Participatory Forest Monitoring System for Community Managed Forests.

Participatory Forest Resource Assessment Methodology

FARM Africa / SOS Sahel
Participatory Forest Management Programme

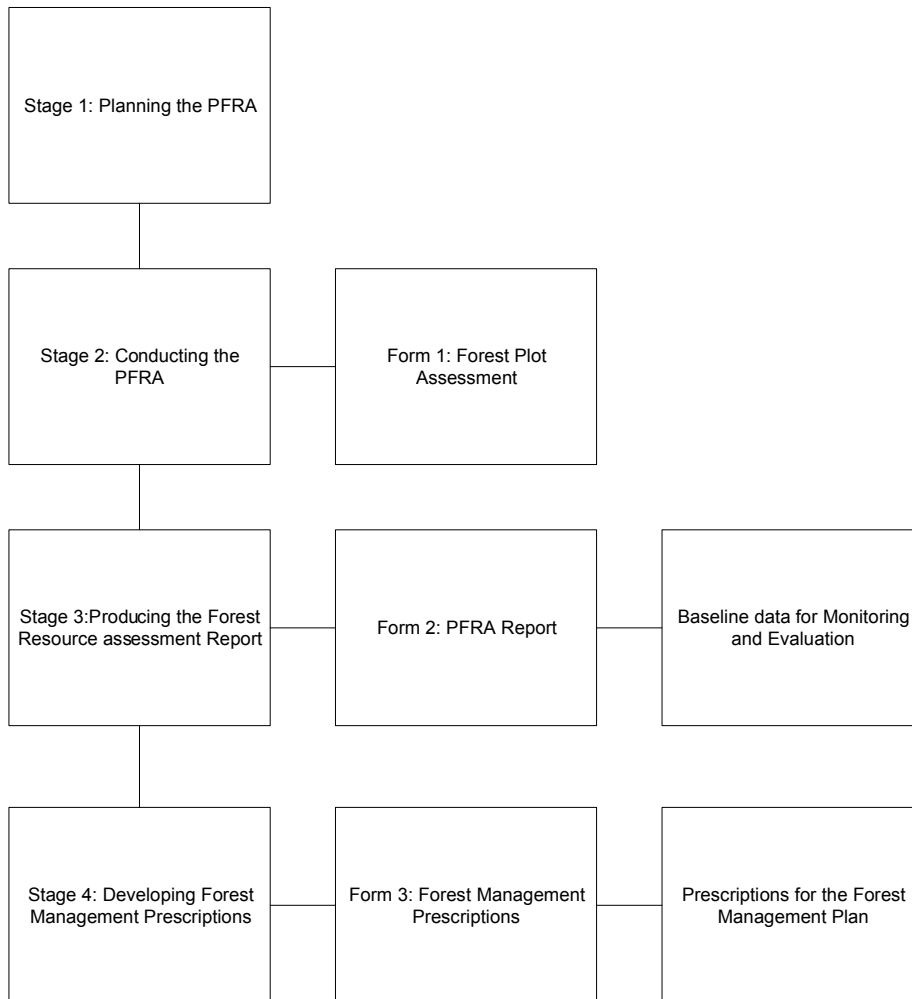**Based on consultancy work by Dr.Gavin Jordan**
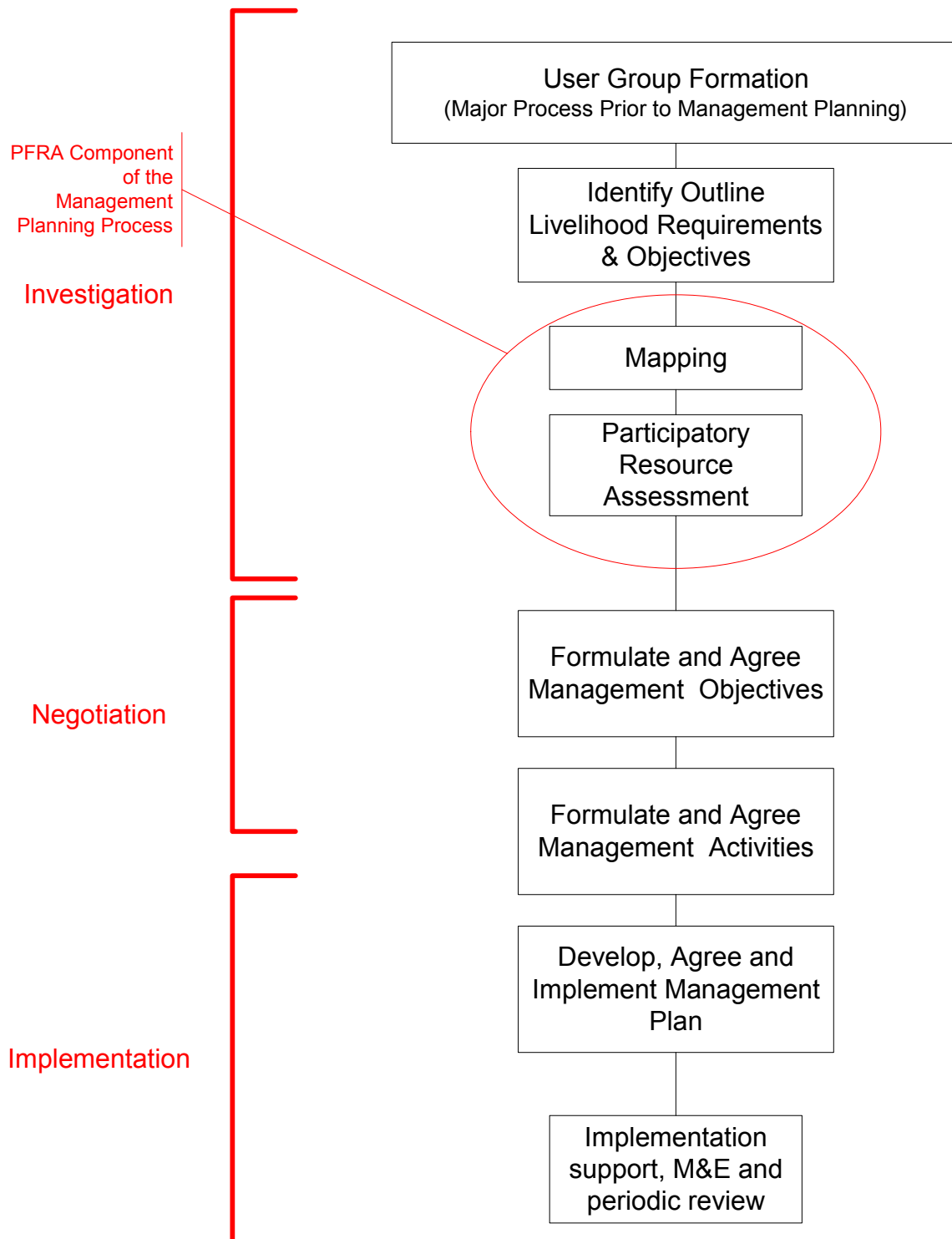
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The Participatory Forest Resource Assessment (PFRA)

This guide is designed to provide information on how to conduct a PFRA, and how to use the information for management planning purposes. There are four key stages in the PFRA process, from initial planning through to developing management prescriptions for the forest management plan. The diagram below illustrates the stages, the associated forms, and how the information is used:

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│ Stage 1: Planning the   │
│ PFRA                    │
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┌─────────────────────────┐     ┌─────────────────────────┐
│                         │     │                         │
│ Stage 2: Conducting the │─────│ Form 1: Forest Plot     │
│ PFRA                    │     │ Assessment              │
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┌─────────────────────────┐     ┌─────────────────────────┐     ┌─────────────────────────┐
│ Stage 3:Producing the   │     │                         │     │ Baseline data for       │
│ Forest Resource         │─────│ Form 2: PFRA Report     │─────│ Monitoring and          │
│ assessment Report       │     │                         │     │ Evaluation              │
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┌─────────────────────────┐     ┌─────────────────────────┐     ┌─────────────────────────┐
│ Stage 4: Developing     │     │ Form 3: Forest          │     │ Prescriptions for the   │
│ Forest Management       │─────│ Management              │─────│ Forest Management Plan   │
│ Prescriptions           │     │ Prescriptions           │     │                         │
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Why conduct a PFRA?

A PRFA is an important core part of the community forestry process. The PFRA component normally involves mapping and physical assessment of the forest resource. The diagram below illustrates how this fits in with the overall process:

PFRA Component
of the
Management
Planning Process

Investigation

Negotiation

Implementation

User Group Formation
(Major Process Prior to Management Planning)

Identify Outline
Livelihood Requirements
& Objectives

Mapping

Participatory
Resource
Assessment

Formulate and Agree
Management Objectives

Formulate and Agree
Management Activities

Develop, Agree and
Implement Management
Plan

Implementation
support, M&E and
periodic review

A PFRA is important for both the Government and the community. It provides the Government with:

- a detailed knowledge of the resource at the time of the assessment. This can be used to determine any changes in the resource over time (by repeating the assessment for **monitoring purposes**), and seeing if the changes are as expected from the management prescriptions. If not, then changes need to be made either to the prescriptions, or to the implementation of the prescriptions.
- A tool for management planning and assisting the community with the management of the resources

It provides the community with:

- information to support the appropriate management of the resource. It is very difficult to manage a forest effectively unless you have information about the resource, which allows management prescriptions and a management plan to be developed.
- Detailed resource information and a record of the management prescriptions

The PFRA should provide information for the following:
- Monitoring: sufficient information to determine any change in the resource, and to determine whether the management prescriptions have been successful
- To help develop meaningful, realistic management prescriptions
- To help determine sustainable off take levels, products to be harvested (not just timber products), and how best to utilise the resource
- Provide an idea of the volume of wood, the Basal Area (see stage 2: conducting the PFRA)
- Information on different canopies (see stage 2: conducting the PFRA)

It is very important that the PFRA can be implemented. To ensure that any method is feasible, it has to fit inside the 'reality framework', illustrated below:
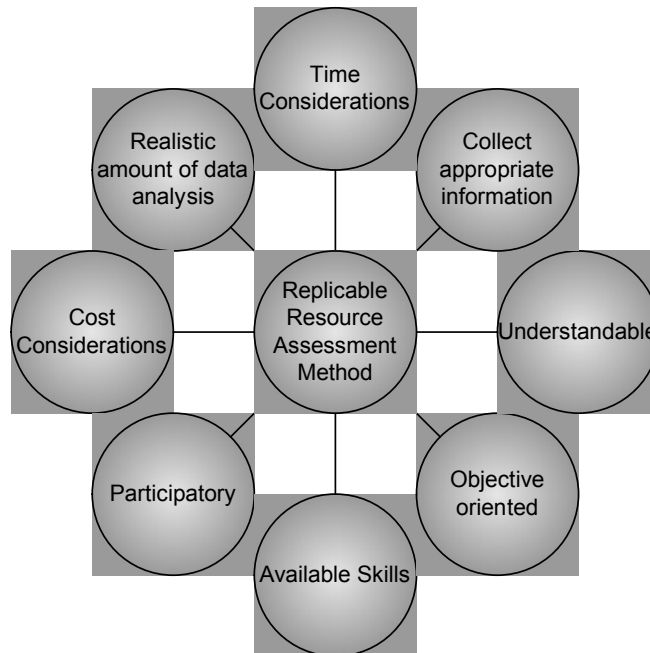
If th me ethod does not fit within the constraints of the reality framework, it will not work effectively or be used. This often happens with complex approaches to resource assessment, where the technical demands or equipment requirements are unrealistic. This PFRA approach has been specifically designed to be workable in reality and gather suff cient information for management and monitoring purposes. i

The PFRA Team

A PFRA is a joint effort by the local community and local foresters. The team needs at least one Government forester or forestry/natural resources technician. They explain to the community the techniques of PFRA. There needs to be, ideally, 2-4 community members for the PFRA team, ideally a mix of men, women and older children (all these community members use the resource in different ways). It does not matter if more community members want to join the team, but it will slow the PFRA down.

Stage 1: Preparation – Preparing to undertake a PFRA

It is essential that the PFRA is conducted after the general User Group formation process (the 'social' side) is well underway. The user group formation process will provide a lot of useful background information on how the community interacts with the forest, their main uses and needs, and their forest related livelihoods.

Ideally, the forest technician who conducts the PFRA should have been closely involved in the user group formation process. If not, they should talk with those workers who were, and get as much background information as possible.

Step 1. Community discussion

The first stage of the PFRA is to sit down with the PFM management Group, and discuss with them the PFRA. This involves discussing:

- The PFRA process: what will be done, why, how, and what the information will be used for
- The level of support for the PFRA. It is important that the community are enthusiastic about the PFRA and see benefits. If not, it is better left until later in the user group formation process.
- Who from the community will be part of the PFRA team
- When the PFRA will be conducted
- The information gathered from the PFRA
- How the information will be used to assist with management

It is also important to discuss how the community will reimburse or recompense them for the time involved. It is important that *the community* provides any reimbursement – such as some small payment or help with farming, or looking after crops - *not the government, NGO or project*. The PFM Management group need to see the long-term value in the process.

Step 2. Maps and spatial information

Some form of map or photo's of the resource will make the PFRA much easier. If maps are not available, they need to be generated as part of the resource assessment process, using survey techniques and/or GPS. A topographic map will provide sufficient information, and allows you to plan the PFRA, know where you are during the PFRA, and record the location of the days work. Aerial photographs will also help, and provide the same information, *but these are not required for the PFRA*. Participatory sketch maps may be of some use, and will identify boundaries and approximate locations, but you should remember that they are always very spatially inaccurate: some form of spatially accurate map will be needed.

You need to determine the boundary of the community forest for the management plan. This s ould be done with the community and Government. This is important as it h determines the area of the forest under the management plan.

If you have no maps, you may need to map the boundary (and internal divisions) of the community forest using a Global Positioning System (GPS), or traditional surveying techniq es (such as chain and compass). It is important to map thu e external boundary of the for st as accurately as possible. It is particularly ime portant to accurately map the boundaries between the communities agricultural land and forest area, as this provides an import nt indicator for monitoring any forest encroachment or expana sion.
Guidelines for using a GPS for mapping are given in Annex one.

You should draw the proposed boundary of the community forest onto graph paper, so you end up with a map of the forest boundary. Mark in internal boundaries (for example,

between plantations and natural forest, and maybe different conditions of forest – highly disturbed, moderately disturbed and undisturbed). Exclude any areas of private agricultural land, and other non-forest areas. You now have a map of the community forest, and can calculate the area by counting the squares on the graph, and converting them to hectares (this depends on the scale of the map). You have also created internal compartments, based on forest type, providing different 'strata' for the assessment. This map allows you to plan your PFRA.

Step 3. Planning

You firstly need to know the correct sampling intensity. Systematic sampling is employed. As the size of a forest strata increases, the spacing between samples can be increased, as you still get sufficient sample points to evaluate the forest.

The following table will help you:

Strata size	Sampling grid
1-20 ha	100*100 m
>20 – 100ha	250*250 m
100-500ha	500 * 500 m
>500ha	1km *1km with sub-plot at 500m intervals

For very small areas (< 2 ha) you need a minimum of 3 plots. This sampling intensity will provide you with enough data on the forest for both monitoring and management planning purposes. A sampling grid is used to lay out the plots. The plots should be marked on a map: each point the correct distance from the others, showing where the sample plot is located. During the resource assessment it will be necessary to go to each of the points marked on the map and conduct a plot assessment there.

For extensive forest areas or compartments (greater than 500ha) a sampling grid of 1km by 1km is used, with sub-plots at 500m.

You should then plan on where and when you will conduct the PFRA. In a large forest, you may have to camp for some of the less accessible PFRA. For other areas, you may need transport to get to the forest. All these logistics must be planned for in advance. You also need to work out how many days the PFRA will take, and where you will go each day. You will probably need to 'test' the PFRA in the woodland, to see how long it will take for the type of forest. In general, 12-30 plots can be measured a day on a 100*100m sampling plot in natural forest, more in open woodland areas. It has been found that 5-10 main plots (with sub-plots) can be measured using a 1km by 1km sampling grid. It is important to remember that it is not the number of plots assessed in a day that it important, but the quality of the information. This is a *participatory* resource assessment, and discussions with the community may take up a lot of time, but they are an important part of the process.

Step 4. Equipment

The PFRA is designed to use simple equipment. The following equipment is required:
- 1 relascope or similar -   1 50 m length of rope
- 1 compass
- pencils
- PFRA forms
- A boundary map of the forest on graph paper

Additionally, a 50m tape is sometimes required, to check that the rope is still the same length (they stretch or can get cut). A clinometer is useful for checking slope angles, but is not necessary. A GPS may be required for boundary mapping, navigation and/or mapping plot locations. A camera is also useful. If overnight stops are required, full camping/cooking equipment will be required.

Stage 2: Conducting the PFRA

Once the planning is completed, the PFRA can commence.

Step 1. The first plot location

The first plot should be near the edge or corner of the compartment/area to be assessed, and at a location that can be marked onto the map. The first plot should be located 50m into the forest. Before discussing what you measure at the plot, we will first discuss how you move from plot to plot.

Step 2. Positioning the plots

Depending on your grid size (which depends on the size of the compartment), your plots will be 100, 250 or 500m apart. You locate the plots by using a compass bearing, and a rope of known length. In difficult terrain it may be better to count paces between plots. You fi rstly have to know how many paces make up 100m. This is different for everybody, and varies depending on the terrain and vegetation. Lay out a 50m rope, and pace along it, counting the steps. Now go back, and average the paces. In general most adults have 100-125 paces for 100m, in easy forest terrain. Once you know how many paces make up 100m, you can quite accurately measure distances between plots. Com ap ss bearings need a little basic training, but once you have been shown how to do this, it is very easy. Once you can take a bearing and pace out an accurate distance, you can reliably position plots. Using a GPS for navigation may help where the canopy is open. GPS navigation takes practice, but once familiar with the principles it can be rapid and accurate. Each GPS provides guidance on how to use it for navigation.

Step 3. Completing Form 1, the Plot Assessment form

The main part of the resource assessment is conducted during the plot assessment. This stage involves both the community members and the forest technician observing the resource and taking some measurements. It is important that the process involves the community members, and that there opinions of the resource are accurately recorded.

Below are guidance notes on how to complete Form 1, and the Form.

Completing Form 1

The form has to be correctly completed, and with enough information so you know what part of the forest it relates to. It is important to understand that the form is completed by *the PFRA team*. It is jointly filled out by the Government and community members of the team, reaching a concensus and agreeing what should be written down. In some cases, there may be different views, which should all be written down.

The form relates to observations for the *fixed point sample point*. There is no defined plot area, as it takes a long time to set a plot up, and still does not obtain statistically reliable information. The information recorded should be for the particular plot in general, and not for the forest in general. For visual observations, the PFRA team should walk around approximately 10m from the fixed point sample point (the exact point reached by compass and pacing).

It is important that the **forest/compartment name** is filled out, along with the **plot number**. This allows us to trace the information to the correct location.

The numbers below refer to the numbered sections on the Plot Assessment Form.

Section 1: Basal Area. The basal area is recorded from the fixed point sample point – the *exact* paced out point. Training is required on measuring basal area (it is actually very easy, but there are a few 'rules'). It is suggested that one or two members of the community PFRA team are instructed on how to use the relascope, and work with the Government worked on this.

Section 2: Fire Evidence. Any fire evidence should be noted on the form, along with any available explanation and detail, noted by the community members of the PFRA team.

Section 3: Soil exposure. Looking at the soil around the sample point, how much is visible around it without disturbing the soil? Can you see any, or is it covered by leaves, humus, ground flora etc? If > 50% is visible, the exposure is high, if 10-50% it is medium, if < 10% it is low. Note if the erosion potential is high.

Section 4: Felling intensity. Look around from the fixed plot, and determine how many trees have been felled or had their main stem(s) lopped. If it more than 25%, the intensity is high, if 10-25% medium, and less than 10% is low.

Section 5: Grazing intensity. Is there any evidence of grazing? What do the community say? The main indicator is pathways, tracks, and browsing. If tracks are extensive, the intensity is high, if few tracks, medium, and if very few or no tracks, low.

Section 6: Crown cover. The crown cover should be recorded, and if appropriate, recorded for each canopy. The canopy is recorded as closed, moderate or open, based on ocular assessment from the fixed point sample point.

Section 7 and 8: Natural regeneration. The type and extent of natural regeneration (less than 2m) is recorded. If the area is well covered with a particular species of NR, it is plentiful, if there are several individuals of a species visible it is moderate, if isolated individuals can be observed it is scarce.

Section 9: Main Important Species. Important species visible and close (*ca.* within 25m) are recorded. The species may be important for a number of reasons: timber production, fodder, other community use, or cultural reasons. NTFP's should also be recorded.

Section 10: Dominant Species. Dominant species visible and close (*ca.* within 25m) are recorded. These may be different to the species mentioned in 9.

Section 11: Quality of the Forest. A description of the quality of the forest should be made, and if appropriate, both Government and community views should be recorded. Any disease or defects in trees should be noted. Indicators of quality should be used and recorded, and as much detail as possible recorded.

Section 12: Forest/Land class. This is a general description of the forest at the plot site, noting anything that has not been recorded, such as erosion etc. The most important feature to document is the size class structure, in terms of the size of individual trees.

Section 13: Main uses of the forest. Main uses of the forest should be documented, in terms of the range of products, and potential for development of the area (perhaps for NTFP's, species enrichment etc. This information will be used to identify and support management prescriptions in the management plan.

Section 14: Problems and issues with the resource. The PFRA team (and particularly the community members) should finally note any problems and issues with the resource. This information will be used to identify and support management prescriptions in the management plan.

Form 1: Participatory Forest Plot Assessment form (version 4)

Note: It is essential that the guidance notes for completing this form are read in detail before filling in form

Forest/compartment name:			
Plot number:		Date:	

Plot: Fixed Point Sample (Ocular and Basal Area)					
1.Basal area (No. of trees through relascope)					
2.Fire evidence:	Yes (comment):			No:	
3.Soil exposure: High, Medium, Low					
4.Felling intensity, and comments:					
5.Grazing intensity: Class as high, medium or low, based on evidence of grazing paths, tracks, browsing etc., and discussion with the PFRA community team.					

6.Crown cover: (For both upper and lower canopy if appropriate)		Closed	Moderate(<70%)	Open (<30%)
	Upper			
	Lower			

7.Natural Regeneration: (Below 2m height)	Species:	Plentiful	Moderate	Scarce	None
8. Description of natural regeneration (taller than 2m). (Describe size/age and condition of natural regeneration).					
9.Main important species: (Commercial, community, fodder, NTFP's)					
10.Dominant species: (For both upper and lower canopy if appropriate)					
11. Quality of the forest (High, medium, low, with Government and community perspectives)					
12.Forest/land class: Description of forest and size class structure. Brief description of the plot, including any important features. A description of the size-class, including saplings, pole stage, mature and over mature. Is the plot young, mature or over mature trees?					
13. Main uses of the forest (mainly community, for the plot, not forest in general)					

14. Problems and issues with the resource & management rec's (mainly community, for the plot, not forest in general).	

Form 1a: Participatory Forest Sub-Plot Assessment form

Note: It is essential that the guidance notes for completing this form are read in d tail before filling in form e

This form is only to be completed for assessment in extensive forest management (forest areas >500ha) where a 1km sample grid is to be used, with sub-plots at 500m between main plots.

Forest/compartment nam : e			
Plot number: (note-should refer to main plot number)		Date:	

Plot: Fixed Point Sample (Ocular and Basal Area)	
1.Basal area (No. of trees through relascope)	
2.General description of sub-plot and comments: (include species description, use of forest, quality of forest)	
3.Management implications (mainly from community	
4. Other comments	

Stage 3: Producing the Resource Assessment Report

The aim of the resource assessment report (Form 2) is to collate the individual plot data and use it to compile an assessment report that reflects the entire assessment area. It 'averages' the information, provides a description of the resource as a whole, and shows the variability. Therefore the report serves as the record of base-line condition of the resource, which can be used for monitoring future changes in the resource.

The report should be developed by the foresters. The information recorded and developed in this form will be used for community disc ssions to identify management practices. u

There are two main elements to writing the resource assessment report (Form 2): collating the information from the individual plots; and then identifying implications for management: these are described below.

Guidance notes for completing form 2, and a copy of the form, are below.

The **general description**, including **problems and issues with the resource**, is taken by combining the answ rs to questions 11,12, 13 and 14 on form 1. For example, are all the e plots similar or diff ree nt? This shows the variability. Are grazing levels high, low or variable? Are NTFP's abundant, scarce or variable? Which NTFP's? This should be preformed for all the information recorded, to provide a rich description of the resource.

The **area assessed and sampled** is taken from the map. This will require counting squares on a grid overlaying the map to determine the area. This is important for determining yields l er on. at

The **Basal Area** is an important indicator of the *stocking* of the resource. Combined with a description of the sizes and types of trees present it gives us a good overview of the resource and how m ch timber is present. The Basal Area also provides a good indicator u of condition of the forest resource.

The basal areas are recorded in the Table, along with how often they occurred (for example B.A 10 in 4 plots, B.A. 11 in 5 plots, B.A. 12 in 2 plots, B.A. 15 in 1 plot). The average is calculated (for the above example, 11.2), and the range given (in the above example, 10-15).

The range shows how variable the resource is, and the average basal area indicates the stocking level.

Implications for management:
The basal area information needs to be considered in conjunction with the description of the resource. For example, if the area was a young plantation, thinning is more important than a rigid Allowable cut. If the area is very over mature, more felling may be acceptable in the short-term to restructure the resource.

It is suggested that in general the following are used until more reliable information can be obtained:

Basal Area < 5, no felling of mature trees (only over mature or poor condition trees utilized)
If Basal Area 5-10, limited felling of mature trees

If Basal Area 10-20, controlled felling written into management plans, intensity of $1m^3$/ha/yr.

If Basal Area >20, controlled felling written into management plans, intensity of $2m^3$/ha/yr.

The community may have no understanding of cubic meters: the forest technician will have to convert this into number of trees, and mark these up.

Fire records any observed fire occurrences, and what they were and why they were there. If fire is observed, the implications for management need to be recorded, such as controlling charcoal burning, instigating a fire watch etc.

Soil Exposure records the number of times high, medium or low levels of soil exposure were observed at plots. If there are many plots with medium or high levels of soil exposure this needs to be discussed, and implications for management identified. For example, is there erosion occurring or a risk of erosion? Is there a need to develop a better lower canopy?

Felling intensity is recorded as a description from each plot, averaged and with a description of variability. If the felling intensity is high in some places there are management implications on reducing these localized pressures: if the felling intensity is high across the resource, there are implications that this may be affecting the resource, and mat need better regulating and more rigorous control measures.

Additionally, the following need to be determined as best as possible. The aim of the following is not to develop ideas and prescriptions that he community have to follow, but points to raise in discussions, and that influence management planning.

Grazing levels are recorded as a description from each plot, averaged and with a description of variability. If the grazing levels are high in some places there are management implications on reducing these localized pressures: if the grazing intensity is high across the resource, there are implications that this may be affecting the resource. It should be noted that grazing on its own is not necessarily having a negative impact on the resource. However, if the level of grazing is too high, then natural regeneration may be seriously restricted.

It is difficult to determine (or monitor) grazing levels. If grazing is identified as a problem from the resource assessment, this needs to be discussed with the community, and if possible a strategy for reducing the pressure should be developed. There is no point in a management prescription that cannot be implemented: for example, if an area is heavily grazed, banning grazing is unlikely to have any effect. However, the community may be able to modify grazing patterns, and perhaps have small grazing exclusion areas or some form of rotation.

Crown cover is recorded as the number of plots where closed, moderate and open canopies were recorded. It is another indicator of the stocking density, and provides important descriptive information on the resource. If the crown cover is variable it may mean that some harvesting/thinning can occur in the denser areas, but not in the more open areas, and if the crown cover is low there may be a need for replanting, enrichment planting or protecting natural regeneration.

Regeneration is recorded as the number of plots with plentiful, moderate, scarce or no regeneration. The management implications are serious if the forest area is open with little regeneration. This indicates degradation, probably with high levels of grazing. It is less significant where the canopy is closed or nearly closed, as the regeneration may be poor due to low light levels, and this may be a natural feature of the forest resource which requires gaps in the canopy for regeneration to occur.

Main important species are recorded from Form 1 to give an overview of the important species present in the forest. Uses of the trees should also be recorded. There are implications for management where few important species are recorded, or important species are scarce or heavily utilized. *It is important that NTFP's are included in the report as these may be of great significance to the community*.

Dominant species are recorded as above. There are implications for management where the dominant species are different to the important species identified. This indicates that the forest is not of great benefit to local people, and some restructuring to encourage important species may be required.

Form 2: PFRA Report – [Name] Forest

Date of assessment:

(Q. 11,12,13) **General description:** (Q. 14) **Problems and Issues with the resource:**

Area assessed and sampled Total area assessed: Number of sample plots: Assessment Team: Community and Woreda foresters (with PFMP staff)

(Q 1) Basal Area

Basal Area Counts:

Basal area	Number of Counts

Average Basal Area:
Range:

Implications for Management:

(Q. 2) Fire:

Implications for Management:

(Q. 3) Soil Exposure:

High:
Medium:
Low:

Implications for Management:

(Q. 4) Felling:

Felling intensity:

Implications for Management:

(Q. 5) **Grazing:**

Implications for Management: (Q. 6) **Crown Cover:**

Closed:
Moderate: Open:

Implications for Management:

(Q. 7, 8) **Regeneration:**

Plentiful:
Moderate:
Scarce: None:

Implications for Management:

(Q. 9) **Main Important Species:**

Implications for Management:

(Q. 10) **Dominant Species:**

Implications for Management:

Stage 4: Producing the Management Prescriptions

Stage 3 above linked the PFRA information with management implications. Stage 3 also produced the PFRA report, which is used for monitoring and evaluation purposes. The next stage is to use the management implications to develop specific management prescriptions: how each area or compartment of the forest is to be managed. This information forms an important part of the management plan.

Form three is the Forest Management Prescriptions form. Most of the initial information is just transferred directly from form 2. The rest of the information is generated through discussions with the community user group. It is *important* to realize that this stage is highly participatory: *it is the community who develop the management prescriptions*, with the assistance of the forest technician.

Completing Form Three

The **Site description** is directly copied from the first section (general description and problems and issues with the resource) of form 2. The **special management considerations** section is completed by copying **all** the management implications from form 2.

The rest of the form (protection, Utilisation, development and monitoring) is developed **by the community** with the assistance of the forest technicians. The forest technicians discuss the implications for management, and help the community to develop management prescriptions. For example, if grazing is identified as a problem with the resource, how is

it going to be managed? There are a range of options that could be discussed with the community, such as preventing grazing from certain areas, protecting natural regeneration, limiting herd sizes in the forest or stall feeding animals. In the utilisation section, the types of product as well as volumes should be addressed. Product types should be based on the size-class information and general description. If the forest is over-mature, some large trees can be felled even if they are widely spaced. If the forest is mature, and widely-spaced, these trees should be left standing to act as seed sources. If there are few small trees, these should be left and not harvested. The product types should reflect the type of vegetation that is in particular abundance. Acceptable uses are those which have little negative impact, and should result in a maintenance or improvement to the resource. These need to be determined by the PFRA team in discussion with the wider community. If there is excessive grazing pressure which is preventing effective natural regeneration, this needs to be addressed in some way. If there is a non-sustainable use of the larger trees or pole stage trees, this needs to be considered in management prescriptions, and agreed by the community and Government.

The management prescriptions are then used in the management plan.

Form 3: Forest Management Prescriptions [Name] Forest

Site Description
(Geographic description and from section 1 of assessment report)

1 Special Management Considerations

(Implications of Management from assessment report)

2 Protection

(From community discussions)

3 Utilisation

(From community discussions)

4 Development

(From community discussions)

5 Monitoring

(From community discussions)

Annex 1: Mapping Guidelines

These guidelines are designed to help with GPS mapping when no computer software is available.

A. Putting a GPS surveyed point onto the map.

Firstly, you need the Latitude/Longitude (Northing/Easting) for the point. This can be read from the GPS for every waypoint, or position on the ground.

Imagine the Lat/Lon for a point is 07º 17'.224, 036º 14'.144, as read from the GPS.

You need a map drawn onto cm/mm graph paper, which has key lat/long lines drawn onto it, for example, lines 7º 17', 7º 18' N, 36º 14, and 36º 15 E. The GPS can be used to give the distance in meters between these lines, using the measure distance function on the MAP view – see the photo below for an example:

For this example it is assumed that the map is at a 1:5000 scale (1cm = 50m), the usual scale for local forestry mapping.

Fo Bonga the follor   wing figures are correct: for other areas these need to be determined using measuring distance function on the GPS to measure distances between 1 minute intervals of distance.

Northing
        1 minute = 1.86km = 37.2cm on map (1:5000)
        0.1 minute = 186 m = 3.72cm
        0.01 minute = 18.6 m = 0.372 cm
Easting

        1 minute = 1.84km = 36.8cm on map (1:5000)
        0.1 minute = 184 m = 3.68cm
        0.01 minute = 18.4 m = 0.368 cm

The map already has the 07º 17' and 036º 14' lines mapped to scale on it.
The point is taken as 07º 17'.224, 036º 14'.144

Therefore the point is 0.224 minutes north of 07º 17', and 0.144 minutes east of 036º 14'. To draw the point accurately on the map we need to know how far at 1:5000 scale these are:

We know 0.1 min N = 3.72 cm, so 2.24 x 3.72 = 8.33cm

0.1 minute E = 3.68cm, so 1.44 x 3.68 = 5.329cm

So, if we measure 8.33cm up from 07º 17', and 5.3cm right of 036º 14', where the lines intersect is point 07º 17'.224, 036º 14'.144 (this point is actually the bridge on the main road out of Bonga, before the Wush Wush junction).

B. Putting a GPS surveyed polygon (boundary) onto the map.

Figure 1 below shows an imaginary forest compartment boundary, or polygon, as shown on the GPS screen. It is made up of 7 waypoints that mark changes in direction in the boundary. It would be obtained by walking the boundary with the GPS and entering a waypoint every time there is a change of direction.
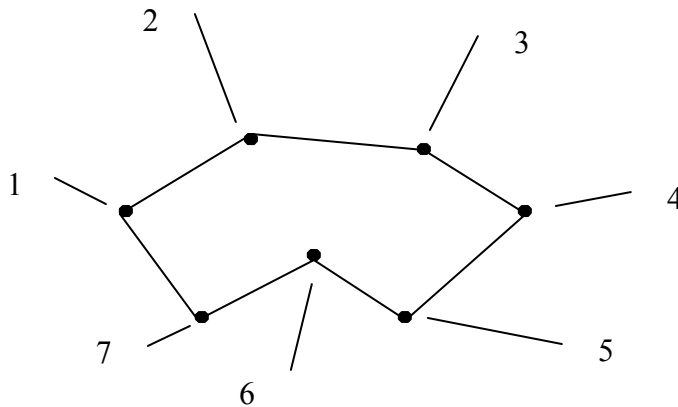
Figure 1: A GPS mapped forest boundary

So how best do we map the boundary on paper at a known scale?

Point 1 above is the point we have previously mapped – point 07º 17'.224, 036º 14'.144.

We can map each point in the same way as for the point above, but this is time consuming and laborious.

An easier method is to use the GPS to measure the distance N and E between each point. For example, assume point 2 is at 07º 17'.325, 036º 14'.335.

Using the 'Measure Distance' function on the GPS it is easy to measure the distance east (342 m) and north (190m). Point 2 can then be drawn on the map: at 1:5000 scale point 2 is 6.84cm north and 3.8 cm east of point 1. The same is then done from 2 to point 3, and so on. The polygon shape needs to be checked with the one on the GPS to ensure no mistake has been made.

C. Loading plot points onto a GPS

The plot locations for the sample plots can be loaded into the GPS before conducting the assessment. *This means the GPS can be used to navigate to each plot*: fast and accurate where conditions allow (usually where the canopy is open).

The plots need to be marked out on the map (se section 3: planning, above). When the sample grid is put on the map, you have each point for the plot assessment marked on the map. For extensive areas this is very easy: the 1km grid squares already on the map can be used. The latitude and longitude for each point can be measured from the map scales in degree, minutes and seconds, and then entered into the GPS (make sure the GPS is working in seconds nor decimal units) as waypoints. You can then use the navigation function of the GPS to direct you to the waypoint, which marks the plot (see GPS handbook for specific techniques for a particular type of GPS).