National Forest Monitoring and Assessment

NFMA approach and process: an analysis of Cost and Time

Background Paper prepared for the National Forest Monitoring and Assessment [NFMA] Expert Consultation "Meeting Evolving Needs". Rome - 26-28 November

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Forests are crucial for the well being of humanity. They provide foundations for life on earth through ecological functions, by regulating the climate and water resources and by serving as habitats for plants and animals. Forests also furnish a wide range of essential goods such as wood, food, fodder and medicines, in addition to opportunities for recreation, spiritual renewal and other services.

Today, forests are under pressure from increasing demands of land-based products and services, which frequently leads to the conversion or degradation of forests into unsustainable forms of land use. When forests are lost or severely degraded, their capacity to function as regulators of the environment is also lost, increasing flood and erosion hazards, reducing soil fertility and contributing to the loss of plant and animal life. As a result, the sustainable provision of goods and services from forests is jeopardized.

In response to the growing demand for reliable information on forest and tree resources at both country and global levels, FAO initiated an activity to provide support to national forest monitoring and assessment (NFMA). The support to NFMA includes developing a harmonized approach to national forest monitoring and assessments (NFMA), information management, reporting and support to policy impact analysis for national level decision-making.

The purpose of the NFMA initiative is to introduce countries to an alternative approach designed to generate cost-effective information on forests and trees outside forests, including all benefits, uses and users of the resources and their management. Special attention is placed on monitoring the state and changes of forests, and on their social, economic and environmental functions. Another main objective is to build national capacities and harmonize methods, forest related definitions and classification systems among countries.

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By

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ABBREVIATIONS

COP -13:	13th Session of the Conference of the Parties
COP -15:	15th Session of the Conference of the Parties to the UNFCCC
FAO:	United Nations Food and Agriculture Organisations
FNPP:	FAO-Netherlands Partnership Programme
FRA:	Global Forest Resources Assessment
GCP:	Government Cooperation Project
IFF:	Intergovernmental Forum on Forests
ILUA:	Integrated Land Use Assessment
IPF:	Intergovernmental Panel on Forests
MDG:	Millennium Development Goals
NFI:	National Forest Inventory
NFMA:	National Forest Monitoring and Assessment
NLBI:	Non-Legally Binding Instrument
REDD:	Reduction of Emissions from Deforestation and Forest Degradation
SIDA:	Swedish International Development Cooperation Agency
SFM:	Sustainable Forest Management
TA:	Technical Assistance
TCDC:	Technical Cooperation between Developing countries
TCP:	Technical Cooperation Programme
UNFCCC:	United Nations Framework Convention on Climate Change
UNFF:	United Nations Forum on Forests
UNICED:	United Nations Conference on Environment and Development
UTF:	Unilateral Trust Fund
WFS:	World Food Summit
WSSD:	World Summit on Sustainable Development 2002

1. Introduction

It is not difficult to find arguments for standardised collection of forest and forestry information that can be used for international analyses or comparisons (e.g. Lanly 1996, Lund 1996). The United Nations Conference on Environment and Development (UNICED) in Rio in 1992, advocates towards comprehensive assessment of forests. The United Nations conventions on biological diversity (CBD), climate change (UNCCC) and to combat desertification (UNCCD) are other milestones. On a more general level, international economic and environmental analyses and forecasting require reliable input concerning the forestry sector. The implementation of these international processes requires monitoring the status of forest (and other) ecosystems including the values of goods and services as well as the legal and political frameworks for the management of land and natural resources.

FAO's periodic assessment of the world's forests (FRA) is designed to collect information on the forest resources, condition and use and monitor changes and trends in forest cover and the resources they contain. The natural or human-induced processes within the forests – degradation and/or improvement - and conversion between forests and other land uses - deforestation, afforestation and reforestation - are the main issues that are monitored. These reporting requirements help countries to better address efforts towards sustainable forest management (SFM) and reduction of emissions from deforestation and forest degradation.

FRA 2000 and 2005 describe in detail the weaknesses and strengthens of the world forest information. The article titled "Gaps in national-level information on forests and trees in developing countries" published in Unasylva, vol 53, 2202/3, depicts the state of forest information before 2000 in developing countries. In 2000, 7% of the forests in developing countries were covered by field inventories in combination with remote sensing. Through the FAO Support to National Forest Monitoring and Assessment (NFMA) programme, which has been active in over fifteen countries, that figure increased to 9.4% in 2008, although not substantially. In addition, the programme has succeeded in improving country awareness of the utility of accurate and timely information in enhancing national forest programme processes.

As a result of increasing concern on adaptation and mitigation to climate change accurate estimates of carbon and changes in the carbon stock in the forests and trees outside forest at the national level are becoming increasingly important. Moreover, monitoring criteria and indicators of sustainable forest management, biodiversity, etc, is increasingly in the spotlight of policy makers and managers of forest resources at all levels.

The field and remote sensing based NFMA is also a major tool to monitor countries' efforts to reduce emissions from deforestation and forest degradation (REDD) as expressed at the UNFCCC 13th Conference of Parties (COP-13) in Bali, Indonesia in December 2007. The Parties targeted to support long-term cooperative action from now, up to and beyond 2012, with the intention of reaching an agreement at COP-15 scheduled for Copenhagen in 2009.

NFMA in the Global Context

The contribution of forests and trees to sustainable development, livelihoods and landscapes, as well as their management resides in inter-sectoral and multi-disciplinary contexts. The primary role of forests and sustainable forest management in national socio-economic development, poverty alleviation, food security and environmental protection has been recognized at the highest political levels in international negotiations, namely the World Food Summit (1996), World Summit on Sustainable Development 2002 (WSSD), Proposals for action (IPF/IFF1997), NLBI (UNFF 2007), and Millennium Development Goals (MDGs).

The Intergovernmental Panel on Forests (IPF) Proposal 30-a underscores the importance of providing timely, reliable and accurate information on the underlying causes of deforestation and forest degradation, where needed, as well as on the multiple roles of forests, so as to create a foundation for public understanding and decision-making. It also promotes integrated approaches towards the formulation and application of national policy frameworks, and in conducting strategic analyses of relevant political, legal and institutional policies that have contributed to deforestation and forest degradation.

The United Nations Forum on Forests (UNFF) adopted 2007 a non-legally binding instrument (NLBI) on all types of forests to strengthen political commitment and action to implement effectively sustainable management all types of forests. Although progress has been made in the international fora, SFM implementation has remained weak in most developing countries, deforestation and forest degradation continue at alarming rates. More accurate information on forest is required for implementation of the NLBI and SFM.

There are wide expectations of support for the upcoming UNFCCC COP 15 in Copenhagen conference on the post-Kyoto treaty at the end of 2009. Climate change and possibilities of including the initiative for reducing emissions from deforestation and forest degradation in developing countries (REDD) initiative to post Kyoto negotiations has generated an expanded need for more accurate information of the forest resources and especially the changes in the carbon stocking.

On the assessment of the multiple benefits of all forest types, IPF/IFF encouraged all countries to improve national forest resources assessment, forest statistics and the capacity to analyse and make proper use of forest resources information to allow for more informed decision-making on the implications of alternative proposals for forest programmes and land-use plans. It also encouraged donor countries and international organizations to support these initiatives.

The NFMA programme results can notably contribute to, among others, NLBI, MDGs, WFS, WSSD and Post Kyoto negotiations by (i) providing harmonized, reliable and regular information on forest resources and related contexts at the national level; (ii) providing support to national decision-making and policy processes, (iii) integrating sustainable forest management into broader national sustainable development processes including poverty reduction, food security, sustainable livelihood strategies and environment protection; and (iv) bringing international concerns into the national debate on forests.

NFMA in FAO Context

Being a national process of knowledge generation and sharing among stakeholders and a tool of country capacity building, the NFMA initiative is a core element of the FAO mandate (see Box 1).

Box 1

The Organization shall collect, analyse, interpret and disseminate information relating to nutrition, food and agriculture. In this Constitution, the term "agriculture" and its derivatives include fisheries, marine products, forestry and primary forestry products

The global goals stated in the overall strategic framework of the Organisation include, among others, conservation, improvement and sustainable utilization of natural resources, including land, water, forest, fisheries and genetic resources for food and agriculture.

Because of the inestimable social, economic and environmental values of forests (more than 30% of the land area of the planet) and the unprecedented pressure on it for resources and land for other uses, the new FAO strategy for forestry recognises that decisions affecting the forest sector at all levels should be based on timely and reliable information.

2. Objectives of NFMA process

The long-term objective of NFMA is to contribute to the sustainable management of forests and trees outside forests by providing national decision makers and stakeholders with the best possible, most relevant and cost-effective information on the state of the forestry resources, their uses and management for the purpose of national and international dialogue on forestry related policy issues and socio-economic development.

Specifically, FAO's support to national forest monitoring and assessments aims at:

- Assisting countries in building their national capacities to design, plan and implement national forest inventories, to manage the generated information and disseminate it to decision makers;
- Generating baseline information on a wide range of forest and tree parameters on the basis of a harmonised set of variables, vegetation classification system and standard forest and tree survey sampling design for continuous monitoring. The generated information is composed of a set of main indicators with acceptable precision and a wider range of indicative information;
- Producing information on management and use of forests and their linkage to local communities and livelihood;
- Promoting multilateral co-operation and international partnerships through providing information and monitoring forest resources.

3. Principles of NFMA

Methodological approach

Forest inventory commonly refers to measurements of several important parameters of forests and trees and to the analysis of abundance and distribution of individuals. The inventory in forestry is, in most cases, based on sampling. Different options of sampling designs exist to survey a given forest area in a country. Each option is chosen to fit the given characteristics of a surveyed population and to satisfy specific information needs on selected parameters for a given budget. Random sampling is commonly used. It may be simple random sampling with or without stratification. It may also be double or multistage sampling, double or multiphase sampling, etc. Systematic sampling may also be unrestricted or stratified.

Forest inventory may rely on temporary or permanent sample plots depending on the objectives of the survey. For monitoring purpose, continuous forest inventory is often adopted and relies often on permanent sample plots. In order to improve the precision of the results, temporary plots may be added to existing permanent plots in successive surveys.

It is proven that relying only upon remote sensing for forest resources monitoring cannot satisfy most of the information needs. Due to the limited scope of information and accuracy of estimations it generates in respect to field sampling, remote sensing tends to be relatively expensive when compared to the combined use of remote sensing and field sampling, which together produces large volumes and variety of high-quality information.

Systematic field sampling and remote sensing are therefore the pillars of the NFMA process in the countries. These two data collection techniques apply at different scales and complement one another. Data collection at the field sample plots reflects the ground reality (1:1 scale) and covers a wide range of biophysical and socio-economic data through measurements and interviews with resources users (e.g. local communities) and managers. Remote sensing, on the other hand, applies at much smaller scales and can be either wall-to-wall[1] or sample-based[2]. Remote sensing surveys serve to gather some geospatial data on land cover /land use that can not be collected from field sampling (e.g. geographic location and distribution of forests, fragmentation of forests, past changes in forest cover and extent, etc). Both methods are complementary and combination of the field survey and the remote sensing survey improve the quality of the statistics.

The NFMA main focus is to generate aggregated information on the main indicators (areas of global classes, volume, biomass, carbon stock, etc) with acceptable precision at national level. This helps countries who lack adequate forest information to acquire data on the most important indicators. Another focus is to produce a large volume of information on other indicators (see Figure 1), which can serve as indicative information to further guide efforts for specific inventories to be implemented in the later phases. NFMA cannot provide high precision for every parameter, especially those which are rare in the country.

The FAO-designed NFMA is intended to be applicable in any country and is open for adaptation to meet the changing needs and requirements of information in the countries and at the international level. It adopts and promotes new knowledge, methods and technologies. Over the last eight years, the NFMA concept and approach have been widely debated and improved. Internationally, two technical meetings and one expert consultation involving policy makers, scientists and experts of forest inventory from all regions were convened by FAO to analyse the approach and adapt it to changing requirements. Intensification of the sampling was suggested to improve the precision and accuracy of estimates. Remote sensing was recommended to strengthen the NFMA process with information that field sampling alone cannot generate.

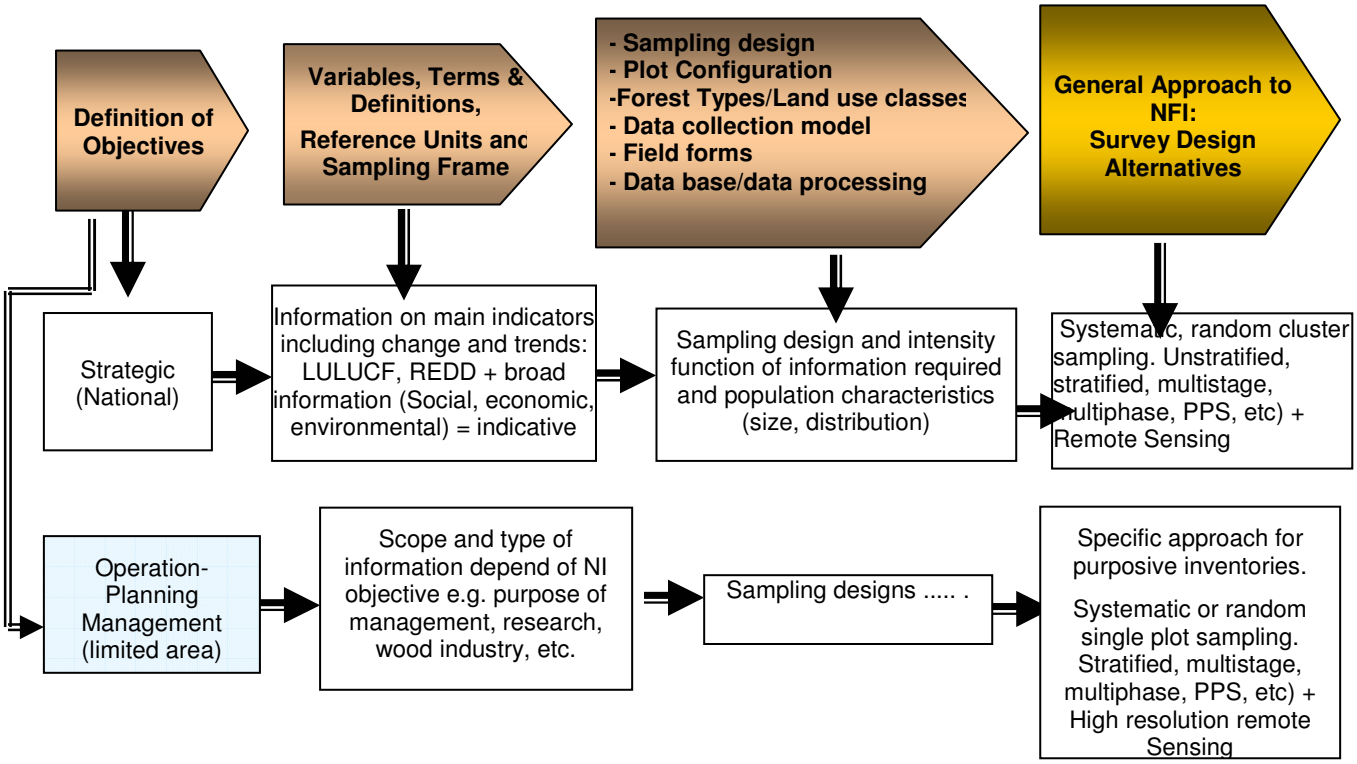
Following the systematic sampling and use of remote sensing, the NFMA was broadened in some countries like Zambia and Kenya to encompass other land use resources e.g. crop, livestock, water, agro-biodiversity, etc. Based on two special studies on incorporation of the socio-economic component to the NFMA, the approach has been greatly improved to collect representative data and generate reliable information on local communities and their livelihoods in relation to the forests. The projects of this nature are called integrated land assessments (ILUA).

Process of forest inventory design

A forest inventory can only be properly designed if the objectives are well defined and agreed upon in advance. The type and scope of information to collect in the field depends on the defined objective. National policy and various other decision-making and planning processes require different information compared to management-oriented or other operation-oriented inventories. Depending on the information required, the sampling frame is conceptualised and designed as illustrated in Figure 1.

[1] Bangladesh, Zambia, Angola
[2] Brazil, Costa Rica

Figure 1: Process of sampling design for (national) forest inventory



4. Ownership of NFMA process

Capacity building

In order to increase the sustainability of the NFMA process, NFMA projects endeavour to build capacity of the partner institutions and enhance the skill of their staff through training personnel for supervision, field data collection, mapping, database development and information management.

Training provided in the workshops covers methods of national forest inventory such as sampling design, field data collection techniques (e.g. measurements, observations and interviews), identification of information needs and harmonising forest/land use classification system. It is also provided through theoretical and practical exercises in the field along with mapping and data processing teams.

Supervision provided by FAO during repeated field missions by hired national and international professionals provides considerable input to capacity enhancement to the national staff at all levels.

By design, the NFMA process is implemented following the participatory approach. Implementation of NFMAs involves a wide range of actors engaged in the forestry or related sectors through expert meetings or multi-disciplinary steering committee often composed of senior personnel from the forest sector and line ministries. This considerably improves the awareness of the NFMA process, helps define the scope of needed information and expected outputs and also enhances the sharing of the generated knowledge.

Bridging knowledge gap in (developing) countries - information generation & policy analysis

One of the major challenges of the NFMA programme of FAO is to establish, from the onset of NFMA projects, a shared vision of the objectives of the process at the national level. Due to a lack of familiarity with different types of inventories, the information they generate, the sampling design they require and the costs they incur, many professionals in countries tend to mix up concepts of national (strategic) and restricted (operational/management) inventories. Countries tend to require more intensive national forest inventories and high precision level for every estimate without considering that rare population elements cannot be assessed at low (<10%) sampling error using the sampling intensity of NFMA.

Most developing countries do not have up-to-date information on their forestry resources and the needed capacity to generate it. The NFMA, therefore, was conceptualised to establish a baseline of core harmonised information on the social, economic and biophysical properties of forest resources. Harmonisation of the information is done in order to compare it with the historical national information framework and to meet international reporting requirements. The forest related terms and definitions employed by the global FRA are the basis of the NFMAs.

The very basic idea of the NFMA is to fill the information gap at the national level by setting up a process which allows generating periodical information on key indicators about the forest and trees outside forest resources for national decision making processes and policies. The information requirements are defined by the country through a participative process involving all stakeholders. The generated information includes the status, uses, users and management of the resources, the change in land use and in forests (LULUCF) and the causes of the land use and forest changes. In the field samples, a wide range of data is collected on tree species diversity, gross and commercial timber volume, biomass, carbon stock and various non-wood products and services. Monitoring of these parameters is anticipated to be transparent, consistent, comparable and accurate so that it may stimulate national policy dialogue and support cross-sector policy analysis from an integrated perspective.

Setting up long term monitoring system of resources

Frequent repetition of inventories allows for understanding trends for the purposes of long term resources monitoring and assessment (e.g. REDD). Repetition also adds value to the NFMA by providing more in-depth knowledge about the developments taking place with forest resources and their use. This helps improving sustainable forest management policies and practises, mainstream forestry within the national efforts to eradicate extreme poverty and hunger, achieve sustainable water and land use, mitigate climate change and in general achieving the Millennium Development Goals.

National ownership and capacity building are essential to ensure that the assessment will be repeated overtime and that a proper monitoring system is set up. By transferring expertise and technologies to the countries, the NFMA programme expects that the country will be able to repeat the inventory every 5 or 10 years with less external support.

5. Information quality

When planning an inventory, especially a national forest inventory, an inventory specialist's goal is at a reasonable cost while obtaining an estimate that is accurate i.e. close to the true value. When only a part of the population is measured, some estimates may be high, some low, some fairly close and, unfortunately, some rather far from the true value.

An NFMA, being based on sampling techniques, is not totally free from different types of error. Bias, systematic distortion of the information, is due to flaws of measurements, methods of selecting the sample or due to techniques in estimating parameters. NFMA results cannot be completely free from such bias, especially given that people with different skills take the measurements in the field. Volume functions to estimate timber stock, for example, can be a source of bias.

In an inventory with minimised bias, the main concern becomes how to secure precise information. Precision refers to clustering of sample values about their own average, which, if biased can not be the true value. Accuracy is the success of estimating the true value of a parameter.

Having these concepts in mind, it goes without saying that NFMA will not be precise for every estimate. As based on sampling at national scale and considering the diversity and different sizes of population elements, NFMA results can be adequately precise and accurate, if not biased, for the most of the key indicators. The precision/accuracy of a large number of other parameters remains low to very low (see Table 1). In countries with high heterogeneity and fragmentation of land uses, sample sizes can be increased to a level that secures expected precision.

Table 1: Land use classes and attributes and expected precision level

Class level	**Land use classes and attributes**													**Target precision of NFMA**
Global classes	**Forest**							**OWL**		**OL**				**High**
2nd Level: National	Natural				Planted			Shrubs	Wooded grasslands	Natural		Cultivated		**Lower (high for some parameters)**
3rd Level: National	Broadleaved		Deciduous		Pine	Eucalyptus	Mixed			Barren land	Grassland	Annual crop	Perennial crop	**Indicative information (acceptable for some parameters)**
4th Level: National	Primary	Secondary.	...	...	...	...	...	...	...	...	...	...	...	**Indicative information (acceptable for few parameters)**

6. Basis of NFMA cost estimates

Time frame

Considering cost and expected quality of generated information, NFMA projects were initially planned for a duration of 18 months, which also was considered to fit the TCP timeframe, which used to be one and a half years. The lessons learned from the first NFMA projects were that 18 months are not sufficient to conclude all activities, due mainly to very slow national administrations. Duration of 36 months has been found to be a more suitable timeframe for planning NFMA projects.

An NFMA project is implemented in three phases:

(1) Phase one includes planning of project activities, fine tuning the NFMA approach to meet specific country scenarios, defining information needs through wide participation of stakeholders, designing forest/land use classification systems, setting up the project organisation and its institutional and monitoring arrangements, recruiting professionals and support staff, procuring equipments and supplies, training of national staff and also designing and developing the database application. This phase requires 6 to 9 months depending on the country.

(2) Phase two is mainly for data collection through a field survey at sample plots and through a remote sensing survey. Approximately 12 to 18 months are needed to complete the entire fieldwork and the remote sensing survey.

(3) Phase three, 6 to 9 months depending on the countries, is dedicated to processing and analysing the field data, producing maps, and to reporting and dissemination of findings and initiating the policy analysis.

NFMA/ILUA activities and inputs

By nature, completing an NFMA and ILUA are complex processes. NFMA requires considerable technical inputs from statisticians, forest inventory specialists and mensurationists, remote sensing and mapping specialists, computer and information system development specialists, data processing (biometrician), and policy analysts. In addition to NFMA requirements, ILUA requires inputs from a number of other specialists such as agronomists, soils engineering, livestock specialists and others. Both models require also, according to inventory objectives, specialists who provide necessary information in their own fields. This is in addition to the technical and support staff for field data collection, mapping, data entry and processing and administrative support.

NFMA and ILUA are very demanding in terms of logistics and equipment. Procurement, maintenance and use of field survey equipment for forest mensuration, data base management, mapping, camping and not least transport require much attention and supervision.

NFMA project budgeting in countries

The budget of FAO supported NFMAs includes technical assistance, transport, equipment and supplies, backstopping and other incurred expenses of involved local staff and logistics for the field activities. The budget of an NFMA can be grouped into two main clusters of activities. The first cluster includes the cost of technical assistance and the expenses of internationally procured equipment and supplies (forest inventory equipment, remote sensing data, etc). The second cluster is composed of country-specific cost categories. The technical assistance and the equipment and supplies procured in the international market are similar to all projects except that some countries require less technical assistance than others. For example, the NFMA project of the Philippines consumed much less technical support from FAO than the NFMA projects in Central America and Africa. The technical assistance is based on official UN rates, which also vary depending on the

category of experts assigned (TCDC, retiree, international expert, etc). The cost of inputs from inside the countries depends largely on the actual costs of living in these countries. In countries like Zambia and Kenya, the field allowances for the national personnel is substantially high (above US$70 per day per person) compared to other countries like the Philippines or Bangladesh. The volume/scale of technical assistance is very often the limiting factor, because very often it is dependable on support from outside sources (bilateral or multilateral donors). Therefore, in practice technical assistance is defined firstly according to available funds and secondly according to country needs.

7. Sources of funding

The NFMA projects undertaken with FAO assistance were funded through different sources, including the Technical Cooperation Programme (TCP) of FAO, Unilateral Trust Funds (UTF), the Government Cooperation Programme (GCP) and contribution in cash or in-kind from the concerned governments. Some projects were also financed from extra budgetary resources under partnership agreements between FAO and donors like SIDA, the Netherlands (FNPP) and Norway.

Table 2 shows countries supported by FAO, the sources of funds and the level of budget allocated.

In the first years of the programme, the NFMA projects of Costa Rica, Guatemala, the Philippines and Cameroon were budgeted relatively low. The low budget was set as a likely guarantee for the sustainability of the processes in the countries. Experiences have shown that costly NFIs introduced in the developing countries in the seventies and in early eighties have not been repeated or not even completed for the incurred high cost. The challenge has been how to design a NFMA that can be affordable to the concerned countries and to donors and on the other hand, how to raise the status of NFMA as a priority in the countries among other important development needs, while ensuring reliable information aggregated to meet the needs of national level decision making processes.

Table 2: NFMA budget estimated by formulator

Countries	Area (km^2)	Funding (US$)					
		Trust Fund	TCP (FAO)	UTF[3]	Bilateral	Government	Total
Costa Rica	22,960	150,000	0	0	0	0	150,000
Guatemala	108,890	228,000	0	0	0	232,000	460,000
Philippines	300,000	250,000	0	0	0	300,000	550,000
Cameroon	475,440	224,000	0	0	0	314,648	538,648
Lebanon	10,100	0	314,000	0	0	200000	514,000
Bangladesh	144,000	0	352,000	0	0	168,000	520,000
Zambia	752,610	104,963	308,532	0	437,854	317,760	1,169,109
Honduras	112,090	0	402,938	0	0	97,514	500,452
Kenya	580,370	372,000	0	0	0	217,000	589,000
Algeria *	2,381,740	0	200,000	0	0	200,000	400,000
Congo	342,000	0	284,000	0	0	500,000	784,000
Angola	1,246,700	0	394,000	940,000	0	0	1,334,000
Kyrgyzstan	199,900	0	330,000	0	0	300,000	630,000
Nicaragua	130,000	0	218,000	850,000	0	0	1,068,000
Brazil**	8,514,880	0	440,000	0	0	400,000	840,000
Tanzania	945,090	0	0	0	3,017,000	794,000	3,811,000
Comoros	1,860	0	378,000	0	0	100,000	478,000
Gambia	11,300	0	440,000	0	0	100,000	540,000
Total		1,344,000	4,061,470	1,790,000	3,429,000	4,200,000	14,876,209

[3] Under Unilateral Trust Funds (UTF), the funds are provided by the country.

The above budgets cover recurrent costs such as Equipment and Supplies, Training of local Staff, In-country Seminars, Workshops and Meetings, Mapping, Technical Assistance (national and international consultants and experts), transport and travel for international and local personnel, general operating expenses and reporting. The budget, however, does not cover costs of physical facilities (offices and training space, communication means, etc.) and the needed national counterpart staff at secretariat and professional levels.

8. Actual costs in NFMA/ILUA countries

To analyse the actual costs of implemented NFMAs/ILUAs, a template was prepared and circulated to the experts who supervised or implemented the NFMA projects and processed the field data. Five countries were surveyed for this study namely Bangladesh, Cameroon, Honduras, Nicaragua and Zambia. In the first four countries, FAO helped plan and implement NFMA and in Zambia, on request from the Forestry Department of the country, an Integrated Land Use Assessment (ILUA) was carried out. In addition to the forest and tree resources, the ILUA covered crop and livestock resources and was planned to stimulate cross-sector dialogue for policy harmonisation.

The compiled information covers all the project activities encompassing capacity building, procured equipments, preparation of field surveys and management of the project, mapping if any, field survey (planning, transfer to sample sites, measurements and interviews), sensitisation, supervision of project activities as well as database/data entry, processing and reporting. The size of technical assistance provided by FAO is also included.

The cost does not include facilities and various in-kind contributions provided by the partner institutions such as office space, communications (telephones, internet, fax), salary of national counterpart personnel.

In order to homogenise the information from the surveyed countries, each of the activities is defined in Box 2.

Box 2: NFMA Scope of activities for the cost and time analysis

- **Capacity building** covers the sessions of practical and theoretical training of the NFMA technical unit on forest/land use classification system and applied terms and definitions, sampling design, planning of field survey, plot layout, data collection and interviews of key informants. It also covers training provided to the field data collection teams on use of the classification system, field forms, sampling design, plot lay out, data collection and interviews. It also covers data entry and data processing training sessions.
- **Equipment**. This line covers only the cost of purchased computer equipment for project and database management, specialised equipment for field orientation and tree mensuration, camping equipment, if necessary, and computer equipment and software for mapping, where needed.
- **Preparation and management** by technical unit, cover updating of work plan, organising and setting up the project technical unit (PTU) and the steering committee, convening meetings of the PTU and steering committee, preparation and organisation of workshops and training session, acquisition process of equipments, recruitment and coordination of national and international consultants, organisation of the fieldwork (technical staff, transport, field forms and maps, survey equipment, etc), mapping and database development and budget management.
- **Mapping** covers organisation and implementation of all mapping activities including reconnaissance field trip in the country (forest types, land uses, etc), interpretation of satellite images, ground truthing of interpretation results, adjustment of interpretation and production of the maps. The mapping was not carried out in all countries.
- **Field survey** covers time spent by the field teams in planning and preparing the fieldwork (field maps, field forms, equipment, itinerary to tracts, people to interview, transport, support labour, etc); time for accessing to/from tracts, camping; measurements at sample plots and interviews with user groups and key informants.
- **Sensitisation and awareness raising** include work to inform the sub-national and local authorities about the project as well as local communities, different other stakeholders and the public in general (radio, TV, meetings...).
- **Supervision** encompasses project activities for coordination and supervision of the field work by the members of the NFMA technical unit as well as by national consultants and national counterpart assigned senior personnel. This activity covers supervision of the field teams to ensure clear understanding of the classification system and related terms and definitions, data registering in the field forms, correct use of survey equipments and to ensure homogenous data collection.
- **Data entry** includes entry of the field data.
- **Processing** covers data validation, data sorting and pre-processing of the data as well as statistical analysis to generate the expected results.
- **Reporting** of the project findings including preparing reports with findings, statistics, maps and policy analysis, and dissemination of those results and findings through workshop and publications.
- **International technical assistance** (TA) provided by FAO includes support by full international experts, when project budget allows, and/or consultants recruited under the FAO arrangement for Technical Cooperation between Developing Countries (TCDC) and retirees as well as backstopping (missions and overhead) from the lead and other technical units at FAO Headquarters and Regional Offices.

The information for the field time estimates was mostly generated from the database using the recorded information in the field forms such as time when leaving road, when getting to plot, time record of work within the plot (starting time, ending time). Also some information was generated through expert opinion. These included time used for planning for the outing by the field teams, and time used for the interviews.

In this analysis, effective time was used for each activity excluding delays caused for different reasons which are often country specific. Among these delaying causes were: vehicles or material not available or not fully operational for mechanical problems, lack of fuel, etc, low staff commitment, slow administrative procedures, delays due to country political situation and instability, climate conditions, etc.

The results of the survey are introduced in Table 3:

Table 3: Time and Cost of NFMA and ILUA Activities in five selected Countries

Project main tasks	Activities	Zambia (221 tracts)			Honduras (156 tracts)			Nicaragua (371 tracts)			Bangladesh (296 tracts)			Cameroon (206 tracts)			Average (250 tracts)		
		Time	Cost, US$		Time	Cost US$		Time	Cost US$		Time	Cost US$		Time	Cost US$		Time	Cost US$	
		day/tract	Total	%	day/tract	Total	%	day/tract	Total	%	day/tract	Total	%	day/tract	Total	%	day/tract	Total	%
Preparatory activities and management	Capacity building		42,000	3.6		21,446	4.3		50,544	4.7		45,000	8.7		12,881	2.4		40,628	5.0
	Equipment		75,000	6.4		7,620	1.5		84,787	7.9		52,000	10.0		86,577	16.1		56,801	7.0
	Preparation & Management		90,000	7.7		36,215	7.2		90,508	8.5		35,000	6.7		82,463	15.3		71,082	8.8
Mapping			50,000	4.3					9,482			25,000	4.8					18,754	
Tree volume function study															18,205			3,437	
Fieldwork (in forest , OWL and OL)	Planning	1.2	72,164	6.2	1.3	19,972	4.2	1.3	50,548	4.7	0.2	10,000	1.9	1	41,231	7.1	0.9	37,794	4.6
	Transfer + logistics	1.2	90,491	7.7	1.2	35,834	7.2	1.5	69,643	6.5	1.0	65,000	12.5	2	92,399	15.9	1.5	72,069	8.8
	Measurements	1.2	90,491	7.7	2.6	41,172	8.2	2.6	83,511	7.8	1.0	30,000	5.8	2	41,180	7.1	1.7	56,360	6.9
	Interviews	1.2	90,491	7.7	1.3	21,226	4.2	1.6	69,314	6.5	1.0	10,000	1.9	1	10,295	1.8	1.3	39,491	4.8
	Subtotal fieldwork	**5**	**343,637**	**29**	**6.4**	**118,204**	**24**	**7.0**	**273,016**	**27**	**3.2**	**115,000**	**22**	**6**	**185,105**	**32**	**5.5**	**205,714**	**25**
	Sensitisation		76,364	6.5		2,201	0.4		19,838	1.9	1	10,000	1.9	1	14,295	2.7		23,971	3.0
	Supervision		80,000	6.8		96,182	19.2		149,000	14.0	0	5,000	1.0	1	27,255	5.1		62,362	7.7
Data entry			4,100	0.4		15,125	8.0		62,166	5.8		4,000	0.8		11,318	2.1		21,261	2.6
Analysis			33,000	2.8		46,947	4.4		95,200	8.9		20,000	3.8		7,730	1.4		34,219	4.2
Reporting			30,000	2.6		3,316	0.7		15,848	1.5		9,000	1.7		10,000	1.9		13,718	1.7
Final workshop						4,945	1.0		11,250	1.1			0.0		8,155	1.5		6,483	0.8
International technical assistance			345,000	29.5		148,250	29.6		142,548	13.3		200,000	38.5		74,475	13.8		191,146	23.7
FAO Overhead									63,814	6.0								63,814	
Totals			**1,169,100**	**100**		**500,452**	**100**		**1,068,000**	**100**		**520,000**	**100**		**579,790**	**100**		**815,314**	**100**
Cost per tract (US$)			5,290			3,208			2,879			1,757			2,614			3,261	
Cost (US$) per km^2			1.6			4.5			8.2			3.6			1.2			2.4	

Time consumption

In terms of time, the effective time of fieldwork varies from a country to another. It is in the region of 5 to 9 months. This depends largely of the resources deployed for this activity e.g. field teams and transport. In some countries the work was implemented more efficiently than in others. Efficiency is however not synonymous of less time spent in the field. It is also expressed by the quality and representativeness of the collected data. In some situations, field teams spend longer time than the average to look for complete and representative information. The breakdown of time used for planning, transfer, measurements and interviews is given in Table 4. While there is relatively high fluctuation in proportion of time used for planning and interviews, the proportion of time used for transfer and effective measurements at the sample plots is quite comparable between countries, varying between 25 and 36% of the total fieldwork time.

The average field work time per tract and per country varies between 3.0 to 5.8 days. The overall mean per tract is 5.3 days. The lowest average of time spent per tract is in Bangladesh. This is due to the relatively easy access to all plots of which about 90% are located in non forest land where the tree population is low.

Despite the volume of work for the socio-economic data collection of the interviews in the ILUA of Zambia which contains an additional household survey, the time spent on interviews is reasonably low compared to those of NFMAs. This is in particular due to the fact that ILUA team has a slightly larger number of specialised people on forest, crop, livestock and statistics. The work load was shared by the different specialists within the field teams.

Table 4: Total project and fieldwork time frame

Country	Number of inventoried tracts	Total project duration (months)	Fieldwork				% of total field work time				
			No of field teams	No of team members*	Effective months	% of total duration	Planning	Transfer	Measurement	interviews	Total
Bangladesh	296	33	10	3	5	11	6.1	31.3	31.3	31.3	100
Cameroon	206	24	8	6	7	13	18.3	36.1	36.5	9.1	100
Honduras	156	24	11	2	9	16	20.3	18.8	40.6	20.3	100
Nicaragua	371	24	24	3	7	8	18.6	21.4	37.1	22.9	100
Zambia	221	45	10	4	6	11	25	25	25	25	100
Average	**250**	**30**	**12.6**	**3.6**	**6.8**	**11.8**	**17.7**	**26.5**	**34.1**	**21.7**	**100**

* The number is related technical staff. Each team has at least one or two workers to guide and to help the technical staff

On average 56% of the fieldwork time is spent on collecting data through measurements and interviews, while 44% is spent for planning and transfer to the sample site.

Cost of fieldwork

Cost-wise, fieldwork is the costliest activity of a NFMA, varying between 22 and 34% of the total NFMA budget depending on the country (see Table 5). The variation depends on the design of the NFMA budget in terms of intensity of international technical assistance and national supervision, capacity building and institutional strengthening needs.

Within the cost of fieldwork, the share of measurements is in the region of 22% to 35%. There are many factors that influence the time spent in collecting the field data in the plots. Among these, the quality and size of the field teams greatly determines the efficiency of work. Unskilled field team members tend to spend more time to collect data in the plots. Large teams are often heavy to manage in the field. Geomorphology and density of the vegetation in the surveyed areas also largely influence the cost of data collection.

Table 5: Cost per main activity

Items	ILUA	NFMA				
	Zambia	Honduras	Nicaragua	Bangladesh	Cameroon	Average
Total cost of fieldwork (USD)	343,636	118,204	273,016	115,000	185,105	**205,714**
% Fieldwork/ Total project budget	29.4	23.3	25.6	22.1	34.4	**25.4**
% Measurement/ Fieldwork	26.3	34.8	30.6	26.1	22.2	**27.4**
% Measurements/ Total project budget	7.7	8.1	7.8	5.8	7.6	**7.0**
% International TA	29.5	29.3	13.3	38.5	13.8	**23.1**
% Supervision National Consultants	6.8	19.0	14.0	1.0	5.1	**8.1**
% Equipment	6.4	1.5	7.9	10.0	16.1	**7.8**
% Preparation and Management	7.7	7.2	8.5	6.7	15.3	**8.1**

Added together in Table 6, the cost for international technical assistance, management and supervision, sums about 40% of the total NFMA budget. The different values from the five countries are the result of different project design. Each project was designed taking into account specific country requirements and budget availability. In low-budget NFMA projects like for Honduras, international technical assistance consumes relatively high percentage of the resources. The NFMA of Cameroon relied on supervisory and backstopping missions from FAO headquarters. Cameroon has strong capacity in forest inventory, but even it needed further targeted assistance that the budget could not meet.

Table 6: Project management and technical support

Items	Zambia	Honduras	Nicaragua	Bangladesh	Cameroon	Overall mean
Project duration (months)	45	24	24	33	24	**30**
Preparation and Management (USD)	90,000	36,215	90,508	35,000	82,463	**66,063**
Supervision (USD)	76,364	96,182	149,000	5,000	27,255	**65,414**
International technical assistance (USD)	345,000	148,250	142,548	200,000	74,475	**191,127**
Total (USD)	515,000	280,647	382,056	240,000	184,193	**318,584**
% of NFMA budget	44.1	55.4	35.8	46.2	34.2	**39.3**
% Fieldwork/ Total project budget	29.4	23.3	25.6	22.1	34.4	**25.4**

It is clear that when the project duration increases, the project cost increase as the inputs for project management, supervision and technical assistance increase accordingly. Excluding the case of Honduras where even with the low budget, the project required continuous TCDC over 24 months. The proportion of the three main activities of management, supervision and Technical Assistance (TA) is relatively high, above 44% of the project budget.

Relation between cost and precision of NFMA results

If we start from the defined objectives for the NFMA which is to bridge the gap of information at the national level for national decision making in countries where there is a lack of knowledge from national surveys, the precision at which the main (global) classes are produced is generally acceptable. It is low for some countries like Honduras and Bangladesh, but quite good for other countries like Zambia and Cameroon. It is good for other countries like Guatemala, Costa Rica and Lebanon. The reason behind the low precision in some countries is the disproportion between the main classes. In Bangladesh the forest area (SE % = 46%) accounts less than 10% of the total area of the country and the other lands (SE=17%) sums 68% of the total area. Fragmentation of the land use system is also a source of higher sampling error. In Zambia the area of forest, other wooded land, other land and inland water account for 67%, 8%, 21% and 4% respectively of the total country area. In Cameroon, the three main classes were estimated as follow: forest area = 45%; other wooded land = 31%; other land = 24% and inland water = 0.6%. Their corresponding SE is 2.9%; 4.8%, 6.5% and 34%.

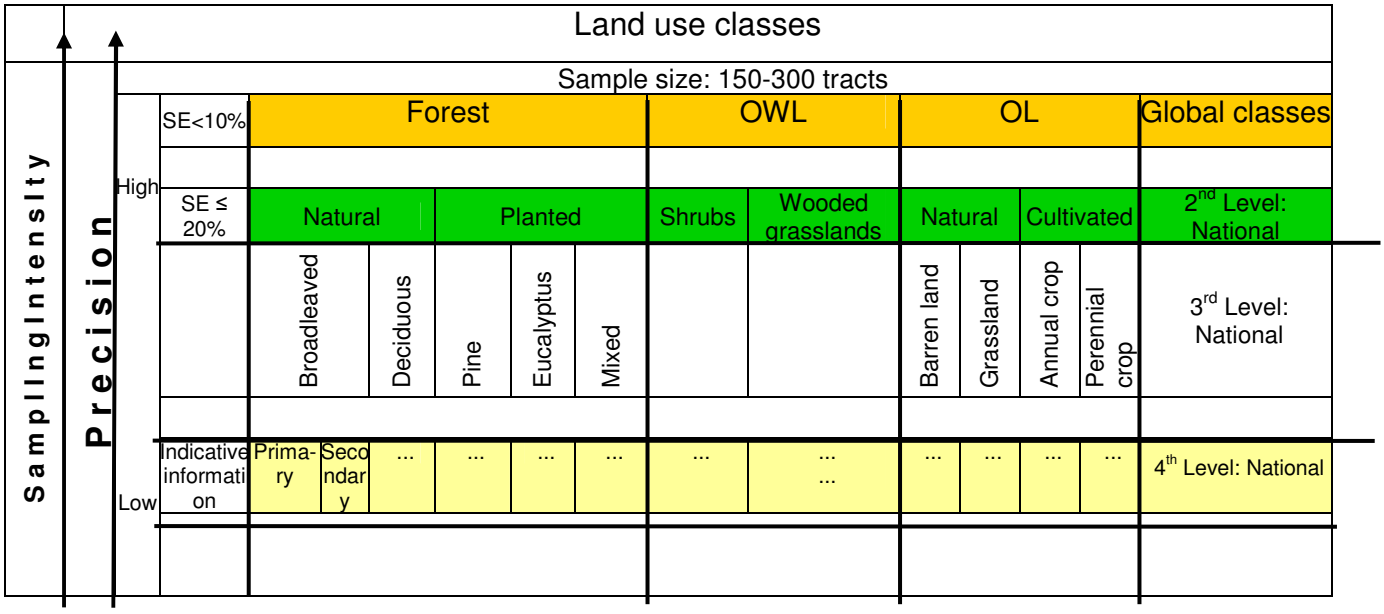
Table 7: Fieldwork cost and precision of results

Items	Zambia	Honduras	Nicaragua	Bangladesh	Cameroon	
Sample size	221	156	371	296	206	
Cost of Fieldwork	343,636	118,204	273,016	115,000	185,105	
Precision of aggregated results	4-10%	13-17%	n.a.	17 – 45%	3-7%	Targeted precision
Precision of 2nd level classes	6 – 40%	10 – 30%	n.a.	14 – 46%	10 – 30%	Indicative information
Precision of 3rd level classes	SE >20%	SE >30%	n.a.	SE >30%	SE >20%	Indicative information

When the NFMA programme was first launched, it was agreed to focus on precise information for the main (global) classes. It was also thought useful to generate as much (indicative) information as possible to help guide future national efforts for specific inventories depending on the need.

The chart below shows the layers of information aimed at and the targeted precision. For the first layer, the NFMA programme aimed at above 90% precision (SE <10%). For the second, third and fourth layers although there are indicators that can be estimated at less than 10% SE, most of the information remain indicative to guide future works of inventories. The precision is better with the increase of sample size and also with the level of aggregation of information that creates large classes.

Chart 1: Land use classes and level of precision of their attributes



Therefore, it is not only the sample size which guarantees higher precision of the main classes everywhere. 200 to 250 sample size can generate high precision results in countries with large main classes or with more homogeneous landscapes. An increase in the sample size can improve many of the second level classes, although some classes will remain estimated with high to very high sampling error where they are small in size (low occurrence).

Assuming that the cost levels of the NFMA activities excluding fieldwork remain the same, if the budget of the fieldwork is doubled, the precision of the NFMA results can be largely

improved. In term of percentage, by doubling the budget of the fieldwork, the fieldwork/total project budget does not reach 40% as is seen in table 8.

Table 8: Ratio fieldwork/total budget if fieldwork budget doubled

	Zambia	Honduras	Nicaragua	Bangladesh	Cameroon
Total cost of fieldwork (USD)	343,636	92,497	294,814	115,000	145,679
Doubled fieldwork budget (USD)	687,272	184,994	589,628	230,000	291,358
Increased budget (USD)	1,856,372	657,508	1,659,628	750,000	830,006
Ratio fieldwork/total budget	37	28	36	31	35

9. Conclusions

The analysis is based on a few countries.

The shorter the project duration, the more cost effective the project is. If the project duration is extended over longer time for a given volume of work for reasons not related to workload, the project tends to be costly as it requires resources for the management, supervision and international technical assistance.

The extended period of project implementation has an inverse effect on the quality/reliability and timeliness of information. The shorter the period, the more representative the information is for on-the-ground realities of a given reference year.

As shown from the sample countries, the time used for the field data collection from measurements and interviews is not that high. The total fieldwork required 5 to 9 effective working months which account for 8 to 16% of the total project timeframe. 34% of these working months are used for measurements, 27% for transfer to and from the sample plots to the base, 22% for interviews and 18% for fieldwork planning by the field teams. Based on these finings, it is important in the future pay attention to all the phases of the inventories and tailor them to country circumstances in order to improve cost-efficiency and improve accuracy of the results.

The length of the project is not always related to the volume of work of the project. Substantial amount of time is spent to operationalise the programme, recruit the TA, release funds, mobilise resources, take decisions by higher level people and/or even in working with lack of commitment.

High cost is consumed by international technical assistance and field data collection. TA used an average of 23% of the total project budget whereas fieldwork covered some 25%. The high cost of the TA component of the project has often been expanded largely due to unnecessary delays in project implementation. By adding supervision and project management by local consultants and counterpart staff to the TA, the level of cost to plan and support field data collection raises to around 40% of the total project budget. Between countries, the total cost of supervision, project management and TA oscillates in the range of 34 to 58% of the project costs. However, methodologies and applied technologies, remote sensing etc. demand highly specialised expertise, which is often not available locally. Use of TA does not necessarily increase total costs, but facilitates efficient use of local inputs.

The 25% cost for fieldwork is actually very moderate. For the same budget, if project implementation is done according to schedule, substantial savings can be had from stretching the

supervision, management and TA which can then go towards fieldwork to improve the precision of information.

Use of remote sensing is becoming increasingly an integral part of NFMA projects. Wall-to-wall mapping is part of the assessment in Bangladesh, Lebanon, Zambia, Kyrgyzstan, Angola, Kenya, Comoros and The Gambia. Sample based mapping for landscape analysis is being carried out in Costa Rica and Brazil. Efforts are being made to improve the quality of the mapping results. Well designed and prepared maps improve the results and informative value of the NFMA and improve readiness for such monitoring needs as climate change and REDD.

Accuracy and reliability of NFMA outputs versus cost is a constant concern. While the NFMA team of FAO aims at cost efficiency and keeping the project budgets relatively low, there is pressure for higher precision and detailed information serving more sub-national needs. Over the last eight years, the NFMA project budget has increased substantially. The budget level went from few hundreds US dollar to above US$ 3 millions/year. With the increase of budget, it is hoped that implementation will be more effective with technical assistance for the whole project cycle, by making available all inputs when they are needed and increasing the sampling intensity to a reasonable level.

The NFMA project budget remains country specific. There are countries where international technical assistance is not needed at all times of the project and for every activity. Other countries with low capacity require more intensive technical assistance. The efficiency of the project implementation remains function of cultural behaviour in the countries. Even when national institutions are very committed, slow decision making and administrative procedures tend to reduce project efficiency and raise costs.

10. Recommendations

- Improve efficiency of NFMA project implementation in countries;
- Continue optimisation of the NFMA sampling design and general approach to meet evolving needs e.g. REDD, carbon accounting, climate change, biodiversity, etc;
- Provide incentives to field staff for more efficient field data collection based mechanism;
- Raise the sampling intensity to broaden the scope of estimates with acceptable precision;
- Improve use of remote sensing in NFMA process;
- Encourage international and regional partnerships for NFMA;
- Encourage countries to earmark their contribution from public funds or allocate them to FAO under the UTF or similar arrangement.