kindled any fire which he has reasonable cause to believe may spread so as to destroy or damage any property of another person. The Act requires that any person permitted to kindle any wildfire must give notice of his intention to burn the vegetation in writing and

deliver it by hand or orally. The notice must be effective from the date it was issued and shall state as near as may be the time at which the burning will take place. Where wildfire lawfully kindled after notice was given spread to other land, Section 71(1) of the Act provides for powers to require other persons to assist in extinguishing the fire.

The Director of FBD may give order to land owners by written notice to provide proper protection to adjoining land from the risk of wildfire, and Section 72(1) (a) requires land owners to provide firebreaks on the boundaries of such width as may be specified in the notice and (b) to establish and maintain internal firebreaks. Should the occupier neglect the order, the Director shall carry out the work and the costs involved shall be debited to the occupier of the land. Section 91(1) of the Forest Act No. 14 (2002) explains offences in connection with wildfires and states that any person who without lawful authority: (a) lights or assist in lighting, rekindles or adds fuel to any wildfire or cause any of these activities to take place, (b) leaves unattended wildfire which he, with or without authority has lighted or assisted in lighting or used or rekindled or to which he has added fuel before such wildfire is thoroughly extinguished; or fails to comply with any lawful order issued to him under Part IX of this Act, shall be guilty of an offence and upon conviction, shall be liable to a fine of not less than fifty thousand shillings and not exceeding one million shillings or to imprisonment for a term not exceeding one year or to both such fine and imprisonment (URT, 2002).

(iii) Wildlife Policy (1998)

The Wildlife Policy of 1998 puts emphasis on establishment of Protected Areas (PAs) for the ultimate goal of conservation and management of biological diversity. Tanzania has designated a significant proportion of her land area for a PA network devoted to wildlife conservation. Under the conservation and management of biological diversity, the policy clearly states strategies to achieve this, and one is a strategy seeking to minimize the damage caused by wildfires. A second strategy is the use of prescribed fires (burning) for management programmes as per PA management plans (URT, 1998b: 13 (Strategy No. xvii and xviii)). The Wildlife Policy also advocates establishment of Wildlife Management Areas (WMAs) outside PAs and this helps in reducing fires originating from public lands (www.tanzania.go.tz/policiesf.html).

(iv) Wildlife Conservation Act No. 12 (1974)

The Wildlife Conservation Act No. 12 of 1974 (Section 9 (1) prohibits burning of bush or grass fire in a game reserve except by and in accordance with the written permission previously sought and obtained of the Director as well as if any part of the game reserve is included in the forest reserve, the Director of Forestry or his duly authorized representative. In the same Section part (2), it emphasizes that any person who contravenes Section (1) shall be guilty of an offence and shall be liable on conviction to a fine not exceeding TZS 5,000 or imprisonment for a term not exceeding two years or to both fine and imprisonment. Wildfire is not given sufficient strength and the punishment is very mild and the Act does not address wildfires

originating from outside the game reserves which incidentally are the main sources of wildfire in most reserves.

(v) The Beekeeping Policy (1998) and Beekeeping Act (2002)

The National Beekeeping Policy mentions wildfire as one of major threats to honey bee colonies which are important in production of quality honey. The use of fire for honey harvesting is discouraged. The policy emphasizes the establishment of community-based beekeeping reserves for maximum protection of bees and their habitats. The Beekeeping Act No. 15 of 2002 prohibits burning within gazetted bee reserves under Section 17 Sub-sections 1(a) and (h). Section 44(2) states that any person who uses open fire to harvest apiary products commits an offence and upon conviction shall be liable to a fine of not less than TZS 50,000 and not exceeding TZS 200,000 or to imprisonment for a term not exceeding six months or to both such fine and imprisonment. The punishment is mild and the Act does not address wildfires originating from outside the bee-reserve which incidentally are the main causes of wildfire in most reserves.

(vi) National Environmental Policy (1997)

The National Environment Policy of 1997 identifies six major environmental problems as: loss of wildlife habitats and biodiversity, deforestation, land degradation, deterioration of aquatic systems, lack of accessible, good quality water and environmental pollution. All these have resulted into land degradation. The policy further explains that poor agricultural practices such as shifting cultivation, lack of crop rotation practices and land husbandry techniques exacerbate the problem. The policy does not treat wildfire as an environmental problem of its own but it seems to be combined with other factors resulting to land degradation (URT, 1997a).

(vii) The National Agriculture and Livestock Policy (1997)

The Agriculture and Livestock Policy of 1997 asserts that agriculture operates in a delicate natural environment which requires proper management and protection. Furthermore, it recognizes that the incorrect use of land, water, and forests in the production of crops and livestock can have far reaching effects on environmental integrity. It is mentioned that frequent bush fires aimed to cause the regeneration of pastures result in increased environmental degradation. One of the objectives of this policy is, therefore, to promote integrated sustainable use and management of natural resources such as land, soil, water and vegetation in order to conserve the environment (URT, 1997b: 21(f)).

(viii) The National Land Policy of 1999

Section 4.2.9 of the National Land Policy provides for the protection of sensitive areas. Policy statement 4.2.10 outlines the creation of mechanisms for the protection of sensitive areas including among others; water catchments areas, mountains, forests, national parks, national heritage and areas of biodiversity. These areas, or part of them, shall not be allocated to individuals. Section 7.1.0 explains the importance of coordination in land use management. It is stated that before user rights such as for mining, timber harvesting, hunting etc are considered, existing land tenure rights should be recognised. Emphasis is given on the formation of an Inter-

Ministerial Committee by relevant ministries to ensure consultation between the issuing authorities and the Ministry responsible for lands. Policy statement is given under Section 7.2.1 on agricultural land use and puts emphasis on community involvement in resource management, land planning and conflict resolution. The whole issue of land tenure features clearly in the policy and discourages shifting cultivation and nomadism which have been always accused of causing forest fires.

(ix) The Fire and Rescue Force Regulations of 2008

The Fire and Rescue Force (Safety Inspections and Certificates) Regulations of 2008 provides clear instructions to take safety measures in all places of work including areas with more than 10 people at any one time (section 1f). Forest premises and operations often involve more than 10 people at any given time and therefore liable to fires. It is therefore important that in such places fire safety measures are given high attention, and in case fire occurs then rescue operations have to be effective and timely.

9.2 Conclusion

There are existing legal frameworks ranging from Acts to Policies which can be used as entry points for controlling fire incidences in the country. These frameworks cut across different sectors including forestry, beekeeping, environment, livestock, agriculture, land and home affairs. They should therefore be interpreted correctly and used effectively by all legal framework enforcers including forest officers and plantation managers, to control fire.

10. INTERGRATED FIRE MANAGEMENT STRATEGIES

10.1 Integration

All stakeholders in the different fire scenarios should have the opportunity to participate in the different stages of fire management, from information and planning to cooperation in pre-extinction measures, according to their knowledge, interests and concerns (Morguera and Cirelli 2009). Governments should define and implement the corresponding legal frameworks and platforms to make public participation in fire management possible and effective. The underlying concept of IFM is to better integrate fire and people into land-use and vegetation management systems. IFM objectives can be successfully realized only if all stakeholders involved in fire management agree on a distribution of responsibilities, decision-making power and resources. The process of negotiation and consensus building requires careful consideration of different perspectives and also the pluriformity of the legal context. Existing rules are often of different and sometimes contradictory origins (e.g. laws and administration rules governed by centralised legislation, traditional rules that may not be legally recognised, or weakening influence of traditional structures due to increasing cultural intermix (migration) or other impacts of globalisation).To overcome possible conflicts and deadlocks, a combination of bottom-up and top-down approaches in defining the appropriate IFM strategy seems to be most effective to build consensus among stakeholder groups at different levels.

10.2 Tree Growers' Associations

(i) Introduction

Tree Growers' Associations (TGAs) are the associations for those who are establishing forest and/or woodlots in Tanzania. Membership is open to those who intend to grow or are growing trees for commercial purposes. Associate membership is available for those who provide goods and services to the forestry sector. In this association, farmers are jointly organized to perform forestry activities together and few of them are organized and registered as Farmers Organizations (FOs) and others are just jointly held performing forestry activities like nursery, planting and good husbandry. It is indicated in administration manual for Tanzanian TGAs (PFP 2017) that each village should have a VFMT. It is therefore strongly advised that the TGA take active role in fire prevention and management and appoints several of its members into the team as TGA representatives.

(ii) Duties of village fire management team

Duties of a VFMT in IFM include:

a) Develop and apply a wildfire management strategy for its area.
b) Provide for agreed mechanisms for the coordination of actions with adjoining companies/agency in the event of some fire crossing boundaries.
c) Make rules which bind its members and that provide for:
    - the minimum standards to be maintained by members in relation to all aspects of wildfire;

- prevention and readiness for fire suppression;
- controlled burning to conserve ecosystems and reduce the fire danger; and
- any other matter which is necessary for the TGA to achieve its objectives.

d) Identify the ecological conditions that affect the fire danger

e) Regularly communicate the fire danger rating to its members

f) Organise and train its members in fire prevention, protection, suppression and rehabilitation

g) Inform its members of equipment and technology available for preventing and suppressing wildfires

h) Provide management services, training and support for communities, in their efforts to manage and control wildfires

i) If necessary, appoint a Forest Fire Officer (FFO), to assist in the day to day functional and operational duties.

10.3 Community-based forest fire management

Community-Based Fire Management (CBFiM) is a management approach which include local communities in the proper application of land-use fires (managed beneficial fires for controlling weeds, reducing the impact of pests and diseases, generating income from non-timber forest products, creating forage and hunting), wildfire prevention, and in preparedness and suppression of wildfires (FAO, 2006). CBFiM approaches can play a significant role in fire management, especially in most parts of the world where human-based ignitions are the primary source of wildfires that affect livelihood, health and security of people. They include planning and supervision of activities, joint action for prescribed fire and fire monitoring and response, applying sanctions, and providing support to individuals to enhance their fire management tasks. CBFiM should integrate indigenous and imported knowledge systems in fire management. The CBFiM may include the new and the old, so there may be new technology involved and there has been strengthening of existing practises. Hence, communication of fire management issues is critical at all levels. Therefore, a common theme among the array of CBFiM is that the community needs to take the lead and responsibility in fire management: either the development of fire management strategies or their subsequent implementation. This involvement includes activities associated with the management of fire-prone land, such as suppression, prevention and the use of fire. Fire management activities are typically associated with livelihood activities and occur with or without the assistance of groups or organizations outside of the community. There are several examples of successful CBFiM strategies in Tanzania outlined in the next sections.

(i) Village bylaws

These are set of regulations established to govern conservation, management and use of village forest resources. In villages with woodlots and forest plantations it is important that there are clear specific sections within the general village bylaws or

forest resource conservation, management and use bylaws, on fire to emphasize the importance of managing fire to ensure optimal forest production. Bylaws include procedures, use permit, punishment and penalties. Bylaws are usually approved by village assembly and come into effect after the approval of the District Council. One point to note is that bylaws should not be contradicting the mother laws. So bylaws should be prepared with the full knowledge of existing mother laws. It is sufficed to say that establishment of bylaws by itself is not enough; it has to be followed up by close enforcement to realize the intended objective. An example of village bylaws is included as Appendix 4.

(ii) Committees

In most villages with forests it is common to find specific committees dealing with forestry. These committees are known by different names including Village Natural Resource Committee (VNRC), Village Environmental Committee (VEC) and Fire and Environmental Committee (FEC). The committee is charged to manage and organise all forestry related activities inside the village boundaries on behalf of the rest of community members. The Forest Policy (1998) and Forest Act (2002) both recognize the VNRC as instrumental organ for sustainable forest management. Members of VNRCs are appointed by the village government and approved by village general assembly. The committee together with village government prepare year-round work plan which outlines activities to be done, time of the year and resources/materials needed. Details on the roles of VNRCs including fire management planning and bylaws enforcement are provided on Section 3.2.

(iii) Village fire fund

This is a special fund often established by TGAs or village governments with the objective of facilitating fire management activities including purchases of firefighting tools, transport of crews to the fire site during fire incidences and purchase of water and food for the firefighting crews. The fire fund can also be used to cover for medication in case a fire crew is injured during the fire control operations. Sources of income in to the fire fund come from contributions of tree growers depending on their woodlot acreage. In some cases, only tree growers residing outside the tree growing areas contribute to the fire fund and villagers contribute by providing fire suppression efforts. Other sources of income for village fire funds are penalties and fines from bylaw breakers. There are also voluntary contributions into fire funds by larger tree growers after suppression efforts took place. The amount to be contributed by each tree grower, penalties and fines charged to law breakers plus the management of fund varies among communities and villages. However, the common practice is that either the VNRC or similar structure or TGAs leadership are entrusted to manage the fund. In case of VNRC, accountability of finances is done to the village government. In case of TGAs accountability is done to the members through annual general meetings. It has been observed, that unutilised fire fund resources are invested in social infrastructure within the village.

(iv) Forestry service providers

These are individuals or group of individuals within communities who are organised and coordinated to provide forestry related services including fire management at cost. They are moderately trained, with basic skills and basic equipment and tools to prevent, suppress and control fire in woodlots and small to medium forest plantations. They work closely with village governments. They act as a bridge between forestry investors and the village government. They have standby teams during fire critical season and whenever there are fire incidences do provide transport and other supporting services to firefighting crews. The owner of the affected forest pays once the fire suppression operation is completed. Payment depends on the efforts and resources put in to quenching the fire. The challenge with this strategy is the low ability to handle large fires with limited technical knowledge, equipment and tools.

(v) Special arrangements between communities and town-based tree growers

These are special arrangements particularly made between medium and large tree growers who are town based and communities. These kinds of growers have forest plantations in villages but themselves do not live in those villages but live in towns usually in big cities sometimes called urban based forest plantation domestic investors. In the arrangement, an agreement (through memorandum of understanding) is signed between the town-based tree growers and the community demanding that those with plantation in the village will work closely with villagers for example through contributing to social infrastructure development and provision of other forestry investment opportunities e.g. jobs to community members. In return community members are actively involved to protect plantations from fires and other risks.

(vi) Incentive models

In the same line an arrangement can also be made whereby a town-based tree grower enters into agreement with the community that villagers will ensure that forest plantations are free from fires until harvesting. In return the community will get a certain agreed percentage (%) of total income from sales of forest products. The role of the village is to ensure that there is no fire in to the investor's plantations otherwise the village loses its share. Although this strategy can be applied the challenge is the waiting time for communities for the returns as rotation takes long time for most plantation tree species.

(vii) Alternative land tenure models

In another arrangement a village lease portion of its land (using the land rent) to investors who establish their plantations but do the same for the village. This model aims to continue keeping the land ownership in the hands of the village while at the same time obtaining profits from forests investments. This is done carefully to avoid land grabbing and therefore after harvesting, the land goes back to the village. This strategy ensures risk sharing between investors and communities and collective

responsibility to protect forests from fires. However, this strategy is applicable only to villages with enough land.

(viii) Incentives provision

Provision of incentives to particularly informers of people who start fires without obtaining permits from the village authority has demonstrated to be effective in controlling fire in some parts of the country. Informers are often royal community members who provide first-hand information on the person who started the fire and facilitate the arrest. Usually they are given incentives in terms of cash from fines provided by a person caught committing illegal activities including those caught starting wildfires. The amount provided as motivation depends on the agreed figures at the village general assembly.

10.4 Early warning systems

The weather forecast is not accurate enough for the fire service in most parts of the country. It is therefore important to have own specialised meteorological service to assist in measuring and rating the daily fire danger. For forest fire control, a daily fire danger rating is needed for: pre-suppression planning; detection action; planning of suppression tactics; and alerting the general public of fire danger situations. For fire danger rating, a weather index scale is needed and daily weather observations around the protected areas must be taken. The Fire Danger Index (FDI) calculated on the basis of relative humidity, wind speed, rainfall, and temperature are an important indicator of the burning conditions i.e. fire behaviour. A very high FDI indicates that the forest fuels are dry and very inflammable while a low FDI indicates that fuels are not inflammable, and that there is no danger of serious forest fire. The FDI can be divided, for instance, into five index classes. Example of these index classes are shown in Figure 12: All fire crews and plantation managers must be aware of the daily FDI. FDI sign board should be placed on strategic areas for example at the entry gate and forest plantations to be easily seen. With the advancement in technology satellite-based detection can complement fire danger forecasting to provide early warning and enhance preparedness against fire.

10.5 Burning prohibitions

Burning prohibition is a viable solution for forest fires during high fire danger period. The annual period can be determined by dates or weather conditions determined by FDI. Burning during the prohibition period is allowed by permit with conditions (including FDI and resource requirements).There has to be burning prohibition announcement which is clear to all actors. Protocol to obtain burning permit should also be understood by stakeholders. Already in some parts of the country small and medium-scale growers are only allowed to burn after 18.00 hrs in the afternoon. It is also not allowed to burn unless there are at least 5 people on site and community leaders must be aware. When you are given permission to burn, fire breaks and firefighting resources must also be in place.

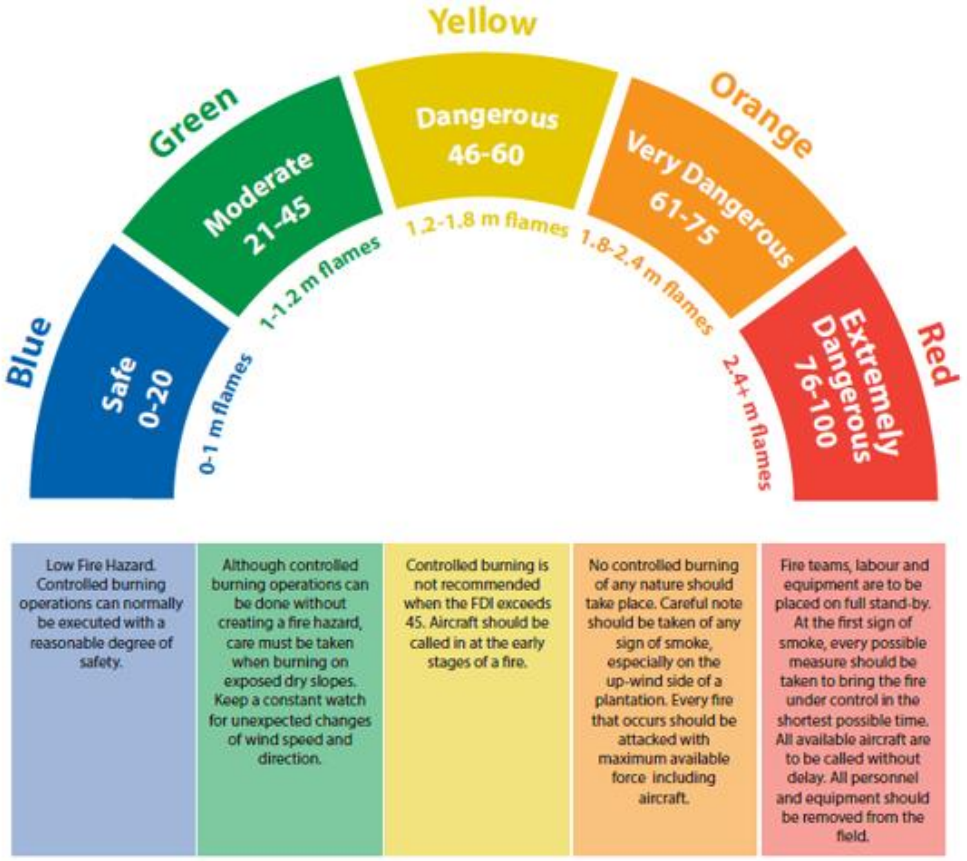


Figure 12: Fire Danger Index system suitable for forest plantations and woodlots

If necessary, no burning on public holidays or weekends can be considered. More explanations on burning prohibitions (for small-medium tree growers) are provided in village bylaws (Appendix 4).

10.6 Investment in basic tools

A suite of fire management equipment and tools are available for any type of grower, e.g. slip-on units at Sao Hill to fire beaters, rake hoes and knapsack pumps for small-scale growers. Each public and private forest agency and TGAs are required to establish a store for containing all basic fire suppression equipment. It is advised all equipment must be maintained regularly to increase effectiveness and efficiency during fire suppression. Also, the nearest fire brigade should be used in forest fire suppression. The suppression of high-intensity plantation fires requires professionally-trained teams that are adequately prepared and equipped for the task. The control of intense plantation fires requires substantial investment to ensure effectiveness and safety of personnel. Successful forest fire suppression depends on a well-balanced combination of people, equipment, tools, and training. The number for each piece of equipment depends on: local conditions; size of plantations; climate; topography and economy. Some could be used in other forest operations before and after fire season. They should be procured before fire season, maintained and given all necessary service or replacement after use. The equipment for fire suppression can be categorized into two groups-hand tools and mechanical

equipment as detailed in the following sections.

(i) Hand tools

There are five basic work functions in forest fire control where hand tools are used: line location; clearing and construction of trails; grubbing, trimming, trenching; burning off; and suppression/mop-up. In choosing firefighting hand tools, the following should be taken into consideration: effectiveness; efficiency and productivity; versatility; portability; durability; maintenance and replaceability and standardization. The hand tools commonly used are: rakes, hoes, hovels, bush hooks; fire-beaters and backpack pumps (Figure 13).

Rake hoe

Knapsack water pump rigid

High pressure slip on machine

Fire beater with wooden or aluminium handle

Collapsible water pump

Drip touch

Figure 13: Examples of fire management equipment and tools

(ii) Mechanical equipment

Includes vehicle for crew and equipment; water bowsers; reliable mechanical water pump fitted with engine or powered from tractor or vehicle (Figure 14); power pumps - augment water supply, tractors wheeled and crawlers with plough and/or dozer blade attachment.

Aircrafts; helicopters for delivering extinguishants (water, chemical fire retardants and foam); and parachutes can also be used in fire control operations.

Figure 14: Fire suppression vehicle at Sao Hill Plantation Forest

10.7 Integrated fire management training

Training on key elements (i.e. prevention, preparedness, suppression, restoration and data collection and analysis) of IFM is important to reduce negative impacts of fires. At local level it is recommended that 15 persons per village be recruited, equipped with protective clothing and fire management tools, and trained in prevention, protection and suppression. The safety of fire fighters is dependent on their knowledge of fire characteristics and the local weather. Training in the effective use of equipment and fire suppression techniques is important. For supervisors and plantation managers, training can help them better understand and effectively deploy resources. During training providing proper equipment to fire fighters is basic for practices. Personal protective equipment such as helmets, gloves, fire-resistant clothing (e.g. 100% cotton overalls and t-shirts) and safety boots (leather) should be considered an essential requirement of the training programme. The tools used should be appropriate to the customs of the firefighters and effective in the local environment. Specific/tailor made training programmes must be designed and provided to meet a range of needs among fire control practitioners and leaders. For example a basic firefighter course should include fuel load management, fire break maintenance, fire danger rating, detection, fire types and characteristics, duties and organisation at fires, patrols, safety, use of basic equipment and mopping up. On the other hand, crew leaders' course should include fire legislation, fire behaviour, initial attack strategies and tactics, human resource mobilization and fire extinguishing

methods. Supervisors are particularly trained in planning and execution of extended fire fighting operations, management of multiple fire incidences, data collection and analysis, reporting, monitoring and restoration.

Integrated fire management training can be obtained from a wide range of sources including fire specialists from public and private large plantations, District Natural Resource and Land Offices with fire-fighting experience, forestry training centres (e.g. Forestry and Wood Industries Training Centre, Mafinga), Forestry Training Institute (Arusha) and Tanzania Fire and Rescue Force (TFRF) offices.

10.8 Conclusion

Design and implementation of effective strategies are important to realize the objective of IFM and commercial forestry. The strategies include integration, establishment and strengthening of TGAs, promotion of community-based approaches to fire management, put in place functional affordable early warning systems, establish burning prohibitions, investment in basic tools and equipment and training on all aspects of IFM. These strategies are effective and should be strongly emphasized in endeavours to boost commercial forestry in the country.

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GLOSSARY

Term	Description
Arson fire	An uncontrolled fire willfully ignited by someone without consent of the owner or his/her agent with the intention that it burn, or spread to vegetation or property.
Combustion	Rapid oxidation of fuels producing heat, and often light.
Continuous fuels	Combustible material with no natural or man-made break to stop the fire spread through it.
Controlled fire	A fire that is subject to a line of control around a fire, any spot fire from it and any interior island to be saved, effectively preventing any unplanned spread.
Control Room	24-hour call centre receiving and dispatching all emergency calls, which, in this context, has a focus on wildfires.
Direct attack	A method of fire attack where wet or dry firefighting techniques are used, in suppression action, right on the edge of the fire, which then becomes the fire line. It generally involves firefighters moving directly onto the fire line to extinguish the flames. This generally happens when the flames are lower than 1.2m.
Fire	A process of combustion, is a chemical reaction called rapid oxidation, and is accompanied by production of heat and light.
Fire danger	A general term used to express an assessment of both fixed and variable factors of the fire environment that determine the ease of ignition, rate of spread, difficulty of control and fire impact – often expressed as an index.
Fire Danger Rating	A relative class denoting an evaluation of the rate of spread or suppression difficulty for specific combinations of temperature, relative humidity, drought effects and wind speed. Rated as low, moderate, high, very high or extreme, indicating the relative evaluation of fire danger.
Fire ecology	The study of the relationships between fire, the physical environment and living organisms.
Fire environment	The surrounding conditions, influences, and modifying forces of topography, fuel and weather that determine fire behaviour.
Fire Effects	Negative or positive impacts of fire on the environment
Fire Control	It is a step to follow and a way of preventing the damage caused by fire in different places.
Fire frequency	A general term referring to the recurrence of fire in a given area over time. Also see “Fire regime”.
Fire line	Term used to define the actively burning wall of fire or flames on the edge of an advancing wildfire.
Fire risk zones	Are the areas that can be easily affected by fire to a large extent.
Fire Management	Fire management activities are concerned with the protection of people, property, forest and woodland areas from unwanted fires.

Term	Description
	It is also concerned with the use of fire as a land management tool.
Fire Management Plan	A fire management plan contains concise information on the fire risk and resources in an area, along with strategic and operational information to support informed decision-making.
Fire Management Unit	A localised area in which Integrated Fire Management efforts between individual landowners can be most effectively coordinated
Fire preparedness	All activities undertaken in anticipation of and in advance of wildfire occurrence to decrease its extent and severity and to ensure more effective fire suppression.
Fire prevention	Activities, including education, engineering, enforcement, and administration that are directed at reducing the number of wildfires (particularly those of human origin), the costs of suppression and fire-caused damage to resources and property.
Fire protection	The actions taken to limit the adverse environmental, social, political, and economic effects of fire.
Fire regime	Periods and patterns of naturally occurring fires in a particular area or vegetation type, described in terms of frequency, biological severity, and area extent.
Fire risk	Fire risk is determined by assessing, firstly, the likelihood of a wildfire occurring at any given place and, secondly, the consequences should this happen.
Fire season	The periods during which wildfires are likely to occur, spread and do sufficient damage to warrant organised fire control.
Fire severity	The degree to which a fire is destructive of life, property, or the environment. This is usually a function of the duration (residence time) of a fire and its intensity.
Fire service	A fire brigade of a local authority or a firefighting unit, designated as such by the Minister.
Fire Triangle	Is the combination of 3 items (Oxygen, Heat and Fuel) which enhance the outbreak of fire.
Firebreak	A natural or man-made change in fuel characteristics which affects fire behaviour so that fires burning into them can be more readily stopped or checked, or provides a control line from which to work. Under favourable conditions an adequate firebreak may stop a fire. However, under adverse fire conditions, it is a place to gain access to fight the fire indirectly through methods such as burnout and back burning
Forest	An area, incorporating all living and non-living components, that is dominated by trees, having usually a single stem and a mature or potentially mature stand height exceeding 2m, and with existing or potential crown cover of overstorey strata about equal to or greater than 20%.

Term	Description
Fuel	Are different things which enhance the outbreak of fire in different areas.
Fuelbreak	An area, strategically located for the fighting of anticipated fires, where the native vegetation has been permanently modified or replaced so that fires burning into it can be more easily controlled. Fuelbreaks divide fire-prone areas into smaller areas for easier fire control and to provide access for firefighting.
Fuel load	The volume of fuel in a given area (the oven dry weight) per unit area. Generally expressed in tons per ha.
Hazardous areas	Those uncontrolled wildfire areas where the combination of vegetation, topography, weather and the threat of fire to life and property create difficult and dangerous problems.
Incident Command System	An emergency management tool, used at incidents by all types and levels of emergency services, to ensure standardisation and efficiency, and that: is adaptable and scalable to any type or size of event; is suitable for use regardless of jurisdictions or agencies involved; employs a common organisation structure; utilises common communication and structures and consolidated action planning; and utilises common terminology.
Incident Commander	The person in charge of the fire or incident.
Indirect attack	A method of suppression in which a control line is located some considerable distance away from the fire's active edge. Generally done in the case of a fast-spreading or high-intensity fire and utilising natural or constructed firebreaks, fuel breaks and favourable breaks in the topography. The intervening fuel is usually burnt out, but occasionally, depending on conditions, the main fire is allowed to burn to the control line.
Initial attack	The actions taken by the first resources on arrival at a wildfire to protect lives and property and to prevent further spread of the fire. Usually done by small, fast acting and localised teams with limited resources, and takes place immediately after size-up. The motto is 'hit hard and hit fast'.
Integrated Fire Management	The holistic and systematic approach to the management of wildfires, which seeks to combine all stakeholders and the various management efforts into a single, albeit diversified, strategy.
Mitigation	Any risk management measure or action that moderates the severity of a fire hazard or reduces risk, including fuel-reduction burning, other prevention measures, and preparedness.
Natural barrier	Any area where lack of flammable materials or physical constraints limit the spread of a fire.

Term	Description
Non-combustible	A material that, in the form in which it is used and under the conditions anticipated, will not aid combustion or add appreciable heat to an ambient fire.
Plantation	A stand of trees or bushes planted and cultivated in rows, at even spaces.
Preparedness	All activities undertaken in advance of the occurrence of an incident to decrease the impact, extent and severity of the incident, to ensure more effective response activities, to recognise changes in fire danger, and to act promptly when action is appropriate.
Prescribed burning	The controlled application of fire, under specified environmental conditions, to a predetermined area and at the time, intensity, and rate of spread required to achieve planned resource management objectives. Generally, it requires the specific authorisation of the fire management authority.
Prevention	All activities concerned with minimising the occurrence of incidents, particularly those of human origin.
Response	Actions taken in anticipation of, during and immediately after an incident, to ensure that its effects are minimised, and that people affected are given immediate relief and support.
Retardant	A substance or chemical agent that reduces the flammability of combustible material.
Risk	The exposure to the possibility of such things as economic or financial loss or gain, physical damage, injury or delay, as a consequence of pursuing a particular course of action. The concept of risk has two elements, i.e. the likelihood of something happening and the consequences if it happens.
Safety zones	Are the areas which cannot be affected by fire
Spot fire	An isolated fire started ahead of the main fire by sparks, embers or other ignited material; sometimes at a distance of several kilometers.
Wildfire	A vegetation fire accidently igniting or deliberately ignited, but burning out of control, including forest fires.
Wildland fire	Any non-structure fire that occurs in the wildland. Three distinct types of wildland fire have been defined and include wildfire, wildland fire and prescribed fire.

APPENDICES

Appendix 1: Standard format for Integrated Fire Management Plan (IFMP)

1. Introduction

This chapter is prepared to introduce the reader to the area covered by the IFMP. State the reasons for developing the IFMP. Provide a general description of location of the area covered by the IFMP with vicinity map and stakeholders involved. Briefly describe land ownership, significant resources and management areas (e.g. natural or commercial forests including forest plantations and woodlots) to help planning.

2. Legal frameworks and Partnerships

The objective of this chapter is to establish the linkage between higher level planning documents, legislation and policies and the actions described in the IFMP document.

2.1 Fire Policy

This section seeks to identify sources of guidance and direction that relate to actions described in the IFMP. These include specific Policies, Acts and bylaws which govern/institutionalize the IFMP. More details on legal frameworks are presented in chapter 9 of the IFM guidelines.

2.2 Land/Resource Management Planning

This section presents documents that relate to the area covered by the IFMP including land management plans and conservation plans

2.3 Partnerships

As indicated in the IFM guidelines working in isolation to manage forest fires is not feasible so identify any internal and external fire management partnerships or planning teams that can help develop the IFMP. At local level, TGAs, VFMT and VNRC are resourceful and in collaboration with District Natural Resource and Land Department they should be able to form planning teams and develop IFMP. This information documents the level of cooperation occurring. Detailed explanations on partnerships are provided in section 10.1 of the IFM guidelines.

3. Fire Management Unit Characteristics

The intent of this chapter is to articulate specific objectives, practices and considerations common to all fire management units (FMUs) and unique to individual FMUs. The primary purpose of developing FMUs in fire management planning is to assist in organizing information in plantations and woodlots. The process of creating FMUs divides the landscape into smaller geographic areas to more easily describe physical and social characteristics. The following sections provide guidance on what to include in this chapter:

3.1 Area-wide Management Considerations

This section documents overall fire management program guidance and characteristics common to all FMUs. Describe fire management related goals, objectives, standards, guidelines, and/or desired future conditions as found in the appropriate land management plan(s) (LMPs) that apply across all FMUs. Include fire management related goals that may come from non-fire program areas within the LMP or other planning documents.

3.2 Fire Management Unit

The section presents a description of the characteristics of the FMU. Examples are: Physical description of FMU including topography, fuel types, special conditions that may result in extreme fire behaviour, access, high value concerns, special areas) jurisdictional boundaries, other values at risk within and adjacent to FMU, previous fire behaviour and weather descriptions. Operational information may be detailed or added as an appendix, such as permanent repeater locations, radio frequencies, radio 'dead spots', communication plan, evacuation plan, water fill sites and helicopter landing spots.

4. Fire Operational Guidance

The objective of this chapter is to document the procedures used in the area covered by the IFMP to implement the fire management program.

4.1 Appropriate Management Response

Describe procedures that should be in place for planning and responding to fires. Examples include:

(i) preparedness (including training, safety, readiness, detection, communication)
(j) cooperative or mutual aid fire management agreements
(k) cost apportionment agreements
(l) cross-boundary fire agreements,
(m) size up, initial response and extended response procedures
(n) dispatching/ prioritization of resources
(o) preparation of equipment and tools
(p) large/prolonged fire cost management
(q) public interaction and media policies
(r) reporting requirements

4.2 Prevention and Education

Describe or reference fire prevention and education strategies for specific area. Procedures to be included are dependent on stakeholder needs. Examples include:

(i) human caused ignition patterns and problems
(j) fire investigation policies and procedures
(k) governance structures to manage fire
(l) firebreak, fuelbreak and fuel load management
(m) burn permit systems, burn prohibitions
(n) law enforcement procedures and agreements
(o) community involvement
(p) education and awareness programmes
(q) bylaws implementation

5. Monitoring and Evaluation

The aim of this chapter is to document processes for determining whether the IFMP is being implemented as planned and fire-related goals and objectives are being achieved. Information obtained from monitoring and evaluations is used to update

the IFMP. Describe monitoring processes that will be used to measure achievement of IFMP objectives.

Glossary

Include a glossary for common terms. Include full definition for stakeholders or unit specific terminology.

Appendix 2: Integrated fire management review form

Name of Forest Plantation/Woodlot:_____
Location:_____

The primary objective of the IFM review is to provide a comprehensive operational inspection, evaluation and report on key components of IFM for commercial forestry. The technical evaluation will, as a minimum, review the following fire checklists that have been selected for this review. This system will allow for efficient documentation and immediate feedback of the results of the evaluation on the selected commercial forest plantations and woodlots. This guide should be adopted to meet local conditions and can be subdivided to use only the appropriate checklists for the selected area. The following will provide suggestion for use:

1. Checklists are designed to be used, all or in part. Select the checklists that are needed to meet the review objectives.
2. The checklists are developed to provide recommended elements and may or may not reflect forest policy.
3. Some checklist elements may appear to be duplicated, but provide adequate coverage, if all checklists are not utilized.
4. The ratings:

E	=	Above Average	Indicates that the element/activity was completed at a level higher than expected.
M	=	Satisfactory	Performance meets expectations.
NI	=	Needs Improvement	Element performance does not meet expectations.
NR	=	Not Reviewed	Element was not reviewed because it was determined to be not needed or appropriate for the review objectives.

Checklists

GENERAL OBSERVATION

- ☐ IFM plan
- ☐ Fire Management Administration
- ☐ Community-based Forest Fire Management
- ☐ Integrate Stakeholders/Actors

PREVENTION (RISK REDUCTION)

- ☐ Institutional Framework
- ☐ Education and Awareness
- ☐ Firebreak
- ☐ Fuelbreak
- ☐ Fuel Load Management

PREPAREDNESS (READINESS)

- ☐ Planning
- ☐ Fire Detection

- [ ] Communication

SUPPRESSION (RESPONSE)

- [ ] Equipment and Supplies
- [ ] Mode of action for sizing-up
- [ ] Phases of fire suppression
- [ ] Methods of fire attack
- [ ] Responsibility for fire control and basic law
- [ ] Other important initiatives for wildfire
- [ ] Organisation and management of wildfires
- [ ] Safety measures

RESTORATION (REHABILITATION) IN IFM

- [ ] Needs of immediate Restoration
- [ ] Components of restoration (rehabilitation)
- [ ] Measures for restoration of burned areas

DATA COLLECTION AND ANALYSIS (RESEARCH) FOR IFM

- [ ] Records and Reports
- [ ] Monitoring and assessment after fire

TANZANIANTREE GROWERS' ASSOCIATIONS (TGAs) AND IFM

- [ ] TGA investment in basic tools for IFM
- [ ] IFM training plan for TGAs
- [ ] Estimated cost of IFM interventions for TGAs

Appendix 3: A standard fire reporting form

Record No: …….

Fire Log No:……

A. **Basic data**

Region: …… Forest plantation/woodlot: ……..

District……. …… Date…….

B. **Meteorological data**

-Temperate of previous days ……..
-Temperature (the day of fire) ……..
-Relative humidity: ……..
-Wind speed: ……..
-Date of the last rain: …..…….

C. **Cause**

Risk day ……..
Time: …….. fire started at …….
Report to station at ……
Date: ……...
Remarks: The fire was detected by ……... at ……...

D. **Detection**

Fire reported to control centre:……...at…..…by …….. at ……

E. Suppression

Fire crew called out at……
Firefighting started at: ……..
Fire appliance/equipment arrived at …….....
Fire under control at: …….
FD equipment arrived at …….. hours (water bowser, fire tender wheel loader and grader) specify.
Firefighting: Took almost ……hours to make the fire under control while mopping up took ……days/hours.
Fire completely safe at ……..

E. **Cost**

INVOLVEMENT	NUMBER			Amount (TZS)
	Fire fighter	Total	Hours	
Personnel permanent Plantation/woodlot workers Others Vehicles				

Fuel consumption: ……..

Other costing: ……

Extended table for detailed causes of fire

Cause	Delinquent	Children	Farmer	Cattle breeder	Hunter	Forest plantation/ woodlot worker	Public worker	Arson	Unknown	Others
Smokers										
Match										
Cooking fire										
Controlled burning without license										
Late burning										
Charcoal										
Hunting										
Heavy equipment										
Waste burning										
Land preparation										
Lighting										
Fruit picking										
Honey picking										
Road/railway										
Unknown										
Others (……)										

NOTE: Write down only one X in the appropriate equate corresponding to the meeting point between the cause and the person responsible for the fire

F. **Losses**

1. Standing trees of between ……. and ……..years which were planted in the compartment……..

Table for detailed losses

Compt. No.	Planting year	Spp.	Site type	Lower upper slope	Area (ha)	Stocking	Estimated volume	Value

2. Is there any need for new land preparation? YES/NO

3. Other losses: ……

G. **Sketch of area burned**

H. **General comments**……..

Assistant Manager: ……
Date……
General comment:……
……
……

Plantation/Woodlot Manager……
Signature……
Date……

Appendix 4: A sample of village bylaws

i. Every villager who cultivates on mountains is obliged to use terraces
ii. Every villager must obtain permit from the Village Executive Officer before start fire on farms
iii. Fire shall be set on farms from 6:00 pm
iv. Fire should not be started in a farm unless there are at least five (5) people
v. After starting fire you should come early morning next day to check if the fire is completely extinguished
vi. It is prohibited for any resident to cause fire in village open areas, woodlots, plantations and natural forests
vii. Every villager is responsible for fire suppression in any open or any other area(s) as instructed by Village Executive Officer or any other person with such authority
viii. It is forbidden for any villager to cultivate food or cash crops in areas used for pasture or other special use areas
ix. It is forbidden for any villager to pollute catchment areas /water sources
x. It is forbidden for any resident to conduct activities which affects negatively the land, forests or catchment
xi. It is forbidden to carry human activities like settlement development, agriculture or livestock feeding within 500 m from water well/pond banks
xii. It is not allowed to do any human activities within 60 m from the water source
xiii. It is not allowed to do any human activities like agriculture, livestock keeping, construction and brick making within 60 m from small rivers and 150 m from large rivers
xiv. It is not allowed to graze livestock inside the forest without permit
xv. It is forbidden to dislocate or remove forest boundaries marks

Any person who shall have contravened these bylaws shall have committed an offense and he/she shall be liable to pay the penalty or sentence of up to 2 months as shown hereunder:

No.	Offense	Fine (TZS)	Sentence (months)
1.	Start fire without permit	50,000	1
2.	Start fire before 6:00 pm	50,000	1
3.	Deliberate assisting fire escape because of negligence for not following the laid down procedures	100,000	2
4.	Not preparing firebreaks	100,000	2
5.	Destroy/degrade the environment	20,000	1
6.	Not participating in fire suppression	20,000	1
7.	Livestock grazing inside the forest with no permit	5,000 per animal head	1
8.	Dislocating or removing forest boundaries marks	50,000 - 100,000	2