PANDA MITI KIBIASHARA

PARTICIPATORY PLANTATION FORESTRY PROGRAMME

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Integrated Fire Management for Commercial Forestry in Tanzania

Training Manual

United Republic of Tanzania
MINISTRY OF NATURAL RESOURCES AND TOURISM
Forestry and Beekeeping Division

Embassy of Finland
Dar es Salaam

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September 2023, Iringa, Tanzania

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ABBREVIATIONS

DC	District Council
DFC	District Fire Coordinator
FDI	Fire Danger Index
FDR	Fire Danger Rating
IFM	Integrated Fire Management
PPE	Personal Protective Equipment
RH	Relative Humidity
RoS	Rate of speed
TGA	Tree growers' association
TZS	Tanzanian shilling
VC	Village Council
VEO	Village Executive Officer
VFC	Village Fire Crew
VFF	Village Fire Fund
VFMAP	Village Fire Management Action Plan
VFMP	Village Fire Management Plan
VFMC	Village Fire Management Committee
VFMP	Village Fire Management Plan
VGA	Village General Assembly

1. INTRODUCTION

This training manual is intended to aid in the implementation of Integrated Fire Management (IFM) for Commercial Forestry in Tanzania. It is intended to be used as course material for an IFM course for fire managers, landowners, forestry extension staff and foresters, but it can also be used as a stand-alone textbook. A Swahili version is also being released.

Strategic elements of IFM include:

- Protection/Preparedness (readiness to face fires),
- Prevention (risk reduction/preventing fires from igniting),
- Suppression (response to a fire/strategies and tactics to suppress a fire),
- Restoration (rehabilitation of areas damaged by fires), and
- Research (data collection and analysis, applied and academic research).

This training manual covers village-level fire protection, prevention, and suppression efforts. It begins with a description of the fire environment and its impact on fire behaviour, and then moves on to provide critical information for Village Fire Crews (VFCs) and Village Fire Management Committees (VFMCs).

This IFM training manual is supported by other programme publications:

1. Integrated Forest Fire Management Instruction Booklet for Commercial Plantation Forestry
2. Customizable Template of Bylaws for the Management and Prevention of Forest Fires
3. Village Fire Management Template

These publications are available in both English and Swahili at https://www.privateforestry.or.tz/resources/publications.

Along with the programme publications, PFP 2 has worked with a Finnish researcher from the University of Eastern Finland (Makutano Project: 320236 funded by the Academy of Finland) to create guidelines for integrating land use planning and fire management through participatory mapping. These guidelines support village fire management plans. This is anticipated to be published by PFP 2 later in 2023.

This IFM training manual takes advantage of the author's international experience in forest fire management and builds on preceding work:

- Tanzania's national, regional, and district governments have committed to reducing forest fire losses and have implemented Integrated Fire Management (IFM) as one of their priorities.
- Regional and local governments have increasingly been providing leadership and coordination in reducing fire damage.
- The national level "Integrated Fire Management - Guidelines for Commercial Forestry (2019)" document was prepared by the Ministry of Natural Resources and Tourism, Forestry and Beekeeping Division based on forest fire trends, and existing national policies, including the forest policy, Food and Agriculture Organization (FAO) recommendations, and the country's increasing investments in small, medium, and large-scale commercial forestry.
- The Sokoine University of Agriculture piloted the introduction of IFM in Wino. Lilondo and Mkongotema villages, Ruvuma region with the Tanzania Forest Service agency, paving the way for widespread national adoption. Furthermore, some private companies have collaborated with their neighbouring communities to adapt elements of IFM, but not in a comprehensive and standardised manner.

2. THE FIRE ENVIRONMENT AND ITS INFLUENCE ON FIRE BEHAVIOUR

1	In this first chapter, you will learn about the fire environment and its influence on fire behaviour. The fire environment includes: - fuel - weather - topography

2.1 Fuel, weather & topography

The term “fire environment” refers to the landscape in which fires can occur. The fire environment is influenced by three key factors: fuel, weather, and topography. Fuel refers to the vegetation and other combustible materials in the area. The type and condition of fuel influence how a fire burns. Weather conditions such as temperature, humidity, wind speed and precipitation also affect fire behaviour. Weather can change at any time, whether it is due to seasonal variations, weather fronts passing through the area, or even throughout the day and night. Topography refers to the physical features of the landscape, such as mountains, valleys, and slopes, and can impact fires by influencing wind patterns that can affect the spread of flames.

2.1.1 Fuels

The fuel characteristics determine the intensity and speed of a fire. It is essential to consider both the fuel that is currently burning and any unburned fuel when planning a burn or fighting a fire. This is important because if a fire spreads into an adjacent area, knowing the fuel characteristics in that area will help fire managers predict fire behaviour and plan suppression strategies and tactics in case the fire spreads.

Fuel characteristics can be distinguished based on fuel classification, fuel load, fuel compactness, chemical content, size and shape, moisture content, and fuel temperature. The state of fuels determines how flammable they are. For example, thick and/or moist fuels are less flammable than thin and/or dry fuels.

Fuel load: The fuel load is determined by the weight of fuels in a given area. The weight of fuel is expressed in kilograms or tons per hectare. A fire cannot burn if there are insufficient flammable fuels to carry it. Different types of vegetation produce different amounts of fuel. The more fuels are available to carry a fire in a specific area, the more intensely that fire will burn.

Fuel classification: Fuel can be classified into ground, surface, and aerial fuels. Ground fuels are dry roots below the ground surface. Surface fuels refer to those fuels between the surface and about man-height. Fuels higher than man-height are classified as aerial fuels. Moreover, fuels can also be arranged horizontally (Figure 2.1) and vertically (Figure 2.2). If fuels are arranged densely in a horizontal pattern, fires will spread faster and more easily in a horizontal direction. Fuels that are vertically close together form a fuel ladder, which allows surface fires to spread into aerial fuels (Figure 2.2).

Poorly managed forest plantations (Figure 2.3) can form vertical fuel arrangements. By climbing dead branches into tree crowns, fires spread easily. Figure 2.4 shows a thinned and pruned plantation without a continuous vertical fuel arrangement that is less susceptible to damaging fires.

Figure 2.1 **Horizontal fuel continuity**
Fuels that are not horizontally continuous will not carry a fire.

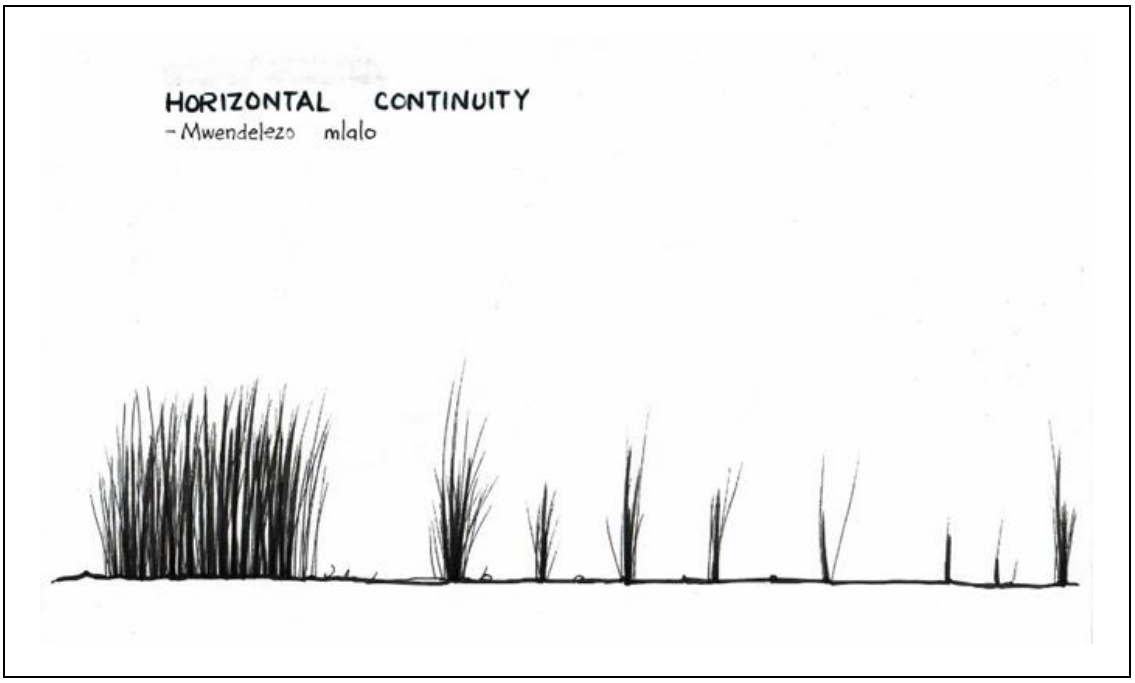


Figure 2.2 **Vertical fuel arrangement**
Vertically continuous fuels will allow a surface fire to spread into the crowns of trees easily.

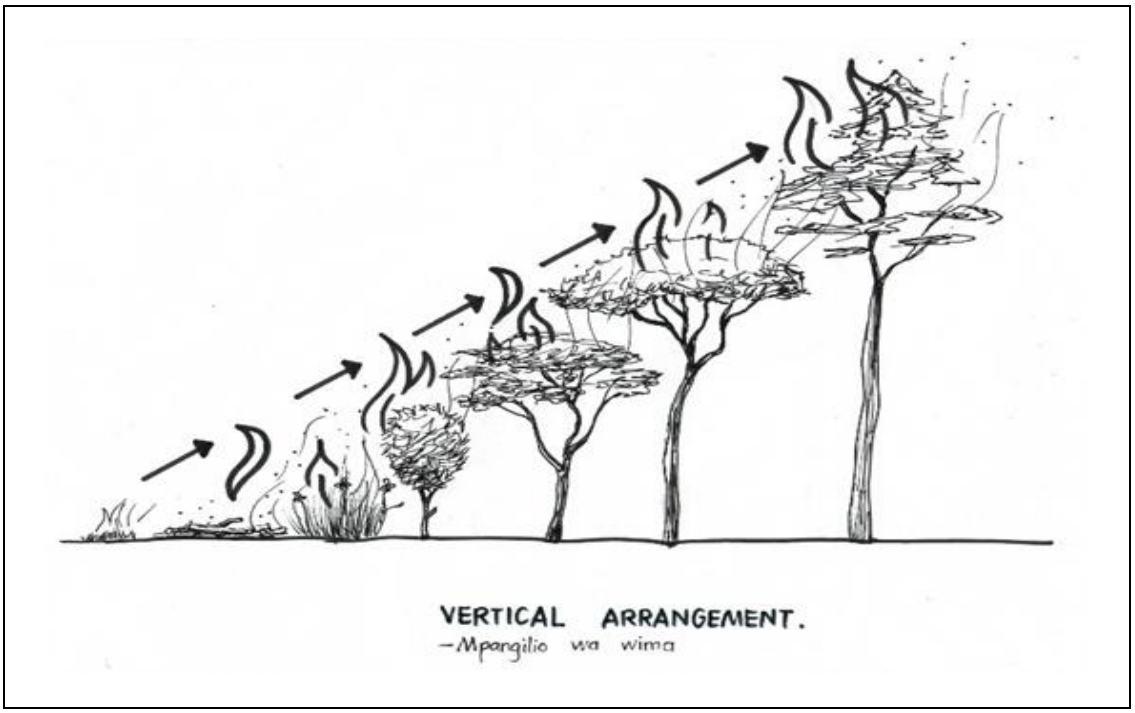
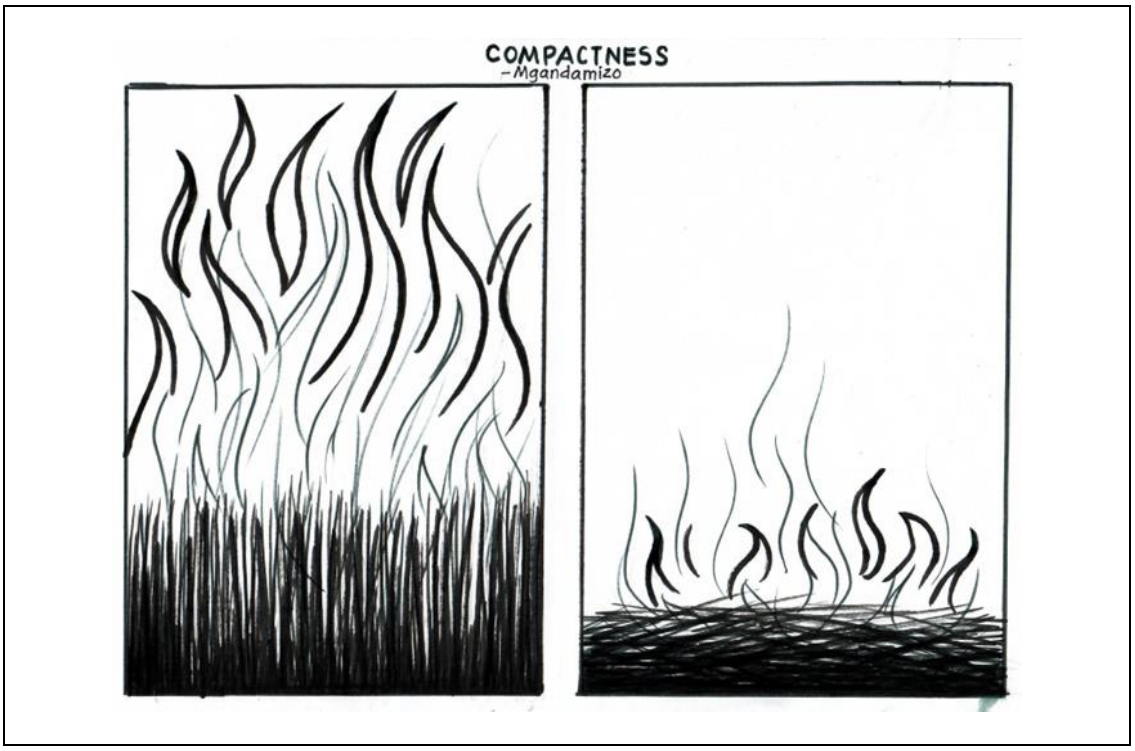


Figure 2.3 Fire Prone Forest Plantation

Figure 2.4 Less Fire Prone Forest Plantation

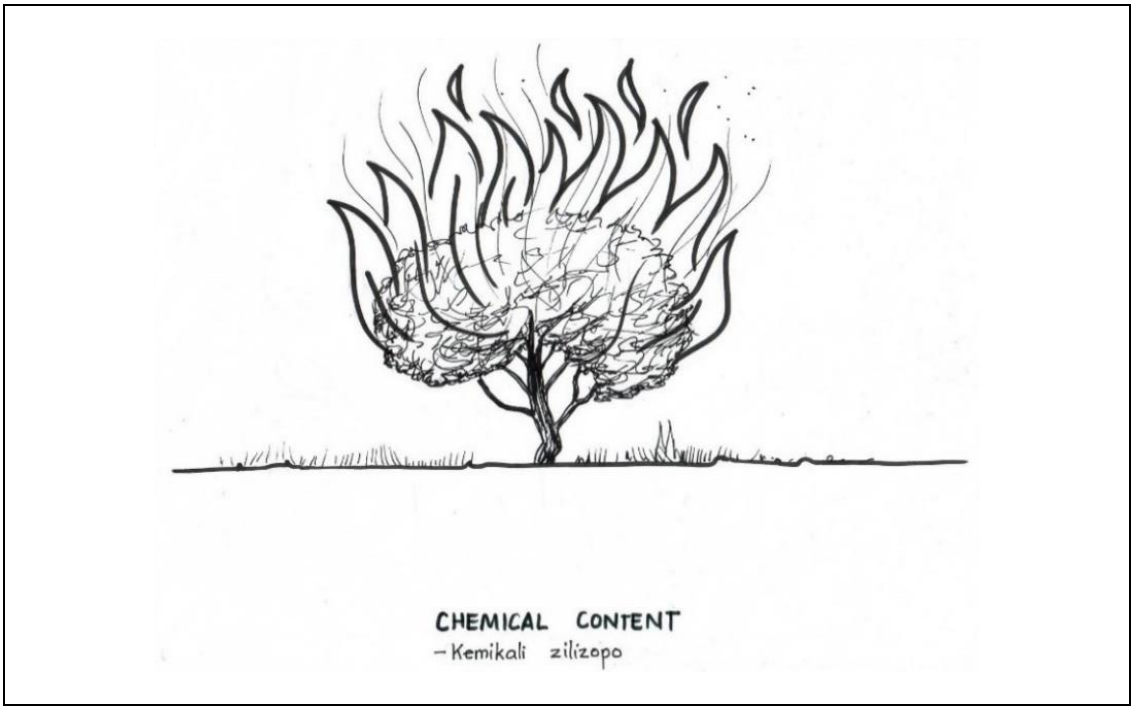
Fuel compactness: Fuel compactness describes how closely packed fuel particles (materials) are. More compacted fuel loads have less space between fuel particles, which reduces oxygen and heat exposure for these fuels (Figure 2.5). Compacted fuels are less likely to ignite and also reduce the rate and intensity of fire spread. Therefore, high fuel loads that are compacted pose a lower fire risk compared to the same fuels that are loosely stacked and allow air to flow freely between fuel particles.

Figure 2.5 Fuel compactness
Grasses that are slashed are no longer oriented vertically but are compacted on the ground. Compacted fuels pose a lower fire risk.



Chemical content: All vegetation contains chemicals which are volatilized (i.e., turned into flammable gasses) when heated. The chemicals vary in volatility and affect the behaviour of fires when ignited. Plants with more volatile chemicals will easily ignite and result in hotter fires (Figure 2.6). The flammability of an area is influenced by the type of fuel.

Figure 2.6 Chemical content
Some plants, even if they look green and alive, burn easily when heated because they contain chemicals that can become volatile gasses.

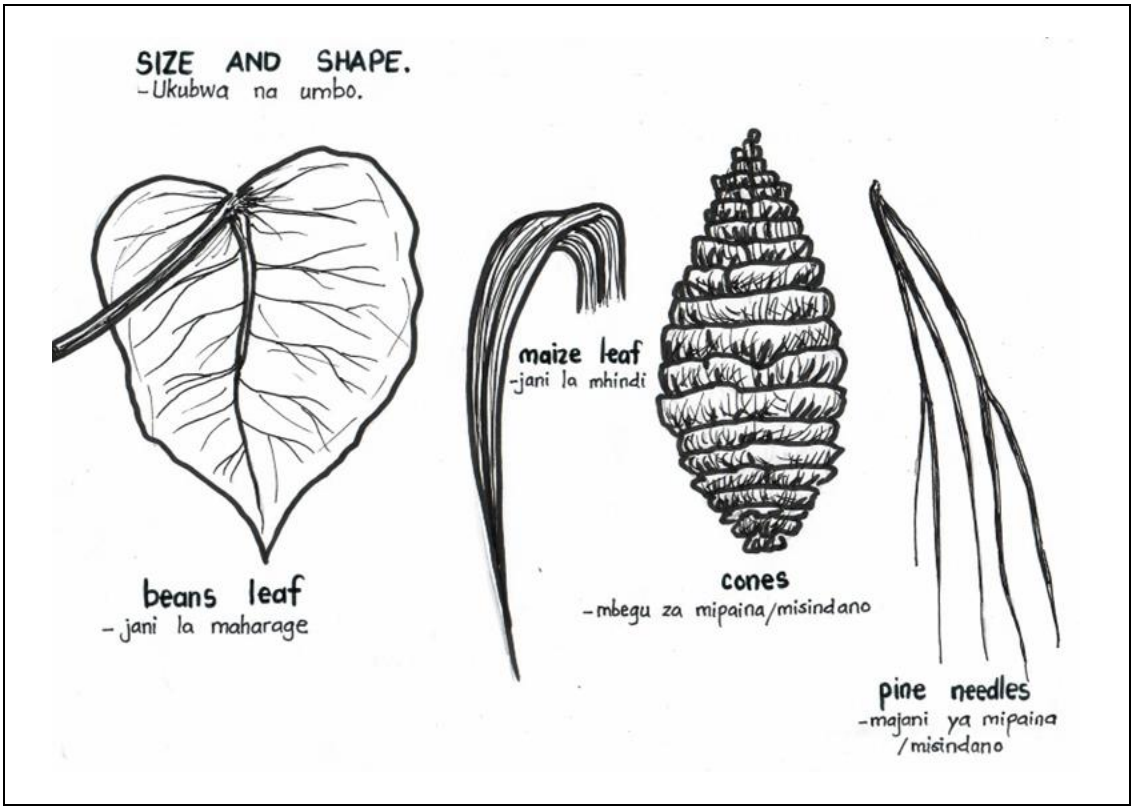


Size and shape: Fuels are classified into different classes based on their diameter size (Table 2.1). The thinner the fuel is, the easier it is to ignite (Figure 2.7). If the greater proportion of fuels is thin and small, then it is easier for a fire to ignite and spread. The fuels that have the most impact on fire behaviour are dead fuels with a diameter of less than 75 mm and live fuels with a diameter of less than 6 mm. Dry fuels can quickly become flammable, even if they are wet from dew or rain because they can gain and lose moisture at a fast rate. Large fuels take longer to dry out and become flammable. Therefore, it is critical to understand the fuel mix in the area to better understand how a fire might behave.

Table 2.1 Fuel class by diameters.

Fuel Class	Fuel Diameter	Example
small or fine fuels	<6mm	annual grass & forbs
medium fuels	7 – 25mm	shrubs & and small branches
thick fuels	26 – 75mm	harvesting slash
large fuels	>75mm	logs

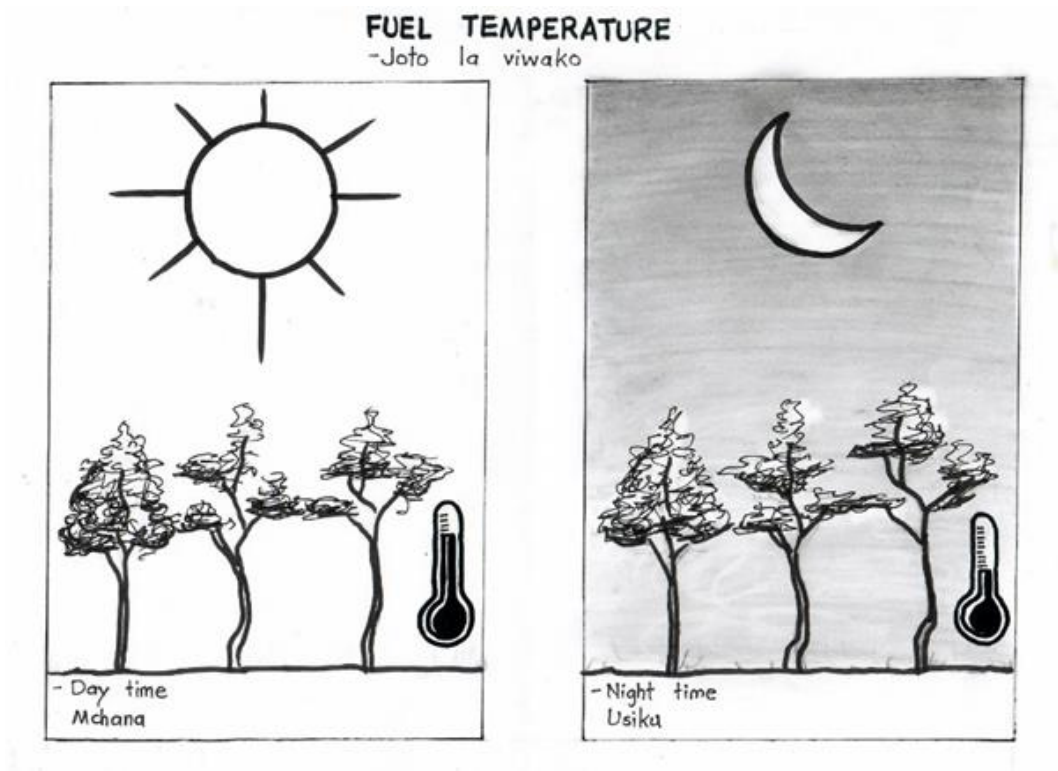
Figure 2.7 Size and shape of fuels
Thinner fuels with a larger surface area are easier to ignite compared to thick fuels



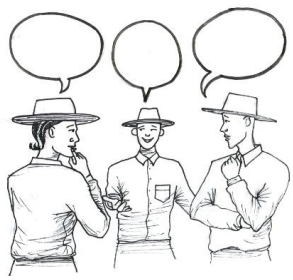
Fuel moisture content: Fuel moisture is determined by the amount of water present in dead or live fuels at any given time. The fuel characteristic with the greatest influence on fire behaviour is fuel moisture. The wetter the fuel is, the slower it will burn.

Fuel temperature: Fuels must be preheated to a certain temperature before combustion. The warmer the fuel becomes, the easier it is to ignite and for the flames to spread. This means that during periods of warm weather and warm winds, when fuel temperatures are high, fuels become more flammable (Figure 2.8).

Figure 2.8 Fuel temperature
During the day, when vegetation is warmed by the sun, it will ignite and burn easily and intensely



Fire managers need to understand fuel characteristics and their influence on vegetation flammability. With this knowledge, fire managers can modify fuel properties to reduce flammability.

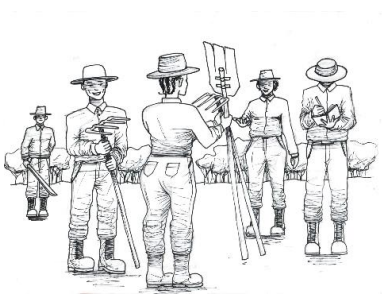


Discussion

Divide into groups and provide 10 minutes for group discussion.

1. What are the different methods that can be used to change fuel characteristics to make fuels less flammable?

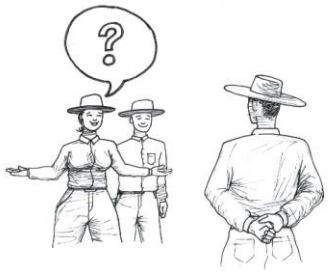
One person in the group should give feedback.



Activity

Take the trainees into the field with some hand tools and change the characteristics of fuel.

1. Slash fuels to reduce vertical distribution and compact fuels.
2. Clear some areas of mineral soil to break the horizontal continuity of fuels.
3. Remove fuel from an area to reduce fuel load.



Questions

1. What are the different fuel characteristics?
2. How do different fuel characteristics influence the way a fire burns?
3. In what areas of the village should fuel be managed to make it less flammable?

2.1.2 Fire weather

Being mindful of weather conditions helps in understanding fire behaviour, predicting the direction and intensity of a fire and ultimately suppressing it. Weather conditions are constantly changing, and can be categorized into short, medium, and long-term changes.

- **Short term:** Weather can change within a very short time. Thus, weather experienced during the morning, afternoon and at night-time may be very different.
- **Medium-term:** Medium-term weather changes are typically associated with changes in seasons or weather systems that move into and through a region, which causes weather changes that can last a few days or weeks.
- **Long term:** Long-term changes in weather refer to gradual changes in the climate of an area, which occur over decades or centuries. These changes are heavily influenced by global warming, which has accelerated the pace of climate change in different regions of the world.

Fire managers must consider several weather-related factors because all these phenomena will either directly or indirectly influence fire behaviour. Important weather factors to consider are wind speed and direction, relative humidity, precipitation, temperature and high-and low-pressure systems. Changes in weather conditions can have a significant impact on the status of fuels, which can become warmer, drier, or moister. These changes in fuel properties can have an indirect impact on fire behaviour as they can affect how easily a fire starts, how quickly it spreads and how intensely it burns.

Relative humidity

The amount of moisture in the atmosphere at any given time is referred to as relative humidity (RH). It is given as a percentage. For example, when the RH is at 100%, it is raining (i.e. there is so much moisture mixed with the air it creates rain or dew that falls to the earth). The lower the relative humidity, the less moisture is mixed into the air, making it easier for a fire to start.

Temperature and relative humidity are inextricably linked. Higher temperatures make the air drier, while lower temperatures make the air moist. During the day, temperatures rise and relative humidity falls, making dead vegetation easy to ignite. In contrast, at night, the temperature is low and the relative humidity is high, lowering the risk of fire.

The moisture content of fuels is also affected by RH. Weather changes can cause RH to rise or fall, which changes fuel properties and has an indirect effect on fire behaviour.

- The moisture content of dead fuel is affected by the percentage of RH in the atmosphere. Dead vegetation can absorb moisture from rain, dew, moist soil, or high humidity in the air.
- Smaller fuels have a higher moisture exchange rate than larger fuels (see Table 2.1). This means that the smaller the fuel, the faster the moisture content will increase or decrease with changes in RH. In a prescribed burn, most fuels are small or fine, and they can dry out in just one hour if the RH drops. In contrast, thicker fuel takes much longer to dry out when the RH drops.
- It is more likely for a spot fire to occur if the fuels are dry. When planning a prescribed burn, fire managers should start the burn during rising RH, which

typically occurs in the afternoon. This is recommended because it would ensure that any fire spotted outside the burn area would be suppressed during a period of increasing RH. This would reduce the time for the fire to spread and cause damage during the rain. In contrast, starting the burn in the morning or later in the day when the RG is decreasing, will increase the potential of an escaping fire. Escaping fires can be difficult to control until the RH starts to rise in the afternoon.

- Burn operations should be performed in the late afternoons if the burning conditions (see section 2.4 Fire Danger Index) are favourable to reduce risks from fires escaping from a controlled burn. Controlled burns during the night are the safest option because the RH is at its highest and there is little chance of fires spotting.
- To ensure a safe burn of dry grass, it is important to monitor the RH levels. When RH falls below 30% all burning operations should be stopped.

Wind

Wind speed is the most dangerous aspect of fire weather because it can cause fires to spread uncontrollably. Because of topography and temperature, wind direction and speed can vary greatly throughout the day (e.g. thermal winds). To reduce the impact of wind, fire managers should obtain forecasts regularly to stay informed of any changes. Burning should take place during stable atmospheric conditions, which are most likely in the late afternoons and evenings. The burn areas can be reduced to smaller (manageable) blocks to reduce the impact of wind even further. If the wind speed reaches 14 km/h, all burning should be halted. If the forecast predicts winds exceeding 14 km/h, no fires should be started. Prefrontal conditions are typically very windy and prone to large changes in wind direction, so fire managers should exercise caution when burning with approaching weather fronts.

Temperature

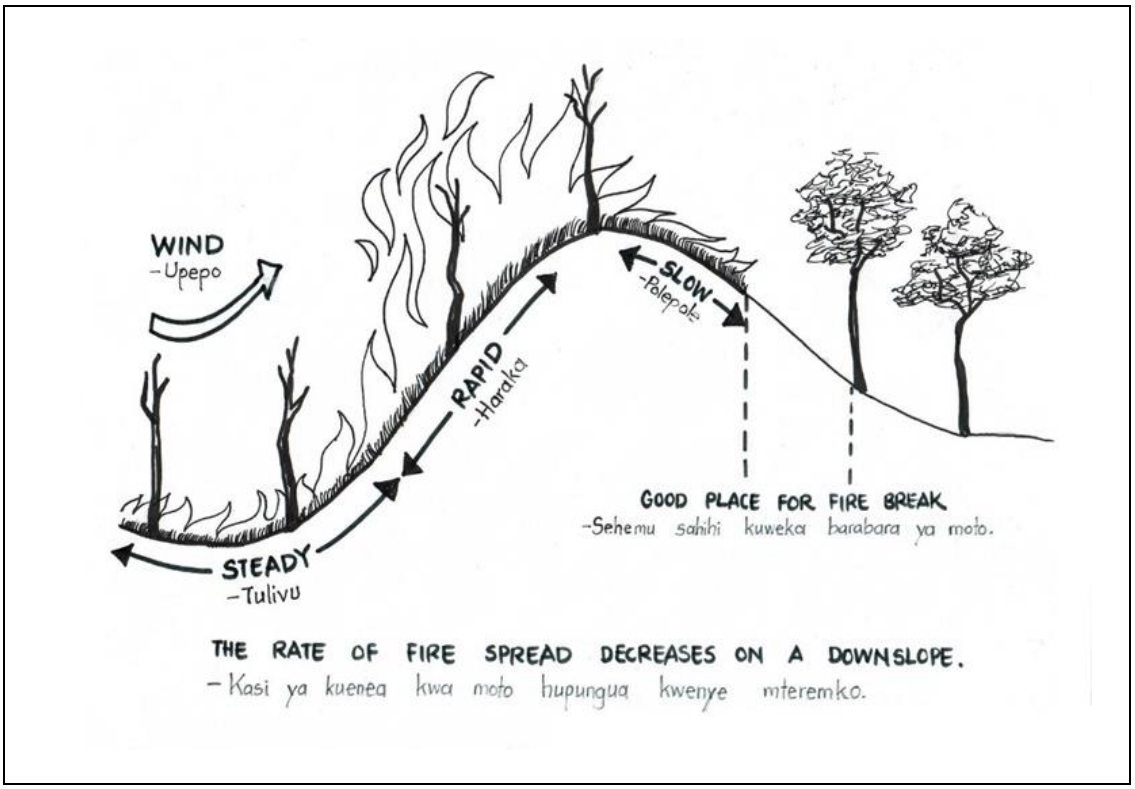
High temperatures result in more intense fires and increase the likelihood of erratic fire behaviour by preheating fuels. The preheated fuels, which have a lower relative humidity, dry out and become more susceptible to embers which are deposited during burning. The air temperature should not exceed 25°C when burning dead grass. For burning woody plants and shrubs, the air temperature should not exceed 30°C. Fire managers can control the air temperature by planning to burn at different times of the day. Burning later in the day can achieve cooler temperatures while burning in earlier in the day can result in warmer conditions.

2.1.3 Topography

Topography, meaning the arrangement of natural and artificial features of an area, influences weather conditions, and the speed and spread of fires and also determines which type of fuel is available for combustion. Land features may influence weather conditions. Wind can be obstructed or deflected, and moist weather may be trapped by different topographical features. For example, a different climate is often experienced on opposite sides of mountains. This will not only determine the vegetation types and characteristics but also cause different types of fire behaviour on opposite sides of the mountain. The most important topographic components are slope steepness and aspect. For example, cooler and moister weather can be expected in high-lying areas.

The most significant influence of topography on fire behaviour is the spread and speed of a fire. Fires burn and spread faster uphill and slower downhill (Figure 2.9). Fighting a fire that is burning downhill is easier since the flames are shorter and slower, which makes fire suppression easier for firefighters.

Figure 2.9 Topography influence on the rate of fire spread
The rate of fire spread decreases on a downslope. The steeper the slope, the faster a fire will accelerate when burning upslope.



Vegetation: The topography of an area influences the type of vegetation that is present. For example, the vegetation on top of a mountain differs from that found in a valley. In some areas, the vegetation is grass with indigenous forests bordering the grasslands. The type of vegetation determines what type of fuel is available for combustion. Listed below are some prominent topographical features that influence the type of fuel, its characteristics, and fire behaviour.

Aspects: The direction of a mountain slope faces can determine the amount and timing of sun exposure it receives, which in turn affects vegetation and fire behaviour. Slopes facing east receive early morning sun exposure and have moist, dense vegetation. South-facing slopes receive less sun exposure and are cooler and moister. The vegetation on these slopes is dense, with high moisture content and high fuel loads. Fires on these slopes are usually small and easier to contain, but under extreme conditions, they can become intense. North-facing slopes are the hottest and driest aspects. Fuels are flashy (i.e. small and easy to ignite) and fires are difficult to control. These aspects also receive radiant heat from the sun during the hottest time of the day. West-facing slopes heat up later in the day and are the last to cool down, with direct exposure to warm, dry winds that can fan large fires.

Elevation and position of a slope: Vegetation types vary depending on the altitude above sea level. This can be attributed to different temperatures, wind, moisture, and soil types that are experienced at different elevations of mountain slopes. The most fertile soil is found at the bottom of slopes, while shallow and rocky soils are found near the mountain tops. The soil supports different types of vegetation. Therefore, fire behaviour will depend on the position of the fire on the slope.

The steepness of slope: Fires spread faster on steeper slopes. A fire burning on a 30° slope will spread four times faster than a fire burning on level ground. This is because fires generate heat that rises against steep slopes, preheating unburned fuels higher up. The preheated fuel ignites quickly and causes a rapid spread of the fire.

Land features such as saddles, chimneys, valleys, and ridges: A saddle is a lower-lying area between two mountain peaks that allows wind to pass through its natural incline. The wind that

passes through a saddle is accelerated and will increase the spread rate and flame length of fires. Figure 2.10 shows an example of a saddle where the wind is accelerated.

Narrow valleys accelerate winds and if these valleys change into “chimneys” that run steeply up to mountain slopes, it can cause strong winds that will cause fires to turn into fire tornadoes racing upslope. Figure 2.11 is an example of a valley and Figure 2.12 of a chimney. Ridges encountered on mountaintops can act as barriers to fires. Lee sides of ridges are sometimes very steep, and it can cause wind eddies that blow in the opposite direction of the general wind. Fires are often stopped from spreading beyond steep ridges.

Figure 2.10 Saddle in a hill
The wind is accelerated through a saddle between to mountain peaks.

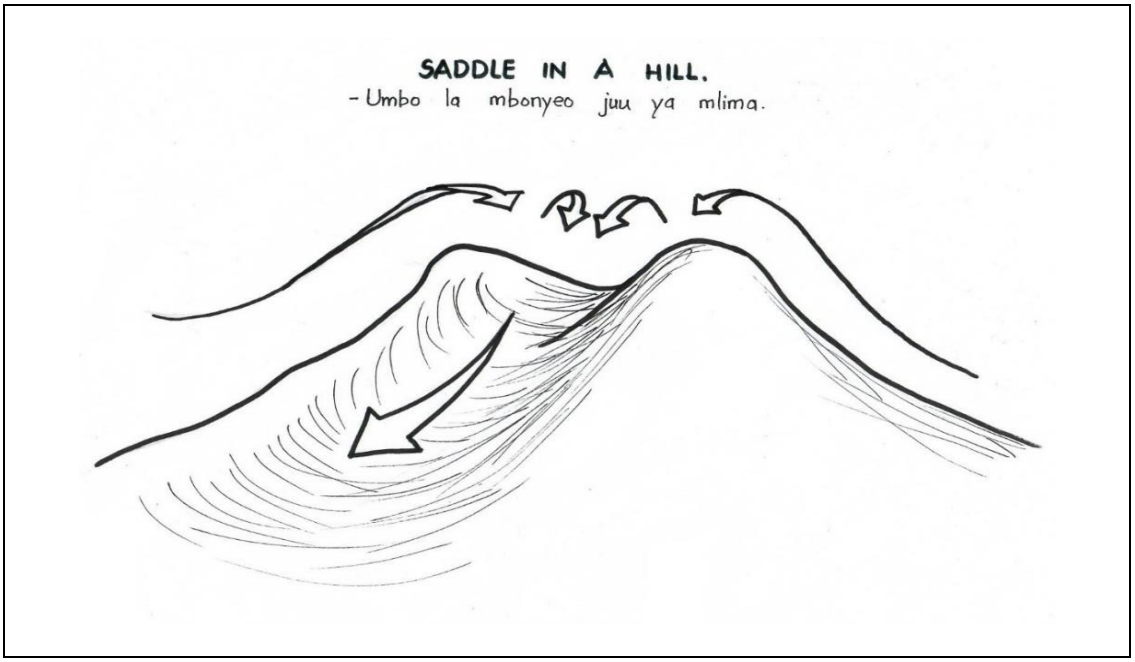


Figure 2.11 Strong valley wind
A valley between two mountains will accelerate the wind. Tall trees creating an alley have the same effect.

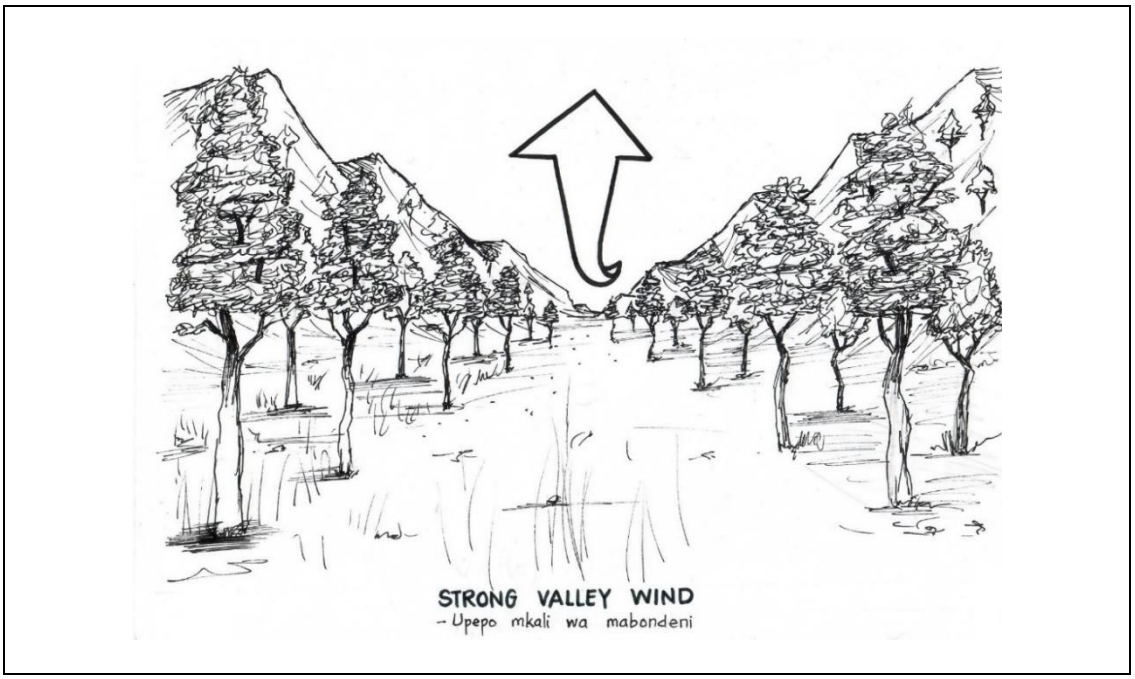
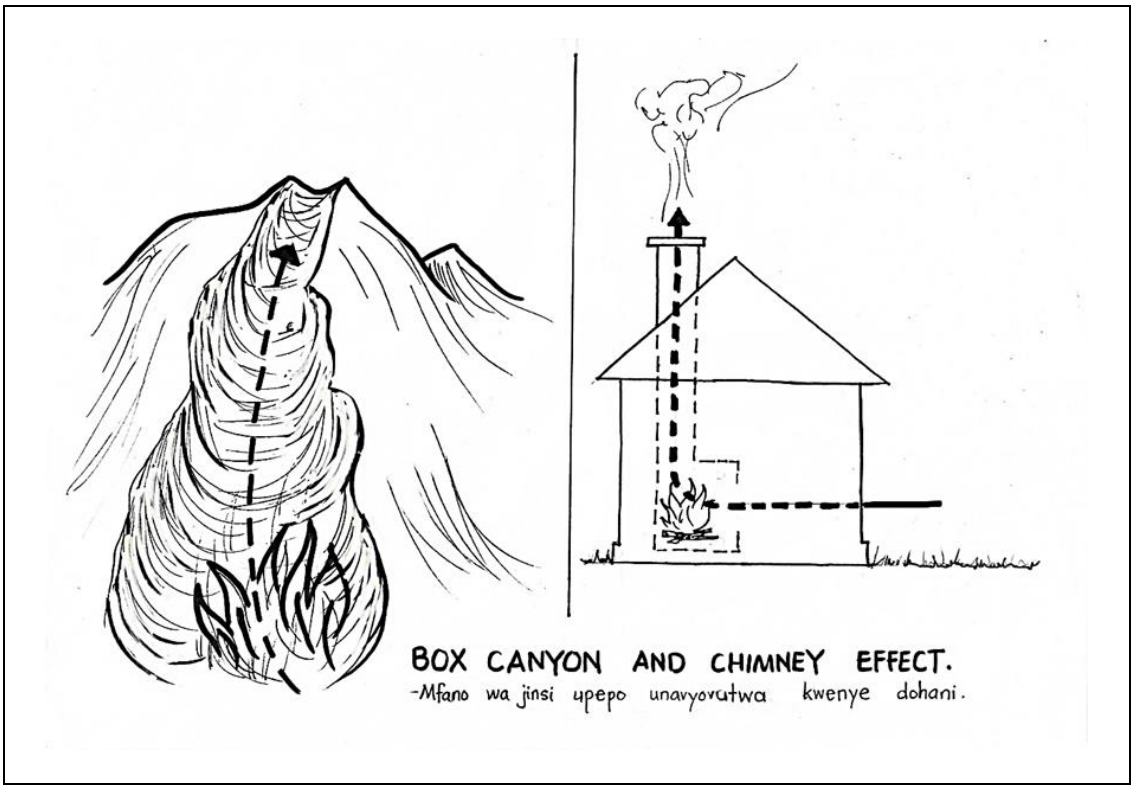
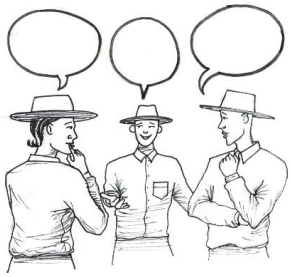


Figure 2.12 Box canyon and chimney effect
In the same way that a chimney accelerates the smoke and heat from a stove, a chimney against a mountain slope will accelerate the spread rate of a fire.



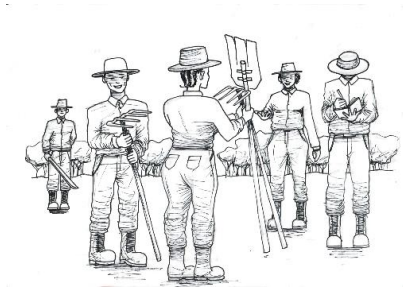


Discussion

Divide into groups and provide 10 minutes for group discussion.

1. How do different topographical features influence fire behaviour?
2. How can this influence be managed in the event of a fire?

One person in the group should give feedback.



Activity

Take trainees into the field and identify topographical features that influence vegetation and fire behaviour.

Questions

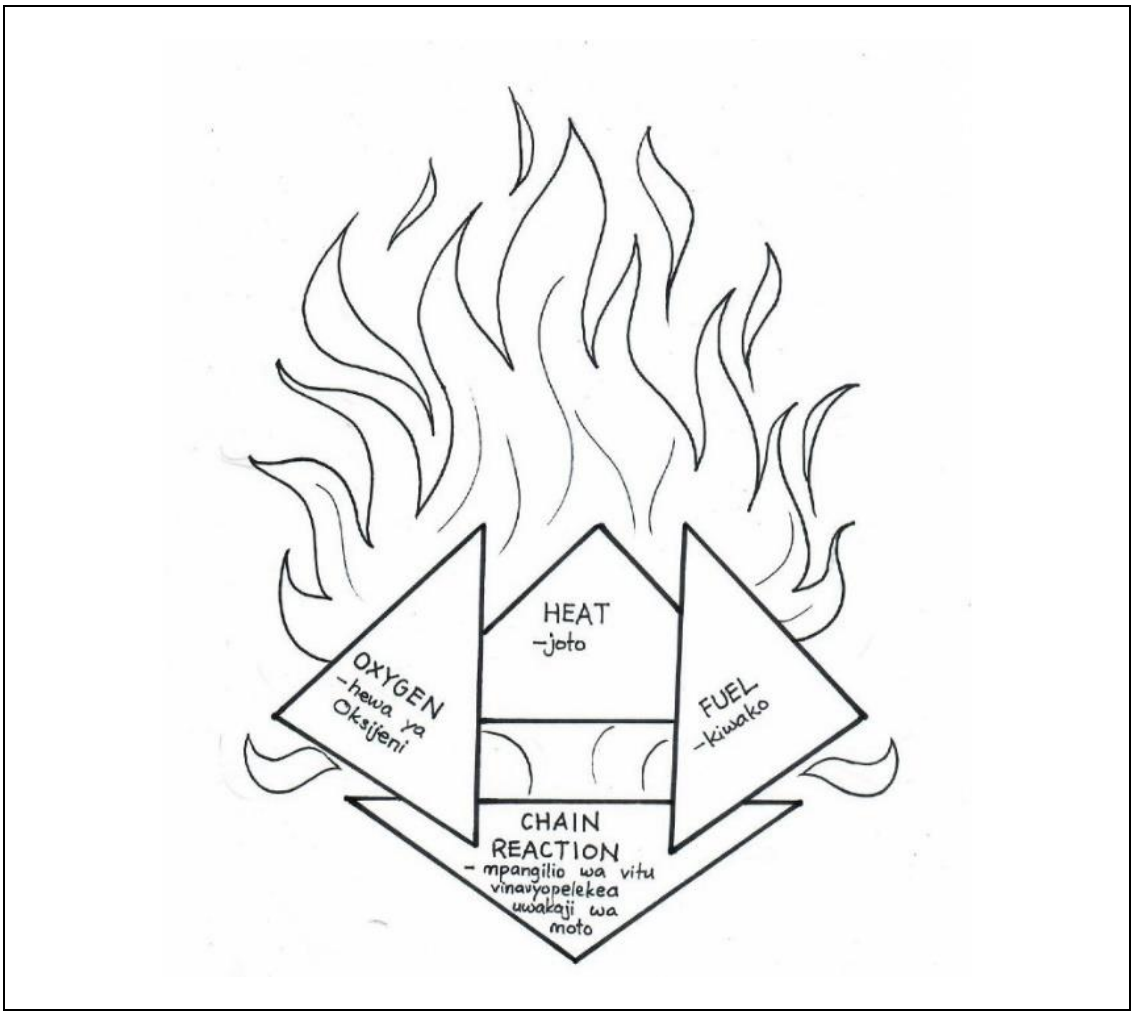
1. What are the different terrain features that influence fuel (vegetation)?
2. How will the different terrain features influence weather?
3. How do different topographical features influence fire behaviour?

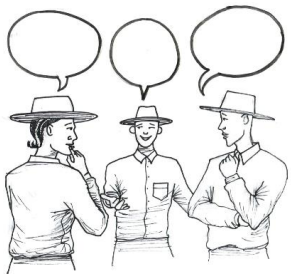
2.2 Fire behaviour

Fire is defined as a rapid, long-lasting chemical reaction that releases heat and light from fuels and is accompanied by flame. The visible portion of the fire is composed of carbon dioxide, water vapour, oxygen, and nitrogen. A fire requires three components: fuel, heat, and oxygen. A chemical chain reaction occurs in the presence of all three elements, resulting in a fire (Figure 2.13). The fire will go out if any of those elements are removed.

Humans have control over the only environmental factor that can be managed: fuel. As a result, it is easier to put out fires if fuels are managed in such a way that they are difficult to ignite and burn. Fire suppression strategies and tactics are based on fire behaviour, which necessitates a thorough understanding of environmental factors such as fuel, weather, and topography to predict fire behaviour patterns and devise appropriate suppression techniques and tactics.

Figure 2.13 Chemical chain reaction of fire
Fire is a chemical chain reaction. It involves fuel, heat, and oxygen



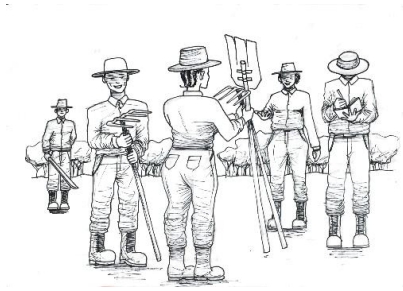


Discussion

Divide into groups and provide 10 minutes for group discussion.

1. What are the different methods to remove fuel, oxygen, and heat from a fire?

One person in the group should give feedback.



Activity

Make a small fire in a safe place and extinguish it by

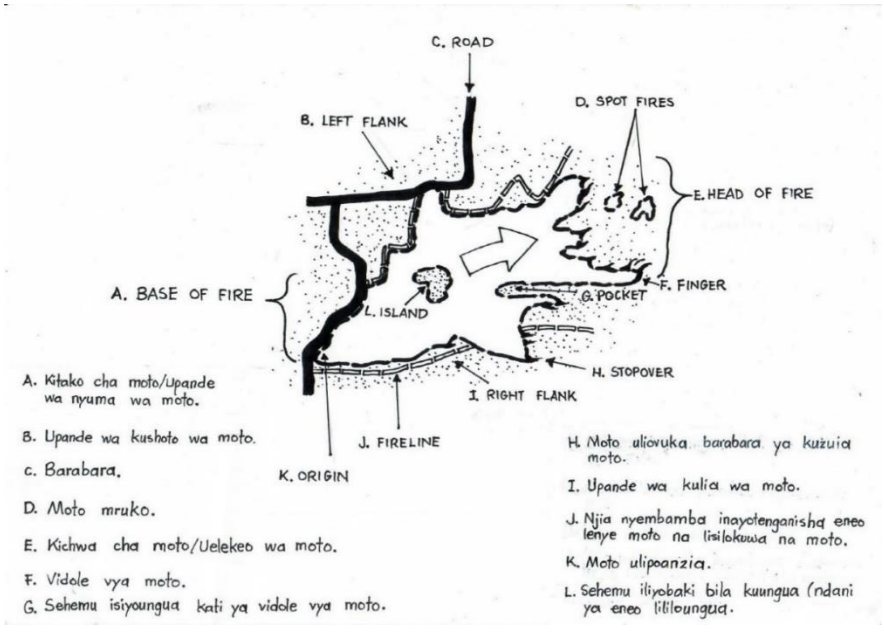
a. Removing the fuel with a drag fork
b. Removing the heat with water
c. Remove the oxygen by covering it with a wet blanket

Fire behaviour is defined as the way fuels ignite, the speed at which they spread, their intensity, flame height, and their potential to cause spot fires ahead of the fire front. The following fire behaviour parameters explain the visual characteristics of a fire:

Ignition of fuels: Fuels must be preheated before they can be ignited. During the preheating stage of combustion, flammable gasses are released from fuels. These flammable gasses can be ignited by a spark or sufficient heat. Once ignited, the fire will continue to burn until the fuel is consumed, or an intervention occurs that breaks the fire triangle (i.e. one of the three fire elements is removed). The ease of ignition depends on the properties of the fuel.

Rate of spread (RoS): The rate of spread (RoS) refers to the horizontal distance that a fire moves within a particular time frame (distance per minute or hour). The RoS is measured at the head of the fire, where the spread is greatest. Figure 2.14 describes the various components of a fire.

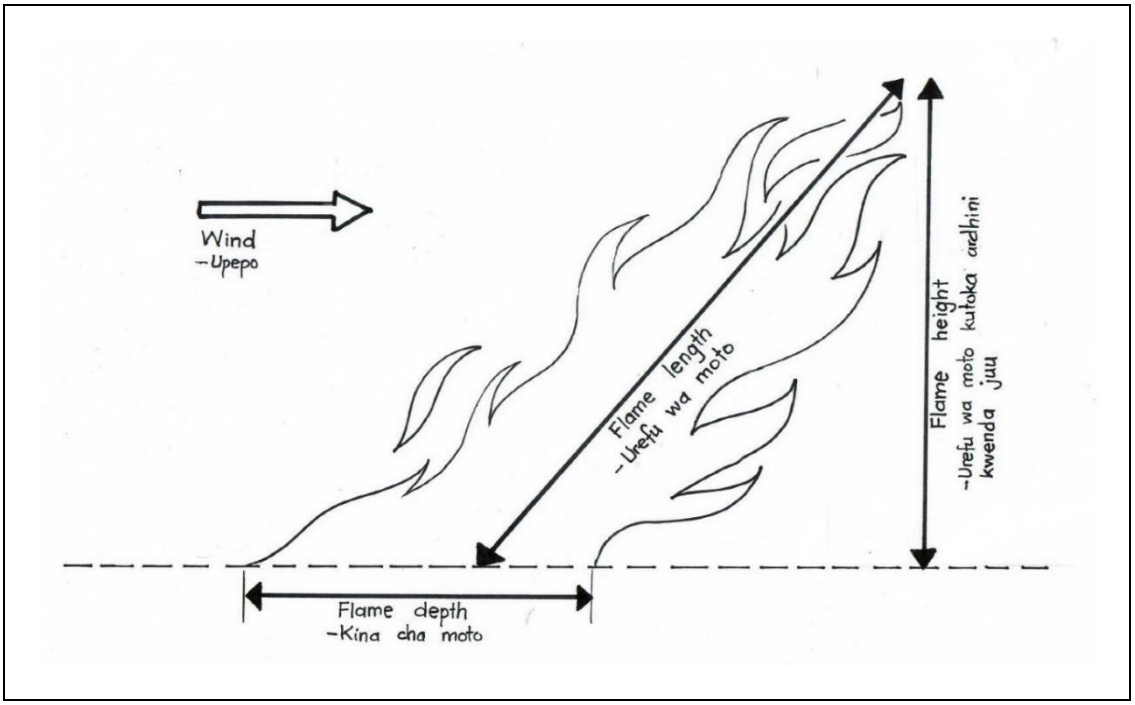
Figure 2.14 Anatomy of a fire



Fire intensity: Fire intensity is the speed at which heat energy (measured in kilojoules) is released from fuel as it burns over a certain area and time. In simple terms, this means that fire intensity refers to how hot a fire is burning.

Flame height: The size and shape of a flame can be determined by measuring its height, length, depth, and angle. Flame height is measured from the flame's base to the flame's highest point. The length of the flame is measured from its base to its tip (Figure 2.15).

Figure 2.15 Difference between flame height, depth, and length



Spot fires: Burning debris can be carried forward by wind (or wind created by the burning fire) and can land on unburned fuels near the head of the fire, resulting in new ignition points. These new ignition points are called spot fires. Spot fires can intensify the heat and RoS of a fire, which makes fire suppression more challenging. Figure 2.16 shows examples of small burning debris, and Figure 2.17 illustrates how spot fires can complicate fire suppression efforts.

Figure 2.16 Plant material that can cause spot fires

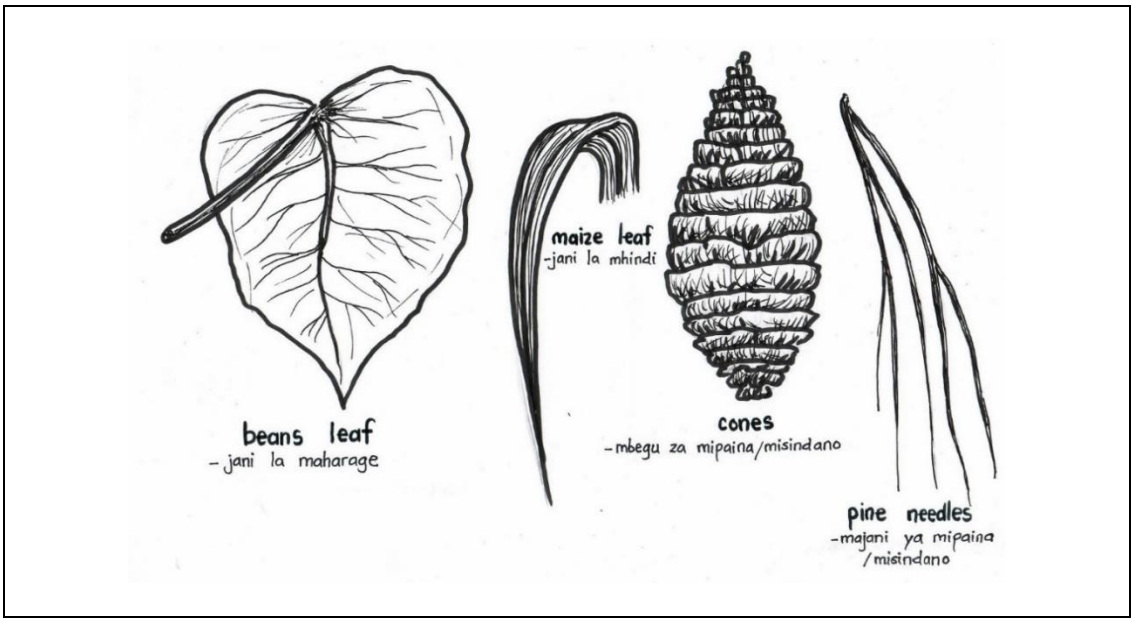
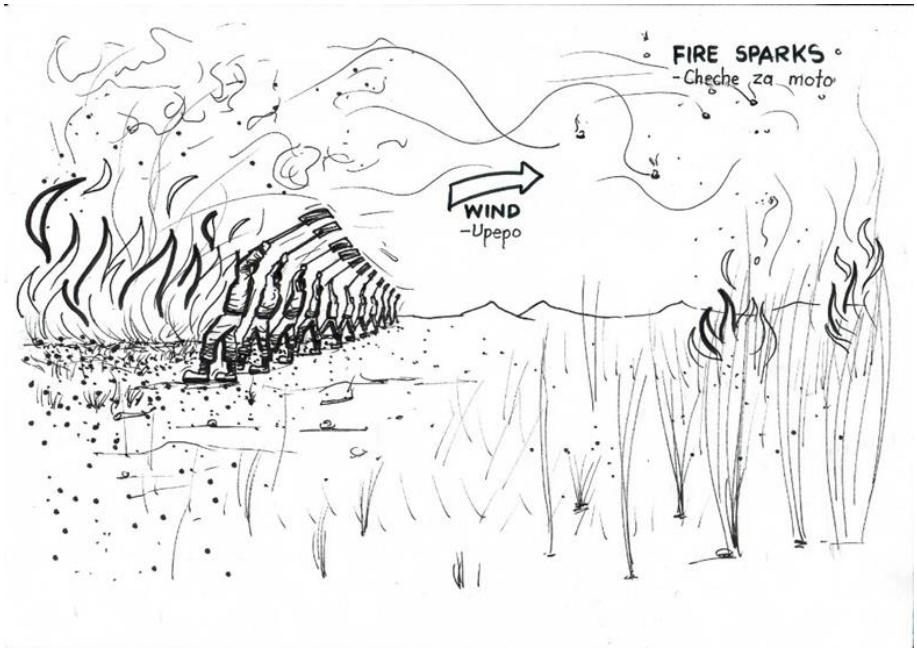
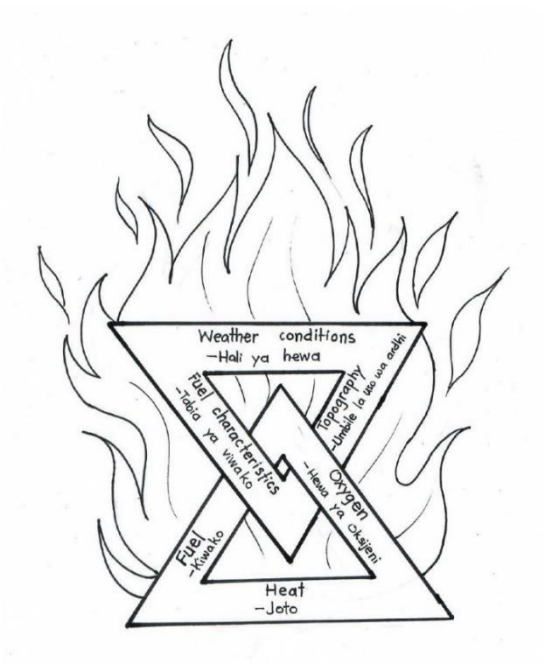


Figure 2.17 Spotfire complicating fire suppression
Spot fires caused by wind borne burning grass and made worse by over aggressive fire beating.



Drivers of fire behaviour: Fire behaviour is affected by the elements present in its surroundings. Changes in this environment can cause a series of events that will either enhance or reduce fire behaviour. Figure 2.18 explains how fire and fire behaviour are influenced by the environmental elements, fuel, weather, and topography.

Figure 2.18 Fire behaviour
Fire behaviour is determined by the type of fuel, weather conditions and topography.



2.3 Extreme fire behaviour

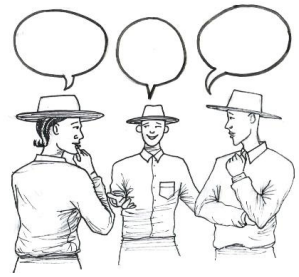
Extreme fire behaviour is defined as fire behaviour that exceeds the level at which conventional or standard fire suppression methods are effective. Predicting extreme fire behaviour is difficult because extreme fires influence their environment and behave erratically and dangerously.

Extreme fire behaviour is possible when all three environmental factors – fuel, weather, and topography – combine to create ideal conditions for fire ignition, development, and spread. During severe fires, the heat energy and force produced by fuel combustion outnumber all external forces that normally influence fire behaviour. Extreme fires, also known as "fire storms," are uncontrollable until the fire's severity subsides.

Here are some examples of extreme fire behaviour:

- Fire spread of more than 16 km/h
- Intense burning (e.g., fuels are exploding)
- Long distance spotting
- Crown fire development (fire consumes the crowns of living trees)
- Fire whorls/tornado development that can pick up big pieces of burning material and deposit them in any direction
- Unpredictable fire behaviour

During extreme fire behaviour, fire managers should prioritize the safety of firefighters, evacuate residential areas, relocate valuable assets (if possible), and transport animals to safer locations.



Discussion

Divide into groups and provide 10 minutes for groups to discuss.

1. How does fire behave under different weather conditions?

One person in the group should give feedback.

Questions

1. Sketch the fire triangle.
2. Sketch the fire environment triangle.
3. What are the different fire behaviour parameters?
4. What is extreme fire behaviour?

2.4 The Fire Danger Index (FDI) system

The Fire Danger Index (FDI) system, which is being introduced in commercial forestry in the Southern Highlands of Tanzania, is used to give land users an indication of the fire danger and the consequences and risk to life, property and the environment should a fire start.

The FDI system involves the collection of weather observations, which are analysed to predict the potential fire risk for a given time. It assigns a score from 0 to 100 to indicate the level of fire danger ratings (FDR). FDRs are derived from the FDI scores. The rating uses the plain language terms SAFE, MODERATE, DANGEROUS, VERY DANGEROUS and EXTREMELY DANGEROUS. Plans for burning activities should be informed by the FDI. Weather forecasts can be used to forecast FDI. The authorities responsible for issuing burning permits should consult FDI information before granting a permit.

Although this method has flaws and is only ± 70% accurate it serves as a guideline that fire managers can use to determine fire behaviour. The accuracy of the FDI can also be verified by comparing the damage caused by a fire to the FDI calculated for the period during which a fire burned.

2.4.1 Calculating the FDI

The Fire Danger Index (FDI) is calculated twice a day, at 10h00 and 14h00, because weather conditions during these times can differ significantly. The FDI prediction at 14h00 is the regional fire danger level and is what should be displayed on the FDR signboard.

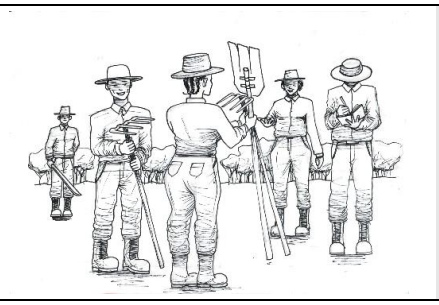
To calculate the FDI, the burning index is determined using an alignment chart based on the relative humidity and dry bulb temperature (Figure 2.19). The wind strength correction factor (Table 2.2) is now added to the burning index and multiplied by the rainfall correction factor (Table 2.3) to obtain the FDI. Thus, the FDI formula is:

Fire Danger Index = (Burning Index + Wind Factor) x Rainfall Correction Factor.

Make use of the FDI calculation chart (Table 2.4) to calculate the FDI. Table 2.4 provides the fire danger rating (FDR) (i.e., different colours), while Table 2.5 is an action plan that outlines appropriate actions to take based on the FDR rating.

Procedures for calculating FDI:

- **Step 1:** Measure the temperature of the day
- **Step 2:** Determine the relative humidity.
- **Step 3:** Calculate the "Burning Index" using the alignment chart (Figure 2.19). After calculating the temperature and relative humidity (steps 1 and 2), use a ruler to align it with the alignment chart to calculate the "Burning Index" number.
- **Step 4:** Determine the "Wind Factor" by calculating the wind speed and using the "wind strength correction factor (Table 2.2)".
- **Step 5:** Add the “Burning Index” with the “Wind Factor”
- **Step 6:** Measure the rainfall and determine the “rainfall correction factor” using chart provided in Table 2.3.
- **Step 7:** Calculate the FDI by multiplying the “rainfall correction factor” with the summation obtained by adding the “Burning Index” and the “Wind Factor”
- **Step 8:** Use the “Fire Danger Rating” (Table 2.4) for rating the calculated FDI and Table 2.5 for the actions to be taken.



Activity

Trainees must create the following registers:

- Weather register
- FDI register

Weather must be recorded and the FDI calculated and recorded daily for the duration of the course.

Figure 2.19 Alignment chart

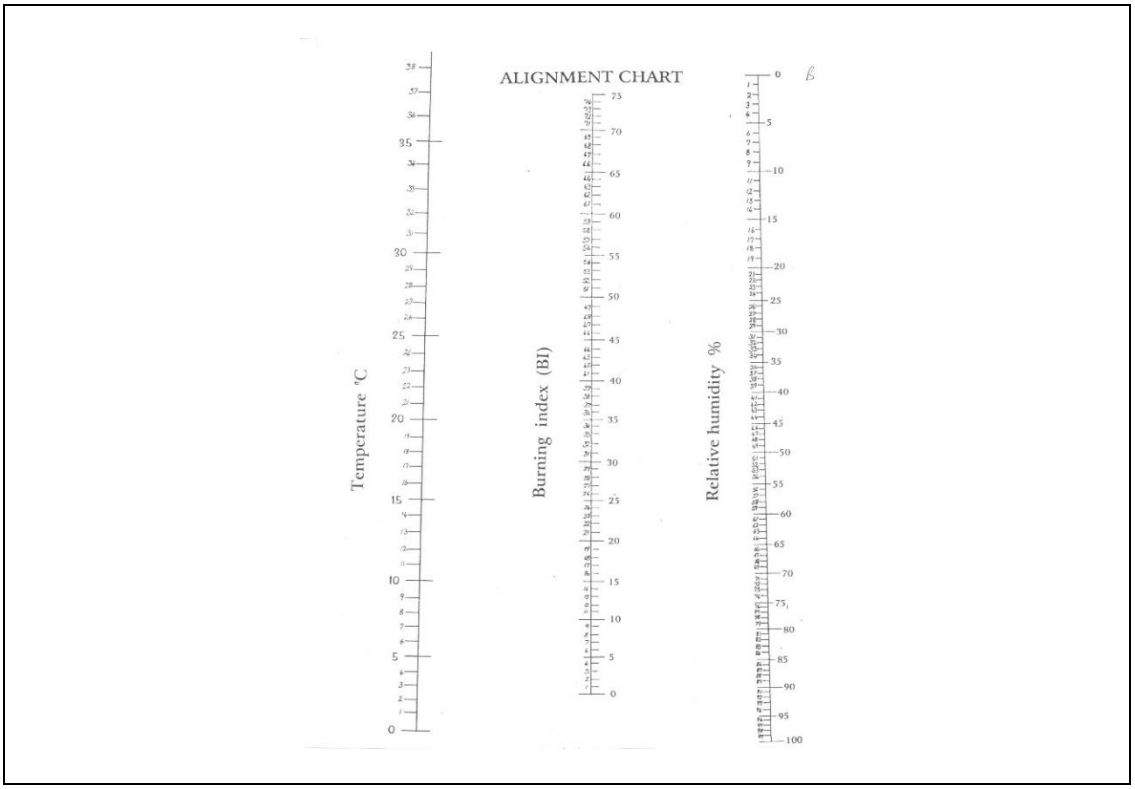


Table 2.2 The wind strength correction factor

Wind speed (km/h)	Adjust BI	Wind speed (km/h)	Adjust BI	Wind speed (km/h)	Adjust BI	Wind speed (km/h)	Adjust BI
0	0	12	10	24	15	36	26
1	0	13	10	25	16	37	29
2	4	14	10	26	19	38	30
3	5	15	10	27	20	39	30
4	5	16	11	28	20	40	30
5	6	17	14	29	20	41	31
6	9	18	15	30	20	42	34
7	10	19	15	31	20	43	35
8	10	20	15	32	21	44	35
9	10	21	15	33	24	45	36
10	10	22	15	34	25	46	40
11	10	23	15	35	25	47	40

Table 2.3 The rainfall correction factor

Rainfall (mm)	**Number of days since rain last fell**										
	1	**2**	**3**	**4**	**5**	**6**	**7 – 8**	**9 – 10**	**11 – 12**	**13 – 15**	**16 – 20**
0.1 – 2.6	**0.7**	**0.9**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
2.7 – 5.2	**0.6**	**0.8**	**0.9**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
5.3 – 7.6	**0.5**	**0.7**	**0.9**	**0.9**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
7.7 – 10.2	**0.4**	**0.6**	**0.8**	**0.9**	**0.9**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
10.3 – 12.3	**0.4**	**0.6**	**0.7**	**0.8**	**0.9**	**0.9**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
12.9 – 15.3	**0.3**	**0.5**	**0.7**	**0.8**	**0.8**	**0.9**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
15.4 – 20.5	**0.2**	**0.5**	**0.6**	**0.7**	**0.8**	**0.8**	**0.9**	**1.0**	**1.0**	**1.0**	**1.0**
20.6 – 25.5	**0.2**	**0.4**	**0.5**	**0.7**	**0.7**	**0.8**	**0.9**	**1.0**	**1.0**	**1.0**	**1.0**
25.6 – 33.4	**0.1**	**0.3**	**0.4**	**0.6**	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**	**1.0**	**1.0**
38.5 – 51.1	**0**	**0.2**	**0.4**	**0.5**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**	**1.0**
51.2 – 63.3	**0**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.7**	**0.8**	**0.9**	**1.0**
63.4 – 76.5	**0**	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**

Table 2.4 Fire Danger Rating (FDR)

Fire Danger Rating	Blue	Green	Yellow	Orange	Red
FDI	0 - 20	21 - 45	46 – 60	61 – 75	75 - 100
Fire Behaviour	**SAFE**	**MODERATE**	**DANGEROUS**	**VERY DANGEROUS**	**EXTREMELY DANGEROUS**
Flame Length	0 – 1m	1 – 1.2m	1.2 – 1.8m	1.8 – 2.4m	2.4m or more
Fire Controllability Guide	The fire spread very slowly and may go out without suppression efforts. There is little flaming combustion and intensity is low. Control is easy and little to no mop up is required.	Ignition may take place near open flames. Fires spread slowly in forests, and moderate in grasslands. Cooler fires with low flames. Control is easy with a few people. Against steep slopes, light mop up may be required.	Open flames will start fires. Tall grasslands and forest litter will ignite and burn easily. Fire spread is moderate in forests and fast in grasslands. Warmer fires with moderate flame heights. Fight fires with direct attack and all available resources (including water resources). Mop-up will be necessary.	Fires start easily and will spread fast in forests. Grassfire behaviour will be extreme. Fires will be very hot with the possibility of crown fires as well as spot fires. Attach fires from the rear as the fire will be dangerous. All available resources must be used with thorough mop-up. Beware of wind change!	Fire can start easily from sparks. Fires will be extremely hot with a fast rate of speed. Control may not be possible during the day due to long-range spotting and crown fires in forests. Suppression forces should stay away from the head of fires. Fire will destroy property. All available resources from neighbouring areas must be used with intensive mop-up and careful attention to areas that can flare up. Beware of wind change!!
Controlled burning activities	Control burns can be done if a valid burning permit has been issued and burning preparation has been done.	Control burns can be done if a valid burning permit has been issued and burning preparation is done.	No controlled burns if the FDI forecast for the day exceeds 50.	No control burns of any nature.	No control burns of any nature.

Table 2.5 Fire danger rating table with action plan.

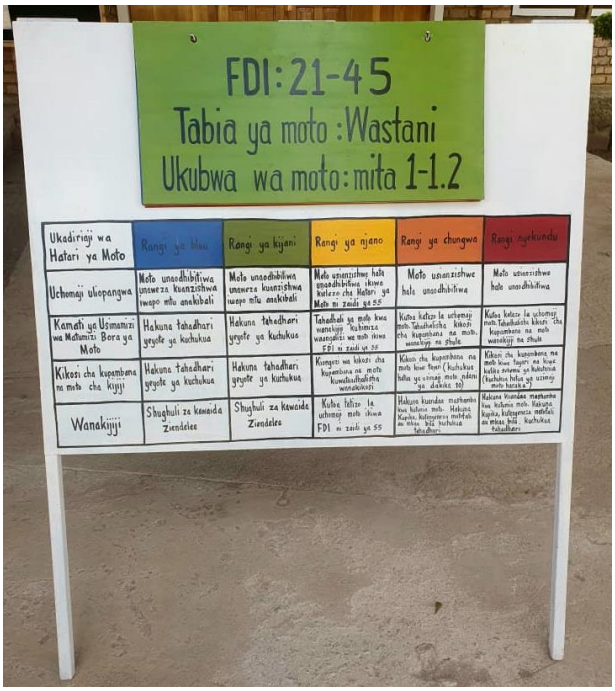
Fire Danger Rating	Blue	Green	Yellow	Orange	Red
FDI	0 - 20	21 - 45	46 – 60	61 – 75	75 - 100
Fire Behaviour	**SAFE**	**MODERATE**	**DANGEROUS**	**VERY DANGEROUS**	**EXTREMELY DANGEROUS**
Flame Length	0 – 1m	1 – 1.2m	1.2 – 1.8m	1.8 – 2.4m	2.4m or more
Village Fire Management Committee	No action required.	No action required.	Communicate FDI to villagers. Activate lookout guard if FDI exceeds 50.	Issue fire ban on all open fires. Alert fire crew, villagers, and schools.	Issue fire ban on all open fires. Activate fire crew. Alert villagers and schools.
Village fire crew and lookout guards	No action required.	No action required.	Crew leader must be in contact with crew members to ensure they are all available in case of fire.	Fire crew must be ready (fully dressed and fire tools at hand) to fight fires and must report to crew leader.	Crew must be on standby at the assembly point (fully dressed and fire tools at hand) and be ready to react immediately if a fire is reported.
Villagers	Resume normal activities.	Resume normal activities.	If the FDI reached 50, no open fires are allowed.	No open fires are allowed unless protected.	No open fires or dangerous activities that can start fires are allowed.

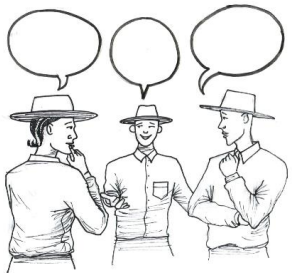
2.4.2 Record keeping and display of FDR

Weather data should be recorded because weather statistics can be utilised for long-term planning. A weather register (Table 2.6) is used to record weather data. A FDI register is illustrated in Table 2.7. It is worth noting that the FDI register offers provision for FDI three days in advance. This information will assist fire managers in planning their burning actions.

The calculated FDI and FDR should be conveyed to villagers (Figure 2.20) and village officials to inform them of the current weather circumstances as well as future fire threat situations (at least two days in advance). The weather data required to compute the FDI can be gathered from a stationary weather station in the burn area. A handheld weather device (such as Kestrel) can also be used to measure weather conditions on the fly. Weather data can also be obtained using Web-based apps such as AccuWeather, YR weather, and others. Alternatively, the Advanced Fire Information System (AFIS) Application for a smart phone or PC can be downloaded and the FDI prediction for a specific area received. Future FDI measurements are calculated using long-term weather forecasts.

Figure 2.20 FDI Display board
The FDR rating must be displayed on a signboard like this. If the FDR is displayed it will be easy to communicate fire danger to villagers of all ages





Questions

1. Why is an accurate FDI reading necessary for land users?
2. Where can a land user get the FDI reading for the day?
3. What information is needed to calculate the FDI?
4. How can the FDI be communicated to all land users in the village?
5. How can you improve the FDI system?

Table 2.6 Weather Register

Date	**RH %** 10h00	**Temp (ºC) 10h00**	**Wind speed (km/h)**	**Wind direction**	**RH % 14h00**	**Temp (ºC)** 14h00	**Wind speed (km/h)**	**Wind direction**	**Rainfall** 08h00	**Reporter**	**Signature**

Table 2.7 Fire Danger Index Register

Date	**FDI 10h00**	**Colour**	**FDI 14h00**	**Colour**	**FDI Tomorrow**	**Colour**	**FDI Day after tomorrow**	**Colour**	**Reporter**	**Signature**

3. VILLAGE FIRE CREW (VFC) TRAINING

2	In this chapter you will learn how to fight fires safely and effectively. This chapter discusses: - Safety - Fire suppression tools - Fire suppression principles - Fire belts and breaks - Planned burning principles

3.1 The purpose, structure, and responsibilities of the village fire crew (VFC)

3.1.1 The purpose of the VFC

The purpose of the VFC is to implement fire management activities. The VFC plays a key role in fire prevention and suppression.

The template for Bylaws for Forest Fire Prevention and Management of Village Councils[1] recommends the structure and responsibilities of VFMCs. However, the customized bylaws as approved by the district council (DC) take precedence over these recommendations.

3.1.2 Structure of the VFC

A village may have multiple VFCs depending on its size and terrain. Each VFC should have 15 members and the selection of members should be based on the following general criteria:

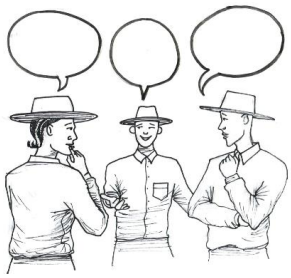
- Must be fit, strong, and healthy because fire suppression is a dangerous and physically demanding activity.
- Readiness to commit substantial time to fire suppression.
- Should be residents of the village. Each hamlet should be represented in the VFC.
- Inclusion of individuals well-suited for specific leadership roles
    - The VFC should include experienced firefighters to provide guidance for unexperienced members.

3.1.3 Main responsibilities of the VFC

The main responsibilities of the VFC are:

- Prepare major fire breaks for the village and subdividing large forest blocks
- Undertake fire patrols, lookout duties and standby
- During days with a red FDI, the VFC should be on standby at a dedicated assembly/lookout point.
- Assist farmers who intend to carry out a planned burn in their fields or woodlots.
- Communicate with VFMC
- Lead fire suppression and mop-up
- VFC members should be the first people to respond to fire alarms.
- VFC must maintain firefighting tools and equipment.

[1] Participatory Plantation Forestry Programme – PFP 2 (2023): Bylaws template for forest fire management and prevention of the village councils. Iringa, Tanzania.



Discussion

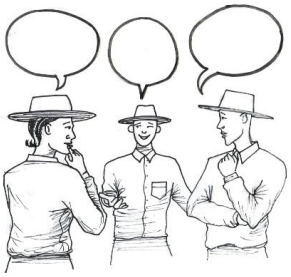
Divide into groups and provide 10 minutes for group discussion.

1. How should the fitness of VFC candidates be tested?
2. How should VFC members be rewarded for their services?
3. How many members should a VFC have?
4. How many VFCs should be in one village?

One person in the group should give feedback.

3.2 Safety on the fire line

Uncontrolled fires are extremely dangerous. They have the potential to kill or seriously injure people. Furthermore, fire kills animals, destroys valuable property, harms the environment, and causes financial losses. Before using fire as a land preparation tool or fighting an unwanted fire, it is critical to understand the dangers posed by fire and the precautions that should be taken to ensure the safety of firefighters and villagers.



Discussion

Divide into groups and provide 10 minutes for group discussion.

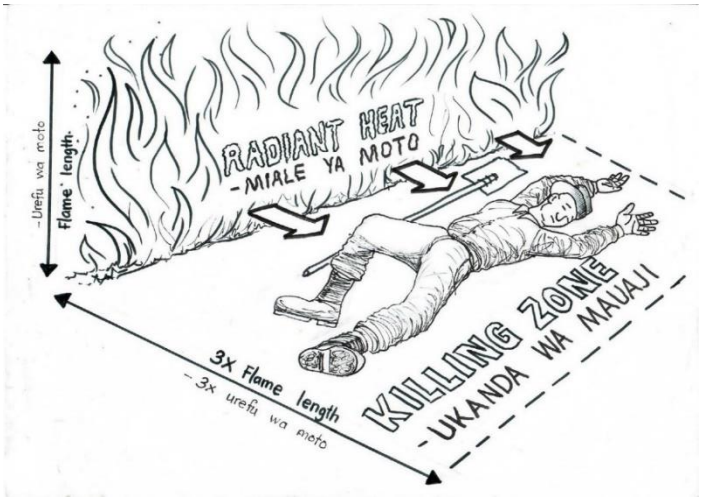
1. Identify some actions of people around fires that are unsafe and can endanger their own lives or those of others.

One person in the group should give feedback.

3.3 The killing zone

Radiant heat kills most people and animals at fires. Radiant heat is the heat that moves in waves away from the fire in all directions. The area close to fires is where most people get killed or injured. This area is known as the killing zone and can be calculated by estimating the length of the flames of the fire and multiplying it by three. If the flames are 3 m long, the killing zone is within 9 metres of the flames. Firefighters must take extra care when fighting a fire in this area. Figure 3.1 shows the killing zone.

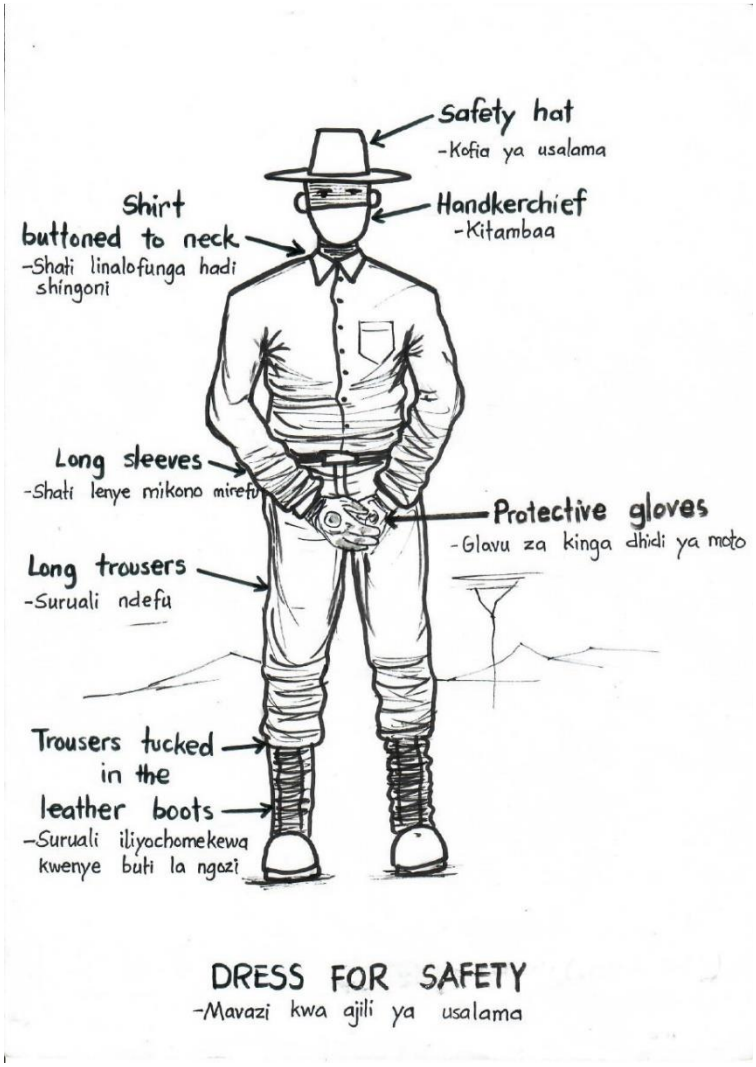
Figure 3.1 The killing zone



3.4 Safety clothes

Firefighters are exposed to radiant heat from fires and should wear protective clothing. Cotton and woollen clothing should be worn to completely cover the body. A broad-brimmed hat offers effective protection from radiant heat and burning sparks that can fall down the back of a shirt. To protect feet and ankles from embers and injury, wear leather boots with heat-resistant soles. Figure 3.2 illustrates the minimum standard for safety clothes that should be worn for firefighting.

Figure 3.2 Safety clothes for firefighting
Do not wear shoes with plastic soles or metal tips.



3.5 Escape routes and safety zones

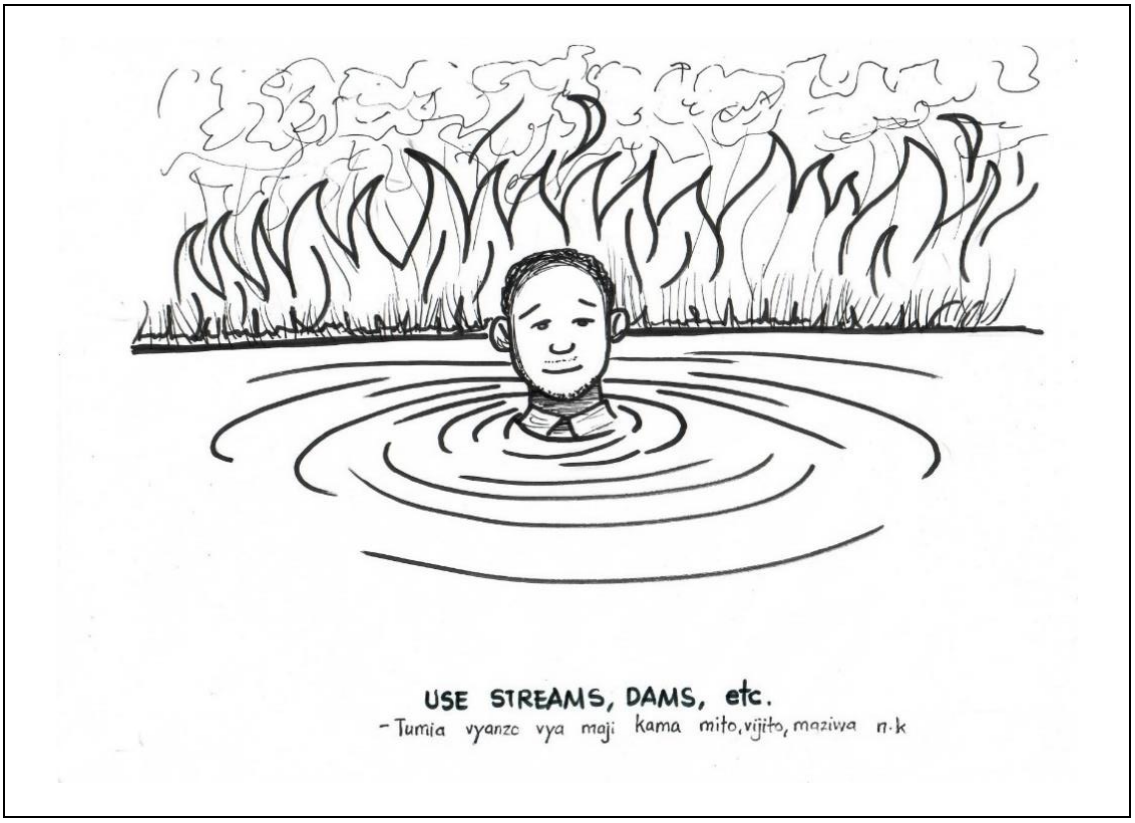
If a fire becomes uncontrollable and threatens the lives of firefighters, they must evacuate the area and seek a safe area. The VFC leader must demonstrate strong leadership skills and ensure that every firefighter reaches the designated safe area.

Escape route: A escape route refers to a pre-planned route that guides firefighters away from harm to a designated safe area. Good VFC leaders will prepare at least two escape routes and ensure that every firefighter is aware of them.

Safety zone: A safety zone is an area that is clean of dangerous fuels and offers firefighters shelter from smoke, heat, and fire. It should be spacious enough to accommodate all firefighters and their equipment. Examples of safety zones include dams, streams, areas with little or no

vegetation, open fields, burnt areas and cleared agricultural fields. The crew leader is responsible for identifying and designating safety zones as the fire progresses. In Figure 3.3, a villager can be seen taking refuge in the water.

Figure 3.3 Villager seeking refuge from the fire in a dam



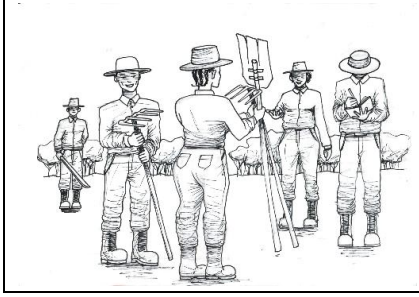
3.6 Wellbeing of the village fire crew

Firefighters must be healthy mentally and physically. A firefighter in poor physical or mental health may endanger himself and his/her coworkers. A panicker shouldn't be on the village fire crew. The village fire crew leader should inform firefighters of these issues:

- Both your physical and mental strength go down when you don't get enough sleep. When people fight fires without getting enough rest, they get tired, make mistakes, and may get hurt. Firefighters shouldn't spend more than 12 hours at the scene of a fire. During this time, the leader of the crew should plan breaks so that people can eat and catch their breath. Firefighters should also switch between hard and easy jobs every so often. For example, if one firefighter has to carry water all day, he or she will get tired quickly, so everyone on the team should take turns carrying heavy things.
- When firefighters are resting, they need good food to get their strength back and clean water to keep from getting dehydrated.
- People who sustain injuries must seek immediate medical attention. A small cut that is treated immediately may allow a firefighter to continue suppression activities, but a small cut that is left untreated can become painful and may prevent a person from continuing to fight the fire.
- Even though there will always be smoke at a wildfire, firefighters shouldn't be around it for too long because it can make them sick from carbon monoxide (CO). Headaches, dizziness, weakness, nausea, vomiting, chest pain, confusion, and losing consciousness are all common signs of CO poisoning. If any of these signs are seen, the person needs to be taken out of the fire and taken to a safe place right away.

- Firefighters should remember that there is less oxygen in the area around a fire. When smoke or lack of oxygen makes it hard to breathe, the best oxygen is near the ground.
- Firefighters must walk in a single file two (2) metres apart when carrying tools. The crew should never leave tools lying around, especially at night, as they could be tripped over or stepped on.
- When working on a steep slope, firefighters should keep a close eye on any fire that is moving uphill. Fires spread more quickly on a steep slope and a fast-moving upslope fire can trap firefighters if they are not careful.
- Regular training on how to put out fires should be given to firefighters. Firefighters' skills get better with regular training and practise, and they can respond quickly to dangerous situations. When firefighters do drills and exercises over and over, it's easy for them to remember how to fight fires and what to do.
- Firefighters should maintain physical fitness (Figure 3.4). A fit firefighter is less likely to be injured and is more effective in fighting a fire.

Figure 3.4 Stay in good physical shape



Activity

1. Take the trainees outside and let them practice how to carry hand tools in a safe way when walking in a single file.
2. Ask for a demonstration of easy fitness exercises for the firefighting crew.

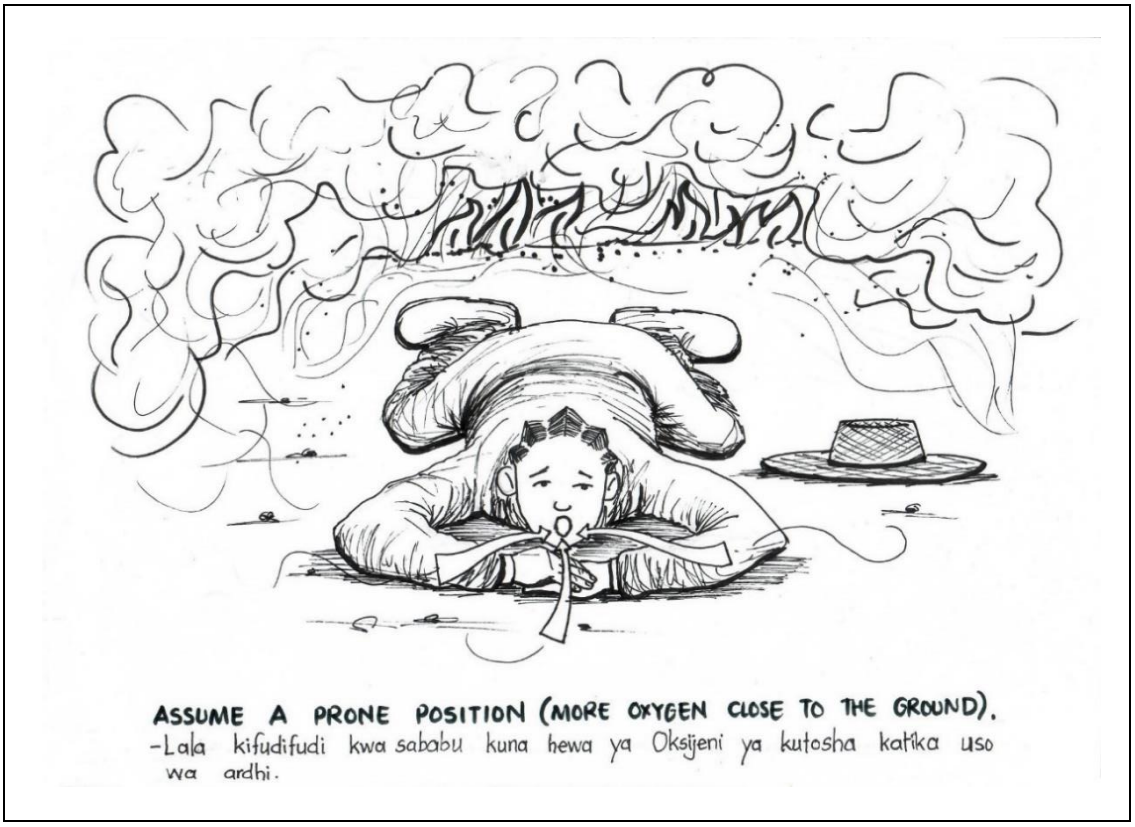
3.7 Trapped in a vehicle

During a fire, it is safer to be in a car than to be walking around. If someone is trapped or engulfed inside the car, they should stay inside and lie down on the floor. Only when there is a clear path ahead should flames be driven through. One should park in a place with few plants. Close all doors, windows, and vents to keep the smoke out. People who are stuck in the car should cover themselves with a wool or cotton blanket or clothing to keep from getting too hot. After the fire has been put out, it is safe to get out of the car.

3.8 Survival and entrapment

When entrapped by a fire, it is recommended to crouch low on the ground for fresh air due to the potential lack of oxygen higher up (Figure 3.5).

Figure 3.5 Survival and entrapment
There is more oxygen closer to the ground.



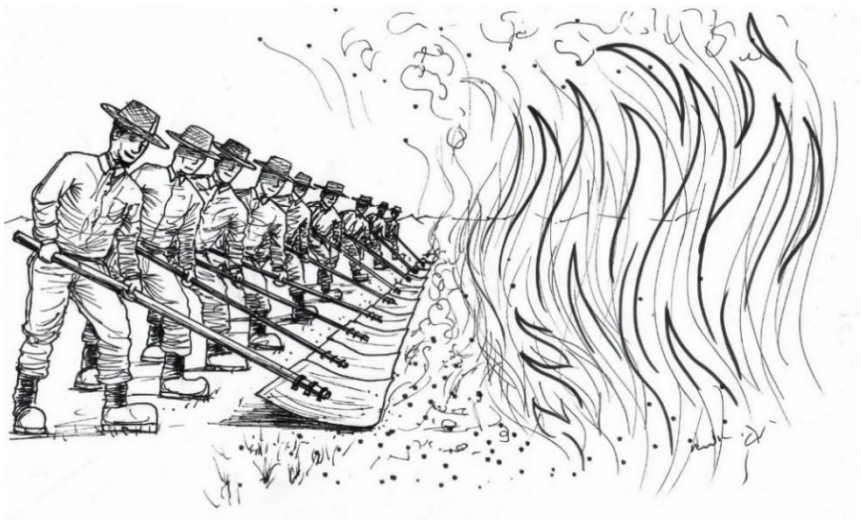
It may become necessary to breach the fire line and flee for safety. In such instance, one should determine the fire front and break through an area with lower flames and a safe place nearby. Working as a team is crucial, and no one should leave the crew without permission. Weaker crew members or injured persons should be helped to safety. When escaping a fire, inhale three times and maintain breath while running. If possible, wet clothes and hair. Consider the type of vegetation, as woody vegetation will be extremely hot with a deep ember bed. Turn the collar of overalls up. If there is a visor, it should be pulled down. Alternatively, a leafy branch or a small bush can help reflecting heat.

3.9 Ten standard safety orders for village fire crews

1. Fight fires determinedly but provide safety first

Firefighters should always approach a fire determinedly whilst prioritizing safety. It is important not to let the urge to fight the fire override common sense. Attack the fire decisively with water, fire beaters, and other tools (Figure 3.6).

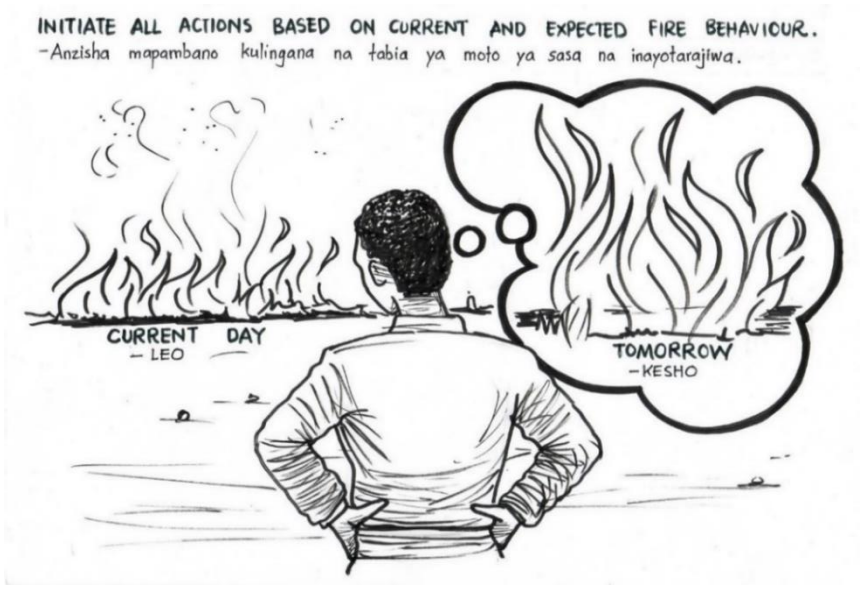
Figure 3.6 When suppressing a fire, do it effectively but safely



2. Initiate all actions based on current and expected fire behaviour

To effectively fight a fire, it is important to use understanding and knowledge of fire behaviour to predict the direction and speed of fire (Figure 3.7). Strategies and tactics should be implemented suppress the spread of fire. Fire behaviour should always be monitored, and a rapid assessment should be made by the village fire crew leader when arriving at the fire to determine the point of attack (situational awareness).

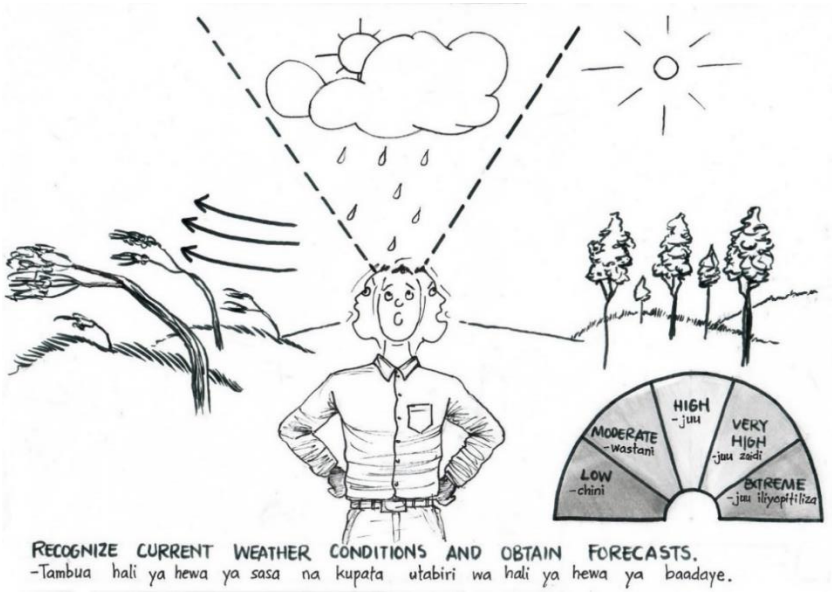
Figure 3.7 Initiate all action based on current and expected fire behaviour
Do not plan before you know current and future weather conditions



3. Recognize current weather conditions and obtain forecasts.

Knowing the weather forecasts is crucial for successful firefighting as it greatly affects fire behaviour. Firefighters should keep themselves informed of the latest forecasts and be mindful of any changes in wind direction and strength (Figure 3.8).

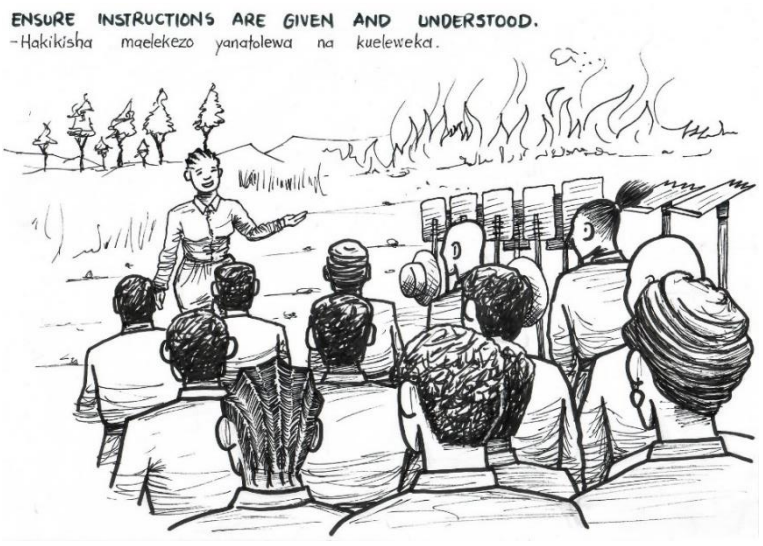
Figure 3.8 **Recognize current weather conditions and obtain forecasts**
If VFC leaders do not know the weather forecast, they are compromising the safety of the crew



4. Ensure instructions are given and understood.

A clear plan is essential for effective firefighting. It is important to know that plan and ensure that every crew member understands it. Having the VFC repeat the instructions is a good way to ensure that they have understood the orders and instructions (Figure 3.9).

Figure 3.9 **Ensure that instructions are given and understood**
If firefighters are not 100% sure about their task, they can find themselves in a dangerous situation



5. Obtain current information on fire status.

It is crucial to be aware of the current fire behaviour, including whether it is spreading rapidly or producing spot fires. VFC leaders should ask: Are there nearby property/houses that are being threatened? What is the status of fuels in nearby areas? Are there other fires in the area? This information can provide insight to the current state of the fire and potential future behaviour.

6. Remain in communication with crew members, leaders and adjoining VFCs.

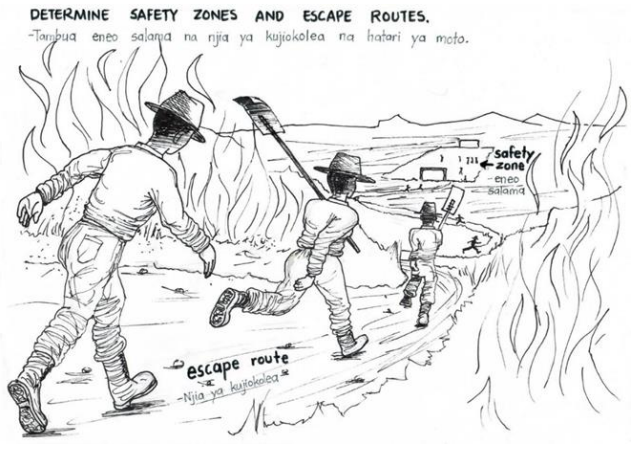
Communication between crew members, leaders, and adjoining VFCs is important because they keep each other informed of any changes regarding the fire, weather or resources at the fire (Figure 3.10).

Figure 3.10 Good communication can prevent mistakes
Firefighters should remain in communication with VFC members, leaders, and adjoining VFCs

7. Determine safety zones and escape routes.

Safety zones may need to be identified and created during the construction of the fire line. If this is not necessary, it is still important to be aware of their location. The location of safety zones and escape routes should be communicated to VFC leaders and the VFC to ensure that everyone is aware of the areas and how to reach them. Escape routes should be easy to navigate and should lead away from the fire (Figure 3.11).

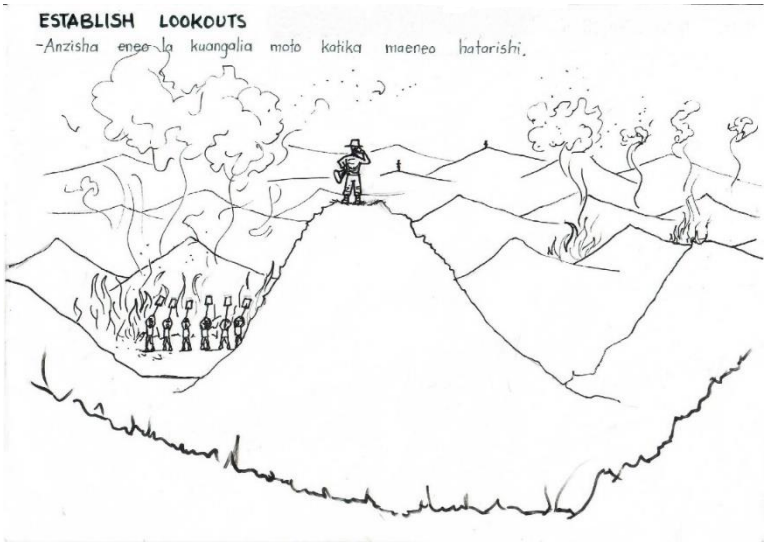
Figure 3.11 Safety zones and escape routes
All firefighters should know where safety zones are and how to get there safely



8. Establish fire lookouts.

The purpose of a lookout is to serve as the “eyes and ears” of the VFC. They can be used to detect potential hazards, understand the magnitude of the danger, and warn people in a dangerous area. The lookout should be manned by a very experienced member of the VFC, who is knowledgeable about the situation and knows what actions to take in response. Reliable communication with the lookout is important because the lookout’s observations are only valuable if they are communicated in a timely manner to the VFC (Figure 3.12).

Figure 3.12 Fire lookouts
Establish fire lookouts in strategic locations where the landscape is clearly visible



9. Retain control at all times.

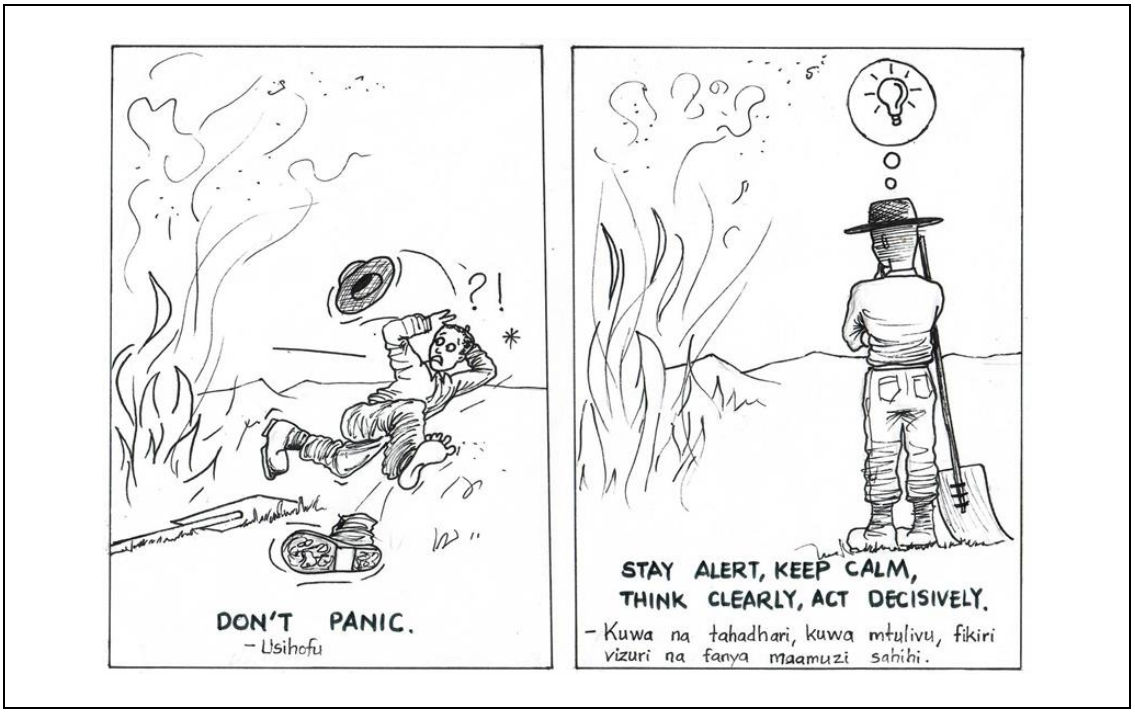
To fight fire effectively, it is essential to know what is happening around you. If others depend on you, assure them that you know what you are doing, and that they should follow. If you maintain control of yourself and those around you, you will decrease the chance of an accident (Figure 3.13).

Figure 3.13 Retain control at all times
Do not run unless necessary

10. Stay alert, keep calm, think clearly, act decisively.

Allowing panic to take over in a tricky situation is dangerous. Firefighters should remain alert, listen for instructions, warnings and appeals for help (Figure 3.14).

Figure 3.14 Do not panic
Stay alert, keep calm, think clearly, act decisively. A cool head can plan in dangerous situations

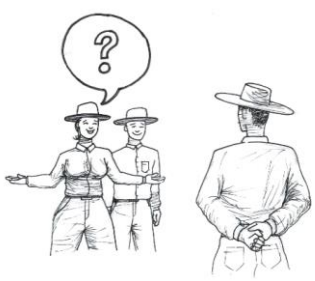


3.10 18 "Watch out" Situations

"Watch out" situations are circumstances that could endanger the lives of firefighters or others at the fire scene. VFC leaders must act if any of these 18 situations arise.

1. **Fire is not scouted and sized-up.** This situation arises when the fire crew arrives at the site of the fire without knowing the circumstances surrounding the fire. To scout and size-up the fire, the VFC answers these questions:
    - Where are the fire perimeters?
    - What are the unburned fuels ahead of the fire like?
    - Who is working at the fire and where are they?
    - What is the topography like ahead of the fire?
    - Who is in command of the fire?
2. **Fire is not clearly observable.** This situation occurs when the fire crew arrives at the fire scene during the night and being unfamiliar with the environment, or when there is nobody in the VFC who is familiar with the terrain.
3. **Safety zones and escape routes are not identified**. If the fire becomes too dangerous for firefighters to remain at the fire, they may have nowhere to escape to.
4. **Firefighters are unfamiliar with weather and local factors influencing fire behaviour.** This situation arises when firefighters do not understand the impacts of weather, topography and fuel on fire behaviour.
5. **Firefighters are uninformed on strategy, tactics, and hazards**. This occurs when the person in charge of the fire fails to inform the VFC about the plan for suppressing the fire, and no one points out dangerous areas around the fire.

6. **Instructions and assignments are not clear**. The VFC does not understand their instructions.
7. **There is no communication between crew members or supervisors.** This situation arises when there is no means to communicate with the person in charge of the fire and therefore cannot receive or give important information or updates about the fire.
8. **Fire breaks/control lines are constructed without a safe anchor point**. Fire breaks/control lines should be constructed in a manner that no gaps are left in the line that will allow a fire to burn through and must begin and end in safe anchor points.
9. **The fire crew is working on high ground and the fire is below**. This is a "watch out" situation" when the fire crew is working on a hill or mountain and an active fire is burning at the base of the hill. The fire can quickly spread uphill and pose a serious threat to the safety of the firefighters.
10. **The fire crew is attempting a frontal assault on the fire.** This situation arises when the fire crew attacks the fire at the head of the fire, which can be dangerous because that is where the flames are the biggest and hottest. The head of the fire also spreads the fastest, which can result in crew members getting trapped.
11. **There are unburned fuels between firefighters and the fire**. This occurs when crew members take a break next to an actively burning fire where there is still unburned fuel between the fire crew. If the wind changes direction, the fire can quickly consume the remaining fuel and endanger firefighters.
12. **VFC members cannot see the main fire and are not in contact with someone who can**. This means that firefighters are uninformed about the location of the main fire and therefore are unsure if their current position is safe or not.
13. **The fire is on a hillside where rolling material can ignite fuel below.** In situations where the crew is working at the bottom of a hill and there is heavy burning material higher up on the hill, there is a risk of dislodged materials (such as logs) rolling downhill and causing serious injury or death.
14. **The weather becomes hotter and drier.** A dangerous situation can arise when unburned vegetation dries out and ignites more easily and quickly as the day gets warmer and the air drier.
15. **The wind increases and/or changes direction**. A change in direction or strength of wind can become dangerous because wind has the most influential effect on the way a fire burns.
16. **There are frequent spot fires getting across the fire line**. The constant occurrence of spot fires that jump over fire breaks indicates a dangerous situation for firefighters.
17. **The terrain and fuels make escape to a safety zone difficult**. This situation occurs if the fire crew is working in a difficult terrain or an area with limited escape routes, which poses danger to their safety. If there is an emergency (for example a change in wind direction) the fire crew may not be able to move away from the fire quickly and safely.
18. **A fire crew member is taking a nap near the fire line.** Firefighters must rest after a long shift of fighting a fire, but if they sleep in an area where the fire can easily consume available fuel then lives can be endangered.



Questions

1. How can you ensure the welfare of the firefighting crew?
2. What are the factors that will contribute to safe but effective firefighting?
3. What are the ten standard safety orders?

3.11 Firefighting tools

3.11.1 Tools for fire management

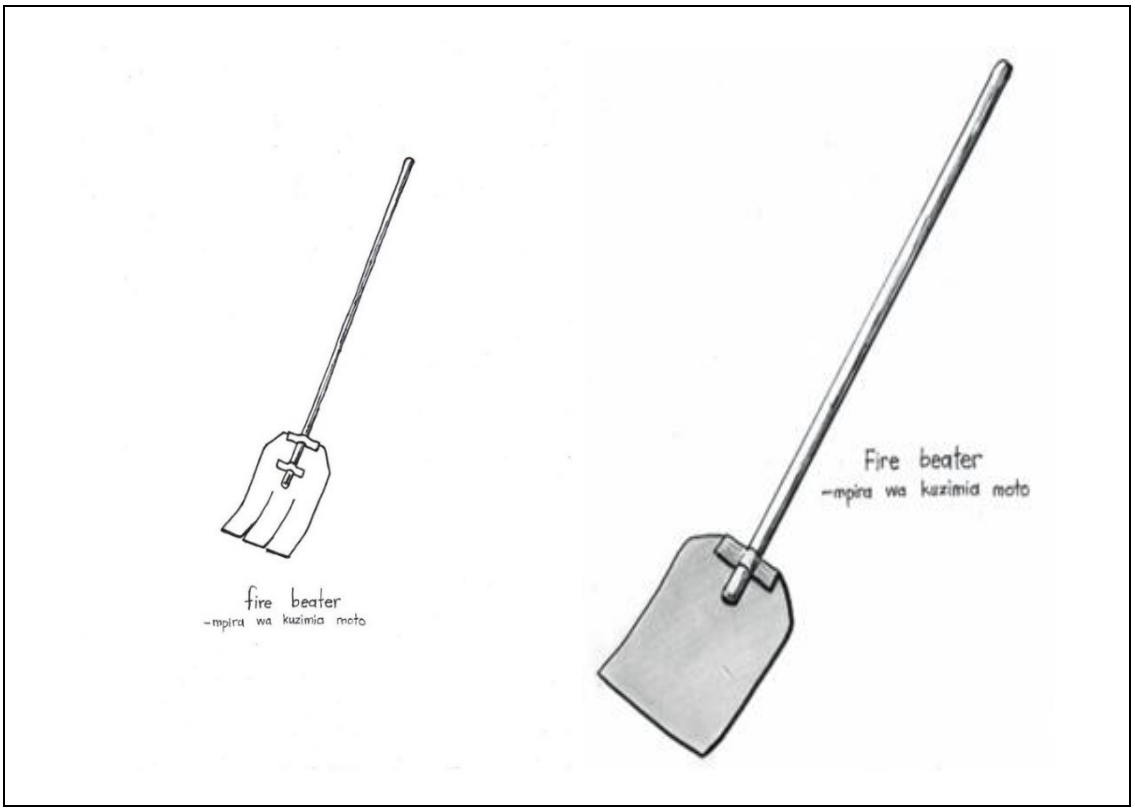
A combination of fire tools is required to suppress a fire effectively. Each tool has a specific purpose and is used for a specific task during a fire. Some tools are used to extinguish fires by suffocating flames or reducing the temperature of burning materials, while others are used to eliminate or alter fuels to prevent a fire from spreading in a specific area.

It is recommended that a 15-person VFC has the following minimum set of PPE and tools:

- PPE for each firefighter (including cotton overalls, leather boots, cotton hats, leather gloves, and safety goggles)
- 12 fire beaters
- 4 firefighting knapsacks
- 4 fire sticks
- 1 drip torch
- 4 rake hoes
- 2 cane knives
- 6 drag forks
- 1 first aid kit

Fire beater: There are two types of fire beaters used to combat fires. The first type is made of conveyer belting or tough rubber and has “fingers” that are used to extinguish fires in woody shrubs by fitting between stems and suffocating the flames. The second type has a solid flap and is highly effective in smothering grass fires (Figure 3.15).

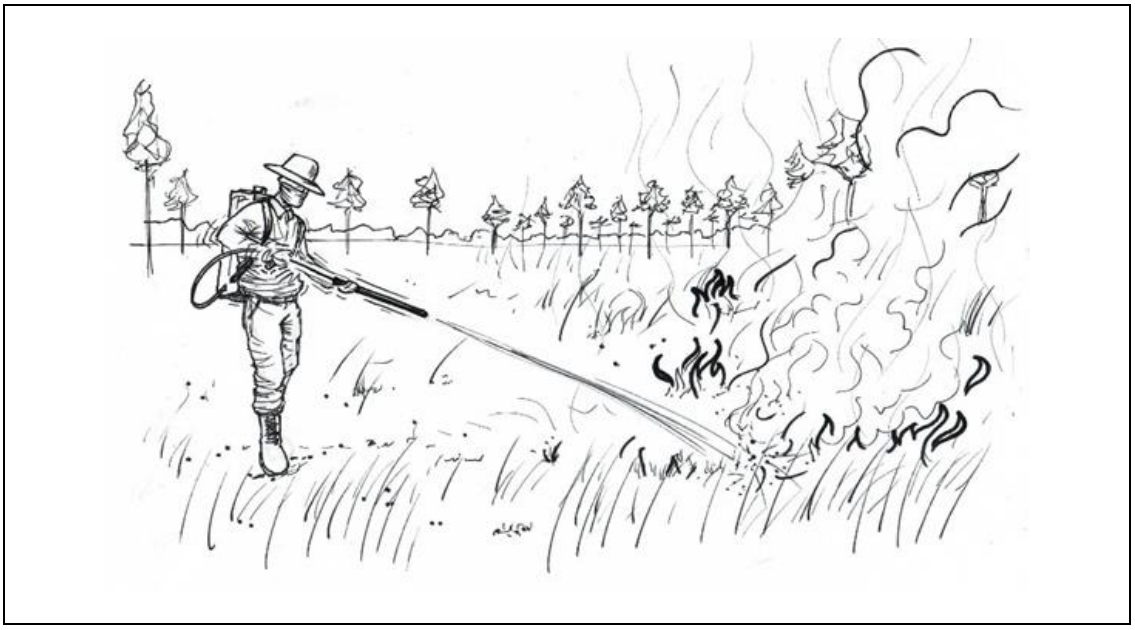
Figure 3.15 Fire beaters



Fire knapsack pump: The knapsack pump (Figure 3.16) is a small and portable device designed for carrying and dispensing water to combat fire. It comprises a water tank, a hand

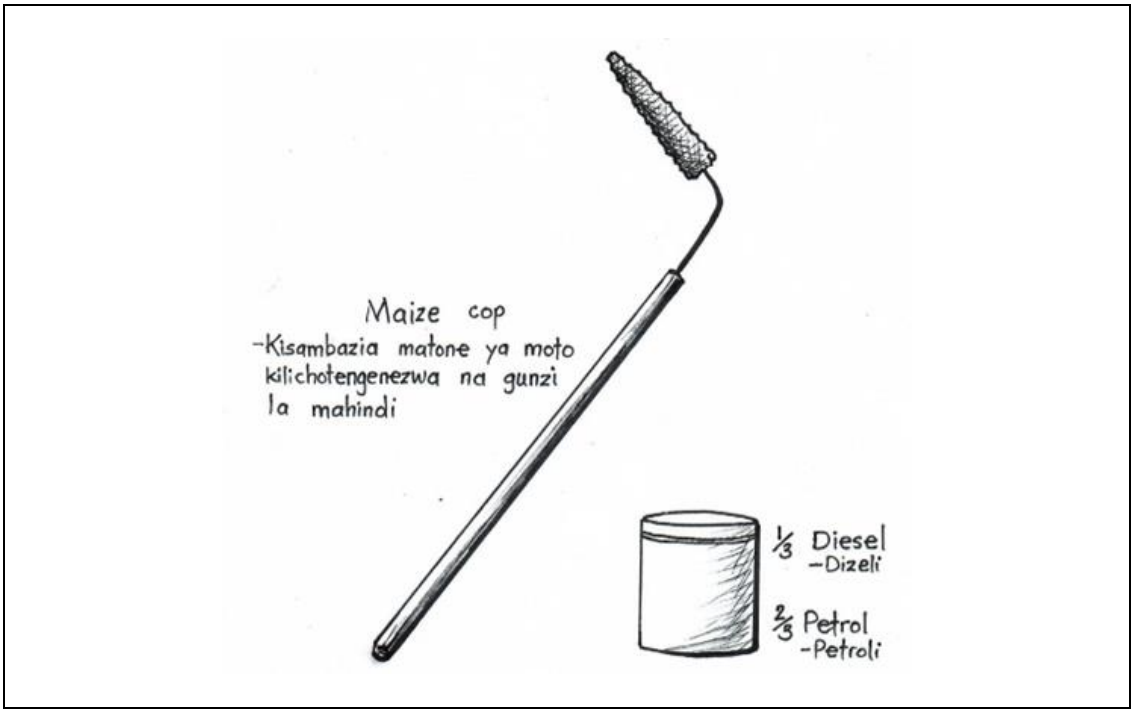
pump, and a discharge pipe with a nozzle for controlling fires from a safe distance. A firefighter carries a knapsack on his back and pumps the handle to release water through the nozzle. The nozzle can be adjusted to release water in the form of a jet, intermediate, or fog stream. The knapsack is useful for cooling fuels and dousing smouldering materials, and it can be employed before a fire beating team to assist with fire suppression.

Figure 3.16 Firefighter with a knapsack pump



Fire lighter/"fire stick": A source of ignition is required to start a controlled burn. A “fire stick” is a simple and inexpensive tool that can start controlled burns quickly. A fire stick consists of a metal rod with a maize cob attached to one end and a wooden handle at the other. The cob is coated in a petrol/diesel mixture and lit to create a torch that can carry fire. Once the flames on the torch have died, it can be soaked in the mixture and ignited again. Figure 3.17 shows a fire stick with a fuel container.

Figure 3.17 Fire stick with a fuel container

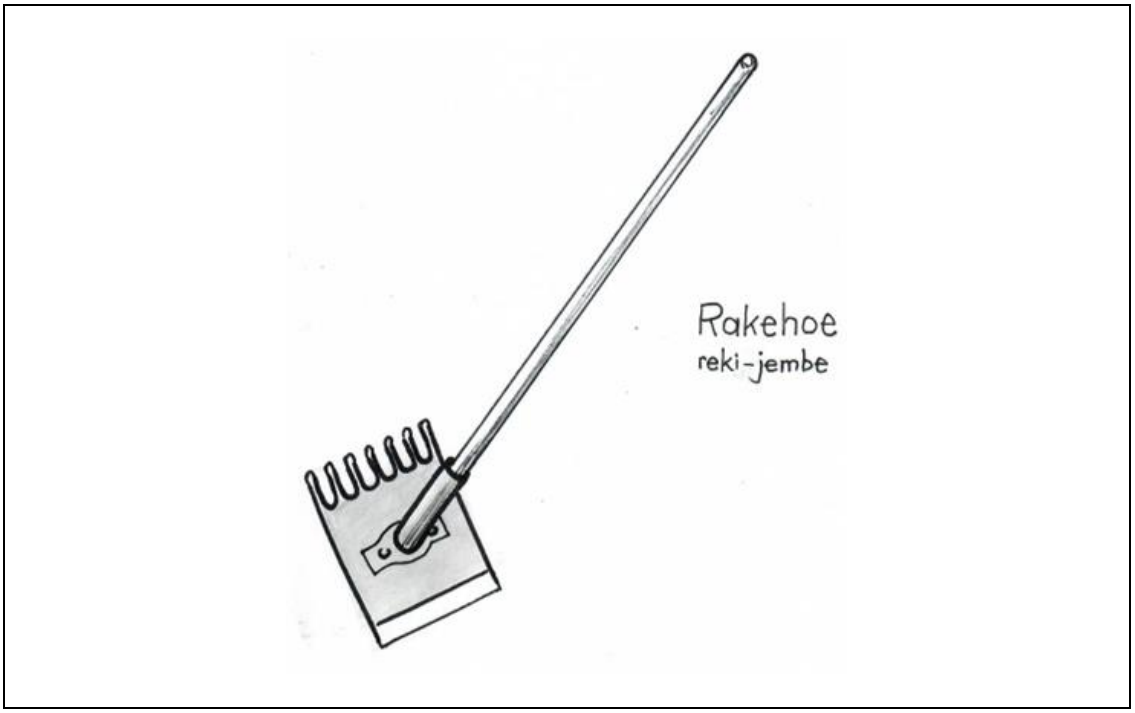


Drip torch: A drip torch is one of the most common methods of ignition (Figure 3.18). It is intended to ignite semi-dry, slow-to-ignite fuels. It uses a 2:1 mixture of diesel oil and gasoline, which creates a “sticky” fuel mixture that clings to plant materials while burning. The torch operator drips fuel onto the plants. The drip torch is equipped with safety features such as a fuel check valve, fuel trap, breather valve, oil proof gasket, and sealed outlet to prevent fuel spillage.

Figure 3.18 Drip torch

Rake hoe (hoes and rakes): The rake hoe (Figure 3.19) is a versatile tool that can be used as both a rake and a hoe. It is commonly used to create control lines by cutting though vegetation with the hoe side and raking away loose material with the rake side. This creates a clear fire break.

Figure 3.19 Rake hoe

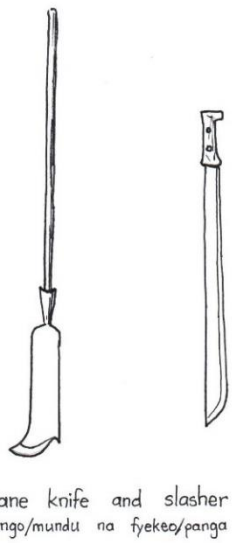


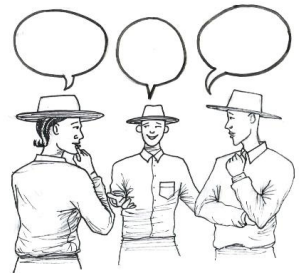
Drag fork: Drag forks are used to clear loose plant material from fire breaks. It resembles a garden fork, but with its tines bent at a 90° angle (Figure 3.20). The drag fork is particularly useful in pine needle beds because it is efficient and causes minimal soil disturbance. Since the drag fork has a long handle, it can be used to separate heaps of burning material.

Figure 3.20 Drag fork

Slasher/cane knife: Slashers or cane knives are used to cut through young trees and shrubs. They can also be used to slash tall grass to create an area of compacted fuels, where flames will be lower and easier to suppress by firefighters (Figure 3.21). Since working with slashers or cane knives can be dangerous, safety precautions should be taken when using them.

Figure 3.21 Cane knife and slasher





Discussion

Divide into groups and provide 10 minutes for group discussion.

1. Why should tools be maintained and controlled?
2. What tools are used to create a firebreak?
3. What tools are used to control fire?

One person in the group should give feedback.

3.11.2 Inspection and maintenance of fire tools

Firefighting equipment must be in perfect working condition when fighting a fire. After use, each tool should be inspected to ensure that it is still fit for use. If a tool is found to be unfit, it should be repaired immediately. The following aspects should be checked during inspections and repaired or maintained where necessary:

Fire beaters, fire sticks, rake hoes, slashers and cane knives

- Broken handles should be repaired.
- Loose handles should be tightened.
- Splints must be removed from handles.
- Handles should be smooth.
- Cutting edges of tools must be kept sharp.
- Metal must be rust free.

Knapsacks

- Water knapsacks should be inspected for leaks, faulty straps and checked for the proper functioning of the pump-action.
- Knapsack pumps must be serviced on a regular basis by disassembling the pump and inspecting the rubber seals and plunger.
- All moving parts should be lubricated with grease to ensure effective pumping.
- If any hose clamps are leaking, they should be tightened.
- “O” rings and seals that are worn out should be replaced.

Drip torch

- The drip pipe, nozzle and wick of a drip torch should be well maintained and inspected regularly. The nozzle can become clogged, but it can easily be cleared with a lengthy thin wire.

All firefighting tools should be stored in dry space. They should be locked away when they are not in used. A tool register can be helpful for the village fire management committee to manage the use of tools. Keeping record of all tools and assigning individuals responsible for their use can ensure timely return of tools that are still in good condition. An example of a tool register is attached in Table 3.1 and Table 3.2.

Table 3.1 Tool register.

No	Name of tool	Number of tools
1		
2		
3		

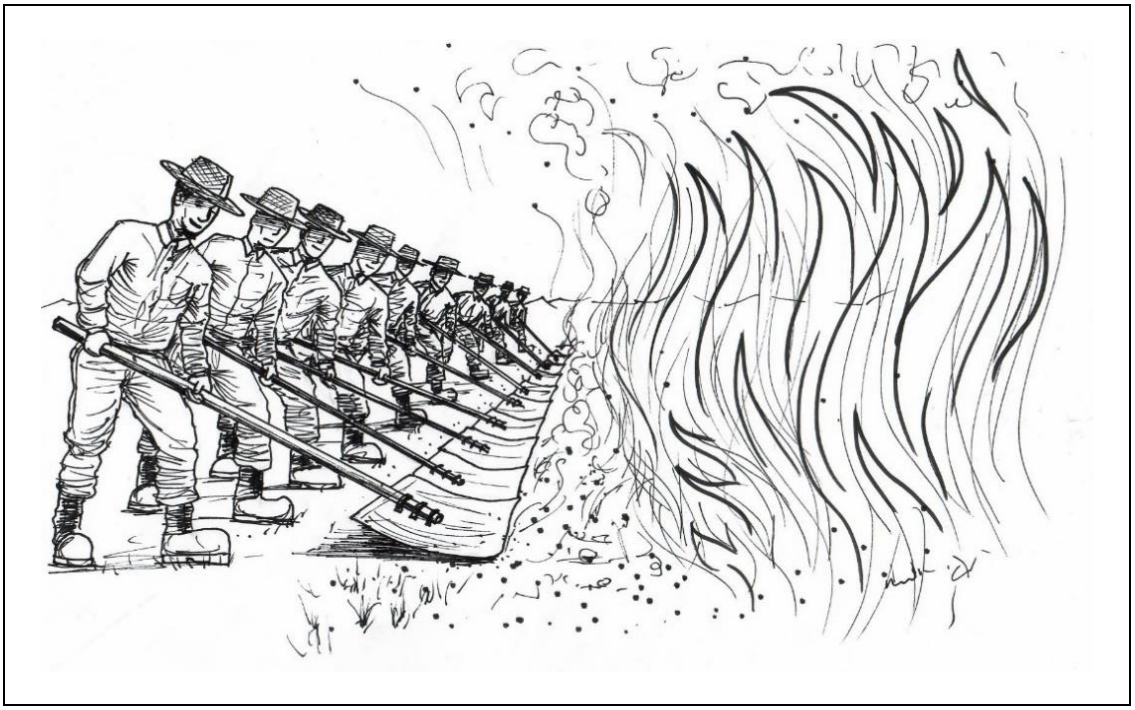
Table 3.2 Tool issuing register

Date	Tool issued	Number of tools	Issued to (name)	Signature	Return date	Number of tools returned	Person returning tool	Signature of person receiving the tool	Other notes

3.11.3 Effective use of fire tools

Fire beater: The fire crew uses fire beaters to rhythmically beat and smother flames on the fire line, without lifting them too high to avoid spreading sparks. Fire beaters have long handles to protect firefighters from radiant heat while extinguishing flames (see Figure 3.21). If the leading firefighters becomes too hot, they retire to the back of the line and are replaced by crew members in second place. As they advance along the fire line with overlapping flaps, the crew must maintain a regular and synchronised beating rhythm (Figure 3.22).

Figure 3.22 Use of fire beaters
The fire crew works as a team with flaps of fire beaters overlapping



Fire knapsack pump: Knapsack pumps are an effective tool for cooling down fuels before fire fighters arrive. They can also be used to cool down hotspots, allowing the fire crew to approach and extinguish the fire with hand tools. Knapsack operators should direct water at the base of burning flames and use it sparingly to effectively cool fuels. They can also be used effectively alongside a crew with rake hoes or hoes to mop up after a fire. Knapsack pumps are especially useful for VFCs who do not have access to backup vehicles with water pumps. It is critical to have water containers on hand to resupply the knapsack pumps, and water should be transported to the fire line by designated people.

Fire lighters: Fire lighters, such as fire sticks or drip torches, are efficient tools for quickly burning a designated fire line. They are particularly useful for creating fire breaks or burning out the flanks of a fire. The person operating the fire lighter must be careful not to get any fuel on their clothing.

Rake hoe (rakes and hoes): Rake hoes are used to clear flammable material from the soil and thus constructing a fire control line (Figure 3.23). They can also be used to turn over logs, burning material, and smouldering material. This allows the knapsack operators to extinguish those materials with water.

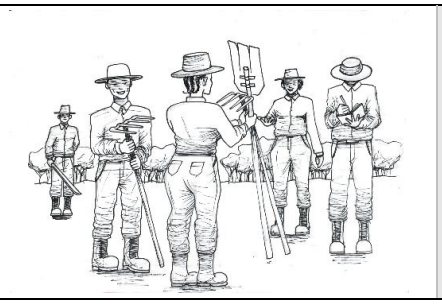
Figure 3.23 Fire crew constructing a control line with rake hoes

Drag fork: Drag forks are effective tools to clear loose flammable materials like pine needles, grass, or branches (Figure 3.24). They have long handles, which allow firefighters to drag burning material away from a pile and extinguish it.

Figure 3.24 The use of drag forks.
The fire crew controls a fire under pine trees with drag forks.

3.11.4 Tool safety

- To avoid injury or damage, tools should be handed down from a vehicle to someone on the ground instead of throwing them.
- When transporting tools to a fire, crew members should walk in single file with a distance of two meters between them and carry tools to the side to avoid catching branches.
- Tools should not be left lying around, especially at night, to avoid tripping or stepping on them.
- Tools should be stored in a secure and clearly marked location.
- The handles of tools should be painted yellow (or any other bright colour) which makes them easy to spot.



Activity

1. Provide trainees with firefighting tools and allow them to use the tools until they are competent in using them effectively.
2. Ask trainees to inspect and repair tools that are not fit for use.

Questions

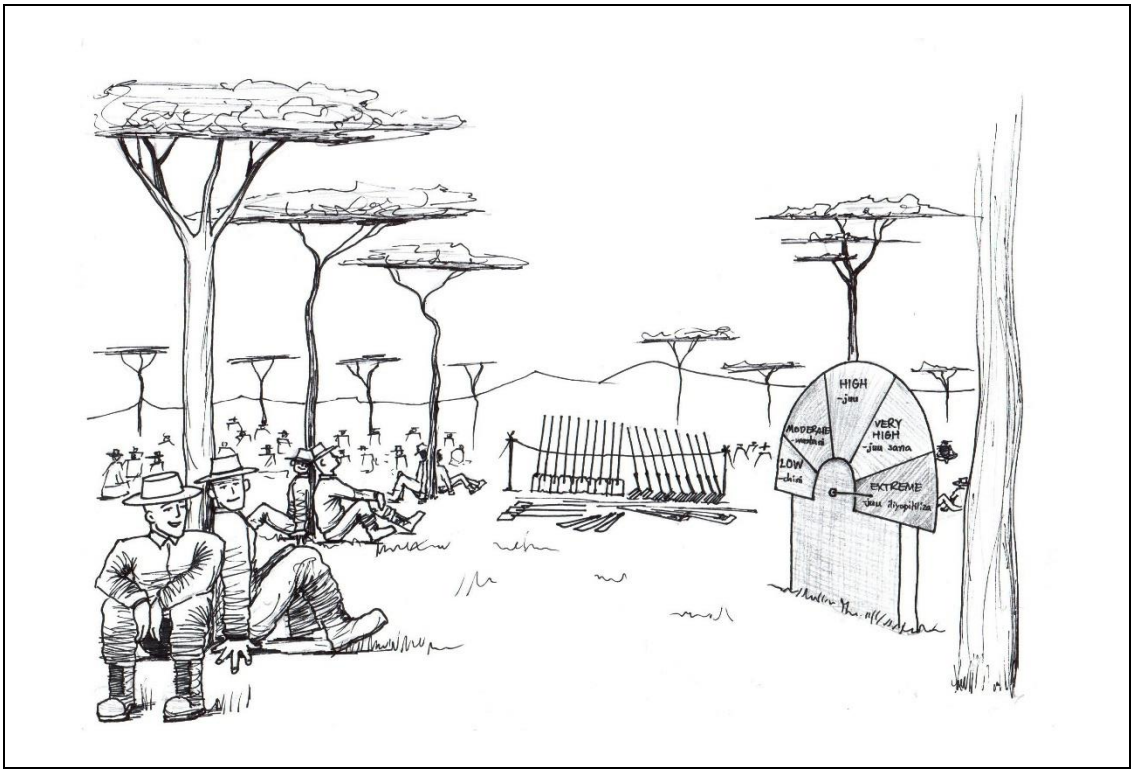
1. What are the most important hand tools used to suppress fires?
2. When and how should hand tools be maintained?

3.12 Fire Suppression

Fire suppression involves all activities and actions aimed and extinguishing a fire and preventing it from reigniting. These activities include being prepared to fight fires, detecting them, reaching them, fighting them safely and effectively, cleaning up after the fire, guarding the area, investigating, and reporting a fire.

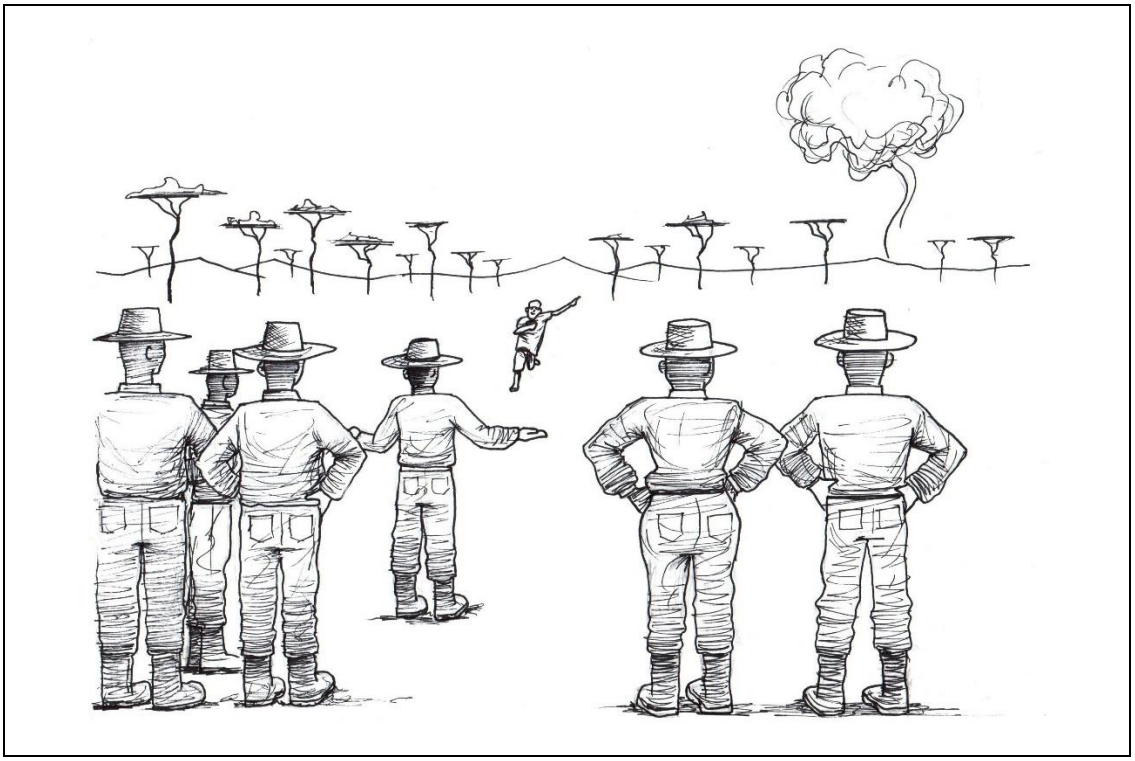
Standby: To be on standby means to be prepared to fight a fire at any moment. Without an organized VFC on standby and ready to react quickly to a fire, time will be wasted in organizing people to suppress the fire (Figure 3.25). This delay can result in the fire growing too large to control by the time firefighters arrive at the scene. To prevent this, the VFC should be on standby when the FDI is orange or red (see Table 2.5).

Figure 3.25 Village Fire Crew on standby during a red FDI day



Detection: The earlier a fire is detected and reported to the VFC or Village Fire Management Committee (VFMC), the easier it will be to suppress it. Reporting a fire quickly to the VFC is crucial in controlling the fire because the earlier it is detected and reported, the smaller it will be upon their arrival (Figure 3.26). Villagers, including children, should understand the importance of reporting fires promptly to the VFC or VFMC.

Figure 3.26 Report fires fast and to the VFC or VFMC



Mobilising: Mobilising refers to the process of getting the VFC and their tools to the scene of the fire. Fast access to the fire scene for the VFC and tools ensures a quick response to the fire. This means that access roads and transportation are important factors to consider.

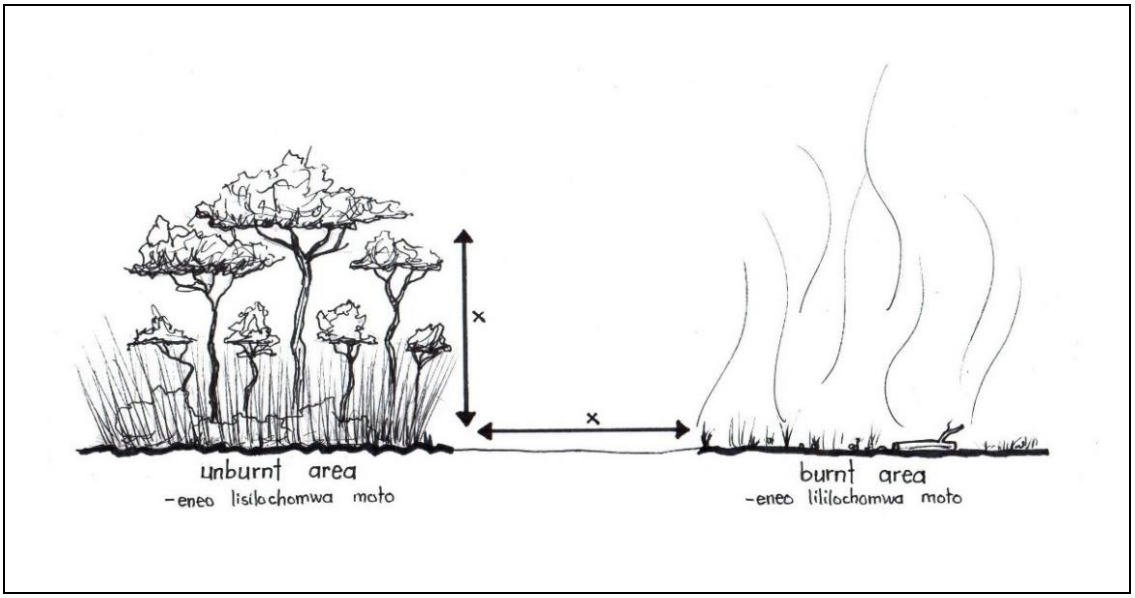
Fighting the fire: Fighting a fire involves different strategies and techniques with the aim to control a fire. The strategies and techniques depend on various factors such as weather conditions, fuel hazard, and topography. Effective and safe fire suppression requires well-trained VFCs, and leaders equipped with appropriate tools and PPE.

The VFC should be the first to arrive at the scene because they are trained and equipped to attack the fire. Other villagers who arrive later should focus on creating a control line and carrying out mopping-up procedures. A VFC member should supervise the mopping-up team.

Mopping up: The process of extinguishing or removing burning material near fires is referred to as mopping up. After extinguishing the flames on the fire line, the mopping-up process begins. Mopping up is less dangerous than fighting fires and can be done by villagers. Mopping up entails the following tasks:

- Building a control line between burned and unburned fuel. However, during the construction of the control line, no smouldering material should be placed in the unburned area.
- The width of the control line is determined by the wind direction, slope, fuel height, and fire intensity. The width of the control line should be at least as wide as the height of the unburned fuel next to it as a rule (Figure 3.27). The control line should be wider in cases of strong wind, steep slopes, and a very hot fire. When the control line is finished, the mop-up team can proceed to the next step.
- After constructing an initial control line around the perimeter of the fire, it should be strengthened by making it wider.

Figure 3.27 The width of the control line should be at least as wide as the height of the unburned fuel next to it



To mop-up a grass/agricultural fire:

- Sweep a 2m – 5m wide section from the unburned area into the burned area, which also extinguishes all smouldering and smoking embers.
- For areas with heavy fuels (such as branches and logs) near the burned area, a wider control line is necessary. This wider control line can be created by hoeing the area between burned and unburned sections.

To mop-up harvesting slash fires:

- Sweep a 5m – 10m wide section from the unburned area to the burned area, which also extinguishes all smouldering and smoking embers.
- For areas with heavy fuels (such as branches and logs) close to the edge of the burned area, a wider control line is needed. A wider control line should be hoed between the burned and unburned areas.

Guarding and patrolling: After the mop-up has been completed, the burned area must be guarded and patrolled. The duration of guarding and patrolling will depend on the weather conditions and the type of fuel that burned. For example, grass areas require less time to be guarded than areas with woody materials like harvesting residue. The following standards should be observed:

- **Grasslands** should be guarded for 24h. The guarding period should be extended if there is still doubt about the safety status of the area.
- **Sawdust heaps and peat areas** should be guarded for 30 days. This lengthy period is necessary because ground fires can often occur in these areas.
- **Harvesting residue smaller than 0.25ha/0.5acres** should be guarded for 24h. It is important to mop-up this area carefully and dig up any burning roots and sawdust. If the weather conditions are unfavourable (i.e., the FDI is orange or red), it is recommended to guard the area for up to 21 days after the fire occurred to prevent any ground fires from flaring up.
- **Harvesting residue bigger than 0.25ha/0.5 acres** should be guarded for 7 days. A mop-up area of 30m should be carefully checked to dig up any burning roots and sawdust. If weather conditions remain unfavourable (i.e., the FDI is orange or red), the area should be guarded for up to 21 days after the fire to prevent any ground fires from flaring up.

The VFC leader must determine the number of fire guards required at the scene of the fire. The VFC leader should take into consideration factors such as weather, terrain, size of the burned area, and vegetation type. The guards should be experienced firefighters who are fully equipped with water, tools, torches, warm clothes, and food. They should also have a secure means of communication and should be well-rested to avoid falling asleep during the night shift.

Investigation and reporting: The investigation and reporting of a fire occurrence is necessary to learn and prevent a similar event from happening again. The investigation of a fire involves examining the cause of the fire, the effectiveness of the suppression, and factors that had negative or positive effects on the suppression effort. Effective fire suppression minimizes losses caused by a fire and ensures that it is extinguished as quickly as possible.

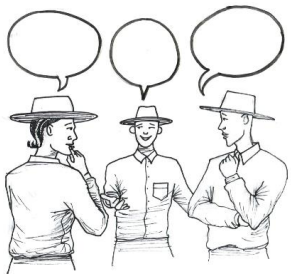
3.13 Firebreaks

A firebreak is defined as a man-made or natural structure/feature that serves as an obstacle that restricts the spread of fires. Examples of natural fire breaks include rivers, lakes, bare rocks or an area grazed intensively by animals that stop or slow down the progress of a fire. Man-made fire breaks are typically created by clearing all flammable materials down to the mineral soil to prevent the spread of an unwanted fire. They are constructed to protect human lives, property (e.g., crops, timber, houses, sawmills) or the natural environment. Firebreaks can also serve as a point of attack or defence when fighting a fire. Examples of man-made firebreaks include roads, sports fields, and any area that has been cleared by grading, ploughing, hoeing or burning (i.e., any area where the combustible layer is removed).

Certain procedures must be followed to ensure that firebreaks are constructed correctly. Firebreaks can vary in size, depending on several factors such as the type of vegetation, slope of the land, wind speed and direction, and the flammability of the crops being protected. It is important to ensure that the construction of firebreaks does not cause soil erosion or destroy protected plants, as this can degrade the natural environment. However, the firebreaks must also be effective enough to prevent unwanted fires from escaping and causing damage.

3.13.1 Types and purpose of firebreaks

While all firebreaks aim to create a gap in vegetation to stop or slow down the spread of the fire, different firebreaks serve different purposes.



Discussion

Divide into groups and provide 10 minutes for group discussion.

1. Is firebreak worth the effort, money and time spent to create it?
2. Should the establishment of firebreaks be included in the law?

One person in the group should give feedback.

Fire belt

A fire belt is a carefully planned and built structure that is placed in a way that stops a fire from spreading (Figure 3.28, Figure 3.29, and Figure 3.30). The size of the fire belt, where it will go, and how it will be made are all planned ahead of time. Fire belts are usually cleared of everything that can catch fire, right down to the mineral soil. But it should be made in a way that doesn't hurt the natural environment (e.g., causing soil erosion or damaging protected vegetation).

Figure 3.28 Fire belt constructed to protect a woodlot.

Figure 3.29 Fire belt is constructed by slashing the shoulders of the road

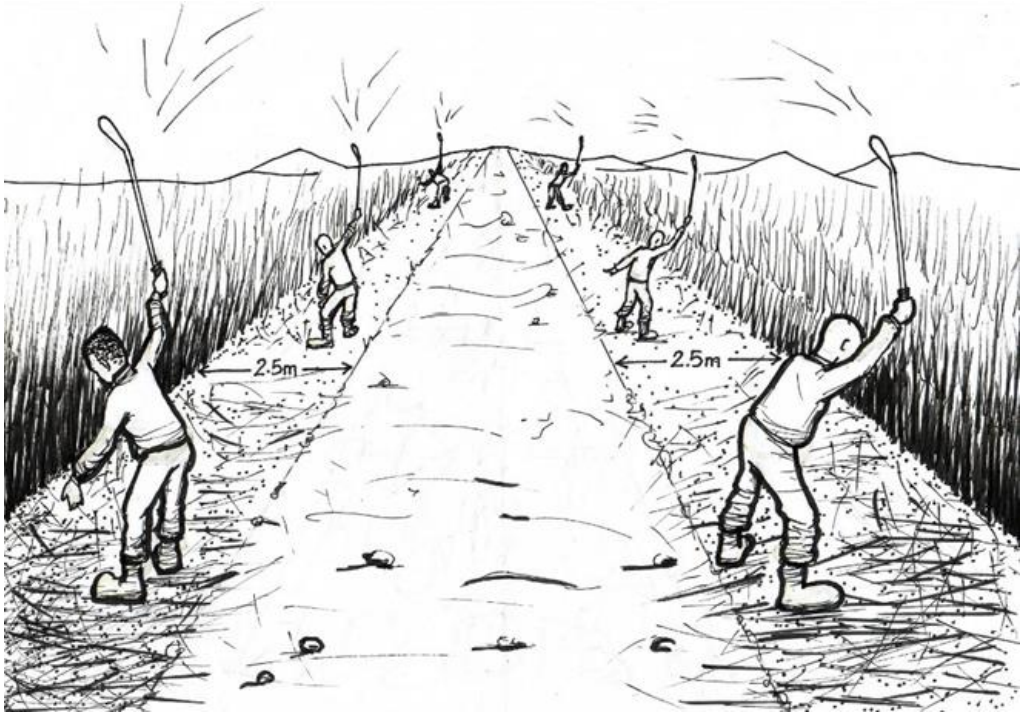


Figure 3.30 Slashing the vegetation next to the road makes it a more effective fire belt

Green/live belt

A green belt (or live belt) is an area containing living plants that will not burn easily in the event of a fire (Figure 3.31). A fire belt is a carefully planned and built structure that is placed in a way that stops a fire from spreading. The size of the fire belt, where it will go, and how it will be made are all planned ahead of time. Fire belts are usually cleared of everything that can catch fire, right down to the mineral soil. But it should be made in a way that doesn't hurt the natural

environment (e.g. causing soil erosion or damaging protected vegetation). One common example of a green belt is the area beneath pruned trees where all fuel has been removed down to mineral soil.

Figure 3.31 Green belt.
The removal of burnable material under pruned trees creates a “living”/green fire belt.

Buffer zones

A buffer zone (Figure 3.32 and Figure 3.33) is a place where a lot of work is done to manage fuel. Some of these activities include thinning, pruning, and getting rid of ladder fuels (i.e. fuels that allow a fire to climb up from the ground to the tree canopy). The goal is to cut down on the amount of fuel a fire can use, which will make it easier for firefighters to put out or contain. Buffer zones are placed in a planned way to strengthen fire belts, protect high-risk areas, and make up for the direction of the prevailing wind. How wide a buffer zone is will depend on the terrain and plants in the area, as well as how likely it is to catch on fire. In areas with dense, easily ignitable vegetation or steep slopes, a larger buffer zone may be needed.

Figure 3.32 Buffer zone created by burning a block of grass next to a fire belt

Figure 3.33 Buffer zone created by allowing cattle to graze between trees

Trace belts

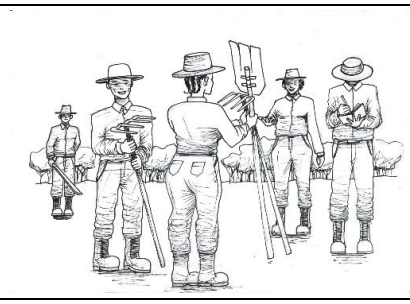
A trace belt is a narrow strip of cleared vegetation on either side of the area that is planned to be burned out as a fire belt. Figure 3.34 provides an example of trace belts.

Figure 3.34 Burning between to trace belts creates a fire belt

Control line

A control line (Figure 3.35) is a narrow fire belt cleared down to mineral soil that serves as a boundary between burned and unburned fuel. Once a fire is controlled, a control line must be built around the burned area to prevent the fire from reigniting and spreading to unburned vegetation.

Figure 3.35 Control line that separates burned and unburned vegetation



Activity

1. Provide trainees with different tools and allow them to create firebreaks with them.
2. Ensure that firebreaks are constructed to the correct standards.

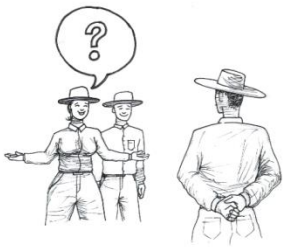
3.13.2 Firebreak criteria

- Every landowner or leaseholder of agricultural farms (for food crops, commercial crops, pastureland, commercial trees, or natural indigenous trees) are responsible for constructing firebreaks to prevent fires from spreading to neighbouring farms. This must be done before the 30th of June, or an alternative date approved by the village government.
- For shared boundaries, each boundary firebreak must be 2.5m wide on both sides, resulting in a 5-meter-wide boundary break between two farms.

- Farmers who plan to burn crop residue must obtain a burning permit and construct a 5m wide firebreak around the burning area.
- If an owner or leaseholder of an agricultural farm plans to create a firebreak through burning, they must prepare trace belts that are at least 1m wide. It is recommended to have cut off tracers every 200m through the firebreak to assist in controlling the fire.
- Fire belts that are prepared on the windward side of a property should be wider. This is because most fires tend to enter the property from that side due to the direction of the wind.
- Firebreaks should be constructed around sawmills, old saw outs, cooking areas, rubbish pits, machinery, or any volatile fuel sources, because fire is often used in these areas. If these areas are not isolated by a firebreak, it can cause the fire to escape.
- If a village area is under a continuous threat of fires from surrounding areas, a strategic fire break should be constructed to protect the village. These firebreaks should be at least 40m wide and can be created using existing barriers like roads or cultivated fields (i.e., natural firebreaks).
- Fire belts located in the middle of slopes and those parallel to the slope should be wider than those at the bottom of a slope or on level areas. This is because fires tend to spread upslope.

Table 3.3 Recommended firebreak width and method of construction by land use/cover.

Land use	Prescribed width (m)	Recommended method
Agricultural field	5 m	Rake crop residue
Natural grassland/ Agricultural land interface	Width = 2.5 x height of vegetation (minimum = 5 m)	Graze; slash; burn; hoeing on slopes less than 30 degrees.
Road edge	2.5 – 3m on either side	Slash; burn; hoe
Alien weed infestations	Width = 2.5 x height (minimum = 5 m)	Slash; burn; hoe
Residential area/ farm infrastructure	10 - 40 m	Slash; burn; hoe
Boundaries between properties/village boundaries	5 m	Rake crop residue



Questions

1. What are the different methods to prepare firebreaks?
2. What is the difference between a fire belt, control line, trace belt and buffer zone?
3. When is the correct time to prepare fire breaks?

3.14 Planned and prescribed burning

"Fire is a good servant but a bad master," says a common saying. This well-known proverb says that fire can be a good servant to land and plants if it is used strategically and the person in charge of the fire keeps it under control. But if the fire gets out of hand, it stops doing what it was meant to do and can become a destructive force (i.e., bad master).

Prescribed or planned burning is the intentional use of fire as a management tool for a variety of purposes. Examples include preparing agricultural fields for planting, renewing grazing areas for domestic animals, burning harvesting residue in woodlots, preparing fire belts and firebreaks, and creating buffer zones. Prescribed and planned burning is done to protect property and lives, as well as to limit the spread of fires. Furthermore, fire can be used as an indirect fire suppression method, such as burnout or backburn, to isolate hazardous fuels or activities, such as charcoal manufacturing.

However, prescribed, or planned burning are high-risk activities. Therefore, it is crucial to prepare areas for safe burning and plan the burning operation properly and carefully. Bylaws should be enforced to ensure that land users follow the correct procedures when applying for a permit to use fire and prepare areas by adhering to the stipulated burning procedures.

NB: The use of fire always carries a risk and therefore all burning operations should be planned thoroughly and must be executed in the presence of experienced users of fire.

3.14.1 Reasons for prescribed or planned burning

There are following reasons to consider a prescribed or planned burning operation.

1. To prepare firebreaks to protect woodlots and other valuable crops (Figure 3.36).

Figure 3.36 A combination of hoeing and burning was used to create a firebreak

2. To burn residue after harvesting (Figure 3.37).

Figure 3.37 Burning harvesting slash.

3. To reduce the fuel load in areas which have not been burned for some time. This is done to prevent accidental intense fires, which can become severe fires.
4. To clear fields for crops prior to planting season.
5. For conservation purposes.
6. To improve areas for grazing.
7. To clear areas around sawmills, charcoal plants and woodyards.

3.15 Guidelines for planned and prescribed burning

Before any planned burn, four factors must be considered. Safe and successful burning operations can be carried out by considering and planning around these factors. These factors are (1) fuel type, (2) fire weather, (3) burning plans, and (4) resources.

1. **Type of fuel**: The type of fuel that is going to be burned and the vegetation bordering the area impacts any planned burning operations. Assessing the vegetation will provide an idea of what kind of fire behaviour can be expected and this will guide the fire manager in preparing better for the burn.
2. **Fire weather:** Fire weather conditions, which include the weather leading up to the burn, the weather at the time of the burn, and the weather following the burn can affect planned or prescribed burning. Even if the FDI appears favourable on the day of the burn, prior weather conditions can affect the landscape and make burning dangerous. If the weather following the burn becomes dangerous (i.e., high FDI), any remaining smouldering material can ignite and cause fire to escape. The weather conditions can also influence the fuels and fire behaviour. It is important to choose safe weather conditions for the burning operation to ensure a successful and safe burn.
3. **Burning plans:** Burning plans outline the starting point, timing, and preparation for burning. Burning plans can help prevent unexpected issues during burning operations. Proper planning considers all potential problems and prepares for them in advance.

   The selection of a correct burning method for a prescribed burn ensures safe burning operations and reduces the threat of the fire escaping and causing damage to neighbouring properties. The burning plan should include method(s) that will be used to carry out the burn. Prior to planning, all necessary information about the intended burn area must be collected, and high-risk zones must be identified.

   In addition, it should also include a suppression plan in case the fire escapes the burn site. The suppression plan helps to prepare for the possibility of spot fires and must identify specific resources (such as trained people with appropriate tools) that can quickly respond to spot fires. Additionally, the plan should incorporate arrangements to obtain external resources in the case the fire cannot be controlled by the available

resources. The suppression team should be notified that they may be called upon to provide backup in case the fire escapes. They should be positioned as close as possible to the high-risk spotting area.

4. **Resources:** The right type and number of **resources** is essential for a successful burn. Important resources include VFC members (number of firefighters and quality of their training) as well as tools (right type, number, and quality) available to carry out the burn.

The success of any prescribed burn depends on the consideration of all these factors during the planning and operational phases of the burn.

3.16 Rules when starting a fire

Before starting a fire:

- Always consider the condition of the fuels adjacent to the area you are burning as this is where the fire can spot into. Always burn blocks of old dense grass late in the afternoon as this will reduce the fires potential of spotting and if it does spot burning conditions will be favourable and extinguishing the escaped fire will be easier.
- Do not burn old dense grass if the temperature exceeds 26°C – it will be too dangerous.
- Do not commence burning in the morning if the relative humidity is forecast to drop below 30%. Rather commence the burn in the late afternoon on a rising relative humidity.
- Do not burn if the wind speed is very strong (e.g., it exceeds 16 km per hour) as the fire will spread too fast and becomes uncontrollable.

When starting a fire:

- Make a test fire to check burning conditions before starting the main fire.
- Watch the burn's smoke column. It indicates strong wind if it flattens above the fire. This wind may drop to the ground and affect your prescribed burn.
- Fire into the wind: Wind-ignited fires spread quickly and become uncontrollable. Figure 3.38.
- Burn the slope from top to bottom: Fires spread quickly uphill and are hard to control. A slow-burning downhill fire is easier to control (Figure 3.39).

Figure 3.38 Burn into the wind

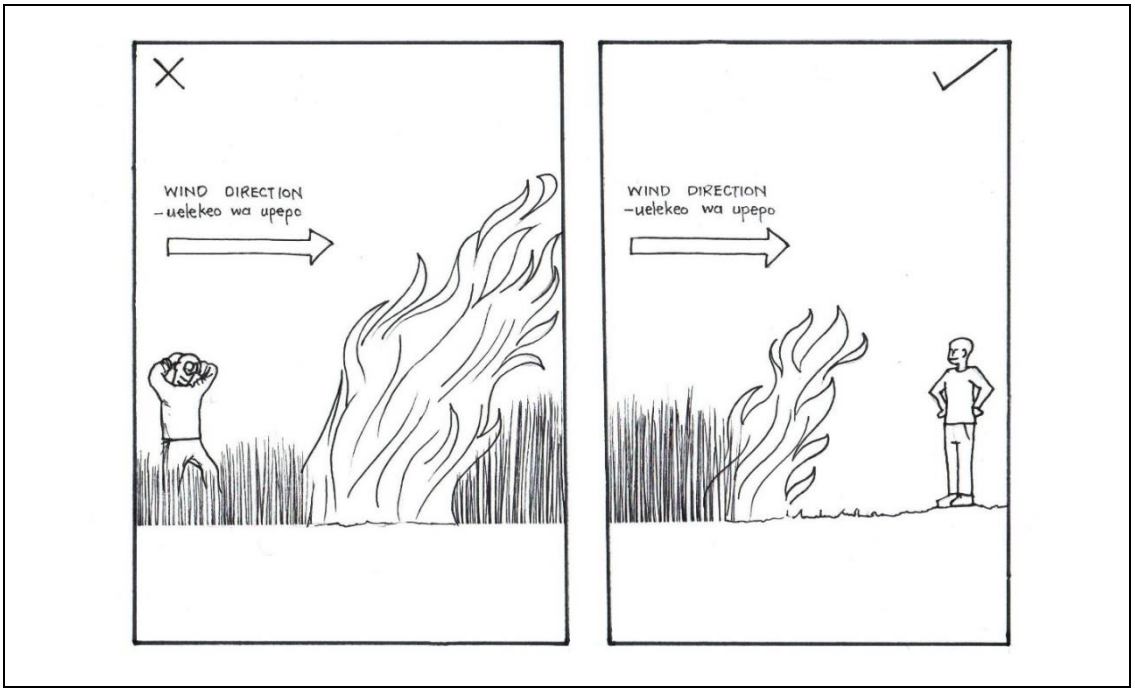
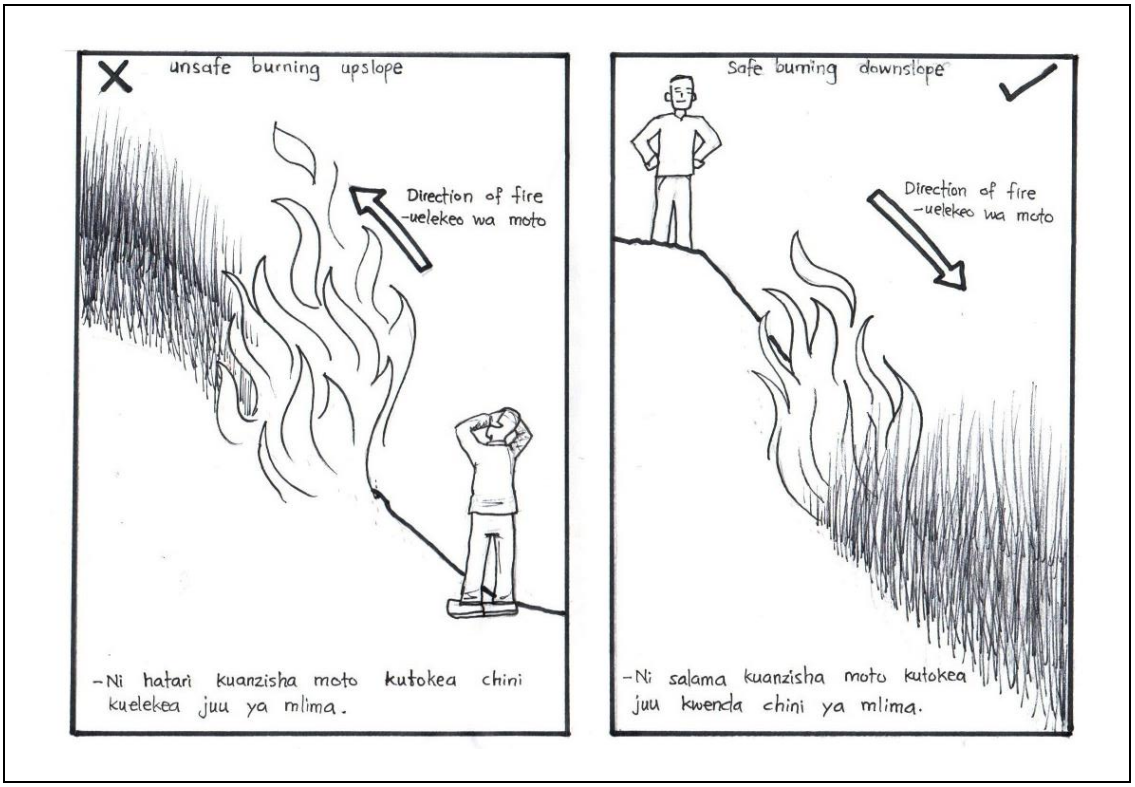


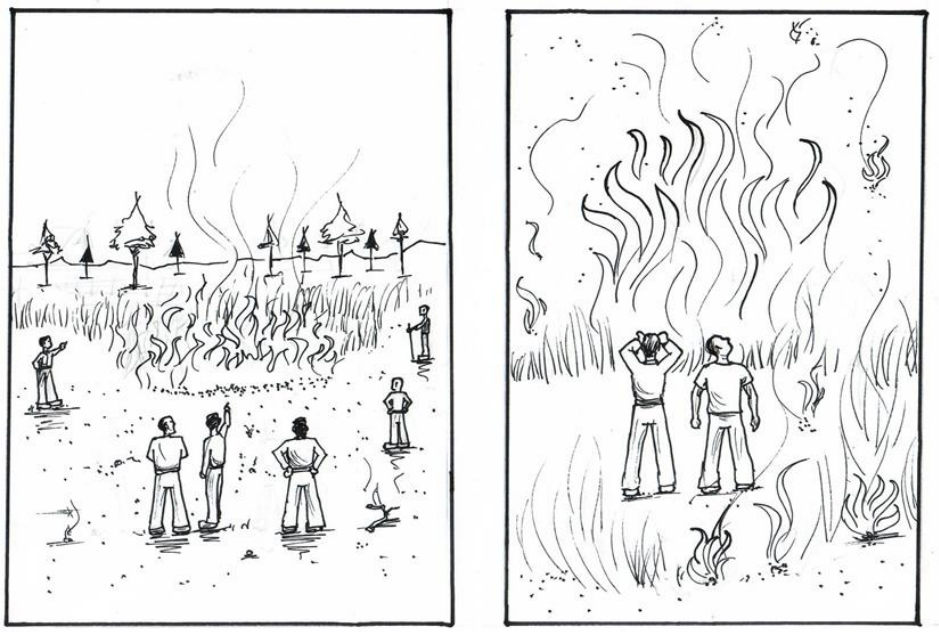
Figure 3.39 Burn from the top of a slope to the bottom.

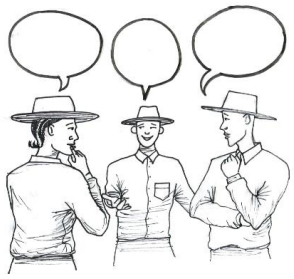


During the burn:

- Watch for constant spotting along the fire line. This is an indicator of worsening fire weather conditions. Rather cease operations and wait until the conditions improve.
- Check the weather constantly to pick up and changes that might influence the fire. Always have a crew mopping up behind the burning team.
- Never put in more fire than the crew can handle. Safety must remain the highest priority when doing a burn. There should always be enough crew members to take full control of the burning fire (Figure 3.40).

Figure 3.40 Never put in more fire than the crew can handle



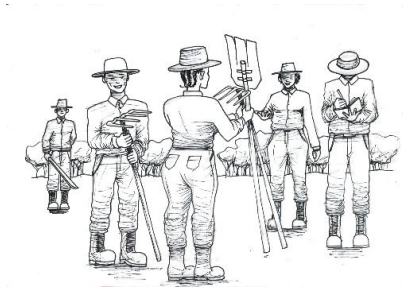


Discussion

Divide into groups and provide 10 minutes for group discussion.

1. Why is it necessary to plan a burn? Are there not enough experienced people in a village to burn without planning?

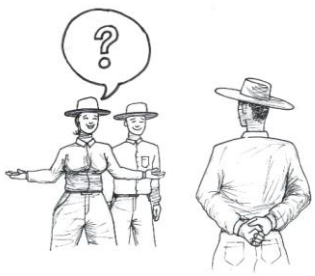
One person in the group should give feedback.



Activity

Take the trainees to an area (firebreak or a field) that needs to be burned.

1. Instruct them to draw up a plan to burn the area safely and effectively. The plan should include a sketch of the area to be burned.



Questions

1. How many people and tools should be available for a planned burn?
2. 2. Why must one burn against the wind and downslope?

4. VILLAGE FIRE MANAGEMENT COMMITTEE (VFMC) TRAINING

3	This chapter will inform VFMC members about their responsibilities regarding all fire management activities in a village. These will include: - Managing a Village Fire Fund VFF - Alerting villagers about fire danger - Issuing of burning permits - Investigating fires - Reporting on the fire management activities in the village.

A Village Fire Management Committee (VFMC) coordinates the fire protection, prevention, and suppression activities within a village. Thus, the VFMC will safeguard assets, prevent fires, and effectively suppress unwanted fires. It is composed of selected representatives from different hamlets who possess expertise and experience in fire management and suppression.

4.1 Purpose, structure, and responsibilities of the VFMC

4.1.1 Purpose of VFMC

The VFMC is responsible for managing fire risk on village land. This involves the preparation and implementation of village fire management plans (VFMP). The VFMC are established where the risk of fire is a major concern and justifying a specialized committee rather than adding responsibilities to existing village natural resource committee.

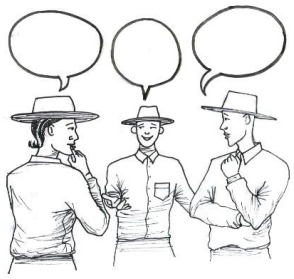
The template for Bylaws for Forest Fire Prevention and Management of Village Councils[2] recommends the structure and responsibilities of VFMCs. However, the customized bylaws as approved by the district council (DC) take precedence over these recommendations.

4.1.2 Structure of the VFMC

Each VFMC should have 25 members and the selection of members should be based on the following general criteria:

- Representation of each hamlet (e.g., the chairperson of each hamlet is a member of the VFMC)
- Representation of tree growers (e.g., any Tree Growers Association, TGA)
- Inclusive representation of gender, age, occupation, and ethnicity
- Inclusion of individuals well-suited for specific leadership roles:
    - The position of chairperson should be filled by an experienced and capable person, who can provide strong leadership to bring people together and ensure effective execution of all fire management responsibilities.
    - Inclusion of secretary, who can fulfil administrative tasks (for example keep registers of fines, permits, donations, etc).

[2] Participatory Plantation Forestry Programme – PFP 2 (2023): Bylaws template for forest fire management and prevention of the village councils. Iringa, Tanzania.



Discussion

Divide into groups and provide 10 minutes for group discussion.

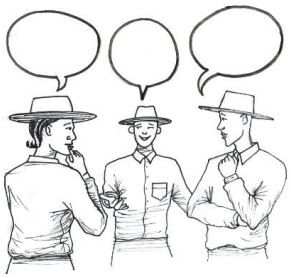
1. Is it worth the trouble to establish a VFMC? After all, it takes a lot of effort and time.
2. What are the benefits of a VFMC for the village?

One person in the group should give feedback.

4.1.3 Main responsibilities of VFMC

The main responsibilities of the VFMC are detailed in the approved bylaws and summarized below:

- The preparation and implementation of the village fire management plan (VFMP) (see Section 4.2)
- The management of the village fire fund (VFF, see section 4.5) and keeping of financial records. This includes the presentation of financial reports to the Village General Assembly (VGA).
- The management of the VFC and maintenance firefighting tools, equipment, and PPE. This also involves an annual inventory and inspection of tools and equipment (see Section 3.11)
- The communication with neighbouring villages on fire issues.
- Raising awareness of fire prevention, protection, and control within the village, including awareness of fire danger index and its implications on use of fire
- Assist the Village Executive Officer (VEO) in issuing permits, specially by inspecting the burning sites (see Section 4.4.2.)
- Keeping registers of daily FDI
- Support the investigation of fire incidents (see Section 4.6), keeping records of fire incidents and reporting them to relevant Village Government Authorities
- Updating the FDR notice board daily

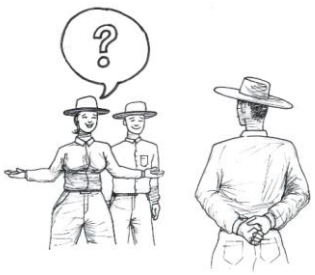


Discussion

Divide into groups and provide 10 minutes for group discussion.

1. List responsibilities of VFMC.

One person in the group should give feedback.



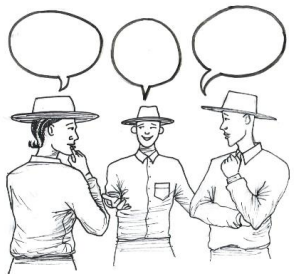
Questions

1. How many members should be in a VFMC? Explain why.
2. What are the ideal characteristics of a VFMC? Explain why the characteristics are important.

4.2 Village Fire Management Plan (VFMP)

The VFMP is a document that specifies fire management activities, including prevention, protection, and suppression. Essentially it dictates **what** should be done, by **whom**, **where** and **when**. The VFMP includes sections on fire prevention, protection, suppression as well as a budget and financing plan (see VFF section). The village fire management action plan (VFMAP), which is embedded in the VFMP, entails an action plan for responding to fire break outs.

A customizable template of the VFMP has been developed.[3]



Discussion

Divide into groups and provide 10 minutes for group discussion.

1. Should fire management activities be organized before the start of the fire season? If so, explain why.

One person in the group should give feedback.

4.2.1 Protection Plan

A protection plan involves the establishment of infrastructure, tools/equipment, legislation, communication, and systems that are implemented to safeguard human life, property, and the environment. The protection plans are developed proactively in anticipation of potential fires and is formulated, budgeted for, and executed on an annual basis.

4.2.2 Prevention Plan

The prevention plan focuses on identifying the causes of fire and implementing measures to minimize them. Prevention is carried out through three approaches:

1. Education and awareness: Informing the community about the dangers of fire and teaching the appropriate methods to use to conduct safe fires.
2. Engineering: Constructing fire breaks, roads, or water points.
3. Enforcement: Enforcement of village bylaws and imposing penalties for non-compliance to motivate land users to adhere to laws and guidelines.

4.2.3 Suppression plan

A suppression plan encompasses all necessary activities and actions to facilitate the successful suppression of fires. These activities and actions are described in Section 3.12.

Several fire-related activities must be carried out throughout the year. These activities primarily focus on fire prevention and protection measures. They are planned in advance of the fire season and scheduled to be executed at specific times. Table 4.1 provides a schedule of these activities in a gantt chart format. Administrative responsibilities such as maintaining registers, issuing permits, and conducting fire investigation are also included among these activities. Furthermore, different actions are also regulated by the FDI status.

[3] Participatory Plantation Forestry Programme – PFP 2. (2023). Village Fire Management Plan Template. Iringa, Tanzania.

Table 4.1 Village fire management activities.

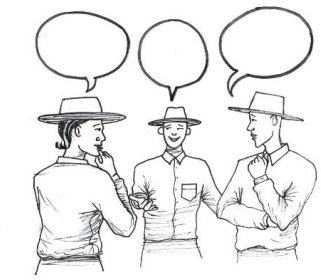
Activity	Timeframe (months)											
	A	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Village Fire meeting after passing fire season												
Identify fire risk areas in the village												
Village Fire meeting before fire season												
Prepare fire breaks												
Inspections for burring permits												
Visit schools and do fire awareness campaigns												
Prioritise village fire awareness during all public gatherings												
Check and maintain fire tools and equipment												
Select fire crew												
Organise training for fire crew and VFMC												
Activate FDI board												
Complete all prescribed burning activities.												
Carry out financial Audit for VFMF												
Update register for external investors and generate invoices for VFMF contributions												

4.3 Village fire management action plan (VFMAP)

In the event of a reported fire, immediate action must be taken to suppress it. These actions should be formulated in the VFMAP. In a village setting, it is crucial that every individual (including members of the village government, VFMC, VFC, and all villagers) fully understand their responsibilities as outlined in the VFMAP.

Based on different FDI conditions (blue, green, yellow, orange, and red) all villagers and VFC are placed on an alert status responding to the FDR level for the day. This alert status

determines which activities can or cannot be conducted. It also requires that VFCs are on standby during exceptionally hazardous period, as indicated in Table 2.5.



Discussion

Divide into groups and provide 15 minutes for group discussion.

1. Write a detailed action plan in case of an unwanted fire. This plan should include detailed tasks for every person in the village.

One person in the group should give feedback.

Questions

What time of year should preparation of all fire belts be finished?

1. If a village member refuses to participate or contribute financially in a planned fire management activity, how should he/she be dealt with?

4.4 Issuing permits to use fire

A permit to use fire is an official document which allows the controlled use of fire for a specific purpose. The template Bylaws for Forest Fire Prevention and Management of Village Councils (VCs) provide for two types of fire permits: the permit to use fire for land management, and the rural industry fire management permit. These permits are issued by the Village Executive Officer (VEO), who may be supported by the VFMC.

The procedure to receive permit to use fire as a land user

- **Step 1:** Prepare a burning plan
- **Step 2:** Construct firebreaks and prepare resources (adequate tools and equipment; water, and at least 6 assistants)
- **Step 3:** Apply for a permit to use fire from the VEO (pay the applicant fee and fill out the form)
- **Step 4:** Check the FDI for 3 following days
- **Step 5:** Inspection of burn site by VFMC member and applicant (applicant takes the inspection team to site)
- **Step 6:** Confirm the FDI for the burning day, receive permit and inform neighbours of burning plan.

4.4.1 Criteria for issuing fire permits

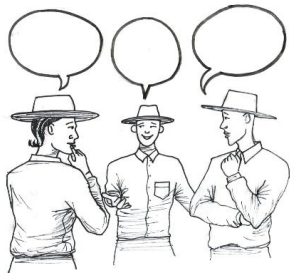
The following criteria should be met before a permit to use fire is issued.

- The FDI must be below 55 on the day of the planned burn and for the following three days. The weather conditions of the following days are important because there is a risk of smouldering material reigniting in unfavourable weather.
- There must be appropriate fire belts/breaks established around the designated burn area. These belts may be reinforced with buffer zones in hazardous areas. Proper fuel management must be implemented within the buffer zone. The fire belts/breaks should be constructed as stipulated in village bylaws.
- Adequate tools (including sufficient water) are available for a safe burn.

- Burns should be conducted in the evening.
- A minimum of six experienced people should be available to assist with the burn.
- The burn site is inspected by the VFMC member.
- The fire manager is responsible for informing neighbours, including the date and location of the burn.
- The burn area must be monitored and inspected to detect any smouldering material for a specified duration, which is set out in the village bylaws.
- If unexpected weather conditions arise, it is advisable to extend the guarding and patrolling of the burn area. Additionally, it may be necessary to assign a dedicated person with a cell phone to remain on-site full-time to ensure constant monitoring and immediate communication if any issues arise.
- The fuel within the designated burn area should be suitable for burning and should not require an extended period to extinguish.

Questions

1. Why is it necessary to regulate the use of fire in a village through issuing permits?
2. Who is responsible for ensuring that the permit system works for the benefit of the village?



Discussion

Divide into groups and provide 10 minutes for group discussion.

1. Create a list of criteria that should be followed before a fire permit can be issued.

One person should give feedback.

4.4.2 Inspecting the burn site

The site to be burned should be inspected by a VFMC member and the person planning the burn. This will allow them to identify high-risk areas that require special preparation and gain an understanding of the vegetation and slope. The VFMC member approves the burning permit after a satisfactory inspection. The inspection of the site to be burned involves the following aspects.

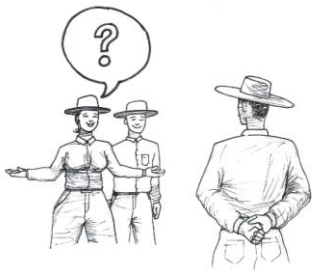
- Identify the objective of the planned burn (land preparation, fire break preparation, fuel load reduction etc.
- If a map is available, it should be studied prior to the burn. Studying a map of the land before a prescribed burn can help identify escape routes and safety zones, as well as provide a clear view of neighbouring properties.
- Ensure that a safe burn is possible in the area and that the burn achieves its objectives.
- Check the condition of fuel to be burned (wet, dry, volume, type and height). If any high-risk hazardous fuels are identified, additional measures should be taken to protect the area. For example, increasing the width of firebreaks where the hazards exist is an additional safety measure.
- Check the overall conditions and width of the firebreaks around the burn site.

- Study the general topography, prevailing wind conditions in the area as well as local wind on the site.
- Identify water refilling points.
- Identify strategic lookout points which allow the monitoring of burns.
- Identify any danger zones that could cause problems during a burning operation.
- Identify escape routes and safety zones.

4.4.3 Reasons for not issuing permits to use fire

Permits to use fire should not be issued in the following circumstances:

1. When the predicted fire danger index (FDI) on the planned burning day exceeds 55 (orange or red).
2. When there is a high FDI (orange and red), or strong winds forecasted for up to three days after the proposed burn.
3. During an extended drought period, particularly in the dry season, when moisture levels in the soil and fuel are extremely low.
4. If the applicant for the fire permit does not meet the criteria specified in the permit.

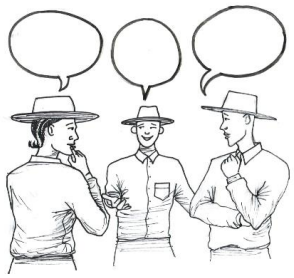


Questions

1. Who should issue permit to use fire? Why?
2. Who should inspect the areas where burning is intended? Why?
3. How can the person issuing and inspecting the burn area be remunerated/rewarded?

4.5 Village Fire Fund (VFF)

The village fire fund (VFF) is a dedicated fund created by the village government for implementing the village fire management plan. The management of the VFF should be stipulated in the village bylaws. Proper financial management of the VFF is important. The person(s) responsible for receiving funds will be held accountable for the secure handling and appropriate utilization of the fund.



Discussion

Divide into groups and provide 10 minutes for group discussion.

1. Are there alternative methods to raise funds for IFM activities in a village?
2. What can be done to ensure that money meant for fire management activities is not spent wrong or does not end up in someone's pocket?

One person in the group should give feedback.

4.5.1 Purpose of the VFF

The funds intended for the VFF should exclusively be used for the implementation of the VFMP, which can include following expenditures:

- tools for fire suppression.
- PPE, including overalls, leather boots and T-shirts.

- expenses involved in transporting fire crews and tools to a fire scene (e.g., fuel costs).
- renumerating persons who perform lookout guard duties.
- food and water for VFC during firefighting activities.
- medical expenses (for instance first aid kits to treat people who were injured during firefighting).

4.5.2 Contributions to the VFF

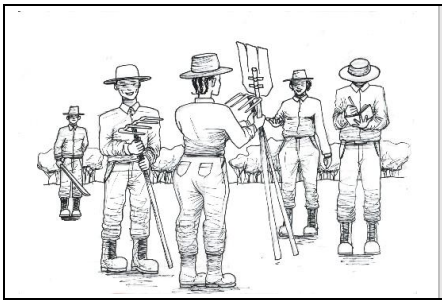
The VFMC is responsible for collecting annual contributions for the VFF as stipulated in the VFMP. The legal framework for these contributions is provided in the bylaws. External investors are expected to be major contributors to the VFF. The VFMC needs to keep records of all external investors in the village. Table 4.2 serves as an example of a register for recording relevant details of investors.

The main sources of income for the VFF include:

- Fines paid by offenders of village bylaws.
- Contributions from external tree grower's investors.
- Contribution by businesses/investors who are dependent on village forest but do not participate directly in village forest fire management.
- Subsidies from village government or council.
- Donations from other stakeholders.
- Applications for permits to use fire.

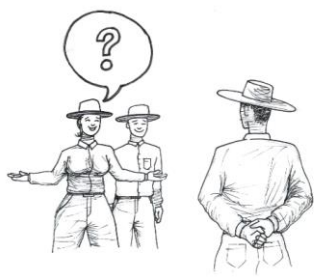
Table 4.2 Information of external investors.

No	Name	Contact	Address	Hamlet of investment	Tree type	Plantation area	Name of supervisor	Contact



Activity

1. Each trainee should create a VFF register. This should include at least 5 entries.
2. Each trainee should draw up a simple budget for a VFMP.



Questions

1. What expenditures should be covered by a VFF?
2. Who should administer the VFF?
3. Who should contribute to the VFF?

4.6 Fire investigations

Fire investigations are conducted to determine the origin and cause of a fire that caused damage. Fire investigation play an important role in establishing accountability for recklessness or negligence, identifying shortcomings, and facilitating better planning for the future.

The use of fire is regulated by bylaws, which includes the issuing of fire permits under specific criteria by the VFMC. The aim of these bylaws is to limit the spread of fires. However, if a person acts in a reckless or negligent manner (for example, by not following the correct burning methods, being lazy or careless), fires can occasionally escape. It is recommended that members of the VFMC conduct fire investigations with assistance from the district fire coordinators (DFCs). Once the results of the investigation are known, appropriate corrective action should be taken by the village government.

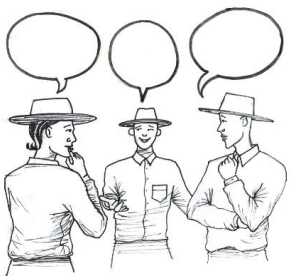
It is possible that sudden weather changes, such as strong winds, during the burning operation can lead to the fire escaping. Other causes, such as arson, honey hunting, children playing with fire, lightning strikes, cooking fires, burning rubbish, or fires originating from a neighbouring village, can also be potential sources of fire outbreak. In such instances, the purpose of a fire investigation is twofold: to determine the cause of the fire and to develop a solution that address the issue and prevents any future occurrence of fire.

4.6.1 Responsibilities of the fire investigator

It is advisable to have multiple persons involved in an investigation to ensure a fair and accurate fire investigation. Having more than one set of eyes and observations increases the likelihood of a thorough investigation. The team of fire investigators should adhere to the following guidelines.

- It is crucial fire investigations promptly after the incident, as evidence crucial for determining the cause and origin of the fire can be compromised or destroyed over time.
- The investigation team should ensure that all procedures and criteria outlined in the bylaws and permits were followed. They should assess whether the landowner acted recklessly or negligently.
- The investigators should interview reliable individuals who were involved in the fire to gather all relevant information about the incident.
- A fire investigation form (Annexe 2) should be completed. This form should be part of generating a comprehensive fire report.
- The fire report should be completed promptly after the fire occurrence and recording in the fire investigation register (Annexe 3). This should be reported to the district fire officer.

Intentional fires are a major concern, which affects the viability of the industry. Information received from whistle-blowers should be investigated thoroughly and evidence should be collected to support prosecutions. The identities of whistle-blowers should be protected.

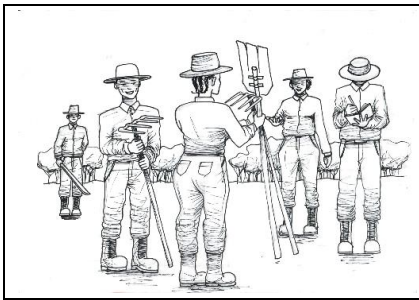


Discussion

Divide into groups and provide 10 minutes for group discussion.

1. Why is it necessary to do fire investigations?
2. Who should be responsible for fire investigations in the village?

One person in the group should give feedback.



Activity

Trainees must go out to an area where there was a recent fire and complete the fire investigation form.

4.7 Fire detection and reporting

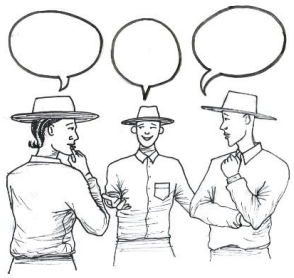
Early detection and reporting of a fire enable the VFC to respond quickly, which increases the likelihood of successfully suppressing the fire while it is still small and manageable. The longer a fire is allowed to grow, the more damage it will cause and the more challenging it will be to extinguish.

A reliable fire detection system is crucial for the timely reporting of unwanted fires and for effective fire suppression. Having a fire detection system in place means that responsible authorities are alerted to the occurrence of a fire quickly. There are different methods to ensure that fires are reported, but ultimately, it relies on the awareness of communities that are threatened by fires.

Lookout guards should have means to report a fire and communicate throughout fire suppression activities. A list of people with their cell phone numbers to whim fire incidents must be reported should be available to the guards. Key fire detection aids include cell phone or radio with a solar cell charger, binoculars, and a map of the area.

The most common methods to detect and report fires include:

1. Formal lookout towers
2. Lookout guards posted at vantage points during high FDI days
3. Dedicated fire patrols
4. Alerts from the general public



Discussion

Divide into groups and provide 10 minutes for group discussion.

1. Should a lookout guard be paid?
2. If so, where should the funds come from?
3. Will employing the service of a lookout guard be beneficial for the village?

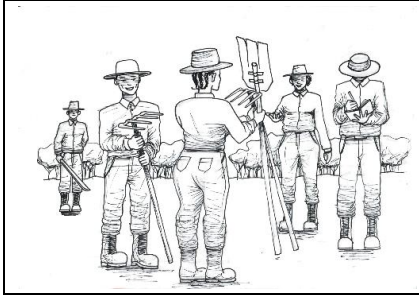
One person in the group should give feedback.

Formal fire lookout towers: A fire lookout tower is a structure that serves as a lookout point for a person whose main responsibility is to search for fire or smoke in the surrounding landscape. These towers are typically small buildings situated at the top of a mountain or another elevated location that maximizes viewing distance and range. By observing the area from this vantage point, the lookout can identify the location of the smoke and alert the VFMC and VFC about the fire/smoke. During a fire event, the lookout will continue to provide updates on any developments at the fire to the VFC.

The location of lookout towers is important. Criteria for the selection of a good fire lookout tower include:

- Provides a good clear view of the area to be observed.
- Is situated at a distance from tall trees and other objects that may create blind spots.

- Is accessible.
- Has reliable cell phone signal for communication. If the signal is inadequate, handheld radios must be utilized.
- Is protected from fires by adequate firebreaks.
- Has a designated area specifically for warming/cooking fires and smoking.



Activity

Take the trainees out to the field and instruct them to identify good lookout points.

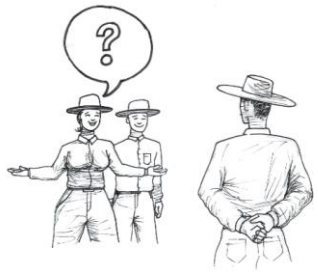
Lookout guards: In areas with small villages a formal lookout tower may be too expensive to construct and maintain. In these situations, a person can be designated to perform the duties of a fire lookout from a vantage point. Lookout guards are typically tasked to assume their duties under high fire danger conditions (FDI is orange or red).

A good lookout guard has good eyesight, is familiar with the surrounding terrain and has basic knowledge of fire behaviour, topography, vegetation type and fire danger. The lookout guard should also be reliable (for example, he/she can be trusted not to fall asleep) and be able to communicate effectively. He/she has following responsibilities:

- To report fire or smoke to the VFMC and VFC as soon as possible. The report should include the exact position of the fire as well as the best route to get to the fire.
- To report relevant information about the fire, including size, fire behaviour, type of vegetation burning, spread direction of the fire as well as properties threatened by the fire.
- To inform neighbours of the fire. If the fire is close to the village border, the neighbouring village should be alerted immediately.
- To report wind direction and speed (and any changes).
- To report any immediate and obvious danger to life and property.
- To be alert while on duty (for example, the lookout guards must not be intoxicated).
- To be properly equipped and prepared (for example, guards must have warm clothes and for protection against the weather elements, food/water, and means of communication).

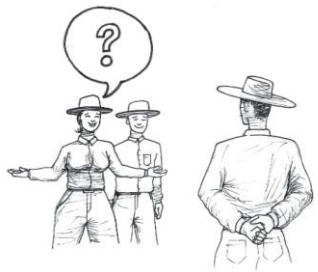
Dedicated fire patrol: Fire patrols are sent out on foot during high fire danger when lookout guards or fire lookouts are unable to see an area due to terrain. These patrols are conducted by members of the VFC, who require a reliable means of communication to report fires (for example a cell phone).

The general public: Traditional methods are used in villages to detect and report fires. The first person who detects a fire usually reports it to the VFMC and VFC. In some cases, a whistle or metal bar struck with a pipe is used to alert villagers and firefighters about the fire. It is important to reinforce the responsibility of reporting fires to all villagers during fire awareness activities held in villages. The villagers should receive awareness training regarding reporting fires, and everyone should know whom to report a fire incident to. The contact information of that person should be widely available. Everyone, regardless of age, should be able to report the fire.



Questions

1. How many lookout points should there be in a village?
2. How many lookout guards should be posted in each lookout point?
3. Is it necessary for a lookout guard to be posted during the night?



Questions

1. What is the purpose of a fire incident register?
2. What should the district fire officer do after receiving fire incident registers and reports from villages?

Annexe 1 Permit to use fire

FIRST SCHEDULE

(Made under clause 4(3))

BY-LAWS FOR FIRE (PREVENTION AND MANAGEMENT) OF THE VILLAGE/MTAA COUNCIL FOR THE YEAR 2022

----------VILLAGE/MTAA COUNCIL, ----------WARD

A PERMIT TO USE FIRE

A: INTRODUCTION

1. Village Executive Officer's telephone number ----------
2. Village Chairperson's telephone number ----------
3. Committee Chairperson's telephone number ----------
4. Commander's telephone Number----------
5. Permit Number ----------
6. Date of Approval ---------- ----------
7. Permit is granted to: ----------

B: **PURPOSE OF USING FIRE**: ----------

C: AREA INSPECTION

1. Will FDI be below 55 for 3 consecutive days? **YES/NO**
2. Are there fire lines? **YES/NO**
3. Have the Neighbours been notified three days before? **YES/NO**
4. Are the waste qualified to be burned? **YES/NO**
5. List the firefighting tools available:

I. ---------- II. ---------- . III. ----------
IV. ----------. V. ----------. VI. ----------

D: NAMES OF THE ASSISTANTS AND THEIR TELEPHONE NUMBERS

1. ---------- 2. ----------
3. ---------- 4. ----------
5. ----------6. ----------

E: THE FOLLOWING CONDITIONS SHOULD BE CONSIDERED:

i. The allowed time to use fire will be after 6 PM

ii. The area must be secured and monitored for 7 consecutive days

iii. When unexpected weather condition occurs, protection and patrols must be carried out in the area. It is also good that those people have phones for communication.

iv. If fire escapes, the above-mentioned Leaders must be informed

v. Failure to comply with any of the terms set forth in this permit may result to legal action being taken against you.

F: LAND INSPECTION BY THE PERMIT APPROVAL AUTHORITY

The land is inspected by: ---------- **Date:** ----------

A MEMBER OF COMMITTEEE

The permit is offered by: ---------- **Date and Stump** ----------

VILLAGE/MTAA EXECUTIVE OFFICER

Annexe 2 Fire investigation form

Incident Number: _____ **Date:**

investigated: _____

Person investigated: _____

Fire occurrence date: _____

Area of fire:

_____
_____
_____

Inspection of Incident	**YES/NO**
1. Was a burning permit issued?	_____
2. Was the village action plan followed?	_____
3. Did the landowner report the fire?	_____
4. Did the landowner meet all the permit criteria?	_____
5. If not, list the permit criteria that were ignored.	_____

I. _____
II. _____
III. _____
IV. _____
V. _____
VI. _____

-

6. If all the permit criteria were met by the landowner, give reasons why the fire escaped/what caused the fire.

_____
_____
_____
_____
_____
_____
_____
_____

7. Describe the damage caused by the fire.

_____
_____
_____
_____

_____
_____
_____
_____

8. What actions were taken against the landowner?

_____
_____
_____
_____
_____

9. What can be done to prevent a repetition of this incident?

_____
_____
_____
_____
_____
_____
_____

Investigator(s): _____

Signature: _____

Annexe 3 Fire investigation register

Incident Number	Date	Investigator Name	Fire occurrence date	Area of Fire	Incident Inspected (Full/Partially)	Fire cause	Damage caused	Action taken by landowner	Signature

Annexe 4 Fire danger index register

Date	FDI 10h00	Colour	FDI 14h00	Colour	FDI Tomorrow	Colour	FDI Day after tomorrow	Colour	Reporter	Signature

Annexe 5 Fire incident register

Incident Number	Date	Person Investigated	Area of fire	Date reported	Reported to district	Investigator	Signature

Annexe 6 Fire permit register

Date	Permit Number	Permit Receiver	Area of fire	FDI Checked (Yes/No)	Area Inspected (Yes/No)	Permit Authority	Signature

Annexe 7 Weather register

Date	RH % 10h00	Temp (ºC) 10h00	Wind speed (km/h)	Wind direction	RH %	Temp (ºC) 14h00	Wind speed (km/h)	Wind direction	Rainfall 08h00	Reporter	Signature

Annexe 8 Village fire fund income register

SN	Date	Name of person paying money	Reason for paying	Amount paid	Signature of person paying	Name of person receiving money	Signature of person receiving money

Indufor ...forest intelligence

NIRAS