REPORT ON WORKSHOP

ORGANISED BY THE EUROPEAN TROPICAL FOREST RESEARCH NETWORK

DEVELOPING NEEDS-BASED INVENTORY METHODS FOR NON-TIMBER FOREST PRODUCTS

APPLICATION AND DEVELOPMENT OF CURRENT RESEARCH TO IDENTIFY PRACTICAL SOLUTIONS FOR DEVELOPING COUNTRIES

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1. Executive summary

Recognising the need for adequate NTFP inventory methods, the FRP decided to identify research requirements in this area. A consultant, Dr Jenny Wong, was commissioned to carry out a review of NTFP inventories and assess their biometric rigour (Wong, 2000) and to identify researchable constraints. Six general topic areas were proposed for research (Annex 3). A special workshop was convened by the European Tropical Forest Research Network (ETFRN) so that a wider group of specialists and interest groups could consider these topics. The workshop was held at the headquarters of FAO, Rome on 4-5th May 2000 (see Annex 1 for the agenda).

The workshop was chaired by Jane Thornback and opened by Dr El Hadji Sene of FAO (see Annex 4). For the purposes of this workshop the term NTFP was used rather than the FAO accepted term, 'NWFP' (non wood forest product). NTFP was defined as 'all products derived from biological resources found on forest land but not including timber, fuelwood, lac or medicinal plants harvested as whole plants' (Wong, 2000). Jenny Wong presented the findings of the methodological review which covered close to 400 references, 97 of which described quantitative studies. It was concluded that 38% of the quantitative studies reviewed used methodology that could not be considered to be biometrically rigorous (Annex 5 and section 5.4 below). The review concluded that the principal difficulties with NTFP quantification are:

- The variety of life forms and distributions represented by NTFPs mean that traditional forest inventory techniques cannot be adapted easily for NTFPs.
- There is a lack of properly researched NTFP-specific sampling designs.
- There is little guidance available on development of appropriate NTFP measurement (mensuration) techniques.
- There has been no application to NTFPs of sampling designs tailored to monitoring needs.
- Lack of theoretical models means that it is difficult to determine the sustainability of NTFP harvesting.
- There has been little application of novel sampling strategies to NTFPs.
- There has been little cross-disciplinary exchange of ideas and methods suitable for use with NTFPs.
- There is no service that provides effective communication of advice to field workers and communities.

The workshop largely accepted Dr Wong's findings and moved on to examine the variety of information requirements that might need to be met through NTFP inventory. Four presentations were made illustrating needs in different contexts and at a range of scales (see Annexes 6-9 and section 5.5 below):

- Participatory non-timber forest product inventory in rural development forestry - *Kathrin Schreckenberg, Overseas Development Institute, London, UK.*
- Natural Resource Monitoring Concepts and Tools of Veld Products Research & Development - *Mpho Mosate, Veld Products Research and Development, Gabane, Botswana*.
- Data needs for national strategic planning and policy development - *Paul Vantomme, FAO, Rome, Italy*.
- Information for international NTFP monitoring – with special reference to reporting on global forest resources (FRA) - *Peter Holmgren, FAO, Rome, Italy.*

Plenary discussions were held and covered the following topics (see section 5.6 below):

- Information needs
- Discussion of methodological approaches to NTFP Inventory including:
  - Multi-disciplinary approaches
  - Product specific approaches
  - The need for biometric rigour
  - Approaches at different scales
  - The FRA2000 approach
  - The use of indigenous knowledge
  - Participatory approaches

The workshop substituted the research topic headings proposed by Dr Wong with the following (see Annex 3 for details):

- Sampling — Topic 1 Evaluation of novel sampling designs for use in NTFP inventory.
- Assessment — Topic 2 Development of measurement techniques for non-wood products.
- Monitoring — Topic 3 Development of NTFP resource monitoring protocols.
- Analysis — Topic 4 Development of methods to determine optimal harvesting levels and Topic 5 Documentation and dissemination of statistical advice on NTFP assessment.
- Linkages — Topic 6 Linking local and scientific knowledge

The workshop concluded that these topic distinctions apply only at the species and product level. Research requirements at the macro and community level are more focused on the identification of information needs, the integration of methods (and studies) to meet these needs and the development of appropriate indicators.

Participants broke into three groups to discuss research needs in three different contexts/levels, the species/product level, the community level and the national/international or macro level. The research needs identified and the issues raised in groups can be summarised as follows (see section 5.7 for a full account of group findings):

Group 1: Species/product level research needs. It was agreed that greatest need in the field is the determination of harvest levels. Therefore the research priority is to develop inventory methods to assess the distribution and abundance of NTFPs including the determination of growth and yield. Development of methods should draw from existing methods in a variety of disciplines and from local knowledge.

Group 2: Community level NTFP assessment research needs. The Group decided that the priority is to devise methods to bridge the gap between community inventory methods and top-down (i.e. government, trade etc.) information demands. The biggest problem is arriving at designs that both build on local knowledge, are intuitive to local people and fulfill the information needs of strategic decision-makers.

Group 3: Macro level research needs. The Group identified that it was perhaps logistically desirable to undertake research on inventory and monitoring designs for particular multi-species product groups. The biggest problem is developing the means to amalgamate and verify data from many sources to give a macro-level overview of NTFP utilisation.

Certain follow up activities to the workshop were suggested (see section 7.2 below for more detail).

- **Practical training workshop.** It was proposed that a workshop should be held in the field involving some training in biometrically rigorous methods followed by an examination of the practical problems of applying these.
- **Biometrics hotline.** It was agreed that a biometrics hotline is needed or some service that could provide field workers with practical and appropriate advice.
- **Discussion group**. It was agreed that the existing email discussion group should be operational over the next 2-3 months so that discussion can take forward the ideas developed in this workshop.
- **Improvement of methods reporting**. A plea was made for adequate reporting of methods in published papers. It was suggested that notices should be sent to journal editors requesting them to ensure that methods are either reported adequately in the journal or that the source of methods used are included in the references.

General conclusions

- There is a need to increase the awareness of the desirability of sound assessment of NTFP populations and dynamics when considering utilisation of these resources.
- There is a need to increase awareness of the importance of including biometric analyses in the planning phase of any data collection exercise.
- Prior to identifying gaps in methods it is important to identify information needs at different levels. Discussion and agreement on needs at different levels is required to ensure that research priorities identified in this workshop are correct.
- There is a clear expressed need from field workers for NTFP inventory methods that are simple and easy to use but at the same time are adequate for the determination of harvest levels.

- Further work by inventory specialists on the development of inventory methods and protocols for NTFPs is required, drawing on methods that currently exist in a variety of disciplines.
- There is an urgent need to provide advice on existing NTFP inventory and analysis methods to field workers.

Additional outputs of plenary sessions

- When undertaking an inventory the issue of whom one is **empowering** with the resultant information must be considered.
- There was no clear conclusion drawn on whether it is better to take a **product approach** to NTFP inventory methods development or to use the more generic approach suggested in the review. Both have positive and negative aspects.
- **Biometric rigour** is not needed in all cases and methods that are more 'rough and ready' should also be developed.
- Utilisation of **indigenous knowledge** as well as scientific knowledge is important. The linkages between these are not straightforward and require further examination.
- Although full **participation** of local communities in inventory is not always realistic this is important because of the potential benefits that can be gained. Further work needs to be undertaken on development of methods that can be used by communities.
- It was acknowledged that in certain cases it is difficult to **prioritise NTFPs** for inclusion in inventories and that there are no generic methods for doing this.

2. Acknowledgements

The successful completion of the workshop was possible through close collaboration of ETFRN, FRP and FAO. The ETFRN Secretariat is thanked for organising and co-ordinating the workshop. The FAO are acknowledged for providing an excellent conference venue, for the secretarial support and administrative assistance provided during the meeting and for funding eight overseas participants to attend. The EU is acknowledged for co-funding workshop participants. FRP are much appreciated for taking the initiative in this important subject area by commissioning the review document. They are also thanked for funding the workshop.

For their role in making the workshop happen the following individuals are recognised. Jane Thornback as chair person. Jenny Wong for preparing and presenting the review and research topics. Willemine Brinkman for co-ordinating the workshop. Laura Russo for FAO based co-ordination. Evelyn White and Lois Marcolongo for administrative support and reporting. Nell Baker for reporting and editing of the proceedings.

3. Acronyms

ACP	African, Caribbean and Pacific
ADB	Asian Development Bank
AfDB	African Development Bank
BP	British Petroleum
C & I	Criteria and Indicators
CARPE	Central Africa Research Programme for the Environment
CIFOR	Centre for International Forestry Research
CITES	Convention on International Trade in Endangered Species
CSIR	Council for Scientific and Industrial Research (South Africa)
DfID	Department for International Development (UK)
DGIS	Directorate-General for International Co-operation (The Netherlands)
INCO-DEV	Co-operation with Third Countries and International Organisations – Scientific and Technological Co-operation with Developing Countries (5th Framework Programme for Research and Technological Development and Demonstration DGXII (EU))
ETFRN	European Tropical Forest Research Network
EU	European Union
FAO	Forestry and Agriculture Organisation of the United Nations
FRA2000	Global Forest Resources Assessment 2000 (of FAO)
FRP	Forest Research Program (of DfID)
GIS	Geographic Information Systems
GPS	Geographic Positioning System
GTZ	German Agency for Technical Co-operation
ICRAF	International Centre for Research in Agroforestry
IDB	International Development Bank
IIED	International Institute for Environment and Development
IIFM	Indian Institute for Forest Management
IK	Indigenous Knowledge
INBAR	International Network for Bamboo and Rattan
IPR	Intellectual Property Rights
IUCN	International Union for the Conservation of Nature
IUFRO	International Union of Forest Research Organisations
JBIC	Japanese Bank for International Co-operation
ODI	Overseas Development Institute (UK)
NGO	Non Governmental Organisation
NHM	Natural History Museum, UK
NTFP	Non Timber Forest Product
NWFP	Non Wood Forest Product
RECOFTC	Regional Community Forestry Training Centre (Thailand)
SAFIRE	Southern Alliance For Indigenous Resources (Zimbabwe)
SAREC	Swedish Agency for Research Co-operation with Developing Countries
SOAS	School of Oriental and African Studies (UK)
TBA	Tropical Biology Association
UK	United Kingdom
USA	United States of America
USAID	United States Administration for International Development
VPR&D	Veld Products Research & Development (of Botswana)
WTO	World Trade Organisation
WWF	World Wildlife Fund for Nature

4. Objectives of the workshop

The objectives of the workshop were:

- to highlight the role of biometric rigour and natural science in the sustainable development of NTFP exploitation,
- to discuss the needs and constraints of NTFP inventories and,
- to identify and prioritise research themes for further action.

For the agenda of the workshop and the list of participants see Annexes 1 and 2.

5. Report of the meeting

5.1 Background to the workshop

The need to identify appropriate methodologies for NTFP inventories is becoming more urgent as studies proliferate. The Forest Research Programme (FRP) of the UK Department for International Development (DFID), recognising this need, decided to examine what research was required to improve the methods available to inventory NTFPs. The emphasis had to be on needs-based methods. The FRP commissioned a consultant, Dr Jenny Wong, to carry out a review of NTFP inventories and assess their biometric rigour (Wong, 2000). Based on her findings, Dr Wong was then asked to recommend a series of research actions to improve the inventory methods available. Six general topic areas were proposed for research (Annex 3). A special workshop was convened by the European Tropical Forest Research Network (ETFRN) so that a wider group of people could consider these topics. The workshop was held at the headquarters of FAO in Rome on the 4-5th May 2000. The workshop was attended by over 40 people from a wide variety of backgrounds and countries including academics, forestry department staff, NGO representatives and others working directly with NTFP assessment or management (see Annex 2 for full list of participants).

5.2 Definitions

Non wood forest products (NWFP) are defined by FAO as '*goods of biological origin other than wood derived from forests, other wooded lands and trees outside forests*' (FAO 1999).

For the purposes of this workshop the term non timber forest product (NTFP) was used. This was defined as '*all products derived from biological resources found on forest land but not including timber, fuelwood, lac or medicinal plants harvested as whole plants*' (Wong, 2000). (The specific exclusions refer to the terms of reference given by FRP for the review.)

5.3 Format and structure of the meeting.

The Workshop was opened by the Chair Ms Jane Thornback representing ETFRN and by Dr El Hadji Sene of the host institution, FAO. Dr Sene highlighted the importance that FAO gave to the topic of NTFPs, he applauded this effort to move the NTFP research agenda forward and he welcomed the participants to Rome (Dr Sene's paper is reproduced in full in Annex 4).

The Chair thanked the various organisers (see acknowledgements above) and presented the objectives for the two days. The definition of NTFP (see above) was considered and accepted for the purposes of the meeting and the technical aspects of the meeting began with a presentation by Dr Jenny Wong who summarised the findings of the review and presented the six research topics for consideration. Four invited papers were then presented to illustrate the variety of needs for biometrically rigorous NTFP data and the contexts in which assessments have to take place. These ranged from the needs of communities, rural enterprises, national statistics and global forest resource assessment. In addition five related papers were tabled at the meeting (see Annex 10).

The Workshop then considered the six research themes introduced by Dr Wong. A plenary discussion ensued which first considered the overall conclusions of Dr Wong's study. Subsequently, the workshop divided into smaller groups to consider matters in greater detail

and to suggest research concepts for each topic. Three general levels at which NTFP resource assessment is required were identified as: the species/product level, the community level and the macro level. Three groups were formed and each discussed the research topics at one of these levels. Summaries of presentations, group discussions and plenary discussions are given in the following sections of this Workshop report.

5.4 The biometrics of non-timber forest product resource assessment

Dr J Wong, UK

Summary of review paper presentation

Dr J Wong presented the findings of the review of biometric rigour of current NTFP resource assessment methods (see Annex 5 for a full version of the paper presented and www.etfrn.org/etfrn/workshop/forum/ntfpwong.htm for a full version of Dr Wong's extensive review).

Nearly 400 references were collated 126 of which were selected for biometric analysis as they included as an objective the enumeration of some characteristic of the resource. Of the 126 studies only 97 actually included quantification of a biological organism rather than comprising a list of useful species or a valuation of vegetation. The 97 studies were assessed for biometric rigour.

The criteria used for assessing biometric rigour were:

- Criterion 1 Reporting - whether protocols had been adequately reported.
- Criterion 2 Randomisation - whether the plots were distributed in such as way as to minimise potential bias in the results.
- Criterion 3 Replication – adequate sample size.
- Criterion 4 Independence - whether plots were independent of each other.

Overall a biometrically adequate study is one that is judged to be well reported, has plots distributed in a considered way to minimise bias, has more than one plot and has plots that are independent of each other. Table 1 illustrates the proportions of studies of different types that can be considered as biometrically adequate.

Table 1 The biometric qualities of the reviewed studies

Study type	Studies	Protocols reported (%)	Biometrically 'good' (%)	Comments
Biodiversity	3	66	0	Often subjective but justifiable?
Demographic	9	44	22	Often based on single study plots or stands
Ethnobotany	10	50	20	Including quantitative ethnobotany
Experiments	5	80	80	Insufficient replication of treatments
Harvesting studies	5	80	60	Insufficient replication of treatments
Resource inventory	42	69	57	Insufficient plots
Mapping	3	0	33	Biometric sampling not a major concern?
Market studies	2	50	0	Econometric not biometric criteria apply
Methodology	11	64	55	Problems with contiguous sub-plots
Monitoring	12	50	25	Different biometric criteria also apply
Rapid assesment	1	100	0	Rapidity and rigour not compatible
Remote sensing	2	0	0	Did not report protocol for ground truthing
Use of secondary data	6	10	17	Did not report protocols for original dataset
Social surveys	2	50	50	Sociometric not biometric criteria apply
Yield studies	13	46	8	Subjective selection of sample individuals
TOTAL	126	56	38	

The overall conclusion of the biometric review is that only 38% of the 126 studies examined passed the four criteria of biometric quality. Note, however, that some of these studies may not need to be biometrically rigorous. Of greater concern is the fact that 43% of resource inventory studies and 90% of yield studies failed in some way. These are studies that usually have quantification as a primary objective. From this result alone one can conclude that there is a serious problem in the methods currently used for NTFP resource quantification.

Whether or not biometrics are important depends upon the use to which information is to be put and is at the discretion of the user of the information. However, users need to understand why biometrics are needed before they can judge whether or not it is relevant to their purpose.

Identifying research gaps

The identification of the problems that need to be addressed by research was based on the findings of the biometric evaluation and also a wider reading of work on natural resource inventory. In summary these are:

1. Problems with adopting traditional forest inventory techniques for NTFPs

The problem of a lack of methods and protocols for NTFP inventory could be easily solved if it were possible to use traditional forestry methods as these are well described and understood. Unfortunately, this is not a practical solution as there are certain characteristics of NTFPs that are not easily accommodated in traditional forest inventory. The main pitfalls are:

- Rarity - many NTFPs are rare which means that only a few plots of a conventional systematic or random inventory will contain the species of interest.

- Imperfect detectability – people dealing with trees have rarely come across the problem of searching for an elusive or moving target because trees are generally easy to find. Unfortunately, many NTFPs are not that easy to find and these require that detectability is considered. This is an area where NTFP studies can borrow wildlife techniques.

- Seasonality - Many NTFPs are seasonal but in comparison, timber quantities are constant, consequently forest inventory methods do not cope well with seasonality.

- Motility - Animals run away, fruit falls off a tree and rolls down a hill but trees are static. This is an area where NTFP studies may be able to borrow wildlife techniques.

- Quantification of yield for non-destructive harvesting - most of the methods for determining timber yield from a forest are concerned with the harvesting of entire individuals. For NTFPs one is often only harvesting a small part of the individual. The review suggests that there is little theoretical background for determining harvesting levels of parts of a plant.

- Incorporation of local knowledge – most NTFP studies value local knowledge but there is at present no formal means of using this knowledge to optimise inventory designs. The fact that many studies have struggled with the problem of linking local and scientific knowledge suggests that this would be fruitful area for research.

2. Lack of properly researched NTFP-specific sampling designs.

There are relatively few research studies that have looked at optimising sampling designs specifically for NTFPs. Most of these studies have been done on rattan and, unfortunately, several of these had their own failings. These were mostly to do with plot independence (the trial plot sizes and shapes were contiguous and from only one study site).

3. Little guidance available on development of appropriate NTFP measurement (mensuration) techniques

The review indicted that even for the most commonly studied products there is little advice or standardisation of methods.

4. No application to NTFPs of sampling designs tailored to monitoring needs.

There has been no application to NTFP monitoring of any of the statistical thinking on monitoring. Monitoring from a statistical point of view is complicated as there is a problem with

controlling the power of the design to discriminate change. Precise observations are required at each time interval to actually detect changes, if the data is imprecise the changes may reside within the errors of the estimates and mask any real change. There has been quite a lot of work done on how to address these problems but to date they have not been applied to NTFPs.

Precise monitoring is often very expensive therefore many NTFP monitoring studies use indicators to track changes in the resource. However, there is little known about the linkages between indicators and the resource base. Where this has been studied it has often been shown that a change in off-take or harvest level (a commonly used indicator) is not directly linked to resource condition. What is required are some relatively easy means of determining and tracking change in the relationship between the chosen indicator and resource condition.

5. Difficulties in determination of the sustainability of harvesting

One of the more stark findings of the review is the general lack of good quality data and the almost complete absence of a theoretical background for determining sustainable yield of NTFPs. Consequently, despite the many hopes that NTFPs can be managed sustainably, we do not actually have the data or the means to demonstrate that this is possible It is suggested that this is a very severe and urgent problem.

The next few points do not identify problems but look at potential ways of moving forward.

6. Application of novel sampling strategies to NTFPs

There are a range of newer (at least to forestry) sampling techniques such as rank set sampling and adaptive cluster sampling, that appear to offer certain advantages for NTFPs. Clearly there is new methodology available, however, much of it may be at the cutting edge of statistics and has not yet been considered for NTFPs.

7. Cross-disciplinary exchange of ideas and methods suitable for use with NTFPs

There is an urgent need for cross-disciplinary exchange in the development of NTFP specific sampling designs and methods. There are many ideas and methods that apply in a wide range of different disciplines but there is little cross-over between them. In this respect the reviewer suggests we should think of NTFPs as wild-grown products from natural or semi-natural environments. Although there are many products that lie in a grey area between the wild and domestic, it seems that the problems of managing cultivated or wild products are quite different and this needs to be reflected in methods selected for their quantification, management and monitoring. Areas where techniques and ideas can be shared between domestic and wild resources might also be identified.

8. Effective communication of advice to field workers and communities

To be effective, any advice that can be offered and the results of any research undertaken has to get to people on the ground. Research must be developed in the field in a manner responsive to expressed needs and then put into a form appropriate for use by field technicians and people in village communities.

Research topics

The research topics as laid out in Annex 3 were then briefly presented.

5.5 Demand and constraints for NTFP assessment: Summary of papers presented

Four invited presentations were made at the workshop to illustrate the variety of needs for NTFP inventory and biometric rigour, and the various contexts in which inventories take place. The presentations are summarised below (note that they are available in full in Annexes 6-9).

Participatory non-timber forest product inventory in rural development forestry.

Kathrin Schreckenberg, Overseas Development Institute, UK

The paper looked first at the actors involved in rural development forestry and the interests they might have in carrying out participatory non-timber forest product (NTFP) inventories. It then outlined some of the data likely to be collected in a participatory inventory and discussed the main constraints faced by a community embarking on such a project. The paper then turned to participatory monitoring and its potential to provide management information in a simpler and more cost-effective manner than through the use of full-scale resource inventories (see Annex 6 for a full version of the paper).

Community-level objectives for NTFP inventories include: 1) securing tenure and rights to resources, 2) valuing the resource, 3) managing forests sustainably and for greater benefits and 4) monitoring individual species of particular value.

The type of data required include: spatial distribution of the resource, tenure, resource abundance and population structure, productivity levels, demand levels and harvest methods. The level of detail or rigour required will differ according to the objectives and purpose of the inventory.

Constraints for community-based NTFP inventory include:

- People may not wish to spend time on laborious NTFP inventory unless the products are of high commercial value.
- Lack of resources, time, funds and technical skills.
- Organisational difficulties.
- Peculiarities of the NTFP resource and its distribution across a range of land uses.

Possible alternatives to predominantly costly and difficult western-style inventories are proposed through the consideration of concepts such as: 1) ‘Optimal ignorance’, 2) taking a ‘step-by-step’ approach, 3) building on traditional management systems and 4) indicator based participatory monitoring.

It was concluded that whether simple monitoring or more sophisticated inventory systems are applied, the technical issues must in all cases be of secondary importance to the key issue of organisation. Responsive management structures are essential to permit a rapid reaction if resource conditions change for the worse. Investment is also needed to improve the support that government agencies and NGOs can provide to communities. Perhaps most importantly, promoting participatory monitoring or inventories requires a high level of commitment by government agencies that local communities can indeed manage their resources sustainably. In such a supportive environment, strong community organisations will be able to choose the best methods to obtain the information they need and act upon it to maintain their key NTFP resources.

Presentation on natural resource monitoring concepts and tools of Veld Products Research & Development

Mpho Mosate, Veld Products Research and Development, Botswana.

This presentation explained some of the difficulties that VPR&D (an NGO in Botswana) experienced in attempting to develop monitoring methods for the grapple plant (*Harpogophytum procumbens*). See Annex 7 for a full version of the paper.

The grapple is a low-lying creeping plant that produces underground tubers that are harvested for the medicinal plant export trade. VPR&D was interested in developing a monitoring tool for the grapple plant as local collectors reported that over harvesting can result in the death of the plant. As grapple makes an important contribution to local livelihoods VPR&D was concerned that harvesting systems needed to be sustainable.

The monitoring system developed involved the use of indigenous knowledge to identify plant types and study areas and a sampling method designed by VPR&D staff. The exercise gave useful insights on regeneration of grapple and the effects of harvesting. A visiting scientist, however, identified problems with this assessment system. Some of the assumptions about the reliability of indigenous knowledge on the grapple plant were shown to be misleading. In addition, as a result of ecological studies, the original sampling design and plot configuration were found to be sub optimal and tended to over estimate plant densities. A new approach was suggested using paired transects.

It was concluded that the 'new' recommended assessment method could be used to monitor management systems. Furthermore, in order for this assessment tool to be used widely by local people its relationship with income generation needs to be ascertained. The key objective is to ensure that the activities of income generation from the grapple plant are sustainable. It is hoped that this will be assured through the establishment of appropriate management systems for grapple.

Data needs for national strategic planning and policy development

Paul Vantomme, FAO, Rome

This paper examined NWFP inventory needs at the macro level (state, national and regional). It covered the information needs, examined the various sectors that require NWFP information and some of the constraints of collecting it. The paper is given in full in Annex 8.

Government sectors requiring NWFP data include: Forestry, Agriculture, Industry, Health, Education and Rural Development.

Data is required for a variety of purposes including:

- Identification of **economic opportunities:** Data is needed for policy development and for investment planning or sector development.
- Determination of **social impact**: Data is needed to determine the potential role of NWFP in rural development programmes.
- Examination of the **potential environmental role** of NWFP enterprises: Data is needed to assist management of conservation and environmentally sensitive areas to determine and manage potential utilisation of NWFPs.

Some of the difficulties are that biometric rigour is needed if national level summaries are to be reliable and maintaining taxonomic rigour can be problematic at the national level.

Information for international NTFP monitoring – with special reference to reporting on global forest resources (FRA)

Peter Holmgren, FAO, Rome

This paper provided an overview of FRA2000, NWFP data in FRA2000, information needs at the international level and the knowledge management cycle. The complete paper can be found in Annex 9.

Overview of FRA 2000

The objective of FRA 2000 is to undertake a world wide assessment of forest resources, covering a wide range of subjects including NTFPs. One subject of great interest is the extent of forest cover and the identification of changes in forest cover including and examination of underlying causes. The process of data collection includes consultation with experts and FAO member countries followed by special studies by FAO staff if required. The results are available on the FAO web page that includes more than 8000 pages providing text, maps and statistics for each country.

NWFPs in FRA2000

NWFPs are included in FRA2000 but the information available is limited. Textual information is provided with standardised headings and some data is provided in standardised tables.

Information needs and issues

Information is needed at the international level to support international policy processes, to compare countries and to raise public awareness. Key issues include: standardisation of terms and definitions, valuation methods, resource assessment methods, consistency over time and ensuring adequate feedback. In generic terms what is needed for management purposes is the ability to build scenarios (or models) that describe what happens under different circumstances. Often inventory is not designed to meet real information needs and scenarios often do not utilise inventory information or do not make proper use of the information available.

5.6 Plenary discussions

Specific points of clarification on the review

Complexity of the problem of developing NTFP inventory methods

There was general agreement about the difficulties of working with NTFPs as described in Dr Wong's presentation. An additional complexity is that NTFPs often occur in a patchwork of land uses and tenure systems. The importance of accounting for this in the development of inventory methods was emphasised.

Coverage of the literature

It was noted that the review document (Wong, 2000) had not fully reviewed mensuration techniques (e.g. fruit abundance/size/yield etc.) from the ecology and autecology literature. It had, however, pointed out that this is a particularly large body of work from which appropriate methods for NTFP mensuration might be sourced. The review specifically concentrated on products with use value but emphasised the need for cross-disciplinary work in order to bring in alternative mensuration experience.

It was reported that there are precise indigenous methods in use for NTFP inventory. However, the review (Wong, 2000) was unable to locate specific references to indigenous quantification of NTFPs in the literature.

Criteria for judging biometric rigour

The reviewer had used replication as one of the criteria for judging the biometric rigour of studies reviewed. As an alternative, it was suggested that the confidence interval of the data could have been used as a criterion. However, this was not possible as very few studies reported confidence limits. It was also pointed out that the term 'replicates' has a very strong experimental design connotation and that the term 'sample size' would have been preferable.

Clarification of subject coverage
It was pointed out that the primary focus of the review was the consideration of the biological basis for sustainable NTFP exploitation. The determination of actual harvest levels would then depend upon the user of the inventory information and might at this stage involve considerations of economic and social sustainability. The latter were, however, considered to be outside the remit of the review.

It was made clear that the review did not attempt to quantify use or value of NTFPs but concentrated on the quantification of the biological resource itself, i.e. how much of the resource there is and how much could be sustainably harvested.

General discussion of issues

Participants agreed that the important distinct levels of information needs are:
1) international, national and sub-national or macro-level,
2) local or community level,
3) species and product level.

Information needs
At various points during the two day workshop participants felt that there was a need to consider actual information needs at the different levels before ratifying broad research topic areas. It was felt that it would be easier to identify commonalities once information needs at each level had been established. However, the conclusion from the review (Wong, 2000) appears to be that most resource information needs can ultimately be met through an understanding of the distribution, abundance, quality and harvest potential of the resource. Certain examples came up that supported this, for example information requirements for certification at the international level encompass detailed species or product level information.

In contrast, some participants felt that information needs at different levels were very different. Furthermore, it was suggested that it was more important to think about information needs for specific purposes rather than to try and define information needs at different levels. Information needs for sustainable livelihoods, alleviation of poverty, food security, conservation etc. may be very different. However, if one considers the biological element in NTFP management even for diverse purposes, it again becomes clear that different presentations of the basic information of abundance, distribution, quality and harvest potential of a resource would meet most requirements.

It was also suggested that the development of methods needed to be prioritised according to demand. If we did not know what the most urgent needs are then it would be difficult to prioritise research. Participants who were currently involved in resource assessment were asked to contribute from their experience of resource information needs.

Patrick Mushove from FAO Mozambique said that his interest was in identifying which variables to assess for certain product groups and how to measure the 'functional part' (i.e. the product) of the plants in question. He could see that there should be different sampling approaches for different resources. Furthermore, he felt that for the practitioner it would be useful to actually go through the research topics and discuss gaps in sampling, assessment, monitoring and analysis methods.

Phosiso Sola from Safire, Zimbabwe said one of the main problems they had was in choosing sampling strategies for a variety of NTFPs. They have difficulties in sampling where life forms, product types (roots, annuals, perennials, bark) and environmental factors (climate, microclimate) vary greatly. In addition they need more assistance with encouraging participation in inventory. At the same time they need to collect information that is of value to both the community and to the scientists. They would like to know how to convert information collected in a participatory way to information that would be authentic to the scientific world and international agencies. For example local communities may not assess their resources in terms of volumes but volume data might be required at an international level. She felt that a discussion of sampling, assessment and analysis would be practical.

Deep Narayan Pandey from the International Network on Ethnoforestry, India said that his organisation works with about 2000 NWFPs. They have debated whether they can apply

modern technology such as GIS and remote sensing to NWFPs. However, they have realised this is not possible and that inventory has to be undertaken manually. Extending the catchment beyond the forest i.e. to farms and even urban environments increases the number of NWFPs that need to be considered. He said that they need a sampling design that is acceptable under these circumstances. They also require methods that can be used by local people.

David Hammond from Guyana said that he had brought three products with him.

1) A furniture-manufacturing product utilised by local people and derived from three vine species. He wanted to know how to determine the quantity that can be harvested, taking into account disturbance and regeneration capacity.
2) Crab oil derived from the seed of a mahogany family species. There is a big local market and he wanted to know how they could capture a slice of the international market for this product.
3) A resin that used to have a big market for polishing furniture. He wanted to know if this could be re-introduced into the market. He also wanted to know what sort of level of rigour is required in assessing the production potential of this resource given that there is no market at the moment.

Eric Boa of CABI Bioscience, UK mentioned the need to be able to quantify the resource in the field and to determine sustainable harvest levels. A specific practical problem he noted was that in many people's mind the establishment of a research plot implies some kind of regulation. This becomes a problem because once one starts to lay out plots an atmosphere is created that affects utilisation patterns on that plot. He wanted to know how one deals with this kind of problem.

It became clear that what is most urgently required is to develop methods for measuring distribution and quantity. At present field practitioners copy methods reported in the literature and thus tend to repeat past mistakes. It was agreed that the crucial issue was to discuss sampling, assessment, monitoring and analysis. Linking of scientific and local knowledge was also considered to be important. These must be considered both from the perspective of quantification of population and the yield of the product.

Intellectual Property Rights

After the presentation of the paper on inventory needs at the national level the issue of Intellectual Property Rights (IPR) was raised. It was pointed out that this topic was very important but could not be satisfactorily covered in this workshop and that there are international agencies working on IPR issues, in particular, on strengthening country institutions to help local people protect their knowledge. However, the following three points are relevant to the subject of the workshop.

1. It was noted that there is a possible divide between government institutions, commercial institutions and communities in their objectives and needs. Therefore ownership of NTFP information (including inventory data) becomes a politically delicate but important issue. The question of who is being empowered by the information resulting from an inventory must always be considered before undertaking an inventory.

2. There is a need to identify information that is required at a national and international level to ensure that any legal rights to information and resources have been recognised. The implications this has for inventory design and subsequent information management need to be considered.

3. Excessive protection of local IPR will be a disincentive for commercial development of products by industry and thus potential investment and local benefit may be foregone.

Selection of NTFPs

There was some discussion on the selection of NTFPs to study. It was suggested that at a national level it is important to prioritise NTFP products for research, according to marketability. Experience in Ghana and elsewhere indicates that it is not feasible to include all species that are considered locally important in a national level inventory as the number of products and species is too great. Methods for prioritising NTFPs for inclusion in inventories

are required. It was noted that prioritisation according to marketability alone would exclude NTFPs that have a high subsistence value but are not traded.

Commercial and Subsistence Categories

A distinction was suggested between three NTFP usage groups, subsistence, commercial and future market. It was noted that this is a useful distinction but one that is difficult to make in practice as many NTFPs could span all three usage groups. In practice, at the community level, individual harvesters will shift between subsistence harvest and commercial use according to their needs and available time. The distinction is useful (at local, national and international levels) as there is often more pressure on commercial species and products. However, this is not always the case and demand for subsistence products is not always less volatile than the demand for commercial products. Some concern was also expressed that by making this distinction one could fall into the trap that forestry fell into of monitoring only those species that are currently in high demand and thus foregoing the opportunity of collecting information on those that may attract a high demand in the future.

Discussion of possible approaches to the development of NTFP inventory methods

Multi-disciplinary approach

The need for a co-ordinated multi-disciplinary approach in NTFP inventory and the selection of appropriate methods at all levels was emphasised. International organisations need to co-ordinate their work as well as individuals working in different disciplines on the ground.

In terms of inventory planning it was noted that efficiency can be improved if several surveys occur simultaneously but care must be taken to consider how the resources under study interact. It was noted that a multi-species approach is likely to be particularly appropriate where communities are involved as local people tend to think in terms of multiple resources.

The species level discussion Group felt that any attempt to try to develop inventory methods common to both plants and animals was unrealistic. However, this does not preclude the possibility of undertaking animal and plant inventory as part of a single exercise. For example transect lines cut for plant inventory can also be used for animal surveys. In Zimbabwe, Safire already undertake resource inventories that include both animal and plant resources.

Towards the end of the meeting it became clear that multi-disciplinary approaches are very important and that efforts need to be made to bring horticulturists and the wildlife people etc. into the discussion. Participants were requested to keep this in mind and to assist in bringing people from other disciplines into the workshop email discussion group. It is clear that involving such people will require personal prompting as those in other disciplines are often unaware that what we call an NTFP may be the products/resources/organisms that they are working with.

During the discussion following the workshop the following matrix was prepared by Dr Wong (Table 2). This illustrates how increasing the integration of studies decreases possible optimisation of methods (per species). The challenge is to understand how to prepare effective multi-species inventory and data analysis routines at a range of scales from local to national level.

Table 2 Integration of studies vs optimisation of methods.

Increasing integration of studies >

	Spatial scale	Local	Macro
Potential inventory initiators		Communities – or their advisors	National agencies
< Decreasing optimisation for specific product	Single species	Local, relatively easy to optimise sampling design.	Large scale, relatively easy to optimise sampling design.
	Multi-species	Local, probably moderately difficult to optimise sampling design.	Large scale, probably requires stratification for known habitats for specific species, perhaps moderately difficult to optimise design.
	Multi-purpose	Local, will probably require relatively complex protocols for sampling and analysis.	Multi-institutional studies, potentially difficult to co-ordinate and probably very difficult to optimise for specific products, therefore may require an approach that endeavours to optimise analytical techniques for peculiarities of specific NTFPs

A product specific approach

The issue of whether or not to concentrate on the development of methods for specific products was discussed at length throughout the workshop. There were calls to limit the discussion to a few chosen products or examples in order to make the discussion of research ideas more manageable. However, Dr Wong observed that in her experience it was extremely difficult to create product groups that would make sense from an inventory perspective. The terms of reference for the methodological review had proposed the development of a generic classification of NTFPs for assessment purposes. However, this was found to be intractable and an alternative, generic, approach based on the general characteristics of a biological organism that should influence different aspects of a fully optimised inventory design was developed. This is explained in more detail in the review but in summary the approach is based on the observation that:

1. an understanding of the distribution pattern (clumpiness, rarity, even spread) of the resource will influence the choice of sampling designs (i.e. plot layout),
2. the life form of the resource (motility, growth form, life cycle) should inform the selection of plot configuration or sampling unit, and
3. the nature of the harvested product (root, fruit, nest, feather) should determine what is actually measured within the sampling unit or plot.

Generic advice and perhaps methods based on the characteristics of the resource can be developed at these three stages of inventory design. It was suggested that the development of generic methods would help to address a wider range of resources. Thus adopting such an approach should assist in rapidly moving forward the process of determining appropriate inventory methods for all NTFPs. Having to develop new methods every time a new NTFP product becomes important, although more direct, would not satisfy the expressed need for methods for a wide variety of NTFPs.

There were reservations that a generic approach was not logical, that it was impractical and that advice delivered in this way would not work in practice.

In addition the following points were made concerning the inventory of important product groups:

- Practical (rough and ready if necessary) solutions are needed to address problems with NTFP inventory methods on the ground and these relate to specific products. Theoretical ideas on how systems might work are not a priority.

- The product is the focus of interest at the National level, and it is through the identification of products that we will be able to obtain funds for this work. This may not be the best way to undertake the research but it is perhaps the most pragmatic way of obtaining funds.

- The macro level discussion Group identified the need to develop product level inventory. In addition they agreed that further work was required in developing an NTFP typology that would make sense for inventory purposes building on the work carried out in the review (Section 5.2 of Wong (2000)).

- Most people naturally focus on a resource and how they might maximise benefits from that resource. Methods have to fit this objective and not some idea of scientific perfection. A product approach is needed because that is what people understand. There are already textbooks that explain idealised inventory methods based on the kinds of resource qualities mentioned.

With particular reference to the latter point, however, it was noted that current advice on methods is demonstrably not accessible to people in the field. Dr Wong's concept is to put together a toolbox of methods that would be more accessible to users. In selecting methods users would consider the distribution, life form and product of the NTFP they were interested in and select methods accordingly i.e. via a decision tree. Such a decision tree is yet to be developed. Currently FAO is updating its forest inventory manual and will include a section on NTFPs. It is currently carefully considering the utility of such a decision tree.

There were still some doubts about the practical application of this 'schematic recipe' approach. In the experience of some of those present many students or field workers to whom one would be providing advice are not familiar with basic statistical terminology. Other participants, however, applauded this approach as a good idea and something that was urgently needed.

It was felt that such an approach could work as long as it was completely user friendly. It would have to use language and information systems easily accessible to the field worker. It was suggested that a good example of the kind of tool envisaged is the database developed by Kew to assist UK nurses in the identification of poisonous plants. This takes the form of an interactive CD-ROM in which the user can choose whether to identify a plant from its appearance using non-technical descriptors or from the symptoms its ingestion produces in a patient.

The need for biometric rigour

The need for biometric rigour (i.e. probabilistic sampling) under all circumstances was questioned. It was clear that biometric rigour would not always be required and that some research should be devoted to developing methods that are adequate for certain purposes but not necessarily biometrically rigorous.

Participants felt that different levels of rigour are required for different purposes. Different levels of rigour might also be required for products that are under different levels of demand. During the presentation on community needs it had been pointed out that the collection of good data is generally not a priority of communities but that organisation of management structures is often more important. It was pointed out, however, that good data will often stimulate official interest and that if one can clearly see the importance of NTFPs then better management organisation is encouraged.

However, it was stressed that in each case it is important to know what the ideal (biometrically rigorous) method might be in order that the risks involved in choosing alternative methods can be analysed and clearly understood. It was concluded that the toolbox proposed above should include adequate, 'rough & ready' methods as well as the biometrically rigorous ones.

Issues of scale

It was clear from the discussion that methods of inventory would change with scale but the exact nature of this change was not clear. There was confusion in the discussion over whether the workshop was considering information needs at different levels or inventory methods that might be used at different scales. The problem of integrating methods at different scales was not discussed at length but was covered to some extent by the macro level Group (see below).

The FRA2000 approach

Participants asked how FRA2000 proposed to collect country data on NWFPs given that NWFPs tend not to be prioritised in National forest policies and are generally not included in national inventories. FRA2000 relies predominantly on national governments to supply information. In some cases they utilise their own staff to collect data or organise workshops in countries of interest for the purpose of information collection. Attempts are occasionally made to collect information from government departments other than Forestry Departments. The FRA2000 group at FAO is aware that this process will result in significant gaps in information but they are expecting this to prompt more discussion on the seriousness of the problem and hopefully subsequent international and national action to address it. It was noted that the use of the term NTFP or NWFP focuses on forestry and that biological resources might be a more embracing term.

Concern was expressed that FRA2000 might concentrate too much on data for commercially traded products and not enough on subsistence products. It was confirmed that FRA2000 rely mainly on information sources that cover internationally traded products as this information is the most readily available. However, they also try to obtain as much information as they can on all resources, including subsistence products. In order to include as much as possible of the latter they collect textual, rhetoric information on NTFPs as well as quantitative data.

The use of indigenous knowledge

It was felt that a sensible way of approaching NTFP resource assessment would be to first collect local knowledge about the resource and then to validate this with biological resource assessment in the field (i.e. NTFP inventory). The value of indigenous knowledge must be recognised, particularly where the results of the inventory are destined for local use.

It was also recognised that there are certain difficulties in using indigenous knowledge to provide information that is scientifically acceptable. One example (but by no means the only one) that was covered in detail in the review is that of species identification and nomenclature (see Annex 8 of review document, Wong (2000)). The difficulty here is that local people's concept of species is often quite different from the biological science concept and therefore translating information that might be perfectly valid for local community needs into that which would be acceptable amongst the scientific community becomes extremely complex. It was pointed out that it is also important to draw on both local and scientific knowledge in developing local sampling techniques or monitoring tools that are valid.

Participatory approaches

The concept of community based inventory with full participation was questioned. Participants asked whether this was realistic or whether outside institutions that wish to use the resulting data might be accused of using cheap labour. It is clear that completely community driven inventory never gets into the literature and it is consequently difficult to properly assess it. There is a hope that where a local initiative to manage resources arises, communities will be keen to undertake inventories, learning from outsiders and each other. It was recognised that the information needs of communities and their desire to be involved in designing or implementing an inventory will vary. Clearly, methods that can be used by communities to meet their information needs should be developed but it was also suggested that there may also be a case for the development of methods that can be used by outside 'experts' to meet local information needs. The latter might be particularly appropriate where communities are required to provide regional or national authorities with information (e.g. to meet requirements of community management agreements). However, it was generally felt that a high degree of local participation in inventory is desirable as it can be empowering and creates a sense of ownership and responsibility for the resource. The development of methods to meet local needs should concentrate on those that can be used by communities.

Specific discussion of the research topics presented in the review

It was suggested that the word 'sustainable' instead of 'optimal' should be used in topic 4 as follows: '*Development of methods to determine optimal harvesting levels*' because optimal could imply destruction of the resource. However, it was decided that the wording should remain 'optimal' for the precise reason that it leaves open the possibility for communities to decide to over harvest if they feel this is the best use of their resources.

In topic 2 it was pointed out that there is a need to include the quality of the product and not only the quantity.

5.7 Working group discussions and research priorities

Group 1 – Macro level research

Group 1 considered NTFP inventory needs at the Macro level, i.e. the national and international level. The Group chairman was Dieter Pelz and John Healey was Rapporteur.

Discussion of issues

It was noted that logistical and political issues are often a bigger constraint at a national level than technical sampling problems.

The Group agreed that at the national level it would be useful if forest cover data could be used as a surrogate for inventory of individual NTFPs. To determine if this is possible would require research on the relationship between NTFPs and forest type. It was noted that NTFPs are also associated with other land use types, agriculture in particular. Therefore it may be important to integrate with existing national agricultural/household surveys as well as forest inventories.

If the distribution of the species is strongly linked to one defined habitat/forest type then use of remote sensing may be of particular value. The concept of adaptive sampling is very relevant for national-level inventory as this improves efficiency by concentrating sampling effort in the zones/areas of greatest abundance of the species. Achieving an optimal design for new dedicated NTFP inventories will be difficult if the species occurs on both forest and non-forest land.

It was noted that many countries don't have useful forest inventories at a national level. It was agreed that a research project should be planned that examines case study countries, some with good national forest inventories, and some without. A focus should be on the need for careful linkage between very local inventories and national scale inventories.

There is a need for a two-way communication system to identify and fill in information gaps on NTFP inventory methods. Optimal solutions need to be found to the fundamental conflict between good design for local inventories and the need for a common protocol for all local inventories to meet national needs. At the national level there is a need to maximise the comparability of data and hence a need to standardise methods at the local level. However, at the local level specific objectives will vary, calling for carefully selected and targeted methodology. Therefore is it possible to identify national guidelines and standards that are sufficiently broad and flexible to satisfy the full range of local purposes? Or do we need to advocate a separate dedicated national standardised inventory independent of local purposes? The latter is likely to be more expensive.

The Group agreed that the purpose of the inventory and the information requirements need to be clearly defined in order to select appropriate methods. The Group opinion was that although certain stakeholders do need information at a national or international level for particular products (e.g. commodity traders and those considering CITES listings), there will not be many cases where inventory of a specific NTFP will be planned and conducted at a national level.

The Group noted that there is also a need to develop capacity to value NTFPs e.g., for commercial stakeholders to decide on investment opportunities or for national land-use planning.

The Group also raised the question of whether, or to what extent, international/national bodies should be concerned about NTFPs that are important at a community level (e.g. for subsistence) but are not traded at higher levels.

It was agreed that for a given product, a research project should compare inventory methods used in different countries, to assess which is best, and what constraints there are on extending this method to other countries. It was noted that new research projects should build on or co-ordinate with an existing EC FAO partnership programme in ACP countries on methods of NWFP resource and socio-economic assessment.

The Group agreed that it was important to link resource inventory with marketing information at a national/international level (WTO) and at a sub-national level. For example a survey of provincial markets could determine in which provinces a NTFP is mainly collected and thus resource (biophysical) inventories could be targeted to these areas. For this there is a need to assess existing measuring and reporting systems. Socio-economic expertise will be important in assessing which market statistic is the best indicator of the distribution of the abundance of the species (the pattern of demand will also strongly influence the location of most harvesting effort).

The Group identified the following overarching issues in considering NTFP inventory needs at the Macro level:

a) Cost-effectiveness
b) Multi-disciplinarity
c) Novel funding sources for forestry research, e.g. bodies concerned with food security
d) Need to consider means of dissemination/extension of outputs of research as a key factor in its design (emphasising the importance of training workshops, rather than focussing only on printed manuals etc.).

Research activities

Building on the issues raised above the Group identified the following topics as possible areas for research.

1. Links to or integration with existing surveys

The possibility of linking or integrating NTFP inventory into existing surveys needs further investigation (note importance of both forest and agricultural inventories). In contrast to timber trees note that NTFPs have different temporal as well as spatial variation.

In addition there is a need to examine the links with local issues and local research projects. The major problems of scaling between local/community and national scales need to be clearly identified and the issues of data comparability and the extent to which national needs can or should dictate standard protocols for local inventories need to be investigated.

Size/cost: Either large scale (multi-disciplinary) and/or a series of case studies (possibly utilising student theses). Studies should be regional, i.e. they should not be restricted to one single country.

Collaborators: These should be multidisciplinary and efforts need to be made to identify people from other disciplines. Inclusion of ICRAF or some other agroforestry expertise is quite important. All Group 3 members were interested in being involved in this work.

Funding: Possible sources include the EU or other multilateral donors. Funding for thesis topics would go via Universities.

2. Product specific inventory

There is a need to optimise methods for product specific inventory (where inventory cannot be solely based on 1 (above)), e.g.

- gum – sahel
- bamboo – SE/S/E Asia; E Africa
- rattan – SE Asia; W Africa
- bark (cork – Mediterranean countries)

This is narrower scope research with a focus on more technical methods and should involve experts on spatial distribution and field scientists amongst others. Note that a specific product focus may open up funding from commercial/trade interests.

Cost/size: Projects would be medium sized or generally smaller than for topic 1.

Collaborators: Collaborators might include INBAR and FAO. Expertise on GIS and remote sensing (for spatial information techniques) and from botanists with field experience and field scientists would be required. All those in Group 3 were interested in being involved in this research.

Funding: There are a variety of possible sources including: INBAR, private enterprise, bilateral agencies (e.g. Belgium) and the Fund for Common Commodities.

3. NTFP classification

It is necessary to understand how to classify NTFPs in terms of inventory needs. This could combine 2 (above) with issues arising from 1. The typology should build on that developed by Wong (2000), i.e. classification by distribution type, life-form etc. It would be important to link this with an existing FAO working group that is already looking at this problem.

Collaborators should include someone who participated in preparing the FAO definitions.

4. Monitoring models

There is a need to develop models or to identify potential indicators of spatial distribution (at the landscape level) and abundance. This should involve adaptive sampling at a macro level/landscape level; stratification; use of multilayer GIS; fuzzy logic etc. Such research should involve statistical/technical experts.

Collaborators: These could include University PhD work (e.g. Helsinki University) and forest services (e.g. Guyana Forestry Commission and Sudan Forest Service). Further collaborators could be identified via IUFRO.

Funding sources: These might include SAREC (Sweden) and the EC INCO-DEV

5. Linking market information to the resource

There is a need to consider how market information can be linked to the resource.

Such research should draw on the expertise of economic geographers, economists and inventory experts.

6. Information needs

There is a need to determine the NTFP resource information needs for certification, commerce (valuation), reporting on compliance with international agreements.

Work on this should link to CIFOR work on criteria and indicators etc.

Group 2 - Community level research

Group 2 considered inventory needs at the community level. The Group was chaired by Kathrin Schreckenberg and the rapporteur was Evelyn White.

Discussion of main issues

The objective of the group was to consider whether the toolbox of NTFP inventory methodology was sufficiently well stocked to meet needs at the community level. The group started out by looking through the questions under the topic on sampling. The group then attempted to set criteria for selecting sampling methods at community level. This raised the question of how important biometric rigour is for communities. It was agreed that this was not a question to answer within this forum but that the toolbox should contain methods for less rigorous as well as biometrically correct studies.

The Group felt that it is important for local communities to have the tools to undertake assessment themselves as this level of involvement is empowering. In identifying appropriate methods for local level NTFP inventory it is necessary to first understand;

- existing community assessment methods,
- existing community management methods,
- existing community monitoring methods.

It is then necessary to understand the local and external information requirements (i.e. as requested by national forestry authorities, trade organisations and potential certification bodies). Note that the type of information required by a community to manage its own resources might be of a different kind from that required by a government administration (e.g. to justify the establishment of a community forest), or by a trade group interested in promoting trade in particular local products (possibly certified). Where there are gaps or inadequacies in existing community methods in meeting the identified information requirements, appropriate 'new' methods need to be identified or developed for local use.

The Group agreed that this kind of research needs to be complemented with other activities that will help communities to control and manage their resources. For example there is a need to help communities express their knowledge in an 'acceptable' form. In addition it is necessary to convince policy makers to accept community information. There is also a need to provide training to people within communities to enable them to work at a higher level, to establish what are the gaps in people's understanding and to help to fill the gaps. Clearly such work goes hand in hand with the development of 'acceptable' inventory methods as these are being developed to link community activities and community information needs with external (regional and national level) information requirements.

From this discussion it became clear that a single programme approach would be the best means of addressing the methodological needs at the community level. Work on the development of NTFP inventory tools can continue but whilst the specific gaps at the community level are unknown it is not possible to start to select and adapt methods to community needs.

Research Programme
The following outline research programme was agreed.

Matching local knowledge with information needs.

Activities

1. Document existing local knowledge on sampling, assessment, monitoring and analysis
2. Document information needs to which communities have to respond (e.g. local needs, government, trade)
3. Evaluate 1 against 2 and identify gaps (level of rigour required and appropriate, replicability of results)
4. Address the gaps through development of methods that build on local knowledge and meet the legitimate requirements of external interests
5. Field testing of methods developed
6. Dissemination of successful protocols and experience

Potential Collaborators

Present

- ODI, London
- Edinburgh University, Lancaster University
- Tropenbos Foundation
- IIFM (India Institute for Forest Management)
- Safire (Zimbabwe)
- Veld Products (Botswana)
- CSIR (South Africa)
- FAO
- ETFRN

Not present

- IUCN
- WWF
- CIFOR
- SOAS-anthropology
- IUFRO (particularly for dissemination)
- RECOFTC (particularly for dissemination)

Potential Funders

- USAID (CARPE)
- DFID
- Other bilaterals (JBIC, GTZ, DGIS)
- Foundations (Ford, Rockefeller, MacArthur)
- EC-INCODEV
- World Bank
- Regional Banks (ADB, AfDB, IDB)

Dissemination

Development practitioners (NGOs, government etc.)

- Training workshops
- Manuals and guidelines
- Exchange visits within and between countries

Communities

- Exchange visits
- Appropriate information packaging

Research and training institutions

- Refereed papers
- Training module

Policy makers

- Workshop
- Briefing papers
- Video
- Sound bites

Group 3 – Species/Product level research

This Group focused on inventory at the species/product level. The Group was chaired by Carol Grossman and the rapporteur was Nell Baker.

Discussion

It was agreed that because it might not be possible to discuss all topics within the time period given, it would be wise to do an initial rough prioritisation and then discuss topics in order of priority. Topics were prioritised in the following order:
Assessment,
Monitoring,
Sampling,
Analysis and,
Linkages between scientific and local knowledge.

The first three topics were discussed within the time given. It was agreed that the fifth topic spans through the other four. The Group first redefined the key questions proposed by the review (Annex 3) and then made suggestions for research activities. In general the Group broadened the questions, only discarding one question completely. Proposed activities were also broadened and some terms were redefined.

A central issue that was raised was the need to apply existing scientific knowledge to needs on the ground, and that this requires applied research.

Assessment

The Group was interested in altering the problem definition but decided that this was not the task at hand. The Group also agreed that it was not possible in the present forum to prioritise products and species that needed to be worked on. It was agreed that any research commissioned would have to be undertaken for specific products and species identified via the research proposal.

There was some discussion about where yield assessment fits within the 5 topics. It was concluded that 'assessment' should include measurement of the actual resource (species and or product) and measurements that need to be made for the assessment of growth and yield.

The first three key questions presented by Dr Wong were adopted but the fourth was considered inappropriate. The questions adopted were:

1. Do measurement techniques for NTFPs exist in other disciplines e.g. agriculture, horticulture, animal science etc.? If so how much modification would they need for adoption for NTFPs?

2. Are there significant resources for which there are no suitable measurement techniques? How might suitable protocols be developed for these resources?

3. Are existing methods for harvester/hunter self-assessment adequate and widely known? If not, what research, by whom, would be appropriate to develop processes for developing participatory assessment protocols?

Suggested activities adopted by the Group were:

1. Screening of a wide range of disciplines for resource (species and or product) measurement (including measurements for growth and yield) for potential use with NTFPs.

2. Development, testing and adaptation of field protocols (includes tools and technologies) derived from the most promising methods. Development of protocols for any common and important product types for which there are no existing methods. E.g. variants for use with linear features and products (e.g. lianas) and for measuring areas.

3. Collation and evaluation of user-based resource assessment studies. Development and testing of suitable methods to include local knowledge in the selection of growth and yield parameters and the choice of quality factors to measure.

Monitoring

The group decided that 'assumed indicator' was a more useful term than 'proxy indicator'. In recognition of the fact that the indirectness of an indicator is not the problem, but rather the fact that those using the indicator assume (often without adequate verification) that it relates to the resource they are interested in monitoring.

Questions adopted by the Group were:

1. There are different types of monitoring methods for assessing growth and yield and exploitation. What are these and what are the difficulties with them? Can we develop generic methods or protocols for groups of products or resource stocks?

2. Is it practical to develop systems for investigating and monitoring the links between assumed indicators and resource condition?

3. It would be useful to have monitoring systems that cover a range of objectives at the same time but how feasible is it to design and implement such systems and will they work?

4. How can we assist users to develop their own monitoring systems that are scientifically and methodologically sound?

Activities adopted by the Group were:

1. Collation and evaluation of forest monitoring systems for potential application to NTFP species. This would most likely be a desk study followed by pilot studies. The pilot studies should test efficiency of different methods.

2. Examination of the linkages between biometric methods that monitor growth and yield and those that monitor extraction.

3. Investigation of the linkages between assumed indicators (e.g. market data or photographs) and resource condition for a range of products and contexts.

4. Preparation of guidance on the selection of monitoring protocols for NTFPs in the form of a decision-support system.

Sampling

The Group felt that activity 4 in J Wong's original list fitted better under Assessment than under Sampling.

Key questions adopted by the Group were:

1. There are new sampling designs with potential use for NTFPs. How relevant are they and how can they be adapted for NTFP sampling?

2. What are the pragmatic steps we can take to improve sampling techniques in the field for NTFPs?

Research activities agreed by the Group were:

1. Evaluation of the relative efficiency (costs, time, relative precision etc.) of new sampling designs (adaptive protocols) in the field for a range of resources and product types.

2. Evaluation of the potential utility of rank set sampling for utilising indigenous or prior knowledge in the selection of sampling locations.

3. Investigation of the use of local knowledge for generating sampling designs in a way that is biometrically acceptable.

The following additional points were agreed regarding all activities identified. Those undertaking the research would have to come from multi-disciplinary backgrounds. Methods should be tested in a range of sites where there are different products and species. The methods need to be tested where they will be applied. It is important to be certain that there are people available who can do the research when choosing where to undertake research. Research should be undertaken in places where there is a specific expressed need. The methods developed must be tested in such a way that they can be transferred to other areas.

For dissemination it is important first to identify who needs the methods most. Secondly we urgently need a central place where information on NTFP inventory methods is located. This could be an institution, a publication or a web page. The mode of dissemination will depend upon the identified end user.

Summary of group outputs

From the results of the group discussions it became clear that the distinct research topics as defined by Wong (2000) only really make sense when discussing research at the species product level. The discussions at the macro and community level embraced the need for

species/product level research but were concerned with addressing different kinds of need. The following matrix provides a useful perspective of the group discussions.

Table 3. Summary of group outputs

	Perceived problems				
Macro	Need to draw information from a wide range of sources for multi-species product groups Need to undertake large-scale assessments in the context of multi-purpose inventory				Integration
Community	Need for protocols to be participatory Use of local knowledge				
Species	Sampling	Assessment	Monitoring	Analysis	

5.8 Summing up of workshop

It is clear that the workshop had been asked to undertake an extremely complex task, that is to consider complex statistical issues across a broad range of information needs. It has not been possible to complete this task but the workshop has moved the process forward and has generated a great deal of consensus on the key issues that need to be addressed.

6. Conclusions emerging from the workshop

1. There is a need to increase the awareness of the desirability of sound assessment of NTFP populations and dynamics when considering utilisation of these resources.

2. There is a need to increase awareness of the importance of including biometric analysis in the planning phase of any data collection exercise.

3. Prior to identifying gaps in methods it is important to identify needs at different levels. Discussion and agreement on needs at different levels is required to ensure that research priorities identified in this workshop are correct.

4. There is a clear expressed need from field workers for NTFP inventory methods that are simple and easy to use but at the same time are adequate for the determination of harvest levels.

5. Further work by inventory specialists on the development of inventory methods and protocols for NTFPs is required, drawing on methods that currently exist in a variety of disciplines.

6. There is an urgent need to provide advice on existing NTFP inventory and analysis methods to field workers.

7. Outputs of the workshop

The workshop exposed to a wider audience the lack of biometric rigour in the vast majority of NTFP inventories. This was acknowledged by the workshop.

It exposed the general lack of understanding of the need for biometric rigour and helped to clarify the research activities and processes required to improve NTFP inventory. It was acknowledged that biometric rigour is not required in all cases but that an understanding of what constitutes biometric rigour is necessary.

The workshop clarified certain aspects of the review document as follows:

- The review covered as far as possible all methods that have been used to inventory NTFPs. It did not seek to cover all methods that *might* be applied to NTFPs.
- In judging biometric adequacy the reviewer could not use confidence limits to indicate adequate replication as confidence limits are rarely reported in the literature. The number of plots was used instead as an indicator of adequate sample size.
- It was clarified that the review focused on sustainability from the biological perspective and did not attempt to cover social or economic sustainability.

The workshop endorsed the requirement to examine inventory method needs at different levels. The important levels for this purpose are:

- international, national and sub-national level (macro)
- local or community level,
- species and product level.

The workshop substituted the research topic headings proposed by Dr Wong with the following:

Title proposed by workshop	Title proposed by Dr Wong
Sampling	Topic 1 Evaluation of novel sampling designs for use in NTFP inventory.
Assessment	Topic 2 Development of measurement techniques for non-wood products.
Monitoring	Topic 3 Development of NTFP resource monitoring protocols.
Analysis	Topic 4 Development of methods to determine optimal harvesting levels and Topic 5 Documentation and dissemination of statistical advice on NTFP assessment.
Linkages	Linking local and scientific knowledge

The workshop discussed research needs at three different levels.

The workshop concluded that these topic distinctions apply only at the species and product level. Research requirements at the macro and community level are more focused on the identification of information needs, the integration of methods (and studies) to meet these needs and the development of appropriate indicators (see Table 3 above).

7.1 Research areas proposed

The following areas of research were proposed (see section 5.7 for more detail).

Species or product level research

It was agreed that greatest need in the field is the determination of harvest levels. Therefore the research priority is to develop inventory methods to assess the distribution and abundance of NTFPs including the determination of growth and yield. Development of methods should draw from existing methods in a variety of disciplines and from local knowledge.

A series of projects that seek to provide more efficient protocols for NTFPs was proposed.

- Assessment
  - Screening of a wide range of disciplines for resource (species and or product) measurement (including measurements for growth and yield) for potential use with NTFPs.
  - Development, testing and adaptation of field protocols derived from the most promising methods. Development of protocols for any common and important product types for which there are no existing methods.
  - Collation and evaluation of user-based resource assessment studies. Development and testing of suitable methods to include local knowledge in the selection of growth and yield parameters and the choice of quality factors to measure.

- Monitoring
  - Collation and evaluation of forest monitoring systems for potential applicability to NTFP resource species. Desk study followed by pilot studies. Pilot studies should test efficiency of different methodologies.
  - Examination of the linkages between biometric methods that monitor growth and yield and those that monitor extraction.
  - Investigation of the linkages between assumed indicators (e.g. market data, photographs) and resource condition for a range of products and contexts.
  - Preparation of guidance on the selection of the monitoring protocols for NTFPs in the form of a decision-support system.

- Sampling
  - Evaluation of the relative efficiency (costs, time, relative precision etc.) of new sampling designs (adaptive protocols) in the field for a range of resources and product types.
  - Evaluation of the potential utility of rank set sampling for utilising indigenous or prior knowledge in the selection of sampling locations.
  - Investigation of the use of local knowledge for generating sampling designs in a way that is biometrically acceptable.

Local community level research

It was decided that the priority is to devise methods to bridge the gap between community inventory methods and top-down (i.e. government, trade etc.) information demands. The biggest problem is arriving at designs that both build on local knowledge, are intuitive to local people and fulfill the information needs of strategic decision-makers.

One co-ordinated approach to community issues in NTFP assessment was proposed. This could be either a single large project or a set of co-ordinated studies following the same process. The component activities suggested were:

- Documentation of existing local knowledge on sampling, assessment, monitoring and analyses.
- Documentation of information needs to which communities have to respond to (e.g. local needs, government, trade).
- Evaluation of local knowledge against information needs and identification of gaps (level of rigour required and appropriate, replicability etc.).
- Development of methods to address the gaps that build on local knowledge and meet the legitimate requirements of external interests.
- Field testing of methods developed.
- Dissemination of successful protocols and experience.

National or international (macro) level research

It was decided that at this level it was logistically desirable to undertake research on inventory and monitoring designs for particular multi-species product groups. The biggest problem is developing the means to amalgamate and verify data from many sources to give a macro-level overview of NTFP utilisation.

Six areas for research were suggested:

- Links/integration with/to existing surveys
- Optimisation of methods for particular product groups. E.g. gum arabic, bamboo, rattan, bark, etc.
- Classification of NTFPs in terms of inventory needs and methods.
- Development of models and identification of indicators that would help to characterise distribution and abundance of NTFPs. Developing ideas on how one would stratify sampling and assessment methods in the context of national laevel planning.
- Linking market information to the resource.
- Identifying the information needs for certification/commercial/ international reporting and identifying measurable variables or indicators of changes in abundance that meet the needs of these stakeholders.

7.2 Further issues raised

There was a strong call for the identification of information needs at different levels before prioritising research areas.

A strong demand was expressed from field workers for advice on sampling designs suitable for specific products and for use by communities. At present past mistakes are being repeated.

It was acknowledged that there is a need for inventory specialists to develop methods for NTFP assessment. What is most urgently required is to develop methods for measuring distribution and quantity of NTFP resources.

There was consensus that further cross-disciplinary work is required to identify protocols that could be adapted for use with NTFPs.

It was acknowledged that when undertaking an inventory the issue of whom one is empowering with the resultant information must be considered.

There was no clear conclusion drawn on whether it is better to take a product approach to NTFP inventory methods development or to use the more generic approach suggested in the review. Both have positive and negative aspects.

It was agreed that biometric rigour is not necessary in all cases and methods that are more 'rough and ready' should also be developed.

It was agreed that the utilisation of indigenous as well as scientific knowledge is important. The linkages between these are not straightforward and require further examination.

It was acknowledged that although full participation of local communities in inventory may not always be attained this is important because of the potential benefits that can be gained. Further work needs to be undertaken on development of methods that can be used by communities.

It was acknowledged that in certain cases it is difficult to prioritise NTFPs for inclusion in inventories and that there are no generic methods for doing this.

7.3 Proposed post workshop activities

Practical training workshop

Participants felt that it would be valuable to have a workshop in the field involving some training in biometrically rigorous methods followed by an examination of the practical problems of applying these. It was felt that the workshop had helped to highlight the need for training. An examination of the practical elements in the field would help to expose the effects of academic background of field workers and the cultural context on the development of methods.

Biometrics hotline

It was suggested that a biometrics 'hotline' would be the preferred mode of delivery of advice to field workers. It was noted that some organisations are already running advisory services of this type, e.g. the UK Natural History Museum provides experimental design advice for the British Petroleum funded exploration projects. The Tropical Biological Association is attempting to provide this kind of service and Reading University provides statistical advice for DFID projects. In addition Christoph Kleinn provides an advisory service covering Latin America from CATIE. The FAO have publications that can assist in this respect but they do not provide an official service where people can e-mail or call an advisor. It was noted that it is time-consuming and therefore expensive to operate such an advisory service. FAO is attempting to set up a permanent network for the discussion of inventory needs and experience.

Discussion group

An e-mail discussion group will be operational over the next 2-3 months that can be used to take forward the ideas developed at the workshop. This will help to translate important issues into concrete research proposals. The results of this discussion will be reported in the final workshop proceedings scheduled for publication later in the year.

Dissemination of research ideas

It was made clear that ETFRN would not market research proposals developed but would ensure that funding agencies are made aware of the workshop and the results of discussions. For information on research funds participants were advised to refer to the ETFRN web site. ETFRN can also help people to get in touch with each other if they are interested in doing research on similar topics but this is only possible if people inform ETFRN about their work and their interests. It was stressed that ETFRN plays a facilitatory role in information sharing on research, it is neither a funding organisation nor a research implementation organisation.

Improvement of methods reporting

A plea was made for adequate reporting of methods in published papers. It was suggested that notices should be sent to journal editors requesting them to ensure that methods are either reported adequately in the journal or that the source of methods used is included in the paper's references. Journals could also be asked to publish news items on the workshop requesting that contributors are encouraged to report protocols fully. Suggested journals to contact included Economic Botany and the People and Plants Programme.

8. Post-workshop activities

The following provides information on known activities up to April 2001 that relate to the workshop.

8.1 Email discussion

An email discussion was conducted through the ETFRN web site after the workshop in order to continue to debate some of the issues that had been raised and the suggested research themes. The discussion was divided into several topic areas and the following provides a summary.

The need for better methods

This topic area was included to give people an opportunity to express their own particular methodological problems. It was envisaged that such input would help to target methodological research and/or technical advice and support systems. Contributors included Trevor Abell, Jenny Wong and Isabelle Gambetta.

Trevor Abell sent in a request for an NTFP manual as he felt that NTFPs should form a component of the national forest inventory programme in Ghana. Isabelle Gambetta requested advice on how to include a variety of NTFPs in one inventory in an efficient manner. Jenny Wong responded to the latter suggesting that one should determine the best design for each NTFP of interest and then come to some compromise between the different designs so that plots could be used for more than one NTFP. She suggested that one should aim to minimise errors for the more important NTFPs and referred the reader to chapters 4 and 5 of the review document (Wong 2000).

Pseudo-replication

This topic came up during the discussion and built on the findings from the review. In particular the fact that poor replication seems to occur quite often in plant survey work. Contributors included Faizal Moola[1], Andrew Robinson, Becky Kerns and Jenny Wong.

Initially an interesting contribution came from Faizal Moola who wished to know why many studies of the spatial structure of plant communities often have low replication and what were the statistical implications of this. Andrew Robinson responded stating that often people were genuinely ignorant of statistical issues. Lack of replication often means that hypotheses of interest cannot be tested, in addition a low number of transects can lead to the breakdown of large-sample theory. Tools do exist for small samples, like the bootstrap, but their usefulness depends on the problem. Becky Kerns provided additional clarification stating that pseudo-replication occurs when there is no replication at the level of the population of interest, i.e. taking the results of a study undertaken in a small area and extrapolating these to draw conclusions about a larger area. Jenny Wong pointed out that people often make this mistake, not realising that such conclusions are not valid.

Objective oriented data collection

This topic came up during the discussion and built on issues that came up during the workshop (see discussion topic 'Information needs' on page 15). Contributors included Paul Van Gardingen, Sheelagh O'Reilly and Jenny Wong.

Paul Van Gardingen started the discussion stating that the workshop had not spent enough time considering issues on data analysis, interpretation and application. He pointed out that many of the suggested research topics were at risk of being 'supply driven' when they should target expressed needs. This requires an initial understanding how data will be used and a definition of the minimum data requirements for such uses. Such a demand led approach has been successful in targeting agricultural research and should be used to target NTFP research. Sheelagh O'Reilly added to this stating that one of the key uses of NTFP data is to support local communities. Here she suggests that the challenge is to apply novel and innovative thinking that will give a high validity to local knowledge and control and develop appropriate low-cost methods that can be implemented in resource poor situations. Jenny

[1] The contributions from Faizal Moola and Andrew Robinson were taken from the forest listserver.

Wong agreed that the development of methodology should be needs driven but pointed out that the results of the review suggested that basic information on distribution, abundance and yield of products is almost always required despite a variety of end-uses for the data. She said that the intention of the workshop had been to concentrate on the technical inventory issues relating to these information needs. She added that any NTFP inventory manual should provide guidance on the analysis, presentation and interpretation of results.

Community level group

This topic was set up to discuss the research proposals that had been put forward by the community level group during the workshop (see section 5.7 above). Contributors included Isabelle Gambetta and Jenny Wong.

Jenny Wong noted that, as concluded by this working group, the Community Forestry Unit at FAO also recognises that there is a gap in the area of determining sustainable yields of forest products.

Isabelle Gambetta stressed that community knowledge is important and useful in undertaking an NTFP inventory. In particular, the use of vernacular names was promoted. Jenny Wong noted that local names are important and useful but that the scientific names tended to more consistent and were needed if one intended to link with scientific knowledge.

Species level group

This topic was set up to discuss the research proposals that had been put forward by the species level group during the workshop (see section 5.7 above). Contributors included Charlie Shackleton, Eric Boa and Jenny Wong.

Charlie Shackleton stressed that monitoring programs need to be focused to avoid the collection of excessive or unnecessary data. Methods need to be developed that are tailored to answer specific resource questions.

Eric Boa and Jenny Wong provided clarification on the pint that the workshop was addressing 'methodology' defined as groups of methods as well as the study of methods.

Macro level group

This topic was set up to discuss the research proposals that had been put forward by the macro level group during the workshop (see section 5.7 above). Contributors included Christoff Klein and Jenny Wong.

Christoff Klein called for the recognition of the fact that a specific research facilitating issue was the need for networking between institutions in the same region. He also asked whether there was really a need to develop new non-traditional methods for inventory design or whether it would be more advantageous to concentrate on applying the more traditional methods. Jenny Wong pointed out that because of the specific problems of NTFPs, i.e.

1. Clumped distribution on a range of scales.
2. Low population on a macro scale
3. Severe limitations on resources (financial, skills and time)

it would be advantageous to investigate the applications of a range of newer, existing, methods to NTFP inventory. She noted further that initial application of adaptive cluster sampling in Cameroon is producing promising results.

Response to the review

In this topic contributors were invited to comment on the review (Wong 2000) that had been placed on the workshop web site. Contributors included Trevor Abell, Juan Alberto Porcar Castell, M. Sivaram and Jenny Wong.

Jenny Wong announced that the review was to be edited for publication in the FAO NWFP series. All contributors applauded the work on the review and several wished to be kept informed of developments.

Juan Alberto Porcar Castell queried the use of ordinal scales for inventorying herbs as described in Box 2 of the review (Wong 2000). Specifically he wanted to know more about the method for determining percentage cover as well as the limitations this might place on

statistical analysis. Jenny Wong agreed that this method can limit statistical analysis and referred readers to Bullock's chapter in Sutherland 1996, which describes a variety of methods.

8.2 Other reported activities

Jenny Wong informed us that a project has been funded by the EU/FAO to develop a decision support system for the design of NWFP inventories in Africa. A major component of this project is the preparation of a draft manual for NWFP inventory followed by the testing and refinement of methods suggested in the draft.

Christoph Kleinn informed us that a project has been funded by the EU under the INCO-DEV programme entitled 'Research for sustainable management of Guadua bamboo in Colombia and Costa Rica'. This project will run for three years commencing in August 2001 and will include elements of inventory, assessment and evaluation as discussed at the workshop. It will be co-ordinated from the University of Freiburg and the research will be undertaken in Costa Rica and Colombia. Research partners include Imperial College, London, UK; University of Costa Rica, San Jose; CATIE, Costa Rica; and the Technical University of Pereira, Colombia.

9. References

FAO (1999) Towards a harmonised definition of non-wood forest products. *Unasylva*, **50**(198): 63-64. (Peer reviewed paper)

WONG, J.L.G. (2000) The biometrics of non-timber forest product resource assessment: A review of current methodology. Report prepared for project ZF0077. Department for International Development, Forestry Research Programme, UK. 174 pp. www.etfrn.org/etfrn/workshop/forum/ntfpwong.htm

10. Annexes

Annex 1 Agenda

European Tropical Forest Research Network (ETFRN)
Forest Research Programme (FRP)

Developing needs-based inventory methods for non timber forest products

4-5 May 2000
Philippine Room
FAO, Rome

Thursday 4 May

09:00 Coffee - registration

Session 1 – Introduction to workshop
09:30 Welcome speech to participants by FAO – Mr El Hadji Sene
09:35 Welcome by Chair – Ms Jane Thornback
09:45 Presentation of general objectives
09:55 Presentation of specific objectives and workshop programme
10:05 Introduction of organisers/facilitators/rapporteurs

Session 2 – The biometric rigour of current NTFP inventory methods
10:10 Overview of paper and identified research themes
10:30 Coffee / tea (served in meeting room)
10:45 Points of clarification

Session 3 – Demand and constraints for NTFP assessment
11:15 Participatory NTFP inventory in rural development forestry - Kate Schreckenberg

11:45 NTFP inventory for NTFP management planning – Mpho Mosate.

12:15 Lunch

13:45 Data needs for national strategic planning and policy development – Paul Vantomme - FAO

14:15 Information for international NTFP monitoring – with special reference to reporting on global forest resources (FRA) – Peter Holmgren – FAO

14:45 Questions

15:15 Tea / coffee

Session 4 – Defining and prioritising the problems and topics
15:45 Plenary: Prioritisation of NTFP information needs
16:15 Plenary: Prioritisation of identified research topics

Friday 5 May

Session 5 – Development of concept notes
09:30 Introduction to group work sessions
09:45 Group work on agreed research themes

10:30 Tea / Coffee

12:15 Lunch

13:45 Plenary session

15:15 Tea / coffee

15:30 Close

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Annex 3 Research themes identified by Dr J Wong

Determining the demand and constraints on NTFP biometrics

In order to prioritise research needs, it is essential to understand where the strongest unsatisfied demand for NTFP assessment lies. In particular it is useful to be aware of the spatial and temporal scale, skill levels of field teams, information needs and context in which the inventories will take place.

Presentations will be made of the information needs, scale and field logistics of NTFP inventory in the following contexts;

- rural development forestry,
- operational management planning,
- national strategic planning and policy development,
- international monitoring and reporting.

The key questions for consideration are:

- Will it be possible to develop generic methods to address these inventory needs? or will each context require a unique set of tools?
- What criteria can be used to prioritise information needs? E.g. severity of current methodological problems? Number of studies being undertaken? Relevance to critical management decisions?

Proposed priority NTFP assessment research topics

The following are a set of six research topics derived from the literature review, or suggested in discussions with practitioners. These topics will be reviewed, prioritised and elaborated for further action by working groups in the workshop and also in an e-mail discussion group on the ETFRN web site.

TOPICS

1. Evaluation of novel sampling designs for use in NTFP inventory.
2. Development of measurement techniques for non-wood products.
3. Development of NTFP resource monitoring protocols.
4. Development of methods to determine optimal harvesting levels.
5. Documentation and dissemination of statistical advice for NTFP assessment.
6. Linking local and scientific knowledge.

The process of prioritisation will be assisted by consideration of the following questions;

- Are there any important issues that that have not been adequately addressed?
- Are there any topics which do not really warrant this much attention?
- Is it possible to prioritise the topics?

The following general questions together with the topic-specific key questions will form the basis for development of research programme ideas for each topic.

- Are there any key questions or issues for this topic which have not been adequately addressed?
- Have the research activities required to investigate each key question been correctly identified? If not, what changes to the proposed activities are required?
- Which skills will be required to undertake the research?
- How and where could the research be field tested?
- How can the results of the research be delivered to those who need it most?
- What are the relative costs of each activity?
- Is it possible to identify potential funding sources for the envisaged research?
- Can we identify people and institutions who would be interested in developing these ideas further?

Research topic 1: Evaluation of novel sampling designs for use in NTFP inventory

Problem definition

Good management has to be informed by high quality, relevant and recent data. This means that sampling, whether for stock-taking or dynamic yield assessment should be objective i.e. unbiased. A series of problems with the more popular sampling designs for NTFPs have been identified:

- conventional inventory designs are inefficient for sparse and clumped populations,
- traditional biometrically rigorous designs are too costly to be afforded from the revenues of low value or uncommon products,
- current practice tends towards the use of subjective short-cuts which may introduce bias,
- there are no formal means of using local knowledge to increase the efficiency of the sampling without compromising objectivity.

There are a range of new or neglected sampling designs and innovations which may offer significant advantages in terms of efficiency and be able to produce unbiased results. Although a few of these have been suggested for use with NTFPs none have yet been evaluated or tested in the field. What is required is a comprehensive review of novel designs and their evaluation in the forest for typical population distributions with the aim to prepare a guide on the use of these designs in a range of contexts. If successful this will serve to enhance the ease and efficiency with which good quality data on the abundance and location of specific resources can be made available to resource managers.

Key questions

- Can adaptive designs (e.g. adaptive cluster sampling, adaptive allocation) which purport to be efficient in sampling sparse populations be adapted to work in a dense forest environment?
- Can prior knowledge be used to generate sampling efficiencies?
- Can methods which do not depend on sampling areas and individuals (e.g. plotless sampling) make estimation of resource availability more straightforward?

Suggested activities

1. Evaluation of the relative efficiency of adaptive protocols in the field for a range of resources and contexts.
2. Field testing of guided transect sampling using remote sensing, habitat or land use maps as sources of prior knowledge.
3. Evaluation of the potential utility of rank set sampling for utilising local or prior knowledge in the selection of sampling locations.
4. Field testing and development of the use of line intersect sampling and its variants for use with linear features and products (e.g. lianas) and for measuring areas.

Review links

6. Conclusions
3. Sampling design
   3.3.2 The value of indigenous knowledge to inventory methodology
   4.5.2 Sampling design – randomisation
   4.5.4 Number of observations - replication
   6.2 Evaluation of novel sampling designs for use in NTFP inventory

Research topic 2: Development of measurement techniques for non-wood products

Problem definition
NTFPs can be derived from a multitude of substances derived from almost every life-form present in the forest. However, there are few protocols for the quantification of forest-based resources which are not derived from the wood of trees. There is a need to provide guidance on suitable enumeration techniques for the range of common product types including exudates, fruit, bark, leaves etc..

In recognition of the need to place information and decision-making in the hands of the resource users it is important to ensure that inventory technologies are accessible to local communities. There are a few examples of user-based enumeration techniques such as hunter diaries and harvester records. There is a need to develop these further, evaluate the conditions required for their successful implementation and disseminate experience of self-assessment systems.

Despite considerable interest in multi-purpose resource inventory, there appear to be few examples of tropical forest studies that include both plants and animals. The best form of forest management would be holistic and ecosystem-based. At present this is barely possible because of a lack of cost-effective means of gathering the requisite data. Facilitation of a unified approach to forest exploitation would require the development of protocols that could accommodate both plants and animals.

Key questions

- Do measurement techniques for NTFPs exist in other disciplines e.g. agriculture, horticulture, animal science? If so how much modification would they need for adoption for NTFPs?
- Are there significant resources for which there are no suitable measurement techniques? How might suitable protocols be developed for these resources?
- Are existing methods for harvester/hunter self-assessment adequate and widely known? If not, what research, by whom, would be appropriate to develop processes for developing participatory assessment protocols?
- Would unified protocols for plant and animal resources be feasible? Is there a strong enough demand for these to justify research? If so, how might such protocols be developed and field tested?

Suggested activities

1 Screening of a wide range of disciplines for product measurement methods for potential use with NTFPs. Development and testing of field protocols derived from the most promising methods. Development of protocols for any common and important product types for which there are no existing methods.

2. Collation and evaluation of user-based resource assessment studies. Development and testing of suitable methods for developing participatory resource assessment techniques, in partnership with interested communities.

3. Development and field testing of unified protocols for plants and animals in a range of environments.

Review links

4. The importance of involving local people 3.7 Yield assessment

1. Participatory issues

5.4 Enumeration protocols 5.6 Yield measurement
6.2 Development of measurement techniques for non-wood products

Research topic 3: Development of NTFP resource monitoring protocols

Problem definition
Monitoring is required in order to gather information on the growth of a resource species, to monitor compliance with regulations and to provide information on the consequences of exploitation.

Designing effective resource monitoring systems is not straightforward. Complexities arise from the need to monitor changing spatial distribution patterns as well as changes over time for specific individuals and sites. There is a lot of interest in NTFP monitoring and growth assessment but there are few studies which demonstrate an appreciation of the statistical issues involved. There is a need to provide guidance on the design, enumeration, data handling and analysis of resource monitoring schemes for use by resource users and managers.

In many cases direct monitoring of resource condition has been deemed impractical and proxies of resource condition such as market or trade statistics have been employed. In the few studies that have been done it appears that such measures can be very insensitive due to distortions resulting from market economics, social factors, pricing, demand and the availability of alternative employment. There is therefore a need to devise means of investigating the linkages between indirect indicators and resource condition and to monitor these in an effective manner.

Key questions
- How many types of monitoring required for the sustainable exploitation of NTFPs are there? What are the key difficulties with each? Which of these would be amenable to biometrics assistance or research?
- Is it possible to have monitoring systems which can tackle a range of issues at the same time or do they require different protocols?
- Will it be sufficient to provide guidance on the use of resource monitoring systems or is there development work that will be required to optimise advice for the particular problems of NTFPs? If development is required, what form should this take?
- Is it practical to develop systems for investigating and monitoring the links between proxy indicators and resource condition?

Suggested activities
1. Collation and evaluation of forest monitoring systems for potential applicability to NTFP resource species. Preparation of guidance on the selection of monitoring protocols for NTFPs in the form of a decision-support system.
2. Investigation of the linkages between proxy indicators and resource condition for a range of products and contexts. Generalisation from this experience of guidance on the calibration and tracking of the degree of association between the proxy and resource condition.

Review links

10. Monitoring
7. Growth and productivity

6.3 Development of NTFP resource monitoring protocols

Appendix 7 Summary of newer sampling methods with potential for NTFP inventory

Research topic 4: Development of methods to determine optimal harvesting levels

Problem definition

Ideally, once good quality data on the abundance, patterns, life history dynamics and productivity of a NTFP resource species are available, the next step is to determine a sustainable level of exploitation. However, experience from fisheries and forestry indicates that this is not a straightforward matter. The difficulties are further compounded by many resources already being over-exploited before any studies or management interventions are initiated. The review indicates that there are three main mechanisms that are proposed for determining sustainable harvesting levels. These are:

- forecast models for ephemeral products,
- population models (matrix) for larger plants and animals and
- periodic harvest adjustments.

Generally these are pragmatic or empirical methods and there is much that could be done to improve the theoretical basis for sustainable exploitation of NTFPs. However, in the interim there is a need to evaluate the utility of each of these methods for wider application to tropical NTFPs and provide guidance on their limitations and use.

Key questions

- How difficult would it be to adopt empirical yield forecasting in the tropics? For example, are there sufficiently good climate records available?
- Are there alternatives to matrix models for the determination of sustainable yields of NTFPs? If so, what level of development would they require?
- Are there ways of simplifying models to make them accessible to local harvesters and retain their effectiveness?
- Are there ways of providing advice on the use of periodic harvest adjustments so they can be easily adapted to different species, environments and contexts?

Suggested activities

1. Evaluate temperate experience with berry forecasting for possible application in the tropics and sub-tropics. Test protocols for a representative range of tropical seasonal fruits. Prepare advice on the use of forecasting methods as a means of regulating harvesting.
2. Evaluate the use of population models for determing harvest levels. Test the potential of each in a range of tropical contexts with reference to the extent of prior ecological knowledge, degree of management control and the technical resources available to the managers. Prepare guidance on possible approaches to the determination of sustainable yields.

Review links

3.9 Determining sustainable harvest levels
6.4 Development of methods to determine optimal harvesting levels

Research topic 5: Documentation and dissemination of statistical advice on NTFP assessment

Problem definition

Despite the intense demand there is a general lack of good quality data on NTFP resources. Many of the studies that have been undertaken in the recent past suffer from problems with design, analysis and reporting. This is due to a wide range of factors including;

- the lack of formal recognition of the biology, management, use, marketing etc. of NTFPs – even the term is unfamiliar to wildlife biologists although all definitions include animal products,
- a lack of cross-disciplinary communication – each researcher drawing only from their own disciplinary experience,
- the lack of text books, manuals and field guidelines dealing with the design, implementation, analysis and reporting of biometrically sound, ecologically appropriate and context sensitive NTFP assessment protocols,
- the lack of readily available advice on the correct procedures for the calculation of errors and statistical testing of the binomial and poisson distributions common in NTFP datasets.

In order to generate synergy among the disparate interests involved in NTFP research and maximise sharing and dissemination of experience and good practice there is an urgent need to improve the level of cohesion among those working in NTFP research. There is also an urgent need to provide easily accessible support to the field practice of NTFP resource assessment and biological science.

Key questions

- What would be the most effective means of delivering advice on NTFP biometrics to all potential users?
- Is there a need for a handbook on alternative means of analysing NTFP data? Can this be written from existing knowledge or is there more development work required?
- Would a network be an effective means of co-ordinating NTFP assessment research? If not what other means should be considered?
- How could a NTFP network reach people active in current assessments? Should the network operate an advisory service as well as preparing and disseminating publications?
- Which institutions would make a suitable 'host' for a NTFP network?
- Would there be any benefit from advocating a more formal recognition of NTFP utilisation as a *discipline*? If so what could it be called and what would be its scope? How might wider recognition of NTFP study as a cross-disciplinary activity be achieved?

Suggested activities

1. Develop a decision-support system to assist NTFP assessment designers to optimise protocols to suit the species, products and context of an inventory.
2. Establish a network for NTFP biometrics.
3. Prepare a handbook for the application of statistical methods for use in the analysis of NTFP datasets

Review links

3. Demand for biometric rigour
6. Documentation and dissemination of statistical advice on NTFP assessment

4.5 Biometric evaluation of reviewed studies

Research topic 6: Linking local and scientific knowledge

Problem definition
The naming of NTFPs is fraught with difficulties which often prevent effective communication between researchers, managers and resource users. Local collectors will use folk names, biodiversity specialists will use Latin names while foresters may use timber trade names. Managers often need to use information from all these sources and therefore requires a means of linking the names together. Experience suggests that recognising all alternative names for a product or species is not a simple matter and lists of equivalent names are rarely complete.

Key questions
- Are there methods by which folk names can be gathered systematically?
- Is it possible to develop a formal system for generating equivalent lists of alternative names for a resource species and products?

Suggested activities
1. Evaluation of the utility of knowledge-bases for managing NTFP names.
2. Development of folk taxonomic models for the collection and recognition of NTFP names.

Review links

2. Naming resource species

3.3.7 The reliability of informal methods
6.5 Linking indigenous and scientific knowledge

Annex 4 Welcoming address by Dr El Hadji Sene, FAO

Ms Chairperson, distinguished participants, ladies and gentlemen, in opening this workshop, please allow me to welcome you in my name and on behalf of the ADG of the Forestry Department. I would like to extend my sincere thanks to the European Tropical Forest Research Network and the Forest Research Programme of the Department for International Development (DFID) for convening and funding this important event and for giving the opportunity to FAO to host the meeting in Rome.

Ms Chairperson, ladies and gentlemen, several million households world wide depend heavily on non-wood forest products for subsistence consumption and/or income. Some 80 percent of the population of the developing world use NWFP for health and nutritional needs. At a local level, NWFPs also provide raw materials for large-scale industrial processing, including for internationally-traded commodities such as foods and beverages, confectionery, flavourings, perfumes, medicines, paints or polishes. Presently, at least 150 NWFPs are significant in terms of international trade, including honey, gum arabic, rattan and bamboo shoots, cork, forest nuts and mushrooms, essential oils, and plant or animal parts for pharmaceutical products.

Non-wood forest products have attracted considerable global interest in recent years due to increasing recognition of their contribution to household economies and food security, to some national economies, and to environmental objectives such as the conservation of biological diversity. FAO assigns a great importance to NWFPs. Since 1991 the FAO Forestry Department has maintained a programme, "The promotion and development of Non-Wood Forest Products". This programme aims at enhancing the sustainable utilisation of NWFPs in order to contribute to the wise management of the world's forests and the conservation of their biodiversity and to improve food security for rural people. Besides this specific programme, other technical units in FAO cover various aspects of NWFP promotion and development. Among others, the Forest Resources Division with the Sustainable Management of Natural Forests Programme, the Arid Zone and Mediterranean Forestry Programme, the Community Forestry Unit, the Forest Products Marketing Programme, the Forest Products Trade Programme, and some units of the Agriculture Department and of the Economic and Social Department.

Dear Participants, your being here today comes at a most opportune time when the importance of accurate information as a basis for planning sustainable forest policies and interventions is more and more recognised and the need for improved methods for data collection in the forestry sector is felt at all levels. Good data are needed to document the role of NWFPs in supporting livelihoods (e.g. their contribution to household nutrition and income), and to orient actions towards improved forest resource management (knowledge of the biology of the resources providing NWFPs, levels of use, etc.).

The subject of this workshop is “developing needs-based methods for NWFP”. Aspects such as how to design NWFP inventories, who should be involved in this, what is the state of the research, what are the constraints, where are the major needs felt, and what would be the most important research themes to be developed, are among the topics which will be discussed during the next two days. These topics are of high interest to FAO and to the work we are conducting to increase the capacity of our member countries to collect better data on forests. This is why we have responded positively to the offer to collaborate with the FRP and ETFRN on this subject.

We are pleased to see that this collaboration has brought to Rome a group of motivated and interested persons who will share ideas and experiences. The heterogeneous nature of NWFPs and the multitude of their end-uses calls for multidisciplinary involvement and co-ordinated efforts. The FAO believes that building partnerships between all stakeholders is the way to go about promoting sustainable NWFP development. We hope that successful collaboration with all of you will continue in the future.

I wish you all a successful workshop and a pleasant stay in Rome. Thank you.

Annex 5 The biometric rigour of current NTFP inventory methods: Overview of review paper and identified research themes.

By Jenny Wong, UK

Introduction

About 18 months ago, the Forest Research Programme of the UK Department for International Development initiated a pre-project (ZF0077) with the intention of identifying the researchable constraints in the biometrics of current NTFP resource assessment methods. The first stage of the pre-project was the preparation of a review of the biometrics of current methods. The following is a summary presentation of the results of this review.

Review methodology

A literature review was undertaken of the anglophone literature. Literature in other languages was not reviewed because of the difficulties of obtaining and translating non-anglophone literature in the UK. This is unfortunate as, during the course of the study it became apparent that there are considerable bodies of experience and literature available in Spanish (e.g. the work of CATIE), Russian, Finnish and Japanese. However, within these constraints I endeavoured to be as inclusive as possible. This meant taking a broad view of what constitutes an NTFP study and material from the following disciplines was reviewed:

- Biodiversity inventory
- Social science techniques e.g. IK and household surveys
- Anthropological methods e.g. ethnobotany and quantitative ethnobotany
- Economic methods e.g. valuation studies and market and income studies
- Quantitative plant inventory e.g. forest inventory
- Wildlife management
- Autecology

In screening these disciplines I did not assess all material in detail but attempted to get a feel for the breadth of study types covered by each. Although the definition of NTFPs is commonly understood to include animals as well as plants, most work that uses the term 'NTFP' focuses on plants. However, animals were included in the review due to expressed demand from foresters. It was discovered that there is a body of work on the sustainable harvesting of animals reported in wildlife journals that has interesting parallels with that being undertaken on plants. However, there is little crossover between the disciplines. Based on this discovery the reviewer started to examine the literature of further disciplines for relevant material and also broadened the study to include temperate work. Even so, the review is by no means exhaustive.

During the course of the review nearly 400 references with relevance to either inventory methods or the assessment of NTFPs were collated. The criterion for including papers was that they should concern some plant or animal resource that was being exploited by people. The sub set of 126 studies selected for biometric analysis included the enumeration of some characteristic of the resource, e.g. its abundance, growth rate, yield or describe monitoring methods. The review paper contains a large appendix that tabulates the protocols used in the 126 studies as a resource to be used in the identification of gaps and good practice.

Of the 126 studies, it was discovered that, although several of them included the term 'inventory' or 'quantitative' in the title, they were not in fact biometric resource studies. Some of these studies were designed to produce a list of useful plants in a particular forest while others quantified the usefulness of the plant or forest rather than the abundance of the resource itself. After excluding these, 97 quantitative NTFP resource studies remained for analysis.

In order to assess the biometric qualities of the studies it was first necessary to establish criteria for judging biometric quality. It must be stressed that in defining these criteria the focus was on the biometric quality of the resource quantification aspect of a study. No other aspect of the study was being judged, i.e. the review was not judging whether a study was

relevant to the questions or whether it had produced something useful. So if a particular study has been judged badly it does not imply that it was a bad study, only that the quantification methods could have been better. Four criteria were defined for the purposes of the review.

Reporting of protocols

I originally selected three criteria but soon found that a fourth had to be added, as many of the studies did not report methods sufficiently well to make a judgement of their biometric quality. This was very disappointing as even papers that had been taken from peer reviewed journals failed to report how plots had been located, whether plots had been used, how big they were and the number of plots measured. Therefore the first of the four criteria had to be whether protocols had been adequately reported.

Of the 97 quantitative studies: 14% gave no details of how plots were located or distributed and 26% did not report exactly how many plots were measured. To be able to perform my analysis I needed to know, how plots were distributed, how many there were and what they looked like. Although this is very basic information it was only reported in 61% of the studies. This is actually a rather more serious failing than simply preventing me from doing my analysis because if protocols are not carefully reported it is not possible for anyone else to judge the value of the results, to learn from, or replicate the study elsewhere. This lack of attention to detail is one of the reasons why NTFP researchers are struggling with methodology.

Randomisation – reducing bias

I have used the term 'randomisation' to indicate whether the plots were distributed in such a way as to minimise potential bias in the results. The classic statistical advice is that plots should be located randomly (a design based approach). This can often be difficult to achieve in the field and there are mapping advantages to using systematic designs (using a model-based approach). I did not insist on random plots but wanted to see that there was some thought given to sampling design that would minimise the risk of bias. There are many different designs that can be used for resource assessment as illustrated in Table 1. There is some degree of overlap between the designs listed in Table 1; you can have a stratified subjective design, stratified random design and many other permutations, all of which are acceptable. The problems are really in the last two, subjective and opportunistic sampling.

Table 1 Sampling designs used in the reviewed studies

Design	Number	% of studies*
Census	5	6.0
Random	18	21.7
Systematic	24	28.9
Experimental designs	3	3.6
Stratified	21	25.3
Subjective	18	21.7
Opportunistic	11	13.2

Percent of the 83 studies that reported sampling designs.
Note percentages do not add to 100 as many studied combined designs i.e. stratified random etc.

Subjective designs are those were the researcher chooses where a plot is going to be located. This is often done as a cost-cutting exercise, the argument going; I have only got two weeks here so I am going to use my professional judgement to select a typical bit of forest in which I will place one plot which will be representative of this forest type. This can be a perfectly acceptable approach for some purposes but is not acceptable as a basis for quantifying the resource. As an example of the problems, one study considered the problem of how many plots would be required to typify a 54 ha grove of Sequoia in California. It was discovered that there was significant variation in tree density across the grove and that one plot in the centre would not be representative of the whole grove. If this is the case for 54 ha patches it is certainly not possible to say that one plot represents the whole of Amazonia.

I termed plots which had been located only in accessible areas opportunistic rather than subjective because I felt that in many of these cases people where trying to make the best of a logistically difficult situation. Access constraints can be severe in many tropical forests and it is often not practical to simply advise that plots are located in inaccessible areas. However,

under the rules such studies have to be judged poorly and I suggest that improving the quality of estimates derived from opportunistic sampling is something that might be an interesting research question.

Of the 83 studies that reported their designs well enough to be able to assess the quality of the sampling design, 22% were subjective and 13% were opportunistic. Adding these together means that 35% of the studies had not located their plots according to biometric principles.

Replication – sample size

For a study to be statistically sound it needs to contain a number of plots. It is not possible to calculate a mean from one observation. A good biometric study should be capable of generating sufficient data to calculate a mean and sampling error, which requires a number of plots. In my analysis of the number of sample plots in each of the studies it became apparent that there is a link between sample sizes and the type of study being undertaken. Table 2 illustrates the number of studies using a range of sample sizes for different types of studies.

Table 2 Number of plots used in reviewed studies

Type of study	Number of plots reported									Total
	1	2-19	20-39	40-59	60-79	80-99	100-499	>500	Many	
Demographic	3	1	1				2			7
Ethnobotany	3	2	1				1			7
Experimental		2	1	1						4
Harvesting		3			1	1				5
Inventory	1	10	6	1			6	6	6	36
Market		1					1			2
Methodology	1	3	2				1		1	8
Monitoring	1	5		1				1		8
Social								1	1	2
Yield	2	6	1					2		11
Total	11	33	12	3	1	1	11	10	8	90

Overall, 12% of the studies that quoted sample sizes used only one plot. These are studies that are definitely not biometric. A further 36% used sample sizes of less than 20 plots which is really still too few to calculate reliable means and errors. This means that 48% or just less than half the studies used small sample sizes. Only 32% of the studies used sample sizes of more than 100 plots and these are mostly national level forest inventories that include the enumeration of NTFPs. However, to be fair to the various type of study, one has to consider that they don't all have the same internal imperative for large sample sizes. For example, experimental designs generally work with small numbers of plots in highly ordered designs that are biometric.

Plot independence

This criterion was developed to check whether plots were independent of each other. This may seem to be a strange criteria to use but I found it necessary to include it when I discovered several studies that apparently had large numbers of plots but on closer examination these were discovered to be contiguous. Plots that touch are not independent observations as the presence of a large tree in one plot could shade and therefore influence the next plot. Touching plots should more properly be treated as sub-plots rather than as separate plots. There were relatively few studies (six) that failed this criteria but it is worth emphasising that I used 'plot' in a very wide sense as illustrated in Table 3. In order to be statistically sound it is necessary to try and ensure that whatever the plots are (interviews, people, 10x10 m areas of forest etc.) they are independent of each other. This applies to the choice of interviewees as it does to more conventional forest plots.

Table 3 Plot types used in the reviewed studies

Plot shape	Number	Comments
Arealess	1	
Circular	6	
Household	1	Households taken from village usually for interview s
Square	18	
Rectangular	14	Length greater than width but not excessively so
Strip	8	Long, thin plot of pre-determined length
Transect	7	Fixed width and variable length
Line transect	7	No width or variable width and variable length
Line plot	3	Plots spaced along a line
Cluster	6	Groups of plots at a sample location or 'plot'
Compartment	3	Forestry management units
People	5	
Individual plants	2	Trees etc. selected from sample for measurement of yield or growth
Torus	1	Arrangement of strips around a square
Timed	1	
Days	3	Days on which observations made i.e. as in hunter diaries
Interviews	1	Interview occasions – maybe with the same people
Net hunt trips	1	
Informal cruise	2	

Overall assessment of biometric rigour

Putting all of this together meant that in order to be judged biometrically adequate the study had to well reported, have plots distributed in a considered way to minimise bias, there had to be more than one plot and the plots had to be independent of each other. Table 4 gives the proportions of studies of different types that could be considered biometrically adequate.

Table 4. The biometric qualities of the reviewed studies

Study type	Studies	Protocols reported (%)	Biometrically 'good' (%)	Comments
Biodiversity	3	66	0	Often subjective but justifiable?
Demographic	9	44	22	Often based on single study plots or stands
Ethnobotany	10	50	20	Including quantitative ethnobotany
Experiments	5	80	80	Insufficient replication of treatments
Harvesting studies	5	80	60	Insufficient replication of treatments
Resource inventory	42	69	57	Insufficient plots
Mapping	3	0	33	Biometric sampling not a major concern?
Market studies	2	50	0	Econometric not biometric criteria apply
Methodology	11	64	55	Problems with contiguous sub-plots
Monitoring	12	50	25	Different biometric criteria also apply
Rapid assessment	1	100	0	Rapidity and rigour not compatible
Remote sensing	2	0	0	Did not report protocol for ground truthing
Use of secondary data	6	10	17	Did not report protocols for original dataset
Social surveys	2	50	50	Sociometric not biometric criteria apply
Yield studies	13	46	8	Subjective selection of sample individuals
TOTAL	126	56	38	

Some of the figures in Table 4 illustrate the dangers of using small sample sizes. For example, I only included two market studies. Of these 50%, or one did not report its protocols and the other does not pass my criteria. Of course, one would not use this as a basis for judging the biometric quality of all market studies but this is in effect what one is doing when calculating the yield of a NTFP based on only a small number of plots. Someone's livelihood could depend on recommendations based on such data.

The overall conclusion of the biometric review is that only 38% of the 97 quantitative studies examined passed my four criteria of biometric quality. However, to be fair some of these studies may not need to be biometrically rigorous. What is perhaps more of a concern is that

43% of resource inventory and 90% of yield studies that failed in some way. These are studies that usually have quantification as a primary objective and it seems clear that there is a serious problem in the methods currently used for NTFP resource quantification.

Is biometrics important?

Having discovered that many NTFP studies are not biometric the next question we need to ask is, does this matter? Most NTFP studies are associated with management of resources in some form or other. As in all forms of management inventory the methods should be matched to the information needs of the management system and need not be biometrically rigorous as long as objectives are met. This is why this workshop is 'needs-based'. Rather than presume to speak on behalf of the users, we will have three speakers after the break who will present the perspectives of a range of NTFP management and information contexts from the local to the macro scale.

Identifying research gaps

Having completed the review I had to then try and identify areas where applied research into quantitative methods could help resolve some of the deficiencies discovered. It seems apparent that there is huge gap between biometric ideals and current practice, which is why the research topics are more or less exhaustive. However, the topics that follow are a personal impression of where the gaps are. One of the reasons for holding this workshop is to open up the discussion on the identification of research needs in NTFP biometrics to a wider group of interest.

Identification of the research topics was based on the findings of the review and also a wider reading of work on natural resource inventory. In summary the major problems in NTFP assessment methodology were identified as:

1. Problems with adopting traditional forest inventory techniques for NTFPs

The easy solution to the problem would be to adopt traditional forestry inventory techniques for NTFPs. Unfortunately, this does not seem practical as there are certain characteristics of NTFPs which are not easily accommodated in traditional forest inventory. The main difficulties being;

- Rarity - many NTFPs are rare which means that only a few plots of a conventional systematic or random inventory will contain the species of interest.
- Imperfect detectability - people dealing with trees generally do not deal with the problem of having to search for an elusive or moving target because trees are generally easy to find. Unfortunately, many NTFPs are not that easy to find, animals are NTFPs too, and cryptic organisms such as mushrooms, also require that detectability is considered. Yet this is an area that is familiar to wildlife ecologists.
- Seasonality - many NTFPs are seasonal, fruit and leaves appear and disappear over a year and may vary dramatically between years. In comparison timber amounts are static, consequently forest inventory methods do not cope well with seasonality.
- Motility - animals run away, fruit falls off a tree and rolls down a hill. Again this is an area where NTFP studies can borrow wildlife techniques.
- Quantification of yield for non-destructive harvesting - most of the methods for determining yield from a forest are to do with timber. If you harvest timber you cut the tree down and generally the individual is killed. For many NTFPs only a small part of the individual is harvested. The review suggests that there is little theoretical background for determining sustainable harvesting levels for parts of a plant.
- Incorporation of local knowledge – most NTFP studies value local knowledge of the resources being considered but there is, at present, no formal means of using this knowledge to optimise inventory designs. The many studies that have struggled with the problem of linking local and scientific knowledge also suggest that this would be a fruitful area for research.

2. Lack of properly researched NTFP-specific sampling designs.
There are relatively few research studies that looked at optimising sampling designs specifically for NTFPs. Most of these studies have been done on rattan and unfortunately, several of these had their own failings mostly to do with plot independence (the trial plot sizes and shapes were contiguous and from only one study site). So even for rattans there is still development work that needs to be done.

3. Little guidance available on development of appropriate NTFP measurement (mensuration) techniques.
Looking at the literature it would appear that there has been quite a bit of work done on measuring tree fruit and rattans. However, closer inspection reveals that even for rattans there is no standard mensuration technique. There are several methods in use for estimating the length of stems and there are a range of alternative parameters that have been used, e.g. cane length, dry weight or headloads. For fruit there is also a wide range of methods in use but most of these are either common sense or borrowed from ecology, there has only been cursory work on the potential use of methods used in horticulture for cultivated trees. Even for the most intensively studied products there is little advice or standardisation of methods and for less common ones there is often nothing at all.

4. No application to NTFPs of sampling designs tailored to monitoring needs.
There has been no application to NTFP monitoring of any of the statistical thinking on monitoring. There has been quite a lot of work done, especially in the USA, on forest monitoring protocols. Monitoring from a statistical point of view is actually quite a difficult thing to do. There is a problem with controlling the power of the design to discriminate change. Precise observations are required at each time interval to actually detect changes. If the data is imprecise the changes may reside within the errors of the estimates and mask any real change. There has been quite a lot of work done on how to address these problems but to date they have not been applied to NTFPs. This is yet another example of the lack of crossover from other disciplines into NTFP studies.

Precise monitoring is often very expensive so many NTFP monitoring studies use indicators to track changes in the resource. However, there is little known about the linkages between indicators and the resource base. Where this has been studied it has often been shown that changing offtakes or harvest levels (a common indicator) is not directly linked to resource condition. What is required are some relatively easy means of determining and tracking change in the relationship between the chosen indicator and resource condition.

5. Difficulties in determination of the sustainability of harvesting
One of the starker findings of the review is the general lack of good quality data and the almost complete absence of a theoretical background for determining sustainable yield of NTFPs. So despite the many hopes that NTFPs can be managed sustainably it appears that in many cases the data or the means to demonstrate that this is possible is lacking. I suggest that this is a very severe and urgent problem.

The next few points move away from identifying problems and consider potential ways forward.

6. Application of novel sampling strategies to NTFPs
There are a range of newer (at least to forestry) sampling techniques such as rank set sampling and adaptive cluster sampling that appear to offer certain advantages for NTFPs. Rank set sampling in particular appears to offer an opportunity to incorporate local knowledge and dramatically reduce the number of plots required to achieve a specific sampling error in an unbiased manner. Adaptive designs may likewise be able to concentrate sampling effort on the target species and thereby increase the cost-efficiency of sampling as well as the possibility of being developed in manner that would be more intuitive to less technical people. So there is new methodology out there, however, I am informed that it is at the cutting edge of statistics and it has not yet been applied to NTFPs.

7. Cross-disciplinary exchange of ideas and methods suitable for use with NTFPs
There is an urgent need, as has been repeatedly highlighted in this presentation for cross-disciplinary exchange in the development of NTFP specific sampling designs and methods. There are many bits and pieces in a wide range of different disciplines but no crossover between them. In this respect I would like to suggest that we try to identify NTFPs as wild-grown products from natural or semi-natural environments. Although there are many products that lie in a grey area between the wild and domesticated it seems that the problems of managing cultivated and wild products are quite different and this needs to be reflected in methods selected for their quantification, management and monitoring. This is not to say that there are not large areas where techniques and ideas can be shared.

8. Effective communication of advice to fieldworkers and communities
To be effective any advice we have to offer and the results of any research undertaken has to get to the people in the forest. Research needs to be developed in the field in a manner responsive to expressed needs and then put into a form appropriate for use by field technicians and people in village communities. This again brings us back to the reason why we have invited so many people representing different interests to this workshop – it is because any research has got to remain relevant to the needs for information in the forest.

Research topics
In summary the research topics I have proposed for your consideration are the following:

Topic 1: could any of the newer sampling designs be used with NTFPs? If so would they really offer any advantages over traditional designs?

Topic 2: how far is it possible to borrow product enumeration techniques from other disciplines, how might they need adapting for NTFPs and what gaps might still remain?

Topic 3: we need to develop NTFP resource monitoring resource protocols. This should be considered from a statistical as well as a logistical viewpoint. This is an important and pressing issue for a lot of people, CITES for instance use harvest records to monitor elephant populations. Effective monitoring is a generic problem in the management of wild resources.

Topic 4: we need to develop methods for determining optimal harvesting levels. Answers are required to questions such as: Is 10 fruit per tree per year going to be sustainable? Are current harvesting levels going to cause the population to be extinguished in the future? At present we don't have the means to address such questions.

Topic 5: we need to get all of this out into the hands of field workers. There is a lot of advice we could give even now and it is not getting to the people who need to know it. So I have identified this as a particular issue though it is not really something that requires research *pers se*.

Topic 6: we need to link all these pools of knowledge together. It is necessary to build bridges between local and scientific knowledge and also between the various disciplines represented by 'science'.

Annex 6 Participatory non-timber forest product inventory in rural development forestry

By Kathrin Schreckenberg, Overseas Development Institute

Introduction

The World Forestry Congress session on Non-wood forest products (NWFPs) "*recommended that participatory programmes be developed, involving local people in the evaluation of the NWFP resource base and in planning the management of resources for sustainable production, harvesting and use of key NWFPs, and that these programmes be incorporated into government policies;…*" (quoted in Non-wood News 5, March 1998, page 3). This is an ambitious goal to achieve because, despite some of the unique characteristics of forest products, there is no distinct set of research methods that can be applied. Rather, as pointed out by Wollenberg (1998), we need to be entrepreneurial in identifying appropriate methods from a variety of disciplines and learning how to adapt them. This is certainly true in the case of non-timber forest product (NTFP) resource management as conventional forestry or ecological methods are not sufficient to meet information needs.

This paper looks first at the actors involved in rural development forestry and the interests they might have in carrying out participatory non-timber forest product (NTFP) inventories. It then outlines some of the data likely to be collected in a participatory inventory and discusses the main constraints faced by a community embarking on such a project. The paper then turns to participatory monitoring and its potential to provide management information in a simpler and more cost-effective manner than through the use of full-scale resource inventories.

Who is involved in rural development forestry?

Rural development forestry is a broad term encompassing a great variety of actors and activities. There are a number of actors at the national and international level such as donors and national policy-makers, but the immediate stakeholders include:

Local communities

At the local level, most interest in the forestry sector is currently focused on work with communities to improve management of their forest resources. Participatory forest management, joint forest management and collaborative forest management are all forms of co-management or partnerships with the state, in which the emphasis is on the contribution of communities (Brown, 1999). Amidst all the enthusiasm for working with communities, it must not be forgotten that each community is essentially a heterogeneous group of individuals or sub-groups with a wide range of interests and capabilities, all of which need to be taken into account if management is to succeed.

Individual local people

Although at the local level the forestry profession is predominantly concerned with working with community forest resources, many individuals also have important tree resources. These range from scattered parkland-type arrangements to planted woodlots as well as patches of naturally regenerated forest. There is a growing realisation that as population densities increase, tree resources shift from the forest to the farm (Arnold and Dewees, 1995) and that, taken together, on-farm tree resources may make up a significant proportion of a country's forest resources. Many are planted or retained to provide resources previously collected from the forest, including a large number of NTFPs (Leakey and Newton, 1993))

Government departments

Forestry departments are the government agencies most concerned with management of forest resources. However they are often under-resourced and, depending on the type of forest resource, too narrowly focused on management issues related to timber production. It is often agriculture departments that are more concerned with trees on individual farms and may be responsible for extension programmes covering agriculture, forestry and sometimes livestock. Environment departments, where they exist, and livestock departments may also have important roles to play in determining the use of forest resources. While other departments such as Transport and Industry do not have a forestry remit, they may also take decisions with important impacts on the management of local forests.

NGOs and projects

In principle, co-management need only involve two partners - the community and the state. In many cases, however, NGOs and/or projects act as facilitators in the process or provide the funds and human resources necessary to initiate activities. Projects can be extremely important in providing the context for the development and testing of new approaches which can later be applied in wider areas.

Private sector

Depending on the type of resource involved, the private sector including timber merchants and traders in a variety of NTFPs may be an important player at the local level.

Community participation in NTFP inventories

Each of the above actors may have their own reasons for wanting to carry out NTFP inventories. Some of these (such as national-level reporting requirements) are dealt with in other presentations at this workshop. The participation of community members in NTFP inventories may range from being employed to collect data, to being collaborators, partners or directors (see Box 1). Employing local people in inventories is now fairly standard practise and the value of consulting them on aspects of the local resource is widely recognised (Wong, 2000; Lund, 1998; Carter, 1996)

Box 1. Participatory research and action: a continuum of approaches

Mode of local people's participation	Type of participation	Outsider control	Potential for sustaining local action and ownership	Role of local people in research and action
Co-option	Tokenism – representatives are chosen but have no real input or power	**********		Subjects
Co-operation	Tasks are assigned, with incentives; outsiders decide agenda and direct the process	********		Employees/ Subordinates
Consultation	Opinions asked; outsiders analyse information and decide on course of action	******		Clients
Collaboration	Local people work together with outsiders to determine priorities; outsiders have responsibility for directing the process	*****	***	Collaborators
Co-learning	Local people and outsiders share their knowledge to create new understanding and work together to form action plans; outsiders facilitate	***	******	Partners
Collective action	Local people set and implement their own agenda; outsiders absent		**********	Directors

Source: Carter (1996) based on Cornwall (1995)

This presentation will therefore focus on the still rather problematic areas of achieving a greater degree of participation (i.e. collaboration, co-learning and collective action) by communities in NTFP inventories. The type of community participation achieved may vary in

different parts of the inventory process. Thus Hamilton (1996) describes several stages in an inventory of a proposed community reserve in Namibia that progressed as follows:

- The agenda was set by the community through *collective action* at the invitation of outsiders to assist in undertaking an assessment of the forest resource;
- The assessment was *collaborative*, i.e. outsiders directed the process but the priorities were set by the community;
- The consideration of management options involved *co-learning.*

There are relatively few well-documented cases of participatory NTFP inventories (Wong, 2000). Much of the information in this presentation is therefore drawn from more general work on participatory assessments and monitoring of forest or agricultural resources.

Community-level objectives for NTFP inventories

The distinction made by outsiders between timber and non-timber forest products is often an artificial one. Local people are likely to use all types of products (and services) from the forest and a more important distinction in terms of information needs for management may be that between products used for subsistence and those harvested for commercial ends. Thus Profizi (1998) contrasts traditional management systems (involving little exchange with outside parties and limited environmental impact) and modern management systems (involving intensive harvesting and exchange through organised and well-established marketing routes. Interestingly, in the cases reviewed by Wong (2000), most of the Latin American work was found to be related to commercial scale exploitation in extractive reserves, particularly focusing on yield levels of fruit from oligarchic forests. In contrast, many of the studies emanating from Africa were aimed at stabilising protected areas through collaborative forest management for NTFPs. Situations may shift from subsistence NTFP use to more intensive exploitation of fewer species (Arnold and Pérez, 1996). When this happens, as in the case of *Prunus africana* on Mount Cameroon, exploitation may become damaging to the health of the resource (Acworth, pers.comm.).

Communities are likely to have a range of often overlapping reasons for wanting to carry out NTFP inventories:

Securing tenure and rights to resources

In a growing number of countries, communities are being offered the chance to have their traditional use of forest lands recognised under modern law. Often this is in the form of some kind of community forest, the establishment of which may require the existence of a management plan. Cunningham (1996) highlights the increasing incidence of people's use of NTFPs being taken into account on resource-sharing arrangements in and around conservation areas. In Nepal, for example, statutory Joint Forest Management agreements require the resource to be inventoried, management plans to be approved and routine monitoring to be established (Ingles *et al.*, 1996, in Wong, 2000). An inventory is not required in advance of the approval of a community forest in Cameroon, but must be carried out before exploitation is permitted (Brown, 1999). In Namibia, the setting up of a Community Forest Reserve is preceded by a requirement of the Directorate of Forestry to know 'what's in the reserve' (Robinson, 1998). Here, as in many cases, what represents adequate information may not always be legally defined (Carter, 1996).

Compensation

In situations where communities lose access to a proportion of their resources, whether through the activities of a timber logging company, the construction of a road or the designation of a national park, they may be interested in establishing the value of the resource in order to claim compensation (e.g. Stockdale and Ambrose, 1996). While valuation of forest products (particularly services) is very complex in itself, it may by-pass the need to carry out an inventory of the natural resource by establishing the value of the harvested product through surveys of the harvested or traded products.

Managing forests sustainably and for greater benefits

Whether the fact is recognised by modern law or not, many communities already manage their forest resources and are keen to improve the benefits they obtain from the forest without risking over-exploitation of the resource. Thus Mupapama village in Namibia requested assistance in carrying out an inventory of particularly useful tree products (wild fruit and construction poles) both to meet the presumed information needs for the establishment of a

community reserve, as well as to provide the background information necessary to develop tree management options and rules and regulations concerning access to trees outside the proposed reserve (Robinson, 1998). In the Brazilian Amazon, communities along the Capim River were assisted by the Rural Workers Union of Paragominas to find research collaboration from the Woods Hole Research Centre to answer the questions 'Are the resources we lose from logging more valuable to us than the cash we get from selling the timber?' and 'Are there other forest resources we might sell in lieu of timber?' (Shanley, 1999). In Nepal, many Forest User Groups are finding that they need more information about harvestable yields in order to increase the levels of benefits in a sustainable manner (e.g. Pokharel *et al.*, 1999; Maharjan, 1998).

Monitoring species of particular value

Interest in a particular species may be encompassed within the desire to manage the whole forest resource sustainably. It is nevertheless worth considering separately as the methodological implications of carrying out an inventory for a single as opposed to several species may be important. Inventory needs for single species are likely to be greatest where their products are harvested for commercial purposes rather than subsistence. Thus Andersen (1998) found that *Iriartea deltoidea*, a common and widely used palm in Amazonian and coastal Ecuador, was being sustainably harvested for local use, but that commercial use (largely determined by access to transportation) could trigger a decline in the population. Determining the potential of such species to contribute to improved forest-based livelihoods through increased commercialisation is an important reason for carrying out single product inventories, as is the desire to assess the potential of a particular area for exploitation of a known commercial product (Wong, 2000).

Data requirements for community-driven NTFP inventories

The data required by a community-driven NTFP inventory are likely to be similar to those collected in an externally directed inventory, though the level of detail and methods of collection may differ. The exact nature of the information required, and the necessary level of biometric rigour, will depend on the precise objectives of the inventory which, whether community or outsider driven, must be clearly established from the start. Highest rigour is needed for objectives which require quantitative data especially if called for at national level or for decision-making, while less rigour is needed for studies which only require value judgements or can be addressed non-quantitatively (Wong, 2000).

The type of data required include:

- *Spatial distribution of the resource*. Communities will probably already have a good idea of the spatial distribution (both aerial extent and degree of clumping) of the resources they use. However, where they are interested in developing new products or where they are carrying out inventories in order to substantiate land claims, some kind of mapping will be necessary. Whereas scientists would want to inventory broadly across a landscape, communities may be satisfied with assessments of the resource in existing harvest areas.

- *Tenure.* Where the inventoried resource is distributed across different tenure regimes, as may be the case for parkland trees in West Africa (Boffa, 1999) for example, this may be an additional piece of information needed by communities attempting to develop management plans.

- *Resource abundance and population structure.* Having located the resource in the landscape, an externally directed inventory would normally aim to carry out a base-line inventory of the abundance of the resource and its population structure. While these are often also desirable at the community-level, it may be possible to by-pass a full-scale inventory and work on harvest records instead, or develop monitoring systems that do not rely on a base-line (see below).

- *Data on productivity levels.* These are important for management planning but may be expressed differently by community members and outsiders. Thus Shanley (1999) notes that community members in Brazil preferred to determine fruit production per tree, whereas outsiders tended to work on a per hectare basis.

- *Demand levels.* To put the natural resource information into context and develop sound management plans, communities need good information on use levels (by whom, seasonality, etc.) and potential demand. This is particularly true if products are being used for commercial purposes, in which case demand may fluctuate quite dramatically with little or no forewarning, representing a threat to the sustainability of the resource. Subsistence products, on the other hand, are less likely to suffer suddenly from over-exploitation.

- *Harvest methods.* For many products, harvesting methods are likely to be well known by most of the community. However, where outsiders are involved in collection and/or destructive harvesting methods are employed, the extent to which different methods are applied may also be of interest. E.g. in the case of wild oil palms in central Benin, tappers from outside the area cut down the trees to access the palm wine, thus destroying the source of palm nuts, a major livelihood component for many young men and women in local communities (Schreckenberg, 1999).

On the basis of the above data, communities should be able to define sustainable harvest systems, supported by an appropriate monitoring system. Unfortunately it is not always easy to obtain all the necessary information. The next section deals with some of the constraints communities may need to overcome.

Constraints for community-based NTFP inventory

As in so much of development work, the challenge we face today is that of scaling-up from individual project experiences to broad approaches that can be applied in many different contexts. Most of the studies reviewed by Wong (2000) have taken place at local scales and are essentially experimental in nature, rather than being institutionalised. Peters (1999) asks wryly how many of the monitoring and management activities promoted by the hundreds of projects focused on the development, marketing, and sustainable exploitation of tropical NTFPs will be continued after the outside technical assistance has been withdrawn?

Why is it that it seems to be so difficult to promote NTFP inventories on a larger scale? This section will look at some of the main constraints faced by communities wanting to inventory their NTFP resources. Underlying all the following points is the fact that management of NTFPs is often not as important to local people as outsiders would like to think even though they may represent an important safety net during difficult times, NTFPs are often not a priority for local people in the way that agriculture, livestock, or other subsistence and income-earning activities may be. It is understandable, therefore, that communities are not immediately willing to invest the time and energy required to inventory and monitor the resources except in cases where particular NTFPs are of commercial value to larger groups of people. This is particularly likely to be true if the inventory methods promoted are considered to be very difficult to apply.

Other than the basic issue of willingness to carry out an inventory, community-based NTFP inventories face the usual constraints linked to inventories of lack of resources (time, funds, skills) and organisational difficulties. In addition, peculiarities of the NTFP resource and its distribution may make the selection of inventory methods difficult.

Limited time

Investing time in resource inventory is only likely to be a priority if the individuals concerned stand to benefit from the activity, preferably in the short term as well as the longer term. It may be difficult, therefore, for a community to enthuse enough active individuals to carry out a lengthy inventory. Often a premium must be placed on adopting a quick and labour-effective methodology.

Capital costs

Theoretically a community could contract out inventory work if the time and skills are not available locally. Depending on the level of detail required, however, the costs for this may well be prohibitive. Brown (1999) estimates that the cost of a community forest inventory in Cameroon may be $75 per hectare or more. Monitoring costs can also be very high and are rarely acknowledged in project planning although donors often insist on receiving complex feedback on project impacts (Abbot and Guijt, 1998).

Technical knowledge

Perhaps the greatest concern of outsiders is that communities lack the technical skills needed to carry out good NTFP inventories. Given the lack of accepted methodologies amongst scientists (of which this workshop is evidence), we can hardly expect community members to have skills we ourselves do not. We should not, however, underestimate the ability of communities to understand the principles and techniques we might choose to apply. Thus Hamilton (1996) reports that sampling designs were discussed with members of the Mupapama village committee in Namibia. Methods of sampling were explained conceptually through a comparison with everyday sampling practices (examining millet or maize in sacks and finding new field sites).

In some cases technological advances have made some techniques more available for communities. While the use of GPS and portable computers in community-based inventory may only be possible with financial help from outside, the ability to reproduce and enlarge aerial photographs cheaply theoretically offers the possibility of making information issues surrounding forest management and participatory processes more accessible to non-literate people thereby empowering them to take greater control over decision-making (Mather *et al.*, 1998). With a little more external help, it is possible to create 'photo-maps' (properly called orthophotomaps) which show the same detail as the original images but without geometric errors due to optical distortion, tilt or relief displacement. They are planimetric and preserve consistent scale and can be used for participatory discussion and as the base for participatory survey and monitoring, avoiding the problems associated with PRA maps which typically differ each time they are drawn.

Complexity of the resource

Compounding the problems of lack of technical skills, is the complexity of NTFP resources. As Wollenberg (1998) points out, products as different as fruit harvested for processing into edible oils, porcupines harvested for the medicinal properties of their gallstones, and wild honey collected for a 'green' market will all require inventory methods tailored to their particular features. To complicate matters further, NTFPs are often collected from areas around settlements where humans have heavily influenced landscapes (Arnold and Ruiz Pérez, 1996). Some resources are part way to being domesticated and can occur across a range of land uses from permanent fields to home gardens, parklands, fallows, secondary forests, etc., with very different distributions in each. Inventory methods need to be applicable across the whole range of land uses.

Organisation

Getting the organisation right is often the hardest part of national-level inventories, so we should not be surprised that organisation of community-based inventories may not be straightforward. The basic question of which stakeholders should be involved in the different stages of the process from planning to implementation and data analysis to decision-making is inevitably a difficult one, particularly if the community is very heterogeneous and/or tenure issues remain unresolved. While foresters may expect to be called upon for technical assistance, more and more they also need to be ready to provide facilitation to initiate a process of management, a task for which many foresters are still not adequately prepared. Thus, although the Namibian legislation on Community Forestry Reserves states that communities are to manage their reserves themselves and have the responsibility for rules and regulations, Robinson (1996) argues that their inexperience in management means that there is a clear need for supporting agencies, whether government or non-government.

The way forward

Given the constraints outlined above, what is the way forward? Are foresters trained in modern scientific methods deluding themselves to think that it will ever be possible (or even appropriate) to try to promote wide-spread resource inventories amongst communities? Clearly it is important that communities are provided with every possible assistance in managing their NTFP resources, particularly where these may be threatened by over-exploitation. But if we want to make a real impact, we perhaps need to think about alternatives to predominantly costly and difficult western-style inventories. This section will cover some issues such as 'optimal ignorance' and 'slowly but surely', to see whether it isn't possible to start with management systems that already exist and improve these by using monitoring and simple indicators, rather than base-line inventories.

Optimal ignorance

A useful principle to consider is that of 'optimal ignorance'. The term was first coined by Robert Chambers (1992) and is now widely used in participatory research, describing an approach that focuses on the collection of sufficient amounts of information for the task at hand. This is an important principle for all types of inventory. They always need to tread a fine line between collecting excessive amounts of data that will remain unanalysed, and not making proper use of the opportunity provided by the inventory to collect information that is later revealed as being critically important. At the level of community-based inventories the dilemma is perhaps even greater. On the one hand we want to avoid collecting so little data (or of such poor quality) that management conclusions cannot be drawn, as having to carry out re-inventories will severely dampen the enthusiasm of local participants. On the other hand, it is surely better to have some information on which to base management decisions than to have none at all. Can we work on optimal ignorance and develop harvest systems based on simple indicators, by-passing the need for biometrically rigorous inventories?

Slowly but surely

In addition to 'optimal ignorance' we need to consider a step-by-step approach. Abbot and Guijt (1998) point out that local communities may initially select methodologies where the information collected is very general but move towards the collection of more detailed information as they realise their questions are not being answered. Referring to Joint Forest Management, Carter (1996) also notes that over time the requirement for systematic information is likely to increase and that predominantly qualitative assessments will gradually evolve into more formal methods of resource quantification.

It may also be that communities begin by asking a very specific small question and, as they gain confidence in their ability to carry out such investigations and produce and implement management plans, they expand their questioning to look at broader resource management issues. As Wenxia (1999) has pointed out from China, it is almost inevitable that community forestry assessments focus on other issues in addition to forestry – issues that villagers see as important and inter-related. FUGs in Nepal have also found that the organisation required to establish and maintain successful community forests often leads to further community action. The key factor, therefore, is that inventories or assessments of whatever kind need to be planned to answer the specific needs of the community at a particular time, whether or not this appears to be the most logical approach from an outsider's point of view. It is essential that local people understand the implications of their inventory design decisions so that they can organise their response accordingly (Carter and Jones, 1998). Methods can then be applied iteratively to adapt to changing levels of information and shifting conditions (Wollenberg, 1998).

Starting with local knowledge

There is an abundance of literature on local management of natural resources. Some of it is traditional and has been maintained over many years, while other systems are of relatively recent development. To my knowledge none of the traditional management systems recorded in the literature were developed on the basis of resource inventories. Each of them was probably the product of many years of observation of both the state of the resource and levels of use. If all these systems were still functioning effectively we would not be here today worried about how best to carry out NTFP inventories. Unfortunately many traditional management systems are breaking down under present-day conditions through lack of organisational adaptability, sometimes accompanied by a loss of the underlying ecological knowledge (Box 2). In these situations, outsiders may have a key role to play in facilitating the maintenance of information and its handing on from generation to generation. Thus some damar collectors in Indonesia didn't recognise the worth of their knowledge until it was recorded by outside researchers (Shanley, pers.comm.). Rather than starting from scratch with inventories which may be hard for local people to grasp, we need to investigate what remains of traditional management systems. Both in terms of the ecological indicators they used and the organisational systems in place to implement management decisions. Then we need to help communities to develop these further to keep up with the changing context.

This is not to say that local knowledge is always reliable. Shanley (1999) found that communities in the Brazilian Amazon severely overestimated the abundance of particular

fruiting species on their land. Similar observations have been made in Bolivia for timber stocks (Davies, pers.comm.) and in Cameroon for *Prunus africana* (Acworth, pers.comm.)

Box 2. A traditional management system in a changing environment

Various traditional tree management practices exist in Mupapama village, Namibia. Some have been maintained to the present day, others have been adapted to the changing socio-economic context, and yet others are being rapidly eroded. Thus traditionally accepted norms of how fruit should be collected (e.g. branches should not be broken and the fruit should be ripe before collection) are still applied. Permission to cut a fruit tree must now be obtained from traditional and modern administrative leaders such as the headman, clan chief and the Directorate of Forestry. Certain beliefs, e.g., that cutting the valued fodder tree, *Ochna pulchra*, would lead to the loss of one's cattle, or that using *Swartzia madagascariensis* for fuelwood would lead to divorce, effectively controlled the harvesting of trees in the past. But these beliefs are becoming less and less effective. In some cases new methods of control such as fines are replacing taboos. There is also a danger that some practices and knowledge may be lost for ever, e.g. few people are still aware of the correct height at which to cut species to ensure good regeneration and simply cut at the height necessary to produce a good pole. Some problems emanate from the very agencies charged with maintaining resources. Thus the use of fire as a management tool has ceased since it was made illegal, and the DoF issues permits for harvesting forest products without consulting the community, thus undermining their ability to manage the resource. Encroachment by outsiders collecting firewood illegally is becoming increasingly common.

From Hamilton (1996)

Participatory Monitoring

From a western point of view, inventories are usually considered to be the first step in a management process and must be kept up-to-date through a regular monitoring of the impacts of management interventions. In effect, inventories artificially select a particular point in time as a baseline against which to measure change. We should also consider the potential of frequent monitoring to achieve the same objective without first carrying out an inventory. Irons and Walker (in Abbot and Guijt, 1998) suggest that the alternative to often expensive and difficult inventories "*is to adopt monitoring procedures which side-step the need for a baseline, meanwhile indicating the direction of change – improvement or decline – against either the previous measurement or a desired condition*".

Abbot and Guijt (1998) have provided a concise overview of the key issues in indicator-based participatory monitoring (Box 3). One of its advantages over conventional monitoring is that the people who use and interpret the data are the same people who have collected the information, thus avoiding the problems associated with contextualisation of indicator-based results (Abbot and Guijt, 1998). Nevertheless participatory monitoring is not necessarily easy. Just as for participatory inventories, there needs to be a clear understanding of the objectives of the exercise, the likely benefits (and costs) for participants, how the process will be organised and conclusions drawn and implemented.

Box 3. Key steps in indicator-based participatory monitoring

1. Make the decision to start a participatory monitoring process
2. Identify possible participants
3. Identify the objectives of the monitoring from the perspectives of each of the participating groups
4. Clarify the objectives of the work being monitored
5. Identify and select indicators
6. Selection of methods
7. Decide frequency and timing of monitoring
8. Prepare and fine tune the methods
9. Systematic implementation of the monitoring calendar
10. Dealing with the data
11. Documentation of the findings
12. Using the information

From Abbot and Guijt (1998)

There are basically two approaches to monitoring (Wong, 2000):

- monitoring the health of the residual population, i.e. forest based
- monitoring the size and quality of the harvest, i.e. harvester or market based.

In the case of wildlife, estimates of sustainable yield based on catch data (the number of animals taken out of the environment) may be more straightforward than count data (i.e. how many animals remain) (Inamdar *et al.*, 1999). Wong (2000) warns, however, that basing management on harvest records wrongly assumes that harvest levels accurately reflect changes in the level of the resource whereas they may also be linked to the economic situation of the collectors or the demand for the product. It also assumes that different levels of harvesting are all done with the same care and inflict the same kind of damage on the resource, whereas a sudden increase in harvesting may be due to an influx of new collectors who do not abide by sustainable extraction methods.

A central issue for any monitoring process is how to get the different groups involved to agree on indicators. Abbot and Guijt (1998) argue that indicators should be SMART – Specific, Measurable, Attainable, Relevant, and Timely. In some cases indirect indicators of NTFP stocks (e.g. market surveys, harvest levels, basal area sweeps) will be an appropriate basis for making management decisions (Wong, 2000). In any case, indicators need to be not only technically correct but they also need to be easy to understand and capture the imagination (MacGillivray and Zadek, 1995, in Abbot and Guijt, 1998), as in the case of indicators for grass regeneration in Mali (Box 4). In addition to being locally relevant, indicators should as far as possible be compatible with higher level monitoring and evaluation concerns (Rennie and Singh, 1996, in Abbot and Guijt, 1998).

Box 4. Indicators for grass regeneration

The NGO, ACORD, was working in Mali on the regeneration of *Panicum borgou*, a fodder grass growing along the Niger river. Men suggested that their ability to offer ACORD staff a calabash of milk at their next visit would be a good indicator of the success of the project in providing sufficient fodder for their livestock during the dry season. Women, on the other hand, came up with a different indicator. They explained that the grass was first used as fodder and, if enough was available, it was also used to make a sweet drink (called 'kundou') for children. Thus asking children whether or not they had drunk any kundou could indicate greater regeneration of the grass.

Based on Roche (1993) in Abbot and Guijt (1998)

Conclusion

Whether simple monitoring or more sophisticated inventory systems are applied, the technical issues must in all cases be of secondary importance to the key issue of organisation. Responsive management structures are essential to permit a rapid reaction if resource conditions change for the worse. Box 5 gives an example of the Chuliban Community Forest FUG in Nepal which has adapted its management system over time to promote both equity and conservation ideals. In the case of Korup in Cameroon, Malleson (1999) argues that the way to achieve sustainable management is to strengthen existing local institutions which have a significant contribution to make to forest management, and particularly to involve specific groups of forest users whose interests have so far been overlooked.

Investment is also needed to improve the support that government agencies and NGOs can provide to communities. Taking the example of Nepal, Mather *et al.* (1998) argue that the questions surrounding the accessibility and 'appropriateness' of technologies have largely been answered by recent developments in and reductions in costs of image-scanning, data storage and ink-jet printing. However, they argue, that the greater challenge is to place a service institutionally so that it is technically sustainable and genuinely accessible to support FUGs. Perhaps most importantly, promoting participatory monitoring or inventories requires a high level of commitment by government agencies that local communities can indeed manage their resources sustainably. In such a supportive environment, strong community organisations will be able to choose the best methods to obtain the information they need and act upon it to maintain their key NTFP resources.

Box 5. Managing for equity and conservation

The Chuliban Community Forest FUG in Nepal has adapted its management system over time to promote both equity and conservation.

- The FUG first permitted all users to collect red clay free for domestic use with two households being allowed to collect sufficient amounts for sale and outsiders having to pay for each headload. After a year, however, the rules were changed to minimise soil erosion and all collection by outsiders was banned.
- Users were originally allowed to collect stone for construction purposes for Rs 10 per headload. This practice was later forbidden altogether for conservation reasons.
- The FUG also decided to change its forest protection system from one in which all users had to patrol on a regular basis or pay a fine as this was causing some poorer members to leave the FUG. To remedy this situation, the FUG decided to hire a forest watcher and charge people over a whole month to pay for the services.

Based on Maharjan (1998)

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Annex 7 Natural Resource Monitoring Concepts and Tools of Veld Products Research & Development.

By Mpho Mosate, Veld Products Research & Development , Botswana

1. Background

1.1 Veld Products Research & Development Profile

Veld Products Research & Development (VPR&D) is a non-profit, non-governmental organisation involved in the sustainable utilisation and management of Veld Products for environmental and economic development. Veld products include foods, medicines, craft materials, tannins, gums, resins, dyes, essential oils, ornamental plants, worms and many other renewable resources. Veld Products Research & Development's mission is to satisfy the economic and environmental development needs of rural communities through the sustainable utilisation and management of natural resources and the exchange of veld products and services.

VPR&D's approach is to undertake research and development projects in partnership with rural communities and households to improve their quality of life. In order to achieve this VPR&D aims:

- To engage in innovative research.
- To promote human resource development on the basis of equal opportunity.
- To promote systems enabling communities to develop their own strategies to successfully utilise their natural resources on a sustainable basis.
- To be an international center of excellence in the utilisation and management of veld products.

Within VPR&D there are two main projects: the Indigenous Fruit Tree Research Project and the Community Based Natural Resource Management Project / Community Based Management of Indigenous Forest.

1.2. The Community Based Management Indigenous Forest (CBMIF)

The CBMIF is a collaborative effort of SNV Botswana; GTZ through the SADC Forestry Sector in Malawi and VPR&D. It started in 1996 in the villages of Motokwe, Khekhenye and Tshwaane in the Kweneng West District of Botswana, with the aim of improving livelihoods.

As part of the project activities in 1997, the CBMIF Project developed a methodology that would allow communities to make an assessment of the availability of veld products in a given area. One of the potential products was grapple *Harpogophytum procumbens* (Sack and Thamage, 1998).

2. The ecology of Grapple

The grapple plant, also popularly known as Devils Claw, has been identified for its economic value. It can be distinguished by above the ground runners radiating from a central stem. The sprouting stems radiate from a central tuber also called the parent tuber. From these stems a number of storage tubers develop, these are potato-like in structure. On the ground it produces flowers which are pale pink in colour and usually more than 5cm long (Ntseane, 1990). The most distinctive morphological feature of the grapple plant is its fruits, which have thorns that are recurred at the tips, hence the name Devils Claw.

3. The monitoring tool

The tuber of the grapple plant isthe part that is harvested. It is generally perceived that the side tubers of grapple can be harvested without causing negative impacts to the plant. If the parent tuber is harvested it is believed that the plant will die (van der Vleuten, 1998). As a result, a tool was developed by the CBMIF Project for the grapple plant because of the fear that over-harvesting could lead to localised depletion.

3.1. The procedure consists of the following steps:

i) Identification of concentration areas.

The communities identified concentration areas. It was noticed that the plant tends to occur in high densities in relatively small areas (15 - 30 ha). The project decided to focus its assessments on these areas because it is a practical scale for applying management systems that may be developed (de Wolf, 1999).

ii) Identification of stages in the life cycle of the plant.

In preparation for fieldwork, the project asked the communities to identify distinct stages in the life cycle. The following stages were distinguished:

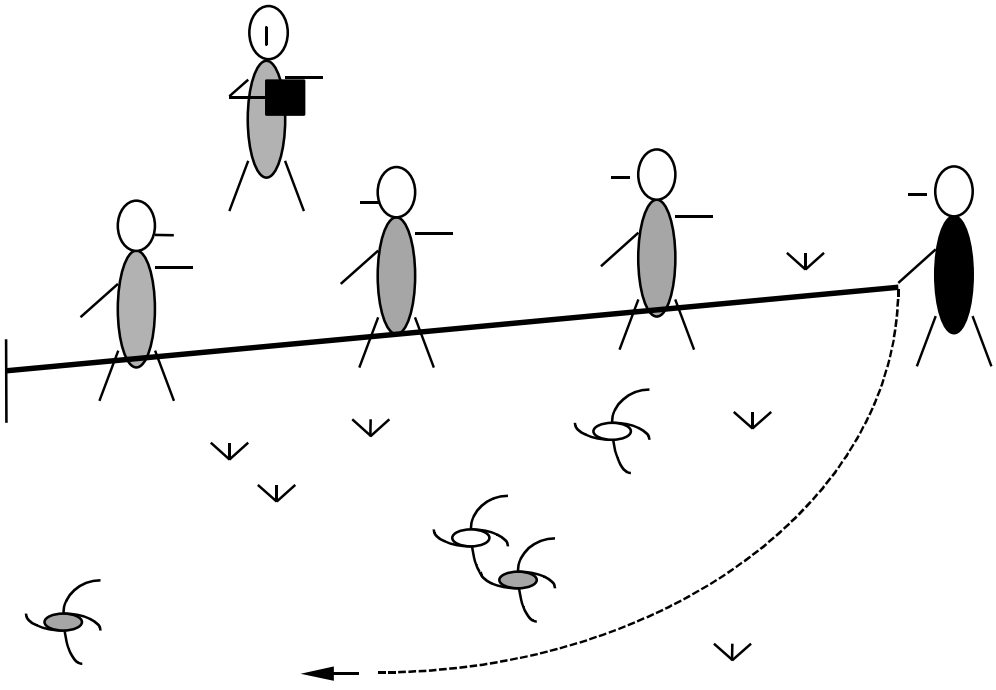
- Young seedlings
- Mature plants which had been dug in the previous year
- Mature plants which had not been harvested in the previous year
- Dead plants

The dead plant is not stage in the life cycle as such, but it was decided to include this category because there was a direct link with management as, according to the communities, death of the plant could be caused by improper harvesting practices. The communities said that they could distinguish a mature plant from a seedling from the leaves (de Wolf, 1999).

iii) Pre-harvest assessment of availability

Assessment was performed in an agreed area. This involved counting plant individuals in sample circles (10 meter radius) which are laid out in a 100x100 meter grid covering a harvest area. Every tenth mature plant was dug out and weighed.

Fig. 1 Circular sampling method



Initially, in the pre-harvest assessments, no distinction was made between the different stages in the life cycle. This resulted in high variation in results of tuber weight and therefore affected the accuracy of the results.

iv) Post-harvest assessment

The same procedure was undertaken as in the pre-assessment except that no plants would be harvested after the assessment. The assessment concentrated on plant densities and the composition of the population. The exercise gave useful insights on regeneration of grapple and the effects of harvesting (de Wolf, 1999).

4. Management

The plant has been classified as a protected species in Botswana to try prevent its extinction from over harvesting. Permission to harvest is given by the Agricultural Resource board of the Ministry of Agriculture by means of an extraction permit. The permit includes the name and address of the extractor, a description of the area of extraction, quantity to be harvested and the expiry period (Ntseane, 1990). The permit system, although a good idea for regulation of harvesting, was not based on any qualitative assessment. The quantities stated to be harvested on the permits are arbitrary. The grapple density results found from the assessment by the CBMIF Project in Kweneng west provide a realistic permissible harvest quantity. This methodology has not yet been adopted by any other organisation or institution and is currently only used in the project area.

The original intention of this assessment tool was to enable us to plot a graph over a period of 10 years in order to establish any trends in the fluctuation of the grapple plant density. Therefore the number of plants that communities would be allowed to harvest could be determined through this assessment system.

5. Revision of the assessment tool

In its quest to try to further understand ecology and ecological monitoring, the CBMIF project recently sought the assistance of a lecturer in desert ecology from the University of Ben-Gurion in Israel. This lecturer was able to help us to improve our monitoring tool and to verify the assumptions that had been made by our monitoring tool. The following tasks were undertaken:

- lecture on ecology and ecological monitoring,
- examination of the distribution pattern of grapple,
- validation of Indigenous Knowledge on life-cycle/ biology,
- assessment of the monitoring tool that is currently used and,
- recommendation.

5.1 Validation of Indigenous Knowledge:

Experiments were designed to test:

- The relationship between tuber production yield and morphological parameters.
- Identification of the distinguishing features of male and female plants.
- The ability of communities to distinguish young from mature plants, (a young plant here is defined as a plant with no tubers).

The relationship between tuber production yield and morphological parameters

This experiment was designed to find out if there is any relationship between visual plant size and the tuber production of that plant. It was concluded that there is no clear relationship.

Identification of the distinguishing features of male and female plants

The communities said that the grapple plant has a male and female version. They said that the male plant has one stem that grows straight upward and does not have tubers and the female plant has a number of stems, which are creepers and it has tubers. The data collected did not support this claim.

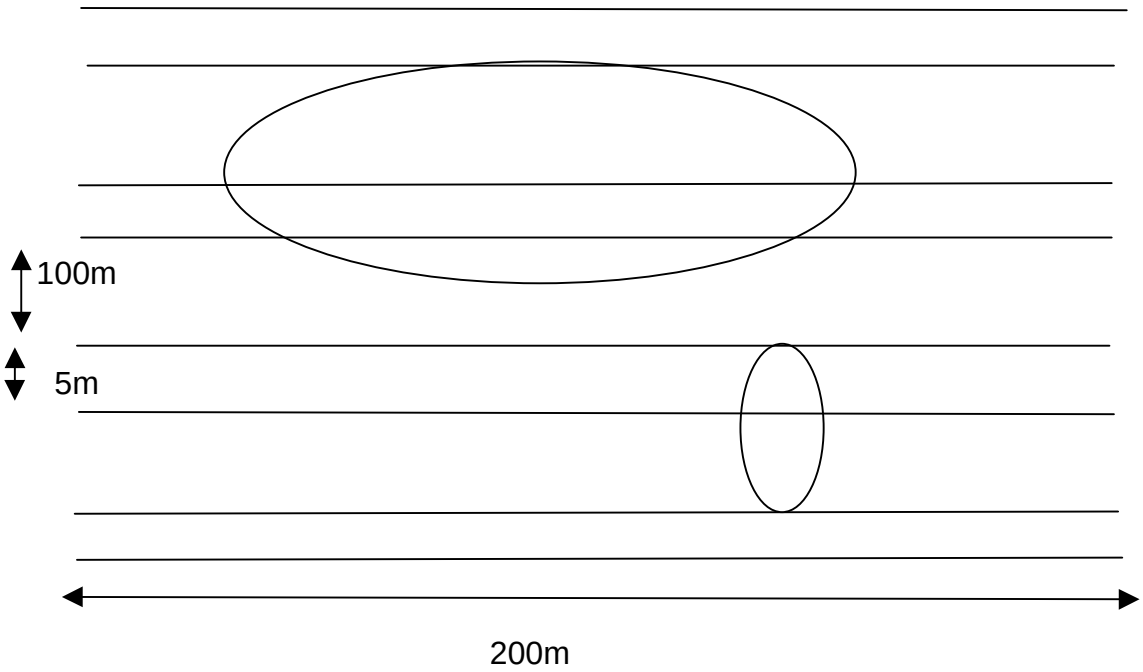
The ability of communities to distinguish young from mature plants

The communities could distinguish a seedling from an adult plant, but it was found that a higher clarity was needed in differentiating the plant stages from seed to adult.

5.2 Spatial distribution

The first experiment (Experiment 1) utilised an area (Area 1) that had been harvested in the previous year (1999). Five pairs of linear transects, 200m in length and 5m apart, with 100m between pairs, were used. Plants were sampled within a 0.5m band on each side of a transect line. On one transect within each pair every plant was counted and every tenth (10^{th}) plant was dug out regardless of its age. On the other transect within each pair every plant was counted and every tenth mature plant identified by the communities was dug out.

Fig. 2 Linear transects sampling method



A similar experiment was conducted in an area that had never been harvested (Area 2).

In another experiment (Experiment 2) two transects of length of 200m were set up in an area that had been visually identified as a concentration area. All mature plants occurring within a 0.5m band on each side of the transect line were counted and dug up. The following parameters were measured:

- lengths and number of primary stem,
- lengths and number of secondary stems,
- the visual diameter,
- distance of plant from first plant and,
- weight and numbers of tubers.

These two experiments gave two types of information: the distribution pattern of the plant, and information about the correlation of morphological parameters of plants occurring in the same patch.

The distribution pattern was found to fit a Poisson distribution curve. It showed that the pattern of the grapple plant is patchy. The size of the patches varies greatly from 10 to 100 meters diameter, as such the spread of a patch is not consistent.

There is a spatial auto-correlation, i.e. a positive correlation was found between some morphological parameters and the distance to the nearest neighbor. This means that plants of the same age (or size) tend to occur together, this could be attributed to seed dispersal or exploitation of the same quality soil patches. It was shown that the production of tubers does not correlate with the distance to the nearest neighbor. The possible explanations are that plants of the same age may differ in developmental plasticity.

6. Assessment

These activities and experiments compared two methods used to determine density. The original methods used by VPR&D using circles and the method used by the Israeli lecturer using linear transects. The same areas were used for both these methods in order to minimise error. It was found that the methodology using the circles tended to over-estimate the average plant densities.

6.1 Recommendations for an assessment tool

i) For a previously harvested area with a dense population of grapple

- Establish four linear transects of at least 200m in four compass directions.
- Count the number of grapple plants (or average plant density) for every 10m section of the transect.
- Follow the plant distribution in all directions and use a certain density as cut off point (0.25 plants/m2, for example).
- Determine the patch size using cut-off point for all four compass directions.
- Estimate average plant density per patch.

ii) For previously non-harvested area

- Rough assessment (scale in kilometers); establish a few linear transects separated by a distance of 2-3km.
- Fine assessment (scale in hundreds of meters) for the transects with high density of grapple. Use method described in (i) above, assessment in four compass directions will serve to estimate the size of a high-density patch more accurately.

iii) Tuber production

Digging of tubers must be undertaken during fine assessment only. The number of plants dug must be a function of plant density with the total number of plants dug about 30.

iv) Future directions

- Establishment of an experimental grapple population (at least 100 plants).
- Study of seed germination and dormancy.
- Study of seed dispersal.
- Analysis of effects of environment on plant survival and tuber production (rainfall, soil, moisture nutrients, etc).
- Study of grapple genetics.

7. Conclusions

Management

The most effective management would result in the greatest change in the growth rate of the plant. This can be achieved by influencing the most sensitive stage in the plant life cycle. With experiments that can give information on transition probabilities the sensitive stage can be identified. Management can be simulated if the transition probabilities are known.

Translation of management to income generation

Organisations involved in development work take this a step further; the relationship of the assessment tool to creating opportunity for communities to generate income has to be found. The key objective is to ensure that the activities of income generation from the grapple plant are sustainable. We hope that this will be assured through the establishment of appropriate management systems for grapple.

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Annex 8 Data needs for national strategic planning and policy development

By Paul Vantomme, FAO, Rome

Definition of national level

The first question we must ask is what do we mean by the national level? Although information is important at the country level it is often also important at the state level, particularly where states have a degree of political independence from central government. Information is also important at the regional levels: EU, NAFTA, SADC, ASEAN etc. This presentation will cover needs at all these levels.

Purpose of data

The second question we must ask is what kind of national level strategic planning and policy development do we need NWFP data for? For whom do we need this information? What kind of data is required and what are the constraints to data collection?

Data for Whom?

In this case we are primarily focused on the forestry sector and its development, i.e. forest resources managers, forest products users. But there are others who need NWFP data such as:

> Agriculture, as NWFPs complement food security/agriculture crops, they are important as fodder and they feature in the process of domestication.
> Industry that uses NWFP derived chemicals, i.e. resins, food additives, aromatic's etc.
> Ministry of Health who require information on medicinals or for food quality control.
> Education departments who require NWFP information for curriculum development purposes and to determine training/extension needs.
> Rural development institutions who require data for social programmes viz a viz disadvantaged population groups (facilitating access to or ownership of the resources) etc.

Why is data required?

At the national or regional level data is required for the following purposes:

- **Economic opportunities:** Data is needed in the planning for investment or the development of a sector. For example in investigating the potential use of pine resin as raw material for chemical industries (turpentine, rosin), rattan for furniture, tannins as substitutes of imported polyphenols and glues for plywood production etc. Information of this kind it also used to determine policy on financial incentives for import substitution or export promotion (import tariffs) etc.
- **Social** criteria: Data is needed to determine the potential role of NWFP in rural development programmes.
- **Environmental** criteria: Data is needed to assist management of conservation and environmentally sensitive areas to determine and manage potential utilisation of NWFPs.

Data requirement details and constraints

Resource Status:

When considering data requirements on resource status one first has to decide which species to collect information on. This requires some initial knowledge on species, their products and distribution. Basic information might also be required on what, where, how to locate, yields, harvesting techniques and levels. Taxonomic rigour is also a potential difficulty (especially for medicinals and mushrooms). The quantitative information that then needs to be collected relates specifically to the question of “how much” is available.

National Forest Inventories (NFI) (or Agricultural censuses in case of domesticated products) may collect NWFP information. These tend to be based on some form of stratified sample. Inventory at this level has high biometric rigour requirements. At management unit (operational) level (MUL) lower biometric rigour is required depending on the size of the unit. Data collection can vary from the assessment of a few samples to a systematic (full-scale)

assessment. At the smaller scale taxonomic problems tend to be somewhat less of a concern.

Social aspects

Information is needed on

- Ownership and/or access to the resources or species (private, public ownership status and trends).
- The level of dependence of livelihoods on the resource (who, where, how).
- The impact of other sectors (agriculture, labour availability, farmers).
- Decision making processes in country (planning cycles).

Economic aspects

Information is needed on

- How important is investment in the NWFP for the national economy and what are the trends.
- The influence of (inter-) national markets (e.g. providing substitutes for NWFPs).
- Financial possibilities, e.g. joint ventures, World Bank loans and incentives etc.

Institutional and Policy aspects:

Information is needed on

- (Forest) legislation and rules (NWFP rights in "timber concessions").
- Training and education needs.

Reporting to international/regional agreements

Information is needed on

Statistics on the resources, e.g. distribution, quantity of resource base, production and trade data

Annex 9 Information for international NTFP monitoring – with special reference to reporting on global forest resources (FRA)

By Peter Holmgren, FAO, Rome (summarised by the Editor)

Overview of FRA 2000

The objective of FRA 2000 is to undertake a world wide assessment of forest resources, covering a wide range of subjects including NTFPs. One subject of great interest is the extent of forest cover and the identification of changes in forest cover including and examination of underlying causes. The purpose of the whole exercise is to stimulate discussion, mainly at an international level, on the issues surrounding forest resources and the availability of information. A secondary objective is to disseminate information on natural resources in general.

The process of data collection and analysis is as follows:

1. Consultation and consensus obtained from experts world wide.
2. Endorsement from FAO member countries.
3. Planning and organisation of data collection. Data is predominantly collected through collaboration with national institutions but also through searches undertaken in FAO itself.
4. Data collected is analysed.
5. Data is pre-released to countries for ratification.
6. Results are disseminated.

The approach to information collection is to rely mainly on reports produced by countries. For industrialised nations this provides sufficient data but for some countries little data can be obtained in this manner. Some good data on forest cover is also obtained through a remote sensing survey in collaboration with member countries. Special studies are also undertaken to uncover additional information.

Currently the FAO is in the process of disseminating the information gathered through the FRA 2000 project and there are about 8000 pages now on the web providing text, maps and statistics for each country (www.fao.org/forestry/nav_world.jsp).

NWFPs in FRA2000

NWFPs are included in FRA2000 but the information available is limited. The NWFP Unit of FAO has been able to provide a page of textual information per country and for some countries some quantitative information is also provided. The text is presented with standardised headings so that all countries can be described under the same template. In addition a standardised table is provided per country describing the product, the resource and the economic value. In addition all sources of information are cited. This information is not complete and is not expected to remain static. It is intended that a facility should be provided so that new information can be added and the knowledge base will grow.

Information needs and issues

In generic terms what is needed is to be able to build scenarios that described what happens under different circumstances. Scenarios are used to study a number of utilities (timber, NWFP, biodiversity) that have values assigned to them. The sum of values changes under different circumstances and with time. Scenarios also differ depending on the assumptions that are built into them. Scenarios can be used to assist management in determining how to maximise certain utilities. One of the main difficulties in building scenarios is in deciding how to value different utilities.

The forest planning cycle is as follows.

- Information needs are identified.
- Inventory is undertaken.
- An assessment is made based on the inventory results.
- Scenarios of the future are produced.
- Policy development of planning is undertaken.

- Policy is implemented.
- Feedback is provided to further information needs.

Various common problems occur in this cycle. Often inventory is not designed to meet the real information needs. Scenarios often do not fully utilise inventory information or do not make proper use of the information available. Scenarios are used to determine policy but policy is often not well implemented. Finally feedback is rarely obtained for the next cycle.

It is difficult to describe information needs at the international level without being very general. For example information is needed to support international policy processes, to compare countries and to raise public awareness. However the issues can be described in a little more detail. These are:

- How does one standardise terms and definitions to ensure that we are all talking about the same thing. At present we are even struggling with a definition for forest at the international level.
- In determining the value of forest what should be included and who is supposed to decide on this? At present the inclusion of aspects for valuation largely depends on fashion.
- There is a need to determine the methods and technology that should be used in assessment. The resolution of information required will depend upon the subject under study. For example, resin availability has to be studied at the level of the tree and requires inventory on the ground. This is costly, laborious and tedious but on the plus side we do have many years of methodology development to draw on from forestry.
- How does one go about making information collection consistent over time? At present one of the problems experienced by FRA 2000 is that of trying to make current data comparable with old data.
- How does one ensure that feedback is received back into the knowledge cycle? How can we make sure our systems are regularly updated to include aspects that have been lacking?

Annex 10 Additional papers tabled at the meeting.

Non Wood Forest Products in East Kalimantan, Indonesia:

Analysis of forestry and socio-economic aspects of their role and development potential for the local people in a forestry concession[2]

Carol M. Grossmann[3]

As reflected in relevant research publications as well as reports and proposals of international technical cooperation projects non-wood forest products (NWFP) are frequently expected to have a high development potential. On the one hand it is hypothesized that the current contribution of NWFP to the income and subsistence of rural people living on the forest edge is underestimated. On the other hand, an intensified management of NWFP is anticipated to increase the income of these people, as well as offer incentives for the conservation of natural forests in the form of managed natural production forests, especially in the tropics. At the same time voices are on the rise that criticize these expectations claiming that they are often either based on insufficiently tested hypotheses or on unilateral sectoral analyses. These sectoral approaches usually do not take into account either the technical aspects of forest management or the socio-economic aspects of the use and management of NWFP by the selected target groups. Based on this conclusion the following aims of the presented research project were formulated:

- Elaboration of a target group oriented and interdisciplinary research concept: a contribution to the development of a transferable methodology for analysing the role and development potential of NWFP in any area with natural forests.
- Answers to three fundamental questions relevant to the management of NWFP in a timber concession area in East Kalimantan, Indonesia:
    1. How large does the area of natural forest need to be to supply the local population with the types and amounts of NWFP currently used?
    2. How is the supply of NWFP from natural forests influenced by selective commercial logging?
    3. Do the inspected forest stands provide the potential for local people to intensify market oriented management of NWFP that will, at the same time, enhance forest conservation?

An individual working definition of NWFP was formulated for the study as no published definition was suitable to answer these research questions.

The concession area of the timber company Limbang Ganeca in central East Kalimantan was selected as the research area. Long Lalang and Ritan Baru, which border on the concession area, were selected as research villages. The selections took place in the context of the activities of the Indonesian-German Development Cooperation Project “Promotion of Sustainable Forest Management Systems in East Kalimantan”, which initiated the study. The research area is covered with Lowland-Dipterocarp-Forest, including 30% primary and 70% logged-over forest. The research area is typical of East Kalimantan in its high socio-geographic diversity. In contrast to other studies with similar research objectives, research sites were not pre-selected due to their production of particular NWFP or their local economic importance.

An interdisciplinary research concept consisting of two consecutive phases was developed for the study. The focus of the first phase was the analysis of secondary data relevant to the region and the implementation of a pilot study in the research area. The pilot study took place

[2] Source: Carol M. Grossmann (2000): Nichtholz-Waldprodukte in Ost-Kalimantan, Indonesien: Analyse der waldwirtschaftlichen und sozio-ökonomischen Aspekte ihrer Bedeutung und ihres Entwicklungspotentials für die Lokalbevölkerung in einem Holzkonzessionsgebiet. PhD thesis, University of Hamburg/ Bundesforschungsanstalt für Forst und Holzwirtschaft, Chair of World Forestry. To be printed in: Mitteilungen der Bundes forschungsanstalt für Forst- und Holzwirtschaft, Kommissionsverlag Max Wiedebusch, Hamburg.

[3] Institute of Forest Policy, University of Freiburg, Germany.

in the two research villages utilising a 'Participatory and Rapid Rural Appraisal' approach. The most important results of the pilot study were:

1. a list of all NWFP used in the research villages, including local names, properties, uses, harvesting techniques and scientific names,
2. clarification of differences concerning the understanding of terms such as 'forest' and 'NWFP',
3. a collection of locally important socio-economic household criteria and their indicators (primarily economic status and ethnic affiliation of the household members),
4. an impression of suitable social behavior during homestead visits and interviews, and
5. the realization that the interest of the local people concerning NWFP is ranked rather low in comparison to other topics relevant for subsistence as well as for income generation.

In the second phase, the main study, the two aspects most important for the analysis of the significance and the development potential of NWFP (technical and socio-economic aspects) were investigated using appropriate methods from forestry and the social sciences.

The forestry part of the study was composed of a sample inventory of 340 square sample plots (0.04 hectare each) distributed on a systematic grid in two different forest stands of the timber concession forest of the study area. In this inventory, the species and population densities of perennial plants producing NWFP were investigated. A stand of primary forest and a stand of logged-over forest were compared to analyze the influence of commercial logging on the supply of NWFP in timber production forests. In addition the site preferences of the NWFP-producing plant species were analyzed. Corresponding interdependencies were considered in the interpretation of the inventory results to eliminate site-induced differences in population densities on the two investigated forest stands.

Fifty-eight NWFP-producing tree species were identified in the investigated research stands. On average they were represented by 1.3 adult individuals per species per hectare. Groups of different species producing interchangeable NWFP collectively reached an average of 2.0 (maximum 7.8) adult individuals per hectare. Regeneration was assured for almost all NWFP-producing tree species.

Thirty-four NWFP producing rattan species were identified at an average population density of 2.0 (maximum 9.4) adult individuals per hectare. The density of ripe and interchangeably usable canes provided by different species was calculated to be between 6 and 72 canes per hectare. Regeneration was assured for five of six of these groups of interchangeable rattan species.

Population densities between 0.3 and 19.7 adult individuals per hectare were calculated for the 8 NWFP-producing palm species that grow in the form of trees or shrubs. None of these species showed a population structure indicating sufficient natural regeneration in the investigated forest stands.

The two NWFP-producing liana species that included more than 5 detected individuals in the study, reached population densities of 1.2 and 3.2 adult individuals per hectare. Regeneration did not seem sufficient for either species.

Selective logging had a significant impact on the populations of different NWFP-producing perennial plant species. Both negative and positive impacts were observed. No differences in population densities between primary forest and logged-over forest were observed for about half of the investigated species.

For most of the NWFP-producing tree species relevant to local people during the research period, it can be concluded that selective logging does not seem to have a negative impact on their occurrence and population density. For those tree species (*Palaquium* and *Payena spp.*) that interchangeably produce Gutta Percha, a latex used for subsistence as well as for income generation, a further reduction of originally low population densities due to logging was detected.

For most of the NWFP-producing rattans, tree palms, shrub-like palms, and lianas, changes in the structure of forest stand due to logging do not seem to threaten supply. In fact, the density of the respective NWFP-producing plant species actually tended to increase. Nonetheless, data suggested that one rattan species of the "Rattan Pulut" group (i.e. *Daemonorops critina*) and other single NWFP-producing rattan species (e.g. *Plectocomiopsis geminiflorus*), are primary forest species negatively influenced by logging activities because they are shade tolerant and therefore sensitive to changes in the forest canopy.

The analysis of site preferences of all investigated plant species did not reveal any site variables that were significantly associated with more NWFP producing species than others.

Several NWFP-producing wildlife species, or their traces, were encountered in the primary forest stand as well as in the logged-over forest stand. Their occurrence was registered, but no quantitative data were collected. A quantification of the different relevant animal populations and a comparison of their occurrence in either forest stand could not be pursued due to methodological constraints.

The socio-economic aspects of the use of NWFP by local people in the two research villages were analyzed using methods from the social sciences. A sample of 31 households provided quantitative data on the contribution of NWFP to their income and subsistence over the period of one year. In addition, information was collected on the natural properties of the NWFP used, on the harvesting techniques that were applied, and on traditional or governmental rules and regulations concerning the harvest of NWFP. The following main methods were applied: structured and semi-structured interviews, product counts, food diaries, and participatory observation.

The average monetary income of the local people was calculated at 2,500,000 Indonesian Rupiah (Rp.) per household per year. During the research period this amount was equivalent to about US$900. NWFP contributed 124,000 Rp., or 5%, to this total income. Of this 5%, about half was obtained through the sale of game at the village-level. Another quarter of this 5% was indirectly derived from the marketing of edible birds nests. Since nationalization of usufruct (use rights) of the *Collocalia* breeding caves, the former traditional user groups are being compensated with voluntary payments by current tenants.

Together with income from sales of dried reptile skins, over 80% of cash earned with NWFP was obtained on the basis of wildlife and wildlife products. Plants provided the remaining 20% of the income based on NWFP. Thirteen percent was derived at the village-level by sales of articles made of rattan. The remaining 7% was generated by sales of, and trade in, unprocessed faunal NWFP beyond the village limits.

Individual households demonstrated broad variations of total income and of the respective contribution of NWFP to cash earnings. The share of NWFP based income ranged from 0 to 100%. A comparison of the two villages showed the following results. On average, households of Long Lalang earned only about two thirds of the total amount of money earned by households of Ritan Baru. In contrast, income generated on the basis of NWFP in Long Lalang amounted to more than three times the respective earnings in Ritan Baru. But because monetary income from other sources decidedly dominated the economy in both villages, the share traceable to NWFP is small both cases. In Long Lalang, the average share of NWFP based income amounted to 8% of the total income, while in Ritan Baru to only two percent.

Associations between commercial use of NWFP and socio-economic characteristics of different households could be shown in context with economic status of the household as well as with the ethnic affiliation and cultural homogeneity of the household members. The nominal value, as well as the percentage of NWFP based earnings, decreases with rising total income. While poor households generated an average of 11.4% of their annual income on the basis of NWFP, it was only 1.7% for affluent households. In particular, the sale of game contributed disproportionately to the income of poor households, as could be demonstrated with a further subdivision of the analysis into NWFP product groups. A comparison of immigrant households with Dayak households, the latter differentiated into

households with homogenous vs. heterogeneous cultural compositions, showed the following results. On the one hand, these three groups with differing cultural backgrounds had almost equivalent average annual cash incomes. While on the other hand the contribution of NWFP to this income was a comparable 5.4% and 6.5% for heterogeneous and homogenous indigenous households, respectively, it was only 1.3% for immigrant households.

The contribution of NWFP to subsistence was resolved into two components. Firstly, the contribution of NWFP to nutrition and secondly, the contribution of NWFP to articles of daily use were demonstrated. Faunal NWFP were identified as the second most important source of protein in all households. Game was served with one quarter of all meals, surpassed only by river fish, served with 40% of all meals but not considered a NWFP in this study. Vegetative NWFP were served only with 5.2% of meals and then only in very small quantities, primarily as very bitter vegetables or spices and condiments. Their contribution to the diet as appetizers is valued higher than their probably low calorie and nutritive content.

All participating households owned articles and utensils made completely or partly of durable NWFP such as cutlass handles and sheaths, wickerwork and palm hats. The most important raw material were rattan canes, used differently according to their natural properties and final purpose. They were followed by *Licuala* leaves and Gutta Percha, used as adhesive. Further household articles traditionally made of rattan were also made from agricultural products, especially cultivated bamboo canes and leaves of *Pandanus* palms, or plastic. Informants reported an increasing process of rattan substitution. None-the-less Rattan *Sega* (*Calamus caesius*) was considered indispensable.

The village comparison showed no significant differences in the average amount of articles made of NWFP per household. Differences in the use of NWFP between the two villages could only be demonstrated for the use of specific spices, some being preferred in Long Lalang and others in Ritan Baru. These preferences were declared as typical cultural peculiarities by the informants.

The replacement value of all articles made of durable NWFP was used as a method to compare the contribution of NWFP to subsistence with the contribution of NWFP to monetary income. The total replacement value was calculated as the sum of the local market-price values for the average number of articles per household. The results demonstrate that the monetary value of these articles per household is about equivalent to one third of the average annual cash income of the households investigated. A comparison of the annual replacement value of articles made of NWFP for subsistence with the monetary income generated on the basis of NWFP in the same time frame derived the following figure: the replacement value of NWFP harvested and processed for personal use amounted to five fold the amount of money earned by market oriented use of NWFP. Therefore the contribution of vegetative NWFP to subsistence is valued much higher than the direct contribution of NWFP to local monetary income.

An area of 100,000 hectare of natural forest (including primary and logged-over forest) was calculated to be required to continuously supply the people of Long Lalang and Ritan Baru with all plant-derived NWFP at their current rate of consumption. This figure corresponds with the total management area of the timber concession company Limbang Ganeca and surpasses the usual area of forest related activities by the village people. In addition, the harvest of NWFP by inhabitants of the other 14 villages on the border of the concession area would have to be restricted to assure the current rates of consumption. To supply the need for most NWFP, but excluding the rare and sought for Rattan Sega and Gutta Percha, a total area of about 4,000 hectare of managed natural forest would probably suffice.

In the NWFP-inventory, 101 NWFP-producing plant species were identified, of which only 42 species (about 40%) were actually used by the informants of the participating households during the research period. Only 10 of these NWFP were marketed, either as raw material or as processed goods. *Agelaea trinervis* (Mekai), *Calamus javensis* (Rattan Pulut putih), *Daemonorops critina* (Rattan Pulut merah) and *Parkia speciosa* (Petai) were sold unprocessed; species that were processed and marketed included *Calamus caesius* (Rattan Sega), *Korthalsia echinometra* and *K. ferox* (Rattan Merah), *Daemonoros atra* and *D.*

longipes (Rattan Murah/Seringan) as well as *Payena acuminata* (Gutta Percha). These NWFP and articles made thereof were products that were needed for subsistence as well, except for two rattan species providing Rattan Pulut, which were sold exclusively at the village-level.

An underused market potential could be anticipated insofar as products provided by at least 25 of the recorded NWFP-producing species during the inventory were traded at the provincial level and/or in other regions of Borneo. The socio-economic component of the study found that 16 of these NWFP were not marketed in the research villages. For the others, with the two exceptions mentioned above, trade beyond the immediate research area did not take place during the research period.

Several reasons were identified for why more than 50% of all theoretically usable NWFP were not used at all and why more than 60% of all NWFP with market prices were not sold commercially. For most of these species the reasons were low attractiveness or poor quality of their products. Immediately following were economic reasons, which can be traced back directly or indirectly to the scarce plant population densities in natural forest stands. Attempts to promote the marketing of NWFP in the research area would have to deal with these problems of supply and quality as well as limited means of control over vast areas of managed natural forest.

Because of these handicaps the development of more intensive management of NWFP in these natural forests by local people cannot be expected. Consequently, no significant incentives are bestowed for the conservation of natural forests.

A conscious sectoral or solely NWFP-oriented approach to establish and/or increase the use of NWFP as a source of income (in monetary terms or for subsistence) by the local people into the future seems promising only through an increased integration of NWFP in traditional agroforestry cultivation systems, provided that these systems are further developed. A rise of income for the people in the research villages could presumably be achieved more easily by promoting the cultivation and marketing of established agricultural products. Having the official right to harvest timber, the improvement of working conditions in the forestry sector and/or a regular share of the profits from the timber industry, reaping local resources as well as regulated monetary benefits from the nationalized usufruct of *Collocalia*-breeding caves, would be more promising than a unilateral promotion of the management of (vegetative) NWFP.

Based on these conclusions, recommendations were formulated in the context of different development options in the research area. At first, several potential development objectives were described, in which the use and management of NWFP played varying roles. These development options and objectives are partly interwoven and partly mutually exclusive. Conscious decisions for specific development priorities are recommended, though a sectoral promotion of the management of NWFP in natural forests is not a focus in either of these options. None-the-less, the results of the study predict a rising demand for particular local NWFP that possess a certain management potential outside of closed natural forests.

Finally, the research concept as well as the strengths and weaknesses of the particular research methods used, were discussed critically. The innovative approach of the study lies in the interdisciplinary research concept that combines forestry methods, the inventory results from managed natural forests, with methods from social science, i.e. the results of a research component focussing on socio-economic aspects of the use of NWFP by rural people. Such an interdisciplinary approach requires a special evaluation. Exclusively forest-ecology oriented studies on NWFP, as well as studies focussed entirely on socio-economic aspects of the use and development potential of NWFP, have to, and are able to, apply more detailed and hence more comprehensive methods. Presumably each of these mono-disciplinary research approaches would have led to an overestimation of the management potential of NWFP in the research area, as the results of this study demonstrated.

The methodological approach developed for this case study contributes therefore significantly to the further development of forest research and management concepts that are scientifically

sound, but, at the same time, adequately consider social aspects of the use of forest products, especially in regard to the analysis of the significance of NWFP and their development potential in the tropics.

Miombo Woodland Utilisation by Small-Scale Farmers.

Examples from four villages in Handeni-District, Tanzania[4]

Marion Karmann[5]

Background of the study

Miombo woodlands cover about 48 % of Tanzania's land surface and are a settlement area for small scale farmers and cattle-breeders. Although the human population is sparse, the area covered by Miombo is decreasing rapidly. In many regions dominated by Miombo, deforestation is caused mainly by small scale farming together with the increasing activities of professional charcoal miners and the establishment of plantations (teak, tobacco, sisal, cotton and others), settlement areas or hydrological engineering projects. In the research area, Handeni, however, the degradation results mainly from forest fires connected with shifting cultivation, hunting, and other factors.

This study is based on the controversial assumption that comprehensive woodland management with agroforestry systems, including timber and non timber products utilisation, will positively influence the economic and social situation of the population, and thereby contribute to a higher valuation of these resources by the inhabitants themselves.

Knowledge of the possible uses of Miombo woodlands is necessary for further development of appropriate resource utilisation systems. These systems must not only guarantee that the woodlands will fulfil the subsistence needs of the local households, but should also ensure the generation of income through marketing of products from the woodlands.

Methods

Based on this assumption the principal objective of the study is to reach a better understanding about the utilisation of Miombo in the research area through descriptive analysis. A derived objective is to describe the potential development of the region to meet subsistence and income generation needs, covering aspects such as labour organisation and training.

The following research steps lead to the main objective:

1. Assessment of the role of forest utilisation in general, and especially of the role of non wood products, for the predominantly agrarian subsistence livelihood.
2. Identification of the present role of selected non wood forest products (NWFP) of Miombo woodlands, taking into account ecological, economical and socio-cultural aspects of land use.
3. Description and evaluation of the possibilities and constraints of diversification of the product range, and an increase in the direct utilisation of trees and shrubs of Miombo woodlands by the people, based on the carrying capacity of the ecosystem.

The investigation was focused on the inhabitants of four villages from two different ecological zones of the Miombo woodlands. Information related to the utilisation of forest resources, especially the potential use of NWFP, based on the knowledge and experiences of local people and the local experts was collected through individual interviews and group

[4] **Summary** of the Dissertation: Karmann, M.: Untersuchungen zur nachhaltigen Miombowald-Nutzung am Beispiel von vier Dörfern im Handeni-Distrikt, Tansania. IV, 302 S. . Ill., Kt.; (dt.) Freiburg, Univ., Diss., 1998

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discussions as well as field observations and key interviews within and outside the research area.

People and environment:
The villages of Kang´ata, Kwamagome, Kwediboma and Mafisa are not easily accessible. They are located in the Handeni District in the Tanga Region of Tanzania. Most of the people in these villages belong to the Zigua- and Nguu-tribes.

Both tribes basically depend on small scale agriculture (with corn and beans as the main crops) for subsistence needs. Outside the habitats of the *Tsetse*-fly they keep cattle and goats. In addition, Maasai, a semi-nomadic cattle rearing tribe, live in this area at times. They depend on milk and other cattle products. Because the life style and diet of the Zigua and Nguu are basically different from that of the Maasai, different knowledge about useful NWFP from Miombo woodlands was to be expected. All three tribes, however, concur that the primary importance of woodlands lies in their utility for agriculture and cattle grazing.

In fact, life at the subsistence level, and even survival in the woodlands, is only possible through utilisation of a diversity of products from the woodlands. Firewood is the only source of energy in the rural regions and for houses, huts and enclosures not only timber and poles from woodlands are used, but also branches for wall and roof constructions. Bark serves as a connecting element, grass is required for roofing. Wood and bark are processed to make furniture and simple transport vehicles. Wildlife and edible mushrooms offer an important source of protein rich nourishment, particularly where cattle husbandry is not possible (e.g. within the habitat area of the *Tsetse*-fly). Honey from wild bees or from bee-keeping is, among other things, an important basic material for brewing liquor and plays a major role in traditional culture. During extreme hunger periods, which haunt the rural region again and again, food from wild plants often provides a last chance for survival. Medicinal plants may be the only medicines available where there are no hospitals due to financial or technical reasons. Furthermore, medicinal plants are important for health care of livestock.

Main use of NTFP
During the study, four products or product lines from the woodland were identified jointly with the participants . These products are used by different sections of the population and are seen as being suitable for sustainable use and possible marketing. Currently the utilisation of these products is limited and does not exceed the biological potential or meet the market demands.

Honey is mainly used for subsistence consumption, generally in fermented form as local beer. If properly stored, honey can be an important food during hunger periods. Honey can be collected in two ways: through an environmentally sound technique in the form of bee-keeping in hives or using destructive techniques in the form of honey hunting. Honey trade can be profitable for all members of the family as well as for the entire community. The harvesting and processing of honey and by-products can create jobs and income. Men, as is the tradition, carry out bee-keeping and honey marketing and they pocket the earnings. In comparison with honey hunting, the revenue from bee-keeping is higher but requires a small capital outlay. The higher profits of bee-keeping might encourage people to use resources in an environmentally friendly manner. First of all through the establishment of bee-keeping co-operatives women could also be involved in the process, which would give them the possibility of earning income. Honey can be marketed locally and regionally. The entrance of Miombo honey in national and foreign markets is also possible, as shown from experience in neighbouring countries. A strengthened demand for honey and therefore a more intensified skilled bee-keeping system, would not have any negative consequences for ecological functions.

Bark is used in large amounts as a construction material. Bark from selected tree species and bole forms is used for different purposes. De-barking can be practised without severe damage to the tree. Large pieces of bark are traditionally harvested by men, smaller pieces and strings by women and children. Bark strings are locally marketed in small quantities. Potential larger markets for bark are limited, since cheaper substitute materials are available in towns. Production of arts and crafts commodities from bark fibres might have a niche market. With appropriate guidance on this kind of work, men and women can generate income without

much investment. A larger market for bark products, however, could lead to an increase in demand and to destructive bark utilisation. Recommendations for bark use can only be expressed in the context of the utilisation of the whole tree.

Food from wild trees and bushes are used mainly during extreme dry seasons or to prepare certain local meals as an additional food. The collection of wild vegetables and fruits is done by women and children and does not conflict culturally or technically with the cultivation of agricultural crops or other household activities. Seeds of wild vegetables are cultivated to a limited extent around the homestead and in the field. There is only a small market for these products, therefore they are rarely sold and are available to fulfil the rural population's own needs. This is different from agricultural products (e.g. corn, beans, fruit and eggs) which are sold occasionally, even before the producers´ own needs are satisfied, to meet financial requirements.

Hombo, a pulverised mixture of various aromatic herb leaves of different plant species, presents a special case. The pulverised mixture is storable for a long time and counts among the specialities of the region. Because of the abundance of useful species for *Hombo*, their use does not lead to a threat for any individual species. The marketing of *Hombo* can be expanded to a limited extent in local and regional areas because the processing of the raw material involves no financial risk and the product is easily transported and not perishable. Women invest some extra time in the production of *Hombo*, so they could be the major beneficiaries. The profit margin is relatively low, because the product is only a locally demanded speciality, which can be replaced by other food ingredients.

In addition, several different edible parts of plants could be preserved and then be stored through appropriate techniques. These would be useful as food reserves or emergency food during hunger periods or for direct marketing. In order to get a higher profit, co-operatives for production and marketing should be established through which experience and skills can be shared.

Edible mushrooms are represented on a broad spectrum in Miombo woodlands. Mushrooms are consumed only to a limited extent by the local people. People show clearly different personal preferences in quantities and species to be consumed. In the region surrounding the research area dried mushrooms are marketed infrequently. Under proper management, a sustainable harvest of edible mushrooms is a possibility. In several Miombo countries, the enrichment of diet with mushrooms and generating income through the strengthening of trade in mushroom products, are recognised as good opportunities for the economic development of the rural and urban regions. The professional trade is presented with difficulties caused by the seasonality of mushroom fruiting; this problem can be alleviated to a limited extent through the application of appropriate preservation techniques. Other problems are the weak demand of the markets and the bottlenecks in labour availability. This is because during the fruiting season much of the women's time is tied up in agricultural activities. More recently, men have started to participate in collecting mushrooms. An expanded trade in mushrooms can only be recommended in specific cases, but an enrichment of diet with fungi is highly recommended. Comprehensive information about the proper preparation of edible species and about competent preservation is urgently needed; such information should be prepared by ecotrophologists in co-operation with the local specialists, the female users.

Results

Research results from participatory observation and the estimation of the local experts indicated some discrepancies between the extent of knowledge of the rural population about the potential values of the forest and its products and the extent of actual use of forest resources, especially for the selected products. Even though there is a large demand for income sources, a major portion of the available NWFP resource is required to cover household needs. The marketing of these products must be analysed separately and correctly, despite the fact that these products are not harvested by destructive techniques and that market expansion for several products is possible.

In the research area, the marketing of woodland products including NWFP, can be considered an incentive for the conservation of the woodlands. This frequently was made clear during interviews and discussions. Likewise the decline of woodlands is identified as a cause of

scarcities, which must be redressed through financial investment. Up to the present there has been little marketing of products from the forest in these areas, mainly because of the poor infrastructure and lack of knowledge of special methods for post harvest management. As the marketing of forest products is already problematic, expanding the markets would be risky because of uncertain conditions of delivery and purchasing.

The acceptance levels for the expansion of the utilisation and marketing of NWFP vary between and within communities. It will only be convincing if it takes place in connection with a comprehensive introduction followed by training, demonstration and monitoring by local experts, and if corresponding pilot-projects are largely successful. For subsistence economies an increase in use can be recommended for each NWFP in this study except for bark. However, strengthening commercialisation is only cautiously recommended because of the high risks. The establishment of collaborative processing and marketing would favour the commercial possibilities of all product samples.

The essential output of this study is an increment of knowledge and information on the actual utilisation of Miombo woodland and the social and ecological consequences of such use. A specific research procedure to gather detailed information about the research area was developed using regionally and socially specific questions based on experiences during the preliminary research.

Due to the data collection method used interesting discussions took place in the villages concerning the ranking of current miombo use and the possibilities and perspectives as well as potentially effective and sustainable woodland management. These discussions represent an important step towards the increasing appreciation of the resources of the woodlands, as was intended by the study.

The recommendations derived from the knowledge about the possibilities and boundaries of an increase in the direct use of individual products from the woodland for the inhabitants support generally held ideas about an integrated agroforestry management system The implementation of such recommendations is needed.

In general the recommendation is for environmentally sound utilisation of NWFP, with the primary aim of fulfilling the subsistence needs of the household, and a subsidiary aim of accelerating the commercial use of NWFP. Finally, a new system capable of achieving sustainable management of woodlands should be developed based on new theory and knowledge, coupled with results of integrated research (e.g. on yield regulation, marketing and ethnology.) Implementation of the system might positively change the economic and social conditions of local people in the study area and of people living in comparable ecosystems.

Wild Edible Fungi, Miombo Woodland and Rural Livelihoods

Eric Boa[6] and Gerald Meke[7]

In 1999 we began a three year project to investigate the wild edible fungi associated with miombo woodlands. These woodlands consist of native tree species, many of which depend on fungus-root associations or mycorrhizae for their survival. An unusually large number of these associations are ectomycorrhizal and the fungus partner produces fruiting bodies above ground during the main rainy season. A significant number of the fungal species are edible. We prefer to call them wild edible fungi rather than wild mushrooms, mainly because of the

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different definition of a ‘mushroom’. There are some similarities with wild edible fungi found in Europe and North America but there are also many species that are poorly known to science.

The miombo woodlands occur from Zimbabwe to Tanzania and Mozambique to Angola. They are extensively used by local people and in recent years attention has turned to the many non timber forest products or NTFPs that are harvested for food, income and various other uses. Wild edible fungi are an important source of food when traditional sources of nutrition are limited in Malawi and similar countries. There are significant markets trading by the roadside, predominantly for local trade. There is a limited movement of produce to more lucrative urban markets in Malawi, such as Blantyre and Lilongwe.

In the past, NTFPs were dismissed as ‘minor forest products’, a sign of the low significance that foresters gave them. This perception has changed following the decision of donors and development agencies to address the needs and concerns of rural communities more directly, particularly those of the poorest sectors. The label ‘minor forest product’ is no longer applied and a renewed interest in NTFPs has lead to more research and information gathering. It is essential that this research addresses the essential link between NTFPs and local communities, something that the Miombo Edible Fungi project has been striving to achieve. At the same time, there are major gaps in data concerning the types and names of wild edible fungi, the size of harvests and whether increased pressure on the miombo woodlands is leading to a decline in productivity.

Research in Japan and the Pacific NorthWest has paved the way for methods to measure productivity in woodlands. We are also looking in Malawi at the importance of wild edible fungi to local people and their potential to improve livelihoods. Applying the research methods of the North to the South requires some patience, however, and in our second season of sampling natural populations we are learning from previous problems in setting up plots and ensuring regular monitoring of production.

Wild edible fungi are perhaps the least understood NTFP from miombo woodlands. Despite the extensive local knowledge about edible fungi that still exists in Malawi, as witnessed by the bewildering variety of local names, there is also suspicion and caution about poisonous varieties that has been acquired from Europeans. At a recent meeting one or two researchers from Malawi could name over 15 different types of wild edible fungi while most could only name one or two and were generally suspicious of them.

Another reason for the weak history of research on wild edible fungi is the scarcity of specialists to identify them. Most of the detailed work on wild edible fungi in Malawi has been carried out by amateurs, with Brian Morris and Jean Williamson notably documenting many of the local names and providing invaluable guides to species. CABI Bioscience has been able to assist in identifications through the help of Paul Kirk and Graham Piearce, but there is still much to be done in this area.

The main aim of the Miombo Edible Fungi project is to investigate their productive potential. The idea for the research was originally conceived by Dr Jim Waller of CABI Bioscience and developed jointly by Eric Boa together with the late Jimmy Lowore of the Forestry Research Institute of Malawi.

Funding is from the Department for International Development and work began in March 1999. During the first field season, plots were established in four forest reserves in Malawi and regularly monitored during the three month growing season. Surveys of local markets were carried out during the same period (January to April 2000). A preliminary analysis of results from Liwonde and Perekezi showed a total income for traded edible fungi of around US$2000 and US$800 respectively. The weight of edible fungi sold was approximately 5 tons for Liwonde and 5 tons for Perekezi. The actual number harvested is likely to be much higher if we assume that a significant proportion is used directly by the pickers.

Liwonde and Perekezi are only two of the many areas in Malawi where fungi are sold by the road. There are local markets in Mozambique, Zimbabwe, Tanzania and other countries with miombo woodlands but data on volume and value is rarely available. Our own research is

helping to show that wild edible fungi are an important and valuable resource and we urgently need more information so that we can help to improved and sustain rural livelihoods through the application of appropriate knowledge.

Paul Kirk and Graham Piearce are slowly getting to grips with the diversity of edible and non-edible species. They have had to rethink the European concept of some fungus groups. *Lactarius* species, for example, produce milk when the gills are broken. Or at least they do in Britain. Paul Kirk reported finding brown 'milk' on a lactarius from Malawi and didn't expect to find a ring on the stem of a Russula species, another intriguing find.

A priority for the present recording season is to tackle some of the taxonomic gaps that we sense will limit our ability to apply scientific knowledge for the benefit of rural communities. We are as you read this gathering our second set of field data and looking generally for closer links with organisations and researchers interested in the topic of wild edible fungi. Ties have been established across the border with the FAO project led by Patrick Mushove in Nampula and we look forward to closer collaboration in the future.

Research and Development Needs for Non Timber Forest Product Inventories in Mozambique's Miombo Woodlands

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Introduction

Mozambique covers an area of 831 509 km^2 of which over 75% is forest and/or woodland. Nearly 20% (about 15 million ha) of the forest cover is miombo woodland, i.e. woodlands dominated by trees in the genera *Brachystegia, Julbernardia* and *Isoberlinia.* A further 5 million hectares are covered by dense forest. The forest areas are concentrated in the central and northern provinces of the country.

Mozambique's forests and wildlife resources are more important to the subsistence sector of the population than for their contribution to the national economy. This is why the sustainable utilisation and management of these resources is of strategic importance for the well-being of rural families. Community forestry has been chosen as one of the key strategies through which the Mozambican Government intends to promote sustainable and equitable use and conservation of the country's forest and wildlife resources. The Project GCP/MOZ/056/NET *Support for Community Foresty and Wildlife Management* was conceived in this context.

The methodological philosophy adopted by the project is known by its Portuguese acronym IRAPISMu (Mansur, 1997; Mansur and Sambonino, 1999) for ***I**dentofição, **R**elação de confiança, **A**utodiagnóstico, **P**lanificação, **I**mplementação, **S**eguimento e avaliação, e **Mu**ltiplicação,* which roughly translates into IMSePIMER for **I**dentification of potential project areas; **M**utual trust building between the communities and the project protagonists; **Se**lf assessment by the communities; Participatory **P**lanning; **I**mplementation; Participatory **M**onitoring and **E**valuation; and **R**eplication.

The project has developed a flexible monitoring and evaluation system that can be adapted to inventories of timber and non-timber forest products. SIPSA (***S**istema **I**ntegrado de **P**lanificação, **S**eguimento e **A**valiação)* or IMES (**I**ntegrated **M**onitoring and **E**valuation **S**ystem) is based on the concept of 'interest group'. The assumption is that in every community participating in a project of forest and/or wildlife resources management, there exist groups of individuals bonded by a common interest in a particular aspect of resource utilisation and management. These individuals constitute an interest group. Examples of

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interest groups currently implementing microprojects in Nampula province include manual loggers, carpenters, charcoal producers, beekeepers, and mushroom producers.

In this short article we briefly examine the major NTFP categories and their respective assessment limitations based on our experience in Project GCP/MOZ/056/NET. We then propose a methodology for a needs-based inventory of edible mushrooms in a miombo woodland. Finally, we draw up research priorities and the general way forward for NTFP inventories in the project's pilot areas.

Context of NTFP inventories in project GCP/MOZ/056/NET

The frequently mentioned NTFPs fall under 5 broad categories (Costa, 1998; Baldascini, 1999; Masulca, 2000):

1. Medicines
2. Construction materials (bamboo, thatch grass, rope, reeds, palm leaves)
3. Food for people and animals (edible roots and tubers, bush meat, wild fruits, edible insects, mushrooms, wild leaves, fodder)
4. Energy (firewood, charcoal)
5. Handicraft materials (clay, reeds, straw, palm leaves)

Judging from the experience in our project so far, there is virtually no inventory programme for NTFPs in Mozambique: most initiatives are *ad hoc* and project specific. In the first forest resource inventories supported by the project in Goba, southern Mozambique, medicinal plants were assessed for presence, name and use, relying on information supplied by local herbalists and experienced field taxonomists (Direcção Provincial de Agricultura e Pescas de Maputo, 1998). During the same inventory wildlife was assessed for presence through footprints and/or droppings. Baldascini (1999) came closer to quantifying some of the NTFPs in Goba but the sampling intensity and plot size were inadequate (16 x 0.03 ha plots representing a sampling intensity of about 0.005% by area).

There are two major institutional and practical problems with regard to NTFP inventories especially in the humid miombo woodlands and dense forests. The first is the open access nature of the resource. This, for example, removes all incentives for adopting a permanent sample plot strategy, unless a lot of resources are invested in local capacity building and general outreach efforts. This tenure aspect also has implications for the sustainability of NTFP utilisation. The second problem is related to the seasonal growth rhythm in miombo. The best timing for most NTFP inventories would be during the wet season. Unfortunately, this is also the season during which the vegetation is densest, swamps are swelling and all types of hunter ants are so active that it is not advisable to enter the forest.

Quantification and monitoring of mushroom production in miombo woodland[10]

Normally studies to determine the relative abundance and seasonality of mushrooms need to be undertaken over long periods of time in order to get realistic information on the actual productivity of the forest. If the studies are undertaken for commercial purposes, there is a need to pay attention to the discrepancy that normally exists between the forest productive capacity and the actual amounts harvested.

Productivity of a forest

1. The forest area is stratified into vegetation types through the use of GIS databases.
2. Permanent plots are established in the different strata. The number of plots per stratum depends on the size of stratum and also on the ecological ages of the forest. Normally five plots each measuring 50 m x 2 m would be adequate for each stratum.
3. The plots are demarcated with the aid of a tape and the boundaries of the plot marked by pegs driven into the ground at an espacement of 5 m.
4. The number of specimens of each species is determined every two weeks and recorded in the following mushrom occurrence form.

[10] This section is based entirely on the consultancy report by Masuka (2000).

FOREST: ……
BLOCK: ……
COMPARTMENT: ……
SITE: ……
PLOT NUMBER: ……
MONTH: ……

MUSHROOM TYPE	WEEK 1	WEEK 3	WEEK 5
Indadje			
Naluca ndadje			
Inthurue			
Nipussuela			

5. The average weights of various mushrooms determined from the following equation are then used to calculate the plot productivity.

Average mushroom fresh weight (g) = FW/N
Where FW = weight of mushroom sample and
N = number of mushrooms in sample

6. The productivity of the forest, for a particular species, is estimated from the following equation.

Forest productivity of *Cantharellus cibarius* = S x FA/SP
Where S = average productivity of *C. cibarius* per plot
FA = total forest area
SP = sample plot area

Productivity of termite mounds

A different sampling approach has to be adopted for assessing the productivity of *Termitomyces* species which have symbiotic associations with termites. The termite mound is used as a production unit. However, it should be pointed out that it is not the whole termite mound surface area that produces mushrooms; it is normally the upper cone of the mound that actually produces mushrooms.

1. Plots are laid along a baseline, e.g. a road. The plots measure 100 x 100 m each on either side of the road, 50 m from the road and located 5000 m apart. The number of termite mounds per hectare is then calculated as follows.

Average number of termite mounds in sample plot = TN/NP

Where TN = Total number of termite mounds in all plots and
NP = number of sample plots

2. Next, the number of termite mounds in the forest should be estimated.

Number of termite mounds in forest TS x FA/SP

Where TS= average number of termite mounds in sample plots
FA = Forest area and
SP Sample plot area (1 ha)

3. The productivity of forests for *Termitomyces* is then determined.

Mushroom productivity of forest = FW x MN x N

Where FW = average mushroom fresh weight
MN = average number of mushrooms per termite mound
N = number of termite mounds in forest

There is one practical and logistical issue worth considering. Counts are rapid and easy, however, collecting mushrooms and weighing them species by species will require a lot of work and time. The results obtained from such an investment in time and labour maybe more useful to the researcher than the farmer.

Research and development priorities for NTFP inventories in project pilot areas

Project GCP/MOZ/056/N7ET's main interest regarding this workshop revolves around three categories of NTFPs, namely, medicinal plants (trees, shrubs, herbs), construction material (bamboo), and food (mushrooms, bush meat, wild fruits). These are the research and development priority areas some of which (e. g. medicinal plants and mushrooms) are already in the early implementation stages (Macucule and Mangue, 1998).

The specific inventory aspects to consider are illustrated in the following table.

Table 1. Inventory, utility and sustainability issues for NTFPs.

NTFP category	NTFP	Inventory issues	Utility issues	Sustainability issues
Medicines	Leaves, roots, bark, fruits of Medicinal trees, shrubs, lianas, herbs	Variables to be measured; sampling strategies; estimates of productivity per unit area.	Valuation of medicinal plants supply-demand analysis as function of ailments by regions.	Monitoring extraction rates vs natural regeneration; monitoring damage by wildfires.
Construction materials	Bamboo	Variables to be measured; sampling strategies; estimates of growing stock.	Value of bamboo as construction material.	Extraction vs regeneration Rates; population dynamics; damage due to fires; setting quotas and cycles for commercial and subsistence harvesting.
Food	Mushrooms	Occurrences by Species; sampling strategies; occurrences of termite mounds; forest productivity.	Nutritional and food security value of mushrooms; economic contribution to rural household economy.	Monitoring impact of commercial harvesting on Productivity; experiments on artificial regeneration.
	Bush meat	Occurrences by species; sampling strategies.	Nutritional and food security value of bush meat; economic contribution to rural household economy.	Control of hunting and trapping techniques; quota setting; game farming.
	Wild fruits	Sampling strategies; forest productivity.	Nutritional and food security value of wild fruits; economic contribution to rural household economy.	Monitoring impact of harvesting on productivity; monitoring impact of conversion of forest to agricultural land on productivity; monitoring effects of fire on productivity

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Statistical Information on Non Wood Forest Products[11]

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Intoduction

Statistics are about quantities and magnitudes. They are used in communicating information, keeping records and making comparisons. Forestry sector statistics should cover all aspects of the activities of the sector. The information may be needed for many different purposes, both by people within the sector and from outside.

In this paper, four implicit characteristics (what, where, how, when) of the definition of an elementary statistical unit will be discussed in some detail.

Aspects about *who* produces forestry statistics on non-wood forest products (NWFPs) and *why* they vary from country to country according to national infrastructure and priorities. This paper attempts to encourage the appropriate authorities to take necessary initiatives to reinforce existing infrastructure or to create one for collecting and disseminating needed statistics.

In the wake of the United Nations Conference on Environment and Development (UNCED), the priorities in forestry statistics are:

- to maintain and strengthen basic statistics on production, trade and consumption of forest products in order to monitor the productive role of the forest in the economy. **These basic statistics should then be extended by gaining information on the role and magnitude of production, trade and consumption of forest products other than wood**.

- to strengthen the basic information-gathering capability, which corresponds to forest resource assessment and assessment of their productive capacity, and to extend that capability to monitor changes; **and to assess and monitor the forest's protective functions, such as soil and water conservation and the conservation of biological diversity.**

Please visit the web site to view the full paper
http://www.fao.org/docrep/V7540e/v7540e31.htm

[11] See web site for full paper at http://www.fao.org/docrep/V7540e/v7540e31.htm
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