

7. Methodology

During phase I all the preliminary arrangements and preparatory works of the project was carried out. The major activities under this phase were :

- Development of a national Land Use classification system that corroborates with the Global Land Use classes (GLU) identified by FAO.
- Fine tuning of forest and tree assessment methodologies for field data collection.
- Identification and training of team leaders and field crews for the field data collection.
- Collection of maps to be used in the field during the field data collection.
- Identification and recruitment of the local as well international experts required for the implementation of the NFA.

7.1. Sampling design

The sampling design followed a global approach for systematic sampling used by FAO. The basic approach was to go for a systematic sampling. Each sampling unit was designated as a “Tract”. To decide the intensity for field sampling several meetings were arranged, where most of the national stakeholders were present to thoroughly discuss what density was most appropriate for the NFA field survey. The cost involved for field data collection was a major limiting factor for deciding upon the sampling intensity.

Based on these discussions and availability of funds, an agreed principle of systematic sampling was finalized in this inception workshop. It was agreed that sample sites should be distributed systematically throughout the country at an interval of 15 minutes latitude and 10 minutes longitude, where the sample coordinates represent the **South-West corner** of the tracts, resulting in 299 Tracts (or samples site) for the whole of Bangladesh (see Annex IV).

7.2. Tract, Plot and Subplot design

FAO’s standard layout for Tracts, Plots and Subplots was adopted (see Figure 2), where the Tract represents a square of 1 km x 1 km (à 1km²) in which the general context for field data collection is recorded. Each Tract comprises 4 Plots with the dimension 20m x 250m (à 0,5 ha) and it is within the Plots that the actual field measurements are carried out. The coordinates of the Plot starting point were noted on maps and also recorded in GPS receiver to orient to the tracts and the plots during the field work. The orientation (or the approach or direction for collecting data from the plot) of the plots are:

Plot # 1	North-ward
Plot # 2	East-ward
Plot # 3	South-ward
Plot # 4	West-ward

When the Land Use Class is “Forest”, circular subplots are established to collect data on tree regeneration. The Subplots have a diameter of 3.99m (à 50m²) and are placed with their centre at 5m, 125m and 245m from the Plot starting point along the Plot central axis (see Figure 2).

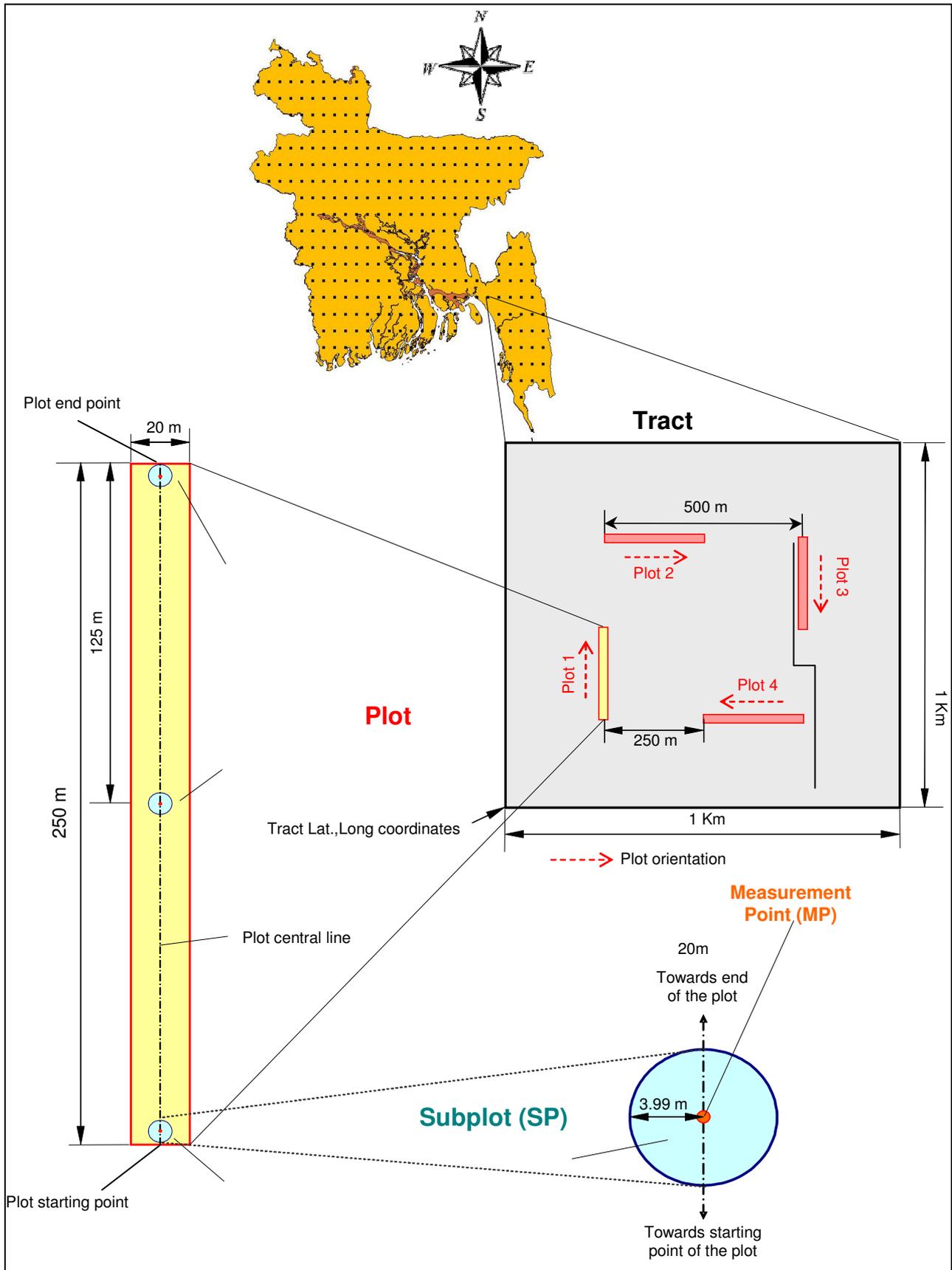


Figure 2: Tract, plot and subplot design

7.3. Classification system

FAO's support to National Forest Assessment (NFA) aims at building national capacities in long term monitoring of the national forest and tree resources. The globally harmonized major land use classes identified and detailed under the FRA program of FAO were studied in details and based on that given frame work the national land use classes were identified and firmed up, so that these while corroborating with the global criteria do not fail to record the possible national land use classes. This task was accomplished through a series of discussions and meetings. This was one of the most vital tasks of phase I of the project.

With the inputs from the Inception Workshop and following the recommendations of experts in this field especially of the LTU experts and the NFAU members 29 land use classes were finally identified for use during the collection of the field data (see Table 6)

Table 6 : National Land Use Classification system and national/international grouping

GFRA	National Land Use Classification				
	L1	L2	L3	Code	
Forest (F)	Forest (F)	Natural Forest (FN)	Hill forest (FH)	111000	
			Sal forest (FSa)	111002	
			Swamp forest (freshwater) (FSw)	111150	
			Mangrove forest (saltwater) (FM)	111160	
			Bamboo or mixed Bamboo/broad-leaved forest (FB)	114000	
		Forest Plantations (FP)	Long rotation forest plantation (PL)	121010	
			Short/medium rotation forest plantation (PS)	121020	
			Mangrove Plantation (PM)	121160	
			Rubber Plantation (PR)	121170	
			Other Wooded Land (OWL)	Shrubs (S)	Shrubs (Sh)
Swamps with shrubs (Sw)	210010				
Other Land (OL)	Cultivated Land (Cult.)	Barren/Grass Land (BG)		312000	
		Annual Crops (CA)	Annual Crops Without trees (CA0)	321001	
			Annual Crops With trees 0,1 – 0,5 ha (CA1)	321002	
			Annual Crops With trees >0,5 ha (CA2)	321003	
		Perennial Crops (CP)	Perennial Crops Without trees (CP0)	322001	
			Perennial Crops With trees 0,1 – 0,5 ha (CP1)	322002	
			Perennial Crops With trees > 0,5 ha (CP2)	322003	
		Range Land/Pasture (RL)		323000	
		Wooded land with shifting cultivation (Fallow) (Fa)		324000	
		Villages (Vill.)	Rural settlement without trees (SR0)		332001
			Rural settlement With trees 0,1 – 0,5 ha (SR1)		332002
			Rural settlement With trees > 0,5 ha (SR2)		332003
		Built-Up Areas (BUA)	Urban settlements (SU)		331000
			Highways and other artificial areas (HA)		333000
Inland Water (W)	Inland Water (W)	Lake (WL)	400010		
		River (WR)	400020		
		Pond (WP)	400030		
		Haor & Baor (WHB)	400040		
-nk-	Not Known (not visited in the field) (nk)		900000		
-OUT-	Outside land area (OUT)		500000		

7.4. Variables

The FAO developed NFA approach comprises the collection of data on the multiple functions of forests and trees, covering their Socio economic, Environmental as well as Productive functions, and the field data collection is therefore associated with a wide range of variables and different methods for data collections.

Please refer to List of Variables and related attributes in Annex III and the Field manual in Annex XII for a detailed description of the variables and their options covered in the field data collection.

7.5. Training of field crews

The NFAU team members as well as the Field Team members were trained at several occasions to strengthen their capacities and to ensure quality and proper collection and analysis of NFA data. The following training workshops were held for this purpose:

- From June 13 to 20, 2005:
Training workshop was held for 14 FD officials including NFAU team on NFA Design on LU class definition.
- From October 4 to 11, 2005:
Field Training of the NFAU team members and of the Field Crews were conducted by SLU expatriates and project consultants on familiarization of field equipments to be used during field survey and data collection.
- From October 23 to 27, 2005:
Further Field training of the Team Leaders of the field survey teams and Senior/Junior Field Investigators were held.
- From November 29, 2005 to December 9, 2005:
The technical back stopping personnel from FAO-FOMR installed the 'NFA-Bangladesh v.1.0 database' and trained the concerned FD personnel on data encoding.
- From February 28, 2006 to March 16, 2006:
The FAO-FOMR team installed the NFA-Bangladesh v.1.2e data base system and trained the concerned personnel from the FD, Government of Bangladesh.
- From March 5 to 15, 2006:
The FAO-FOMR team appraised the national consultants about the data processing. At the same time the same team trained the FD personnel on data processing.

7.6. Field Data Collection – Measurements, Observations and Interviews

The field data collection was started from the 2nd week of November 2005 by 10 teams in the predefined 10 inventory zone all over the country. The field work ended on May 15, 2006, except the data from tract 5. For some of the unavoidable law and order problem the data from tract 5 could not be collected in time. However, the data from tract 5 was gathered and sent to Dhaka by the end of August 2006. These have been entered into the data base in first week of October 2006.

It was expected that both the analysis results of the field inventory data and remote sensing analysis shall be used hand in hand for the compilation and preparation of the report. Though field survey, initiated in November 2005 was completed by May 2006, the classification of the remote sensing data could not be started until the arrival of the imageries in June 2006. During December 2005 to July 2006 data encoding of the sample tract was done by FD. This work was constantly supervised by NFISC and TCDC, while the technical back stopping was provided by FOMR, FAO, Rome. A total of 296 Tract reports were finally encoded by using the application (NFA Bangladesh v.1.2g) and database (NFA-Data_Bangladesh). The encoded sample tract data were examined and validated by TCDC, National Consultant (Analysis) and NFISC based on MS Access queries and MS Excel. Analysis of the findings from field inventory is done in line with the report layout provided by the FOMR, FAO along with the national requirements.

The field survey teams identified the plot-starting points with GPS receivers and placed a galvanized metal pole as a permanent marker at each starting point. Three reference features at suitable locations were noted with respect to the starting point for future location of the plot-starting point. Within the 250 meter long and 20 meter wide Plots, the field teams measured and registered related attributes for all trees $\geq 10\text{cm } D_{bh}$, all stumps $\geq 10\text{cm } D_{sh}$ and all bamboo culms/clumps. The land uses (see Table 6) in the Plots were identified and delineated with their dimensions and attributes related to these land uses were noted accordingly.

Data on the status of forests and trees were measured by the field teams using forest inventory equipment, such as; diameter tape, altimeter, GPS receiver, compass, laser range finder, etc., while some variables can not be measured the field teams made adequate observations to determine the status, and interviews with key informants and user groups were conducted to assess information related to forest and tree resources management, uses and users.

Focus group discussions (FGDs) were conducted to collect information with respect to the products and services that the people generally harvest, collect and obtain from these land-use classes were recorded during the survey. During the focus group discussions the local key informants were interviewed to collect the required data especially with respect to the 'products and services'. All data collected from the tracts are entered and recorded in six field forms. The forms that were used for the purpose are given in Annex II.

7.7. Data entry, processing and analysis

7.7.1. Data entry

The team leaders were responsible for submitting the completed field forms to the NFAC/TCDC expert for review. After both the NFAC and the TCDC expert had cleared the submitted field forms for entry, data encoders at FD headquarters in Dhaka were responsible for the data entry in the NFA database application. Information on the NFA database is presented in chapter 8 and in Annex V.

Before a set of field forms was cleared for data entry the data needed to be checked and cleared by the NFAC or the TCDC expert. Field forms that were found to be incomplete was returned to the responsible team leader with instructions on what was missing or incorrectly registered and how to complete the form.

After the entry of the field data into the NFA database application the data was ready for processing and analysis.

7.7.2. Data processing

To ensure high quality data processing and statistical analysis several FD staff was trained by FAO experts at several occasions. For detailed information on the procedures for data processing please refer to Annex VI.

7.7.3. Data analysis

After data were processed they were analysed by the national consultant for data analysis together with the NISC and the TCDC expert. Most of the measured variables depend on the size of the area over which it is measured. For these variables Ratio estimates are used. All statistical functions employed during the study are illustrated in Annex VII.



Photo 6 and 7 : Training session on data processing and analysis at FD. Lecturer Mr Dan Aitrell from FAO Rome and participants from FD.

7.8. Remote sensing

Table 7 shows the land use classification system that was prepared for the remote sensing survey. The classification system was based on the land use classification system employed by the field survey, but had to be slightly less detailed, due to the limitations in the spectral as well as spatial resolution of the remote sensing data. SPARRSO received the 14 Landsat TM imageries from 2005 that cover the whole of Bangladesh in June 2006. The mosaic constructed by using the 14 imageries procured, covering the whole country is presented in Annex IX. SPARRSO has initially downloaded the “*.tiff” format imageries to their local PCs and imported these from “geotiff” to image (*.img) format. The three layers from the 3 bands were stacked to generate “XS” imageries. Due to poor geometric accuracy of the “geotiff” files of the data (imageries) procured, SPARRSO conducted a geo-rectification of the data (imageries) procured by using the Landsat TM mosaic of 1997 which was available at SPARRSO’s archive. Thus geo-rectification of the procured imageries was completed and is expected to be up to the mark for the given purpose.

Table 7 : Land Use and Forest Type Legend for Land Use mapping

Sl. #	Forest/Land Cover Type	Legend
1	Hill Forest	FH
2	Sal Forest	FSa
3	Mangrove Forest	FM
4	Hill Forest with Mixed Bamboo	FB
5	Mangrove Plantation	PM
6	Rubber Plantation	PR
7	Shrub	Sh
8	Agriculture & Rural Settlements with Tree Cover	ASRT
9	Urban Settlement	SU
10	Haor & Baor	WHB
11	Lake	WL
12	Rivers	WR
13	Large Ponds	WP
14	Highway	Hw

Source: Inception Report SPARRSO, Aug/2006

SPARRSO team along with 4 officials from RIMS Unit of Forest Department processed the remote sensing data at SPARRSO laboratories. Preliminary land use maps were prepared for field verification (ground-truthing) undertaken December 2006 and the final land use maps were generated in August 2007. The outputs from SPARRSO have been integrated into the RIMS at BFD.

The SPARRSO has supplied land use maps in two different scales, namely 1:1,000,000 (one sheet will cover the whole of Bangladesh) and 1:100,000 (67 sheets will cover the whole of Bangladesh)

8. NFA Data base application

Thus data base became ready for query and extraction of data for desired analysis. The National Consultant Result Analysis (NCRA) was hired from July 18, 2006.

The required data was retrieved from the access database by using queries. The query output was exported to MS Excel sheets and the statistical analysis was carried out following the guidelines given by FOMR, FAO, Rome. The details of the guidelines for the statistical analysis are given in Annex VII.

To store and manage the collected NFA data a database application was developed by FAO/FRA in collaboration with the country national team. The database application, based on the MS Access software (2000/2002), comprises two database files; one “data” database (NFI-data_<COUNTRY>.mdb) and one “application” database (NFI-<COUNTRY> v.x.x.mdb). All collected field data (dynamic data) are stored in inter-related tables in the “data” database, while the “application” database contains code tables (static data), forms and queries and macros. The users of the NFA database manage the data through the application database. To open the database application the users double-click on the NFI-<COUNTRY> v.x.x.mdb file. The data are managed through forms and the user navigates in the database by selecting different forms according to required operation.

The efforts in developing the NFA database application have initially been focused on wise data storage and on facilitating the input of primary data, why until now the only activated section in the database application is the section on “*Field Data*”.

The design of the forms for adding/editing field data in the database application follows the same as the field forms employed for the data collection in the field inventory. The idea with this coherence is to facilitate the entering of field data into the database application since the instructions on how to register field data are given in the field manual (please refer to Annex XII).

8.1. Tables

All data in the NFA is stored in tables. All tables with collected inventory data (primary data) is kept in the “data” database (NFI-data_<COUNTRY>.mdb), while all static data like codes, expansion factors, etc. are kept in the “application” database (NFI-<COUNTRY> v.x.x.mdb) (refer to Figure 4).

8.1.1. Code tables

For each variable with attribute options there is a corresponding code table with defined options. The names of code tables all begin with “C-“ and they contain internationally harmonized terminology and nationally adapted options to the variables, where every option has a unique code.

8.1.2. Data tables

For each level of data collection there is a corresponding data table with defined variables. The variables are internationally harmonized and nationally adapted terminology, and may have unbound values or may be bound to predefined attribute options according to code tables. The names of data tables begin with “F-“, “P-“, “Ph-“ or “H-“(refer to Figure 5). The *F-tables* contain the values of all the variables that are collected at corresponding inventory level; Tract data is stored in the *F1-Tract* table, Plot data is stored in the *F1-Plot*, LUS data is stored in the *F5-LUS* table, etc. The *P-table* contains data on informants or other persons involved in the inventory, the *Ph-table* contains data on photos taken during the NFA, and the

H-tables are help-tables that relate the data from two data tables to each other, for example the *H-Person-Function-Tract* relates the information of persons to tracts and indicates what function the person had in that tract.

8.1.3. Relation database

The NFA database application is developed in MS Access, which is a relation database. A relation database allows that data can be collected at different inventory levels (Tract, Plot, LUS, Tree, etc.) and still relate to each other. In practice this is accomplished by creating separate data tables for each inventory level. To relate (link) the data in on table to another the tables must have at least one common field. In this way the tract attributes can be related to the attributes in all plots in the tract through the “ID-TRACT” field, and the Plot attributes can be related to the attributes in all LUS in the plot through the “ID-PLOT” field, and the LUS attributes can be related to all product/service attributes in the LUS through the ID-LUS field and further to the attributes of all trees through the two common fields ID-PLOT and ID-LUS, etc (see Figure 3).

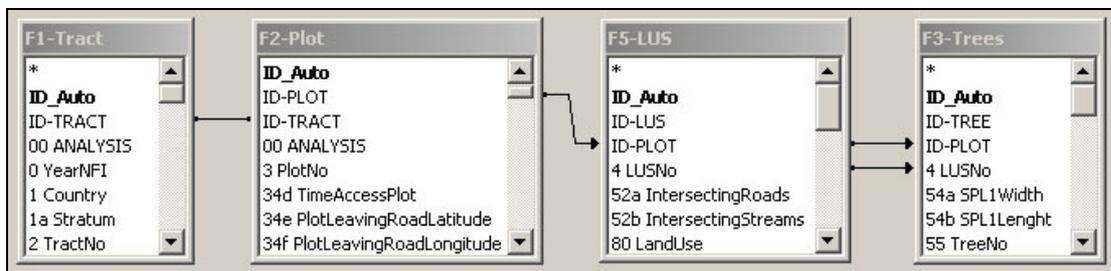


Figure 3: Illustration of the relationship between different data tables

Tables can be linked to each other even though they are not physically in the same database file. A fixed location of the database files is necessary as the database application has linked to the dynamic tables in the “data” database and therefore need to know where the “data” database is located. The NFA database application consists of the two database files “*NFI-data_<COUNTRY>.mdb*” and “*NFI-<COUNTRY> v.x.x.mdb*” and the location of the “data” database is set to the C:\NFA\ folder (see Figure 4).

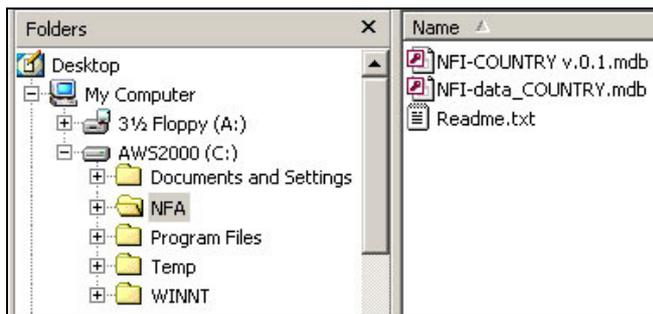


Figure 4: Location of database files

In Figure 5 the database window from the application database (*NFI-<COUNTRY> v.x.x.mdb*) is displaying some of the tables in the database application. The tables displayed with only a table symbol  next to the table name are tables stored in the same application database, while the tables with an arrow symbol next to the table symbol  are the tables with dynamic data (primary field data) and they are linked from the data database (*NFI-data_<COUNTRY>.mdb*).

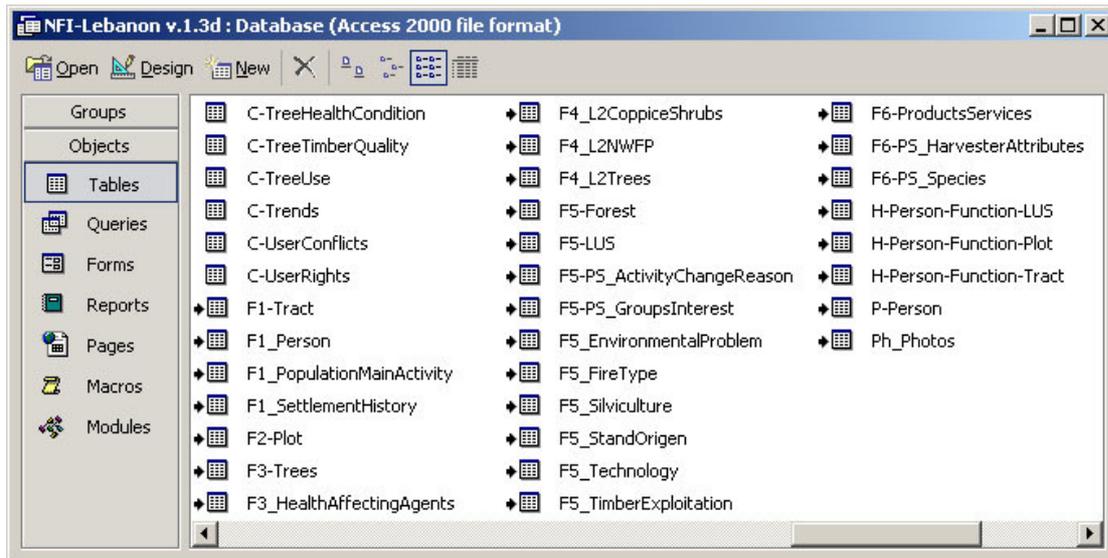


Figure 5: Database window in the NFA application database (“NFI-<COUNTRY> v.x.x.mdb”) showing some of the code tables in the database (beginning with “C-“) and some of the linked data tables (with an arrow symbol next to the table symbol).

The purpose of separating the dynamic field data from the rest of the database application is to allow users to work with the database application from different computers in a network and only have one main database with the inventory data. The NFA application database can be installed on computers in the network and they are all related to one database where the inventory data are stored. In this way only one version of the inventory data exist. Another benefit with separating the dynamic data from the rest of the database is to allow a smoother actualisation of the features in the database application without altering the primary data. A database specialist can in this way develop new versions of the NFA database application, with improved functionality, while other users continue to enter/edit data through an older version of the database application. When the new version of the application database (“NFI-<COUNTRY> v.x.x.mdb”) is ready it will substitute the older version, but the primary data remains unaltered in the data database (*NFI-data_<COUNTRY>.mdb*).

8.2. Forms

The users of the NFA database manage the data through forms. There is a form corresponding to every field form for field data collection, and further sub-forms within these forms (see Figure 6). The users add and edit the NFA field data through these forms. A validation of the field data built-in in the forms. Criteria for acceptable values and reasonable values are defined for most of the variables, so when the users enter the field data through the forms they automatically go through a general validation. For more information on the forms and on how to navigate in the NFA database application please refer to Annex V.

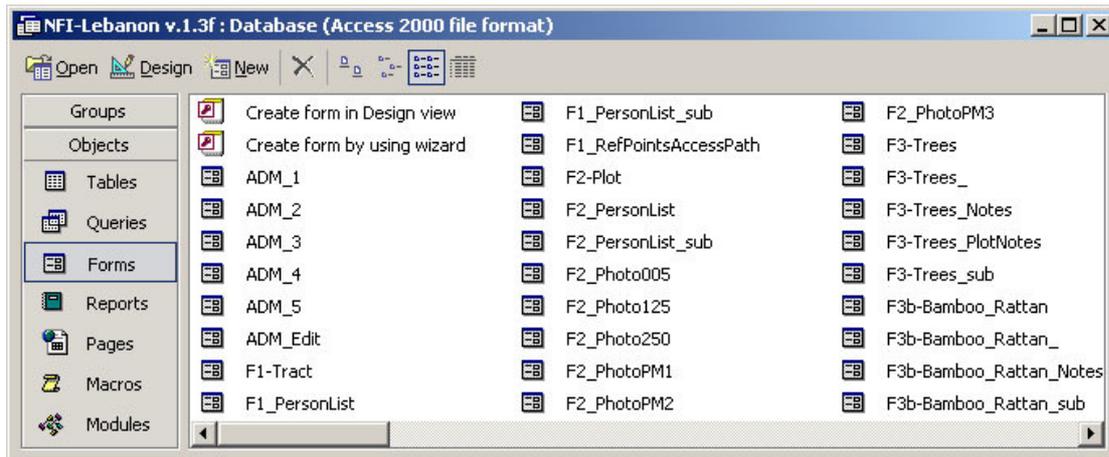


Figure 6: Database window in the NFA application database (“NFI-<COUNTRY> v.x.x.mdb”) showing some of the forms that are employed in the database application.

8.3. Queries

Queries can be used for processing and analysing data that are stored in tables. However it is not recommended to process or analyse the NFA data in any of the two database application files, *NFI-data_<COUNTRY>.mdb* and *NFI-<COUNTRY> v.x.x.mdb*, as it would cause the application to become very “heavy”. Instead the data processing and analysis should be carried out in a separate database that is linked to the two database application files.

In the NFA database application the Queries are only employed to filter the data in Tables or in other Queries. The information displayed through forms is filtered through Queries or through Tables with applied filters. For each form there can be one or more Queries employed depending on the structure and functionality of the form. For example the data source for every sub-form in a form could be based on a separate Query. Some of the Queries that are used as data sources for the forms in the NFA database application are displayed in Figure 7.

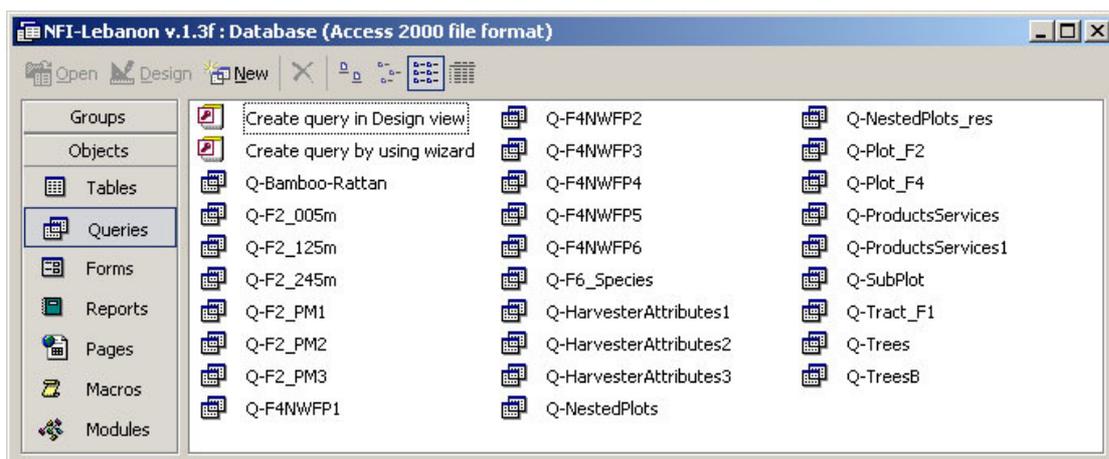


Figure 7: Database window in the NFA application database (“NFI-<COUNTRY> v.x.x.mdb”) showing the queries in the database application.