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MJUMITA

Sustainable Timber Harvesting Manual for Village Land Forest Reserves

August 2020

Acknowledgements

This manual was developed jointly by the Tanzania Forest Conservation Group (TFCG) and the Community Forest Conservation Network of Tanzania (MJUMITA[1]), under the Transforming Tanzania's Charcoal Sector project funded by the Swiss Agency for Development and Cooperation (SDC).

TFCG and MJUMITA would like to express their gratitude to SDC for its support to the project and to the wider development of sustainable value chains for timber and charcoal from village forests in Tanzania.

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[1]Mtandao wa Jamii wa Usimamizi wa Misitu Tanzania.

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1. Introduction

This manual provides guidance on how to manage Village Land Forest Reserves (VLFRs) for sustainable timber production, under Tanzania's legal framework for Community-Based Forest Management. Sustainable timber harvesting is defined as a level of harvesting that can be maintained indefinitely without significantly altering the forest. Harvesting is therefore highly selective, only targeting valuable tree species above a predetermined size and only harvesting a small percentage of those trees each year. This type of harvesting is best suited for natural miombo woodlands with mixed-age stands.

The manual outlines how to develop sustainable timber harvesting plans, set timber harvesting quotas, advertise and sell timber, permit and regulate timber harvesting, and monitor and report harvesting levels and village revenue obtained from timber harvesting. It is targeted at village governments and Village Natural Resource Committees (VNRCs), together with the District Council staff and organizations that support them.

The manual assumes that the village has already established a VLFR, as provided for in the Forest Act (2002). VLFRs created under the Act are managed by village governments and royalty revenue collected on products harvesting within VLFRs may be retained by the VNRC for investing in community projects. This revenue from timber is an important incentive for villages to protect and manage their forests. It is critical that any timber harvesting is sustainable so that villages can ensure a steady flow of revenue, without degrading other services and products from the forests.

This manual reflects the experiences of TFCG in the Swiss-funded Transforming Tanzania's Charcoal Sector project (see Box 1). Villages supported by the project have been advised to sell timber only in finished form as boards (also known as sawn timber or planks). This maintains simplicity, adds value locally, generates skills and jobs in the community, and promotes transparency in sales and royalty collection. In other areas a decision may be made to sell timber in alternative forms, such as sleepers, logs or standing trees, in which case the procedures for setting harvesting quotas and calculating royalty will be different, although many of the principles are the same.

Box 1: Transforming Tanzania's Charcoal Sector project

The Transforming Tanzania's Charcoal Sector (TTCS) project was funded by SDC between 2012 and 2019, and was implemented by TFCG and MJUMITA. Phase 1 (2012-15) established sustainable charcoal production systems in 10 villages in Kilosa District. Phase 2 (2016-19) introduced the model to an additional ten villages in Kilosa, five in Morogoro District and five more in Mvomero District, together with timber harvesting systems in some villages. The project approach was introduced to six additional villages in Mvomero District through the EU-funded Adding Value to the Arc project, bringing the total number of participating villages to 36 across the three Districts.

The TTCS project employed the provisions of the Forest Act (2002), Village Land Act (1999) and Land-Use Planning Act (2007) to support villages in the creation of Village Land Forest Reserves (VLFRs). Having had their VLFRs gazetted by the District Council, village governments may collect the royalties on products harvested within them. Any trader buying charcoal or timber from a VLFR in a participating village is issued with receipts and permits, which ensures supply chain traceability and makes it attractive to purchase from these villages.

The revenues that participating villages raise from royalties on timber and charcoal enable them to manage their forests sustainably and to invest in a variety of community development projects according to their local priorities.

2. Harvesting Plans

A timber harvesting plans for the VLFRs is first required. This should be based on accurate assessment of the available timber stocks inside the areas of the FMU that are zoned for timber harvesting. These are known as Forest Management Units (FMUs). Since natural forests are mixed-age stands with many different species, detailed stocking data is required to make accurate estimates of sustainable harvesting rates.

2.1 Mapping

In order to conduct a thorough timber resource assessment and develop a sustainable harvesting plan, a map of the VLFR is first required. The boundary can either be captured on foot using a GPS, or taken from an existing map of the VLFR, or created using GIS software and a recent satellite image showing the edges of the forest.

In order to develop the harvesting plan, FMUs for timber harvesting should be defined within the VLFR. Due to the low impact of selective timber harvesting in mixed-age miombo woodlands, FMUs for timber harvesting can overlap with FMUs for other uses such as charcoal production. Depending on village preferences, the entire VLFR could even be made available for timber harvesting. The most important factor in deciding where to put FMUs for timber is the feasibility of removing the logs or boards from the forest. Including parts of the forest that won't be accessible for extraction will lead to exaggerating the harvest quota beyond what is actually sustainable. Timber FMUs should not include beekeeping areas, as tree felling could damage hives.

A map for sustainable timber harvest planning should ideally include:

- village boundaries
- village centre
- VLFR boundaries
- timber harvesting FMU boundaries
- roads and tracks
- major streams and gullies
- contour lines.

See Figure 1 for an example of a timber harvesting planning map.

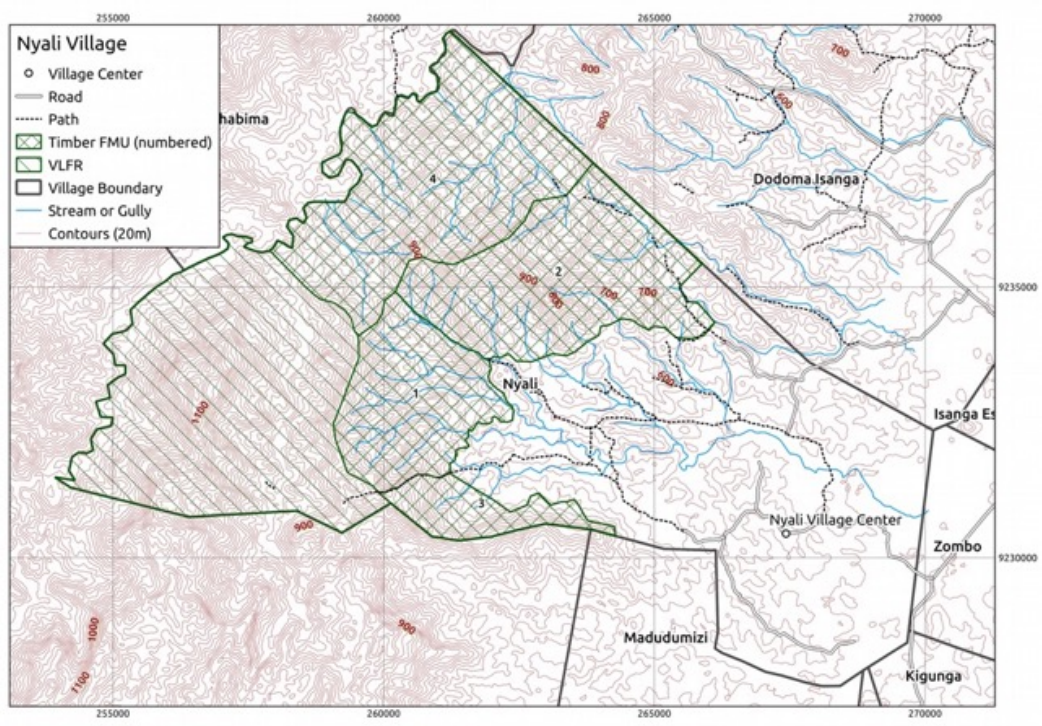

Figure 1: Example of timber harvesting planning map

2.2 Timber Resource Assessment

2.2.1 Timber transects

There are many different ways to carry out resource assessments to determine sustainable timber harvesting levels in miombo woodlands. One of the cheapest methods is to use transects. This method was pioneered in Tanzania by the Mpingo Conservation and Development Initiative (MCDI). Transects allow a known amount of forest to be sampled in a systematic way that does not involve a lot of unnecessary walking without collecting data. It tends to be much more time-efficient than using sample plots.

The transect approach uses a team to walk a 10 metre-wide transect and record the names and circumference at breast height (CBH) of all the potential timber trees they see that have a CBH of at least half of the minimum CBH required for harvesting of that species.[2] For instance, under national harvesting regulations, *Mninga* trees must have a CBH of at least 141.3 cm before they can be harvested. Every *Mninga* tree falling within the 10 metre-wide transect that has a CBH of at least 70.65 cm should therefore be recorded. Any *Mninga* tree below that size will not need to be recorded.

The transect team has four people. One walks a compass bearing or GPS track to keep the team moving in a straight line along the predetermined transect. Then two walk parallel, 5 m out from the centre person on each side, using a 5m length of rope to check if trees are inside or outside the transect. The fourth person records tree information on a transect data sheet (see Appendix

2 The Forest Act Regulations 2004 specify the legal minimum diameter at breast height for harvesting most of the common timber species in natural forests. However, these may be adjusted in some circumstances in VLFRs. For instance, the SULEDO project uses a minimum diameter of 45 cm for all species.

for an example) or on a form on a mobile phone or tablet. It is important that the team walks in a straight line and does not veer off the transect to record trees outside the 10 m width. A good transect team keeping to the straight line will walk at most only 10% more than the true distance of the transect.

Since each timber transect is 10 m wide, 1 km of transect is equal to sampling 1 hectare (ha) of forest. Timber stocks vary greatly across different parts of Tanzania and more data is required when timber stocks are low due to over-harvesting, or when the species being targeted for timber harvesting is less common in the forest. TTCS project experience in Morogoro Region suggests that at least 50 km of transects per VLFR is required to establish a confident estimate of sustainable harvesting for the most common timber species in the forest.

Timber transects can be done rapidly. Depending on the terrain and accessibility of the transect, a team can cover between 5 and 10 km of transect per day. So with two teams, a village can cover 50 km of transect in just four days.

The placement of transects should be done so that the timber FMUs are evenly covered. Putting more transects where more timber trees are expected to be found will bias the results and lead to over-cutting. Thus, planning timber transects is best done with GIS software by trained GIS experts who can ensure even coverage of the area. District Forest Officers, MJUMITA and MCDI may be able to assist.

Under the TTCS project, MJUMITA made some improvements to the MCDI approach for timber transects, including the use of zigzag transects (Figure 2) and recording the transect data using a smartphone connected to a bluetooth GPS.

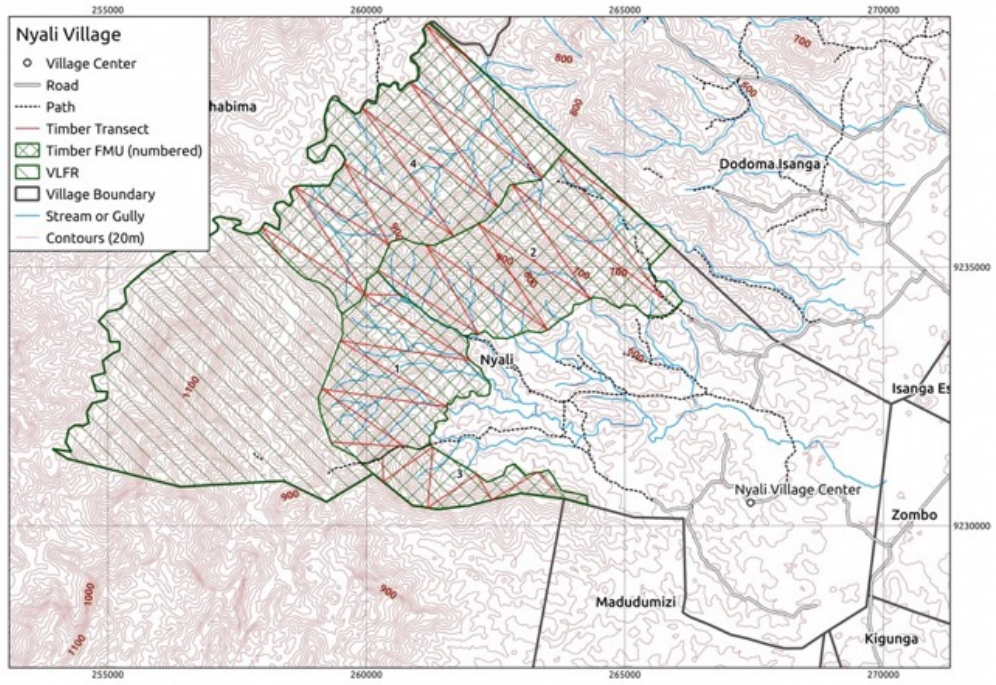

Figure 2: Zigzag timber transect example

Zigzag transects are more efficient than parallel transects because, upon reaching the end of a transect, rather than having to walk to the start of the next transect without collecting data, the

team simply turns in a different direction that takes them back across the forest where they can continue collecting data immediately. The drawback is that the zigzags require careful planning using GIS software to ensure that the transects are drawn using a standardized grid and are unbiased.

Recording transect data using a smartphone connected to a bluetooth GPS allows the location of every tree to be recorded automatically and for the data to be shared easily via the internet. This can help identify the distribution of the species across the forest and pinpoint locations where certain species are more likely to be found, which can aid in harvesting.

2.2.2 Calculating sustainable harvesting quotas

To calculate sustainable timber harvesting quotas from transect data, the quota model originally developed by MCDI is recommended. An improved version of this model can be obtained as an electronic spreadsheet from the TFCG website: www.tfcg.org. The spreadsheet is a crucial tool to accompany this manual. It can be used to calculate quotas on a computer by someone with a small amount of training. It sorts and counts transect data trees by size classes according to the minimum diameter for harvesting for each species, and then calculates annual harvesting quotas. More specifically, the model calculates the volume of boards that can be sold of each species over a period of 5 years, as well as the number of trees that can be felled.

The quota model assumes that miombo tree species take about 100 years to reach average harvestable size and that approximately 9.4% of harvestable size trees between the minimum harvesting diameter and two times the minimum harvesting diameter can be cut sustainably over a 5-year harvesting period. Trees in this size class are referred to as 'green' trees. For trees at least two times the minimum harvesting diameter, known as 'blue' trees, the model assumes that 5.8% can be sustainably harvested over a 5-year period. However, in practice it is rare to find enough trees of this size on transects to establish a quota. Harvesting of these extra-large trees should therefore be discouraged as they are usually important trees for seed generation and biodiversity.

Because the transects are all exactly 10 m wide, 1 ha of forest is surveyed for every 1 km of transect walked. From there we can calculate the proportion of the forest covered by transects. For instance, if we do 50 km of transects, that is equivalent to 50 ha of forests. If the forest is 500 ha, then 50 ha represents 10% of the forest. It is then possible to estimate the number of harvestable-sized trees of a particular species in the whole forest by dividing the number of harvestable-sized trees by the percentage of forest covered by the transect. Returning to the previous example, if we saw 30 harvestable sized *Mtondoro* trees on 50 km of transects, then in the whole 500 ha of forest we would expect to find about 300 harvestable size *Mtondoro* trees. According to the model, about 9.4% of them (28 trees) could be harvested sustainably over a 5-year period.

However, since the transect is only a sample of the forest, we must also adjust downwards for uncertainty. For example, in the previous example we would assume that the 50 ha of trees we surveyed holds 26 harvestable *Mtondoro* instead of 30. The total number of harvestable *Mtondoro* in the forest would then be estimated to be 260 instead of 300, and we would estimate the 5-year sustainable quota for *Mtondoro* by taking 9.4% of 260 trees, which is about 24 trees (rather than 28). By making this downwards adjustment, the risk of over-harvesting due to

faulty transect data is reduced. Other adjustments should be made as well. For instance, for *Mpingo*, heart rot is a problem in roughly a third of trees, so the quotas for *Mpingo* are reduced by a third. Additionally, it is typically difficult to walk in a straight line while on the transect, so the transect length is assumed to be 10% longer than planned.

The spreadsheet model and the sample quota tables shown in the Appendix take all of these adjustments into consideration to convert the number of trees seen on the transect into an estimate of the sustainable 5-year quota of harvestable trees from the transect. The quota for the whole forest is calculated simply by dividing the transect quota by the proportion of the total forest covered by the transect.

The quota model also checks to make sure that there are enough trees between half of the minimum diameter for harvesting and harvestable size to replace the harvestable size trees, while assuming 30% mortality of trees in this size class before reaching harvestable size. If, after adjusting for mortality, the number of trees between half of harvestable and harvestable size is not enough to replace the harvestable size trees, then the quota is adjusted downwards until they match.

The spreadsheet also calculates the total volume of each harvestable size tree recorded on the transects. Only trees that exceed the Legal Minimum Diameter for Harvesting (LMDH) under Tanzanian law are included in the calculations. From these volumes, the average volume is calculated for each type of tree. Finally, to calculate the total volumes, the average volume for each type of tree is multiplied by the 5-year quota for each type of tree. So for each species, the model generates a 5-year quota for both the number of trees that may be extracted, and the equivalent quote in terms of volume of sawn timber.

2.3 Using Sustainable Harvesting Quotas

2.3.1 Tree quotas

Harvesting quotas derived from timber stock data form the basis for the timber harvesting plan. From this point on, the manual assumes that the village has properly calculated timber quotas for each species that it wants to harvest.

Timber tree quotas specify the number of trees of each type of tree that can be cut over a period of 5 years. To calculate annual quotas, the five-year quotas can be divided by five. However, it is also possible to harvest less in one year and then more in another, so long as the harvesting after 5 years does not exceed the 5-year quota. After 5 years, new timber stock data should be collected and new quotas should be established. If the forest area has been reduced, or if the area has been over-harvested, the new stock data will reveal that and the corresponding quotas will be lowered to give the forest a chance to recover. Alternatively, if the condition of the forest improves due to better control of harvesting, then the new stock assessment would show that and the quotas would be increased for the next 5 years.

Unless otherwise specified, the timber quotas are for the entire area inside all of the timber FMUs, and thus harvesting activities during the 5 years are also meant to be spread over all timber FMUs within the VLFR, if there is more than one. It is better to harvest a mixture of easily and less easily accessible trees each year. This will help reduce the impact of harvesting on the forest.

2.3.2 Merchantable volumes, standing volumes and board volumes

The MCDI spreadsheet will calculate the annual allowance per species in terms of cubic metres of boards (sawn timber). In the TTCS project, a decision was made to market only boards. This is to maximise value addition at the village level, to create local employment and to encourage accountability by selling timber in a form that can be easily measured and counted.

The spreadheet makes a calculation of 'merchantible volume' for each species and converts this to 'standing volume' by dividing by 0.7. The timber quota (i.e. the volume of boards that may be sold) is then derived from the standing tree volume by applying a conversion factor of 0.14 within the spreadsheet. This is based on empirical data from forestry research in Liwale District, using local pit-sawing techniques that are typical of community-based timber operators in miombo woodlands. So, for example, if the standing timber quota for a given species is 30 cubic metres (cbm) per year, the model calculates that the village may sell 4.2 cbm of boards derived from that species (30 x 0.14).

The harvesting plan will also specify the number of trees that may be harvested each year. But for the purpose of determining the quantity of boards that can be sustainably produced each year for each species, and for the 5 years that the quotas are valid, it is the volume of boards produced each year which should be the basis for deciding when to stop harvesting, regardless of the number of trees cut. This is because timber producers may choose to harvest larger trees first and will then reach their board volume quota before they have reached the quota for the number of trees to be felled. It is essential to record every tree that is cut, whether legally or illegally, to monitor whether the board quota estimates remain correctly aligned with the estimates of trees that can be felled, or may need adjustment (see next section).

2.4 Payments, Permits, and Calculating Total Harvest

2.4.1 Harvesting permits

Within the TTCS project villages, all timber harvesting and processing is carried out by registered members of the village Timber Producers Association. They should operate only with harvesting permits issued by the VNRC. They may sell the timber to registered buyers in the form of sawn timber (boards). Buyers must also make a royalty payment to the VNRC.

It is the job of the VNRC to estimate how many trees will be required to produce the volume of boards to be sold to a particular buyer, and to issue a harvesting permit for only that number of trees. The harvesting permit should not only specify the volume of wood to be produced to meet the buyer's demand, but should also place a limit on the number of trees that can be cut to achieve that volume. This can be done by first dividing the village sawn timber volume quota for each species by the village tree quota for each species, to arrive at an average sawn timber volume per tree for each species. Then divide the sawn timber volume that the buyer wishes to obtain by the average sawn timber volume per tree, to calculate the number of trees needed. This is the number of trees that should appear on the permit.

For instance, if the village has an annual quota of 10 *Brachystegia microphylla* trees and the annual sawn timber quota is 18 cubic meters for that species, then average yield of boards of a *B. microphylla* tree is:

18 ÷ 10 = 1.8 cubic metres per tree

If there is a buyer who wishes to obtain 9 cubic metres of boards, the number of trees required to reach that volume is:

$9 \div 1.8 = 5$ trees

The harvesting permit would then be for 5 trees and the volume of boards that the buyer should pay for is 9 cubic metres. If the calculation results in a fraction, the number of trees should be rounded down.

3. Harvest process

3.1 Pre-harvest Marking

Prior to harvesting, members of the VNRC should walk through the forest with members of the Timber Producers Association to mark the trees to be cut. The number of trees marked should match the number of trees that appear on the harvesting permit. If the amount is very large, this may require several days and does not need to be done all at once, so long as the area is marked prior to the day of harvesting. The VNRC should use this opportunity to confirm that Association members are familiar with the restrictions that apply on cutting.

3.1.1 Recording

During the marking exercise, the circumference at breast height (CBH) of every marked tree should be recorded in a ledger book so that the actual harvest can be calculated as described in section 3.5 below.

3.1.2 Tree marking method

Trees that have been selected to be felled for timber should be marked using blue paint with a ring around the tree at eye level, and with a ring at the base of the tree below the point at which the tree will be cut. This will ensure that it is easy for the cutters to see the tree, and to recognize the stump later. If a mistake is made during marking, the blue paint should be painted over-using black paint to indicate that the tree was marked by mistake.

3.1.3 Felling / Marking Restrictions

Only marked trees can be cut. The VNRC members should keep the following restrictions in mind when marking trees.

1) It is often the case that certain tree species grow in patches in the forest. In this case, only one out of every three neighbouring trees should be marked for cutting.
2) Only the species indicated on the harvesting permit should be marked for cutting.
3) The total number of trees marked for each species should not exceed what is indicated on the harvesting permit.
4) For each species, only trees larger than the minimum circumference for harvesting should be marked for harvesting. The CBH should be measured before marking a tree for cutting. The minimum allowable circumference for each species is tabulated within the spreadheet, with some additions for species not in the TFS rules, some adjustments to prevent over-harvesting of young trees and some advice from timber harvesters about their own experiences of commercial yields.
5) Trees with diameters two times the minimum circumference for harvesting should not be marked for cutting unless there is a specific quota set for trees this size. Generally, almost no forests have enough of trees this size to establish a quota, so they will not be cut and will instead remain as important sources of seeds and habitat.
6) No trees with bird nests, bee hives, or cavities above 3 m should be cut. These are habitat trees (Figure 3).

7) Any trees in an area with greater than 50% slope should also not be marked for harvesting (Figure 4). Very steep areas will be dangerous for timber cutters to operate and may be subject to erosion if trees are cut.
8) No trees should be marked for cutting within 15 m of the edge of a stream or karongo.

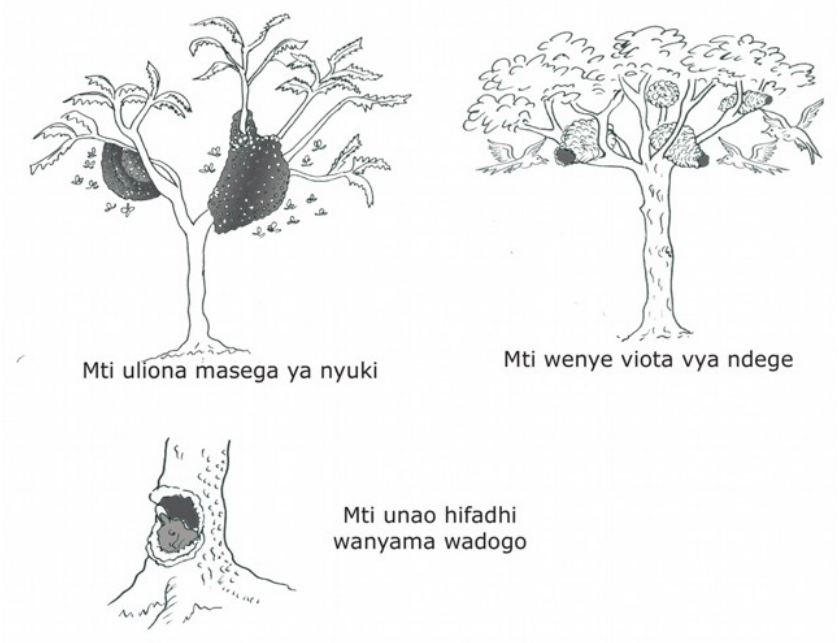

Figure 3: Habitat trees that should not be cut for timber.

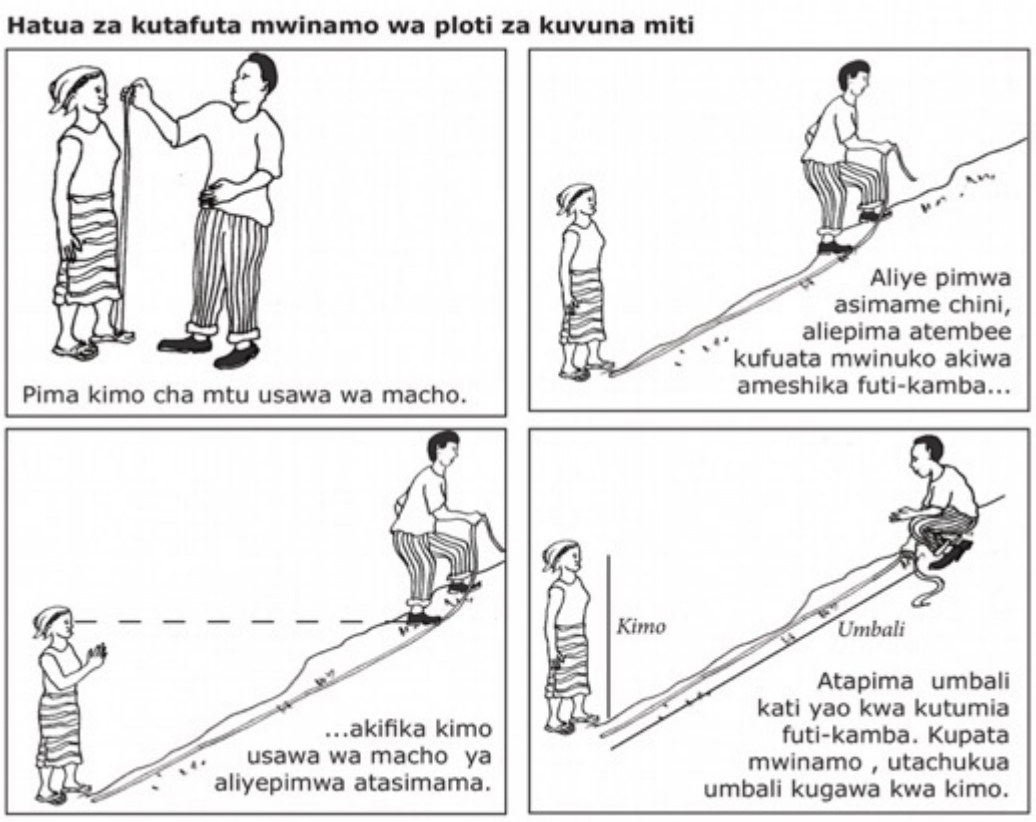

Figure 4: How to measure slope.

3.2 Felling Procedures and Safety

3.2.1 Tree cutter identification

It is assumed that tree felling will be carried out by members of a local Timber Producers Association, assuming that they have received training and are already familiar with the harvesting rules inside the VLFR.

3.2.2 Supervision

On the day of tree felling, at least one representative of the VNRC should accompany the tree cutters into the forest to monitor their work and ensure that they only fell the marked trees. They should also make sure that tree fellers operate safely and follow procedures to avoid unnecessary damage to other trees during harvesting.

3.2.3 Safety Equipment

Tree fellers and the representative(s) from the VNRC should wear and carry proper safety equipment when working in the forest:

- **Be visible** – Bright-coloured clothing or vests to ensure they are easily visible to other people working in the forest.
- **Protect your head** - A helmet to protect them from falling tree branches and other debris that may come loose during tree felling.
- **Protect your hands** - Thick leather gloves to protect hands.
- **Protect your feet** - Proper closed toe footwear that is easy to walk and run in if necessary, preferably boots with metal protection over the toes.
- **Protect your face and eyes** - Eye protection such as goggles, safety glasses or a face shield, especially when operating a saw.
- **Be prepared** - At least one first aid kit per team of cutters.

3.2.4 Felling Safety / Rules

These are the basic rules for tree felling:

- **Chainsaw and handsaws only** - Marked timber trees can be felled using a chainsaw or a handsaw. Axes should not be used.
- **Train cutters** - Cutters should have been trained on tree felling by experts with a chainsaw or handsaw, before attempting to do it themselves.
- **Cut close to the ground** - Trees should be cut as close to the ground as possible (generally around 15 cm) to maximize the length of the possible boards.
- **Plan first** - Cutters should plan the direction they intend the tree to fall before starting to cut. They should consider the way the tree is leaning and the strength and direction of the wind.
- **Avoid damaging other trees** - Care should be taken to avoid damaging surrounding trees during felling, particularly trees that are currently too small for harvesting.
- **Keep spectators away** - People who are not involved in cutting the tree must be at least two times the height of the tree away from the tree that is being felled.
- **Look up** - Cutters should examine the tree they are felling and surrounding trees for dead branches or other debris that may fall during felling. These objects should be removed before felling.

- Make a safe work environment - Cutters should make sure the area around the tree they are cutting is clear of bushes, debris or tools that might impede them if they need to leave quickly.
- Make escape routes - The cutters should plan two evacuation routes away from the tree they are felling at 45 degrees from the direction the tree is planned to fall (Figure 5).

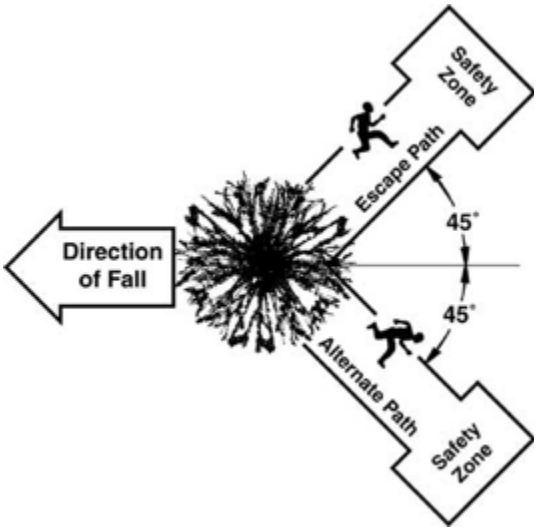

Figure 5: Planning Escape Routes

- Communicate and watch - Once the tree starts to fall, the cutter should loudly notify others in the forest that the tree is falling and take the appropriate escape route. The cutter should back away along the escape route looking up at the tree as it falls to ensure that the tree behaves as predicted.

3.3 Log processing procedures in the forest

3.3.1 Log preparation

After felling a tree, timber cutters can use a chainsaw, handsaw or axe to cut any branches off the bole (trunk) of the tree. They can then use a chainsaw or handsaw to cut the bole of the tree into desired log lengths from which timber will be produced.

3.3.2 Milling in the forest

In many cases, it may be impossible to remove whole logs from the forest. In that situation, the log must be cut into either sleepers or boards that can be removed from the forest. This can be done with pit sawing, or with a licensed mobile sawmill. Under Tanzanian regulations, it is not legal to cut boards out of logs using a chainsaw.

3.3.3 Pit sawing

Pit sawing is generally wasteful, destructive, and dangerous. It should be avoided whenever possible. However, due to the restrictions on harvesting timber using a chainsaw, it may often be the only means necessary to cut boards or sleepers in the forest using a handsaw. It may also in most cases be less destructive than putting a road into the forest to reach logs using a vehicle. Here are general guidelines for pit sawing:

- **Best on slopes** - Pit sawing is best used on sloped ground where there will be little need to dig a pit. The structure to support the log, known locally as a 'garage', can be built just downhill from the log and the log can be rolled onto it with little effort.
- **No extra cutting** - The garage should be made using non-timber parts of the marked trees that were felled under the harvesting permit.
- **No damage to other trees** - Care should be taken when rolling the log onto the garage to avoid damaging other trees, particularly young trees and seedlings.
- **Test strength** - Cutters should test the strength of the garage thoroughly before sending someone underneath it and make sure nobody is underneath when rolling the log onto the garage. Garages more than 3 months old should not be used again.
- **Make a safe working environment -** On slopes, the ground underneath the garage should be levelled to give the operator solid footing. Care should be taken to choose a location free of roots.
- **Refill all pits** - If a pit is required, it must be refilled by the cutters when milling is finished. VNRC members should make sure this is done before the cutters leave the forest with the timber.

3.3.4 Portable saw milling

Registered portable sawmills can be used in the forest to cut boards or sleepers. Some types of portable sawmills can be erected directly above the log without having to move it. Other types will require moving the log. The general guidelines are similar to pit sawing:

- **No extra cutting -** Anything that is required to setup up the sawmill must either brought into the forest from outside or made from the trees felled under the harvesting permit.
- **No damage to other trees** - Care should be taken when rolling the log onto the mill to avoid damaging other trees, particularly young trees and seedlings.
- **Make a safe working environment** – make sure that mill and log are level and that there is no chance for the log to fall off the mill. Also make sure area is free of bushes, roots, or anything that might cause the operator to slip while operating the mill.

3.3.5 Clean up

Regardless of the chosen method for milling, a significant proportion of each tree felled under the harvesting permit will not be converted to timber. There are several options on how to deal with this debris:

- **Make charcoal:** Villages may consider allowing people to produce charcoal out of the branches and residual stems that are not turned into timber. This will need to be carefully controlled by the VNRC to make sure that no trees beyond those covered by the harvesting permit are cut to make charcoal. This option should be planned in advance and the harvesting permit issued for cutting timber should specify the quantity of charcoal that will also be produced from the same trees. In theory, the timber buyer would not need to pay separately for this charcoal as the timber royalties paid are already converted back to the whole tree. However, in practical terms it may prove difficult to transport the charcoal without a separate royalty receipt for the charcoal. The charcoal buyer would also need to pay fees to the district and apply for a transport permit for the charcoal. The charcoal producer will likely need to transport debris from several different trees to one location in

order to have enough to construct a kiln. The charcoal production should follow the charcoal producers' manual to ensure good kiln efficiencies and reduce negative impacts. Most importantly, the kiln must be located in an open area away from young trees, tree stumps or tree roots that will be harmed by the extreme heat of the kiln. As with pit sawing, charcoal producers will be required to fill any hole they produce before leaving the forest with their product.

- **Produce firewood:** Any debris suitable for firewood can be carried out of the forest for use in the village. VNRC members should monitor this. Ideally, it should happen at the same time that timber is being carried out of the forest to reduce the monitoring effort. Again, no extra fees should be required since the whole tree was already paid for by the timber buyer.
- **Scatter:** If the debris is very deep inside the forest and nobody is interested in using it for firewood or to produce charcoal, then it should be well scattered in the forest. In particular, it should not be placed against or near trees or seedlings. It should be well scattered in open areas. The reason for doing this is to avoid giving fires fuel that might kill surrounding trees or even lead to high flames that could ignite the canopy. Mounds of sawdust should also be spread out. The VNRC should make sure that cutters do this before they leave the forest with timber.

3.4 Hammering stumps and sawn timber

The Tanzanian government uses hammers that leave an imprint of a tracking code in the wood that can be used to tell where the wood came from. Under the forest regulations, villages that have established VLFRs and a harvesting plan can be awarded their own hammers. However, this has not happened for most villages. Instead, timber harvested from VLFRs must usually be hammered by the District Forest Officer using the district's hammer.

In VLFRs, the stump of every legally harvested tree should be hammered. Then, whatever part of the tree that is to be removed from the forest for timber should also be hammered. In the TTCS project system this mean hammering boards. In other situations it might mean hammering logs or sleepers.

If the village does not have its own hammer, it will be up to the buyer to organize with the District Forest Officer to have their boards hammered and pay whatever costs the district establishes for this. The VNRC should make sure to educate the buyer about the hammering requirements before harvesting. It is also up the VNRC members to make sure that timber products do not leave the forest until they have been hammered.

3.5 Calculating actual harvest

In addition to specifying the number of trees that can be cut before harvesting starts, the VNRC must also track the volume of the trees that are cut. The volume of boards that are cut will be calculated by measuring the length, breadth and depth of each boards to calculate volume, and adding them up to get the total.

This is important for verification purposes, to check if the harvested timber volume matches with what was expected according to the harvesting plan.

4. Transport

4.1 Procedures for removing timber from the forest

4.1.1 Removal permits

If not provided for by other levels of government, villages should establish their own removal permits that will be required by timber buyers before they can remove boards from the forest. The conditions to be issued for a removal permit should be as follows:

1. The stumps of the harvested trees and any logs, sleepers, or boards to be removed from the forest have been hammered.
2. The buyer has paid the royalty due on the boards to be removed.
3. The VNRC has calculated the total standing volume of the cut trees and cross-checked this with the amount calculated beforehand..

4.1.2 Permitted removal methods

Once they have obtained a removal permit, buyers can remove the boards from the forest. However, they should choose non-destructive means of doing so. Most importantly, timber should be removed in ways that do not damage other trees and do not promote erosion (e.g. dragging on the ground). Some options include:

- Hand carrying – most appropriate for removing boards over rough terrain.
- Log arches – can also be used to remove boards (and also sleepers or small logs).
- Carts – can be pulled by people or beasts of burden, but should be operated only in the dry season when the ground is dry and the cart will not leave ruts.
- Motorized vehicles – can be used to remove timber off-road if the forest is relatively open and the felling site can be reached without damaging other trees and seedlings. In practice, it is very difficult to not drive over seedlings, so off-road driving should be discouraged and limited to the same off-road tracks. As with carts, motorized vehicles should only operate in the forest during the dry season and should not be permitted to drive anywhere where there is damp soil or wetlands.

4.1.3 Road construction regulation

The construction of new roads in the forest should be discouraged, since they may make the forest more accessible for illegal harvesting and conversion to agriculture. Additionally, constructing the road itself will destroy part of the forest and the area of the road itself is not likely to regenerate. Furthermore, roads can create opportunities for erosion. However, if the village believes that the benefits outweigh the consequences, new roads can be established in the VLFR if they are approved by the village assembly.

The village may be able to negotiate with interested timber buyers to help construct the road. Ideally, at the very least, timber buyers should pay for any trees that must be cut in order to create the road. General guidelines for planning roads are as follows:

- Roads represent a loss of forest area – the road area will not regenerate. The trees harvested to create the road must be deducted from the village quota. Significant road construction in a forest will result in a lowering of quotas in the future as the forest area

will be less. Thus, road building should be kept to a minimum, generally no more than 1-2% of the forest area.

- **Avoid wetlands and water crossings** - Roads should be planned to avoid wetlands entirely and to minimize water crossings. Where possible, bridges should be built at water crossings or the road should only be used when the river and its banks are dry.
- **Avoid steep slopes** - Long climbing sections of roads should be avoided, to reduce erosion. Switchbacks should be used instead.
- **Add water bars on slopes –** To reduce erosion on sections of roads on slopes, small trenches known as water bars (Figure 6) should be dug across the width of the road so that any water running down the road will be funnelled away. Water bar spacing depends on the slope of the road (see Table 1). Water bars should drain into vegetated areas and not directly into waterways.

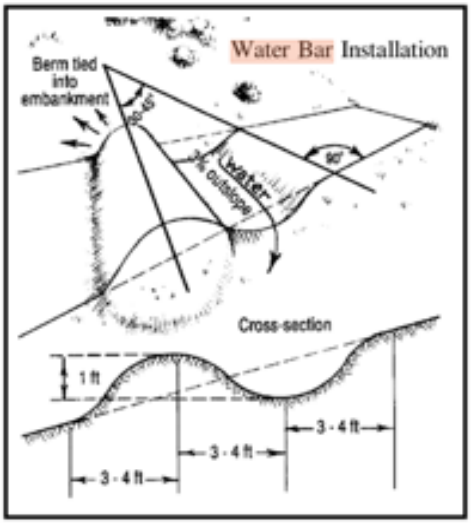

Figure 6: Water bar installation

Table 1. Water bar spacing

Road gradient	Water bar spacing (m)
2%	75
5%	40
10%	24
15%	15
25%+	12

5. Procedure for Selling

Here, the manual provides suggestions for the process of selling timber. The exact details of the process may vary depending on the village. It may even differ for individual residents of the village, local timber producer associations, and for buyers coming from outside the village. However, for all villages, the process should be specified in writing and approved by the village assembly before any timber sales are made.

5.1 Village timber sales committee

The village should form a committee to review, approve and oversee timber sales. This committee should include members of the Village Council and the VNRC. It should have at least eight members. All members must be informed of upcoming meetings at least one day in advance and at least two thirds of members should be present. Minutes from each meeting should be recorded and shared with the village assembly.

5.2 Bids or fixed prices

Villages should strive to sell their timber for the highest price possible. The timber sales committee should meet once a year to decide how timber will be priced for the following year. Since most cutting will happen during the dry season, it may make most sense to hold this meeting in May.

Timber buyers in the TTCS project make two payments. The first payment is made to the individual or group which felled the tree and prepared the boards. The second is a royalty payment to the VNRC. The royalty rates charged by the Tanzania Forest Service (TFS) for trees harvested outside village forest reserves can be used as guidance.

Some less common species may be high quality timber, but may not be specified in the forest regulations and thus charged at the minimum rate by TFS. In that case, it might make more sense for villages to set a higher price. Local timber buyer associations should also be consulted when setting prices.

Alternatively, if the villages have several different buyers who are interested in their timber and their combined demand for timber is more than village quotas, they may choose to sell the timber by bid, whereby each buyer offers the prices that they are willing to pay for different species in terms of standing tree volume. In this case, it is still recommended that the village set minimum prices.

Villages may decide to charge lower timber royalties for residents, local timber cutter associations, or other organizations based in the village that wish to cut timber for use inside the village. The requirements to qualify as a resident individual or organization in the village should be specified in writing and approved by the village assembly. Also, the village may want to set limits on the volume of timber or number of stems that can be harvested by residents who are not paying full price. All timber that is to be traded outside the village, however, should be charged the full royalty rate.

5.3 Calculating royalty

In order to calculate the royalty due for boards, it is necessary to know the dimensions of each board being sold. The volume of one board) is calculated as follows:

Board width (inches) x depth (inches) x length (feet) x 1.966 ÷ 10,000 = volume in cubic meters

For instance, if a board is 6 feet wide, 2 inches deep and 12 feet long, then its volume would be:

6 x 2 x 12 x 1.966 ÷ 10,000 = 0.0283 cubic metres

Under the Forest Act Regulations, 2004, buyers should pay royalty on the basis of whole tree volume. Under the regulations, tree volumes should be calculated from sawn timber by dividing the board volume by 0.3. This is a practice which most timber buyers are familiar with.

In the previous example case, the whole tree volume to be paid for would be:

0.0283 ÷ 0.3 = 0.094 cubic metres

The royalty rate chargeable will vary according to the species class. If the royalty rate for the species in question was TZS 260,000 per cubic metre, then the royalty payable for this board would be TZS 24,527 (0.094 x 260,000).

The volumes of all the boards should be added together to obtain the total royalty payable. In order to reduce the risk of errors, TFCG has produced a simple reference chart that allows boards of all sizes to be converted to cubic metres for royalty calculations.

5.4 Advertising

The quota of sawn timber available for saleshould be advertised to gain the attention of potential buyers. It should be advertised locally through the timber producer associations and on the village government notice boards. Outside the village, advertising can be done using newspapers or by direct marketing to timber dealers. Since timber prices are generally much higher in major urban areas, it would make most sense to advertise in Dar es Salaam and other larger cities. Additionally, since most harvesting will be carried out in the dry season, it makes most sense to advertise in May, as the rainy season is ending.

The advertisements should show:

- The species available and the sustainable quota in terms of sawn timber for each species.
- The price payable per piece, according to size (or state if the buyer is expected to make a bid instead).
- The royalty rate for each species (in terms of price per cbm, calculated by dividing sawn timber volume by 30%).
- Contact details for the village.
- List of information required in application letters (see next section).
- Deadline for applications.

5.5 Application letters

In their application letters to villages, external buyers should present evidence that they are reliable people to do business with. The following are basic requirements:

- a business licence and registration as a timber trader;
- the tree species and volumes of sawn timber they wish to buy;
- the price they wish to pay.

5.6 Reviewing timber buyer applications

An Application Review Committee should meet in June, after advertising in May, though it may be necessary to have other meetings if the village is accepting applications at other times of year. In order to review bid offers, the village should have a minimum of three bids from three un-associated buyers.

The Application Review Committee should review all applicationsreceived at the time of a meeting. They should consider:

- Does the buyer meet the basic requirements?
- Does the buyer have a good reputation in the timber business?
- Is the buyer capable of paying for the timber in advance?
- Does the village have enough remaining quota of the species that the buyer wishes to buy after considering other offers?
- In the case of bids, is the price they are willing to offer acceptable and higher than other bids?

5.7 Responding to applications

The committee should respond to all applications in writing. If the applicant is unsuccessful, the committee should detail the reasons and whether any remedy is available to them. For successful applicants, the letter should inform them of the following:

- The species and volume of boardsthat they will be allowed to buy.
- An estimate of the amount of royalties they will be required to pay to the village and any other fees due to the village associated with the harvesting. The buyers should be informed that they will be required to pre-pay royalties in full. If they cannot afford to do so, they will only be issued permits to take what they can afford to pay for in advance.
- The details of the village bank account where they should deposit their royalty payment.The village may decide to establish a separate bank account specifically for timber and charcoal royalties, or may use the VNRC bank account or the Village Council bank account. Members of the VNRC should at least have the power to obtain statements for this account and to verify payments received.

5.8 Transport Permits

If buyers plan to take sawn timber out of the district of origin, they must obtain a transport permit from the TFS District Manager. They should be able to use the harvesting permits issued by the village to apply for the transport permit.

6. Monitoring and Reporting

6.1 Monitoring (legal and illegal)

To make sure that over-harvesting does not occur, the VNRCs must keep careful track of how many trees of each species have been cut in the forest during the 5-year period. This is most easily done with a ledger book that has a section for each species, with columns to track legal and illegal harvesting and the remaining quota (see Appendix).The number of new cut trees (both legal, and illegal cutting) are written in the rows that follow. Each row can represent new trees cut during a particular sale or during a particular forest patrol in the case of illegally cut trees. Once the number of cut trees is equal to the starting quota, no more cutting of that species will be permitted. Illegal cutting can be tracked with patrols, where new unmarked stumps are recorded in a notebook and then transferred to the tracking ledger. The stumps of illegally cut trees can be marked with red or orange paint as they are recorded in the patrol notebook. This signifies that they were not meant to be cut and will ensure they are not double-counted in future patrols.

6.2 Reporting

6.2.1 For the Village Assembly

The VNRC should compile quarterly reports to share with the Village Council which are presented at regularly scheduled village assembly meetings. The committee should reconcile the harvesting permit records and the harvest tracking ledger to make sure they match. They should also get a recent bank statement to show what has been paid by buyers. They should then present to the village assembly the amount of legal harvesting that occurred during the period and the corresponding income the village received, as well as any illegal harvesting that occurred and the lost village income that this represents.

6.2.2 For the District Forest Officer

The harvesting committee should also compile an annual harvesting report to submit to the DFO showing all the legal and illegal harvesting that occurred that year, the number of trees for which harvesting permits were issued and the number of trees remaining on the 5-year quotas after accounting for all previous harvesting.

7. Appendix

7.1 Timber transect data form example

FMU Name:_____ Date:_____ Transect Number:_____

Transect Team Leader:_____ Transect Team Leader phone:_____

Transect start easting coordinate:_____ Transect start northing coordinate:_____

Transect end easting coordinate:_____ Transect end northing coordinate:_____

Tree no.	Local species name	CBH
1	Mninga	80
2	Mkongo	200
3	Msani	150
4	Mtondoro	142
5	Mninga	145
etc		

7.2 Confidence limits and harvesting quotas

The following table shows the 75% lower confidence limits and corresponding 5-year sustainable harvesting quotas for a given number of trees of either the green or blue size class observed on a transect. The quota calculations also assume that transects are 10% longer than planned and that 30% of Mpingo trees have heart rot.

Mpingo trees			
No. of trees seen on transects	Lower confidence limit	Green trees 5-year quota	Blue trees 5-year quota
10	7.73	0.44	0.27
12	9.52	0.54	0.33
14	11.33	0.65	0.40
16	13.15	0.75	0.46
18	14.99	0.85	0.53
20	16.83	0.96	0.59
25	21.47	1.22	0.75
30	26.15	1.49	0.92

Mpingo trees			
No. of trees seen on transects	Lower confidence limit	Green trees 5-year quota	Blue trees 5-year quota
35	30.85	1.76	1.08
40	35.57	2.03	1.25
45	40.31	2.30	1.42
50	45.07	2.57	1.58
55	49.83	2.84	1.75
60	54.61	3.11	1.92
65	59.40	3.38	2.09
70	64.19	3.66	2.26
75	68.99	3.93	2.43
80	73.80	4.20	2.59
85	78.61	4.48	2.76
90	83.43	4.75	2.93
95	88.26	5.03	3.10
100	93.09	5.30	3.27
110	102.76	5.85	3.61
120	112.44	6.41	3.95
130	122.14	6.96	4.29
140	131.85	7.51	4.63
150	141.57	8.07	4.98
160	151.30	8.62	5.32
170	161.03	9.17	5.66
180	170.78	9.73	6.00
190	180.53	10.28	6.35
200	190.29	10.84	6.69
220	209.82	11.95	7.38
240	229.38	13.07	8.06
260	248.95	14.18	8.75
280	268.54	15.30	9.44

Mpingo trees			
No. of trees seen on transects	Lower confidence limit	Green trees 5-year quota	Blue trees 5-year quota
300	288.14	16.42	10.13
350	337.21	19.21	11.85
400	386.33	22.01	13.58
450	435.52	24.81	15.31
500	484.74	27.62	17.04
550	534.01	30.42	18.77
600	583.30	33.23	20.50
650	632.63	36.04	22.24
700	681.98	38.85	23.97
750	731.35	41.66	25.71
800	780.75	44.48	27.44
850	830.16	47.29	29.18
900	879.59	50.11	30.92
950	929.03	52.93	32.66
1000	978.49	55.74	34.40

Other tree species			
No. of trees seen on transects	Lower confidence limit	Green trees 5-year quota	Blue trees 5-year quota
10	7.73	0.66	0.41
12	9.52	0.81	0.50
14	11.33	0.97	0.60
16	13.15	1.12	0.69
18	14.99	1.28	0.79
20	16.83	1.44	0.89
25	21.47	1.83	1.13
30	26.15	2.23	1.38
35	30.85	2.64	1.63

Other tree species			
No. of trees seen on transects	Lower confidence limit	Green trees 5-year quota	Blue trees 5-year quota
40	35.57	3.04	1.88
45	40.31	3.44	2.13
50	45.07	3.85	2.38
55	49.83	4.26	2.63
60	54.61	4.67	2.88
65	59.40	5.08	3.13
70	64.19	5.49	3.38
75	68.99	5.90	3.64
80	73.80	6.31	3.89
85	78.61	6.72	4.15
90	83.43	7.13	4.40
95	88.26	7.54	4.65
100	93.09	7.95	4.91
110	102.76	8.78	5.42
120	112.44	9.61	5.93
130	122.14	10.44	6.44
140	131.85	11.27	6.95
150	141.57	12.10	7.46
160	151.30	12.93	7.98
170	161.03	13.76	8.49
180	170.78	14.59	9.00
190	180.53	15.43	9.52
200	190.29	16.26	10.03
220	209.82	17.93	11.06
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No. of trees seen on transects	Lower confidence limit	Green trees 5-year quota	Blue trees 5-year quota
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550	534.01	45.63	28.16
600	583.30	49.85	30.76
650	632.63	54.06	33.36
700	681.98	58.28	35.96
750	731.35	62.50	38.56
800	780.75	66.72	41.17
850	830.16	70.94	43.77
900	879.59	75.16	46.38
950	929.03	79.39	48.99
1000	978.49	83.62	51.59

7.3 Harvest tracking ledger example (legal and illegal)

Date	Species					
	Mtondoro			Msani		
	Legal harvest	Illegal harvest	Remaining quota	Legal harvest	Illegal harvest	Remaining quota
1 June 2021	0	0	90	0	0	28
8 June 2021	20	0	70	0	2	26
15 June 2021	10	2	58	10	0	16