TC n° 2

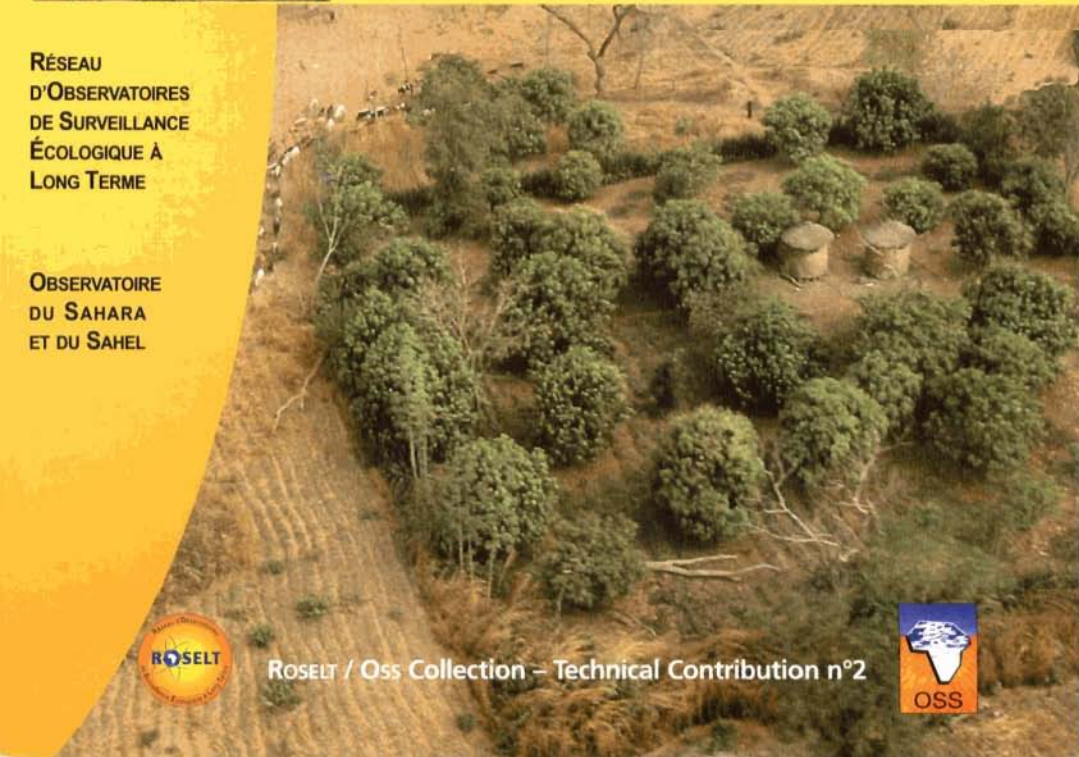
# ROSELT / OSS

OBSERVATORY NETWORK FOR LONG TERM ÉCOLOGICAL MONITORING

## Guide for the evaluation and monitoring of natural resource exploitation practices
ROSELT/OSS programme

RÉSEAU D'OBSERVATOIRES DE SURVEILLANCE ÉCOLOGIQUE À LONG TERME

OBSERVATOIRE DU SAHARA ET DU SAHEL



ROSELT / OSS Collection – Technical Contribution n°2

Sahara and Sahel Observatory (Oss) has set up a Long Term Ecological Monitoring Observatories Network (Roselt/Oss) in the circum-Saharan zone. In the framework of its programme of Environmental Monitoring, helping the policies of implementation of the National and Sub-Regional Action Programme (NAP and SRAP) to combat desertification. This device has been elaborated within and to serve the African countries, to ensure the long term monitoring of desertification and to develop associated research activities. An expertise mechanism has been undertaken, conducting to the selection, and then to labellisation by Oss, of twenty-five observatories in eleven countries. fourteen pilot-observatories have been activated in the first place of the programme, within the financial support of France and Switzerland.

This document is part of the « *Roselt/Oss scientific and technical collection* », which includes the Scientific Documents (SD) and the Technical Contributions (TC).

SD are synthesis documents about the scientific bases of the programme or the scientific items related to desertification. TC are technical documents such as individual works (dissertations, PhD thesis, master dissertations...) or collectives works (thematic or geographic approaches) undertaken in the frame of the programme. Each draft leaflet of the Roselt/Oss methodological guidebook is edited such as a TC. Once tested and validated by the whole body of the network, they will be grouped and edited such as Scientific Documents.

The aim of the « Roselt/Oss scientific and technical collection » is to share, step by step, within the international political and scientific community, the scientific and technical advancements of the network in order to :

- a better knowledge on the causes, consequences, mechanisms and extend of desertification ;
- the elaboration of a monitoring system adapted to the conditions of arid zones for a better help to decision.

It highlights the permanent effort realised by the Roselt/Oss network and completes the others products of the network : local databases, management tools of metadata, Local Environment Information Systems for the integrated processing of the information and the prospective simulation, web site (www.roselt-oss.org).

The regional coordination
Roselt/Oss

Jean-Marc d'Herbès

The executive secretary
of Oss

Chedli Fezzani

# Guide for the evaluation and monitoring of natural resource exploitation practices
## ROSELT/OSS programme

ROSELT / OSS

2005

ROSELT/OSS Collection – Technical Contribution n°2

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# SUMMARY

# Preamble

This document is part of a set of tools whose goal is to collect, harmonise and process data on the ROSELT/OSS observatories. To recap, the ROSELT/OSS network's most fundamental role is to contribute to the implementation of the international Convention to Combat Desertification (CCD), in particular through National Action Plans and Sub-Regional Action Plans (NAP and SRAP). It is the first network in Africa which :

1) organises scientific and statistical monitoring of the environment allowing the causes and effects of land degradation to be assessed, and allowing a better understanding of the mechanisms that lead to desertification ;

2) aims to provide reliable data on land degradation in arid zones : biophysical, socio-anthropological, economic and legal indicators relevant to desertification, as well as a picture of the state of the environment in the OSS zone (cf. ROSELT/OSS, SD1 and SD2, 2005).

Using local observations organised on all the observatories representative of the Saharan region, ROSELT/OSS recommends gathering a minimum of indicators at least cost for long-term environmental surveillance. The comparison of varied ecological and socio-ecological situations in the North African, West African and East African observatories allows a better understanding of how different processes lead to identical consequences, namely land degradation and a possible loss of their biological production capacity.

In addition to ROSELT/OSS's implicit diachronic method, with regular observations in time, this synchronic approach constitutes one of the main assets of the network. It can only be perfectly operational, with the aim of supplying the expected data related to the state of desertification and to environmental changes indicators, on condition that the network works towards coherent organisation and

compatibility of data collection and processing methods over the whole network. The adoption of harmonised methodologies being a progressive process, the ROSELT programme Regional Coordinator has been putting in place a strategy since the year 2000, based on the following steps :

- A regional workshop in June 2000 brought together all the ROSELT/OSS members in Bamako (Mali) and marked the beginning of the programme's operational phase. It showed the necessity for harmonisation of data collection and processing methods in all the network's countries and observatories.
- Two sub-regional workshops took place, centred on specific themes. The first in Ouarzazate (Morocco) in November 2001 for Africa in North Sahara, and the second in Dakar (Senegal) in February 2002 for West Africa. For each theme linked to the understanding of environmental changes, a facilitator was identified and given the role of putting together, leading and coordinating a work group. Each person was also implicated in the writing of a technical contribution document, specifying the sampling, data collection and data processing methods in his personal discipline (phyto-ecology, biology, hydrology, pedology, anthropology, law, economy, etc.).
- The scientific exchanges led by the facilitators were helped along by email, and effectively led to the writing of the first work documents.
- The facilitators of the Africa in North Sahara sub-region, were able to meet up several times during 2003 at organised scientific workshops in Montpellier. They were thus able to conduct discussions about the contents of their methodological contributions in progress, define the importance of cross-referencing between the different thematic contributions, and programme the steps to needed in order to finish the methodological booklets for each theme.
- This set of booklets, still under development, was communicated to the ROSELT countries' institutions as a working document. The most well-developed booklets (vegetation and resource exploitation practices) were tested on a few observatories. More accurately, an initial version of the present document was tested on the Ferlo observatory in Senegal (under the supervision of Magatte Ba) and on the Menzel Habib observatory (under the supervision of Mongi Sghaier).
- The « vegetation » booklet, adapted from the African regions of North Sahara, was discussed with a view to its extension to the context of sub-Saharan regions during a West African sub-regional workshop in 2004 (Praïa, Cape Verde, September 2004). It has now been tested in Mali and Senegal.

- Two « pillar » booklets for environmental surveillance in the ROSELT/OSS framework were finalised in 2005 by the IRD Regional Operator : one on the assessment and monitoring of ecological systems (landscape, vegetation, flora, and surface features), and the present document on the assessment and monitoring of natural resource exploitation techniques. They are written for those responsible for the collection of data in each theme covered by ROSELT. Each theme is dealt with in turn, for integration into the general schema of environmental data collection and processing, with a view to creating products for decision-making (ROSELT/OSS, SD2, 2004).

The present document thus constitutes an intermediate and autonomous technical contribution (TC2) from the ROSELT/OSS collection, focusing on one of ROSELT's central themes.

It proposes, through operational (practical) tools for the monitoring of natural resource exploitation practices on the observatories, a coherent methodological framework, perfectible and adaptable to its users' diverse, specific situations. It presents a system of nested inquiries ready to be applied in the context of the regional network's local environment surveillance system.

This document was conceived and written by Maud Loireau (agro-economist and geographer, ROSELT Regional Coordinator), Mongi Sghaier (agro-economist, IRA, Tunisia), Magatte Ba (geographer and environmental socio-economist, CSE, Senegal), and Catherine Barrière (anthropologist). It has benefited from the contributions of :

- members of the IRD Desertification Service Unit : Olivier Barrière (« anthropo-jurist »), Jean-Marc d'Herbès (phyto-ecologist and agronomist) on the ROSELT integrated approach and the minimum dataset, Éric Delaître (geomorphologist) on the erosion index linked to the agricultural activity, and Didier Leibovici (statistician) on statistical processing recommendations ;
- members of the ROSELT/OSS network : in particular Mohamed Hadeid, geographer, Oran Faculty, Algeria and Mohamed Hammoudou, pastorialist, ORMVAO, Morocco ;
- the CIRAD/PPZS team on aspects related to livestock breeding and pastoral systems : in particular Alexandre Ickowicz (veterinary pastorialist) and Sandra Pédurthe (work placement co-supervised by the CIRAD Pastoralism Partner Research Unit – URPP, *Unité de Recherche en Partenariat « Pastoralisme »* – and the IRD Desertification Service Unit).

The system of inquiries that is presented will be tested on the whole ROSELT network in 2006-2007, validated by the network and its international scientific partners, and finally inserted into the ROSELT « methodological guide », along with the other validated thematic booklets, by 2007.

# Introduction

## *General framework*

The relationships that societies maintain with their natural environment are expressed within complex, open, evolutionary systems. The identification of these relationships as well as the analysis of the mechanisms which underpin them are determining factors in the appreciation of the precariousness of local ecological situations and in judging the sustainability of their equilibrium.

To tackle this type of inter-relationship, one must consider the phenomena as part of a global, integrated vision, and also work at scales sufficiently precise and inter-connected, to be able to understand the reality at these different levels and fully understand the multiple links which exist between the natural environment and the local societies who live there.

The exploitation and extraction practices, development practices (protection, irrigation, etc.), and natural environment management practices that rural societies implement are, depending on the geographic peculiarities of the different observatories, very diverse. The actions exerted on ecological systems depend on the functioning of societies, and global changes are in part as a result of decisions made at the regional or local level, and the national and international levels.

Demographic growth incontestably leads to a growing pressure on resources, but it may also be accompanied by an evolution of practices, techniques, and family strategies, which do not therefore always have a negative impact on the environment. More generally, the phenomena observed are often complex and cannot be explained by a simple cause-and-effect relationship. The attribution of an observed change to one or other factor is not always obvious. However, we are asked to explain and analyse the system dynamics in order to translate them into technical and political orientations and recommendations.

Environmental constraints such as increased scarcity of certain resources, the degradation of soils, etc., can favour the emergence of adaptive survival strategies which generate new social and ecological behaviour. These changes in production relationships can considerably modify the social relationships and bring an end to the equilibrium of the group and, by consequence, to the process of social and family reproduction.

Migration, a factor of demographic regulation, provokes in turn transformations in the production systems and in the systems of natural resource usage (changes in agricultural work, investments with migratory income, etc.).

The implementation of State policies (price policy, free market economies, development policies, agrarian reforms, etc.), adds to social dynamics or socio-economic mutations that explain environmental changes at the local level. (Picouët and Sghaier, 1994 ; Morvaridi, 1998).

On a ROSELT observatory at the local scale, it appears necessary to work on the machinery of local decision-making by identifying the actors, the strategic groups of which they are a part, and the parameters which play a role in the decision-making.

To do this, the different levels of observation must eventually be combined :

- on one hand, the « regional » level, in the sub-national sense, which generally corresponds to the administrative entity (district, local administrative territory, « département », etc.). This scale allows for the statistical representation of analyses and the description of the regional context that encompasses the observed local situation ; it is covered essentially for reasons linked to land tenure-environment ;
- and on the other hand, the local level, which corresponds to a territorial entity judged to be relevant to the socio-economic, juridical and environmental problem identified (the observatory territory) or to a finer level of study subjects (such as Exploitation Units, fields, herds). This second level calls for the concrete implementation of an interdisciplinary system, in particular to achieve joint monitoring of ecological and social systems. All the specific aspects linked to the study and monitoring of societies and their natural resource exploitation activities are also covered at this scale.

In other words, the first level provides the keys to understanding the actions of man on the region represented by the observatory territory. The second level describes the organisation of societies which ensues in terms of natural resource exploitation.

In this methodological booklet, we deal with observation at the local level only. The « regional » level, which deals in particular with questions linked to « land tenure environment », is covered in another methodological booklet.

## *Document objectives*

One of ROSELT's objectives is to understand the functioning of the ecosystems in place on the observatories, at the local scale, and to monitor their dynamics (ROSELT/OSS, SD1 et SD2, 2004). This implies taking into account :

- the ecosystems' endogenous processes, i.e. on one hand the set of existing interactions between populations of different species on the same site, and on the other hand the interactions between populations and the physical milieu : production, succession, resilience, cycles, flux, etc. (Frontier, 1999) ;
- the impact of climatic and anthropic driving forces (demography, policy, economy).

Depending on different points of view, man is considered both as an element of the ecosystem and as an external contributor acting on the ecosystem through his resource and space exploitation practices.

Understanding and interpreting the result of interactions between societies and their environment at a local level requires a spatial approach to biophysical and socio-economic phenomena, in order to observe both the nature and distribution of usages and the corresponding resources.

This relationship between usages, resources and space is defined at the landscape level. Also, the methodology proposed for the surveillance of ecological changes in the ROSELT territories and observatories consists of determining (ROSELT/OSS, SD2, 2004 ; Loireau, 1998 ; Loireau et d'Herbès, 1997) :

- the spaces on which the resources are produced (cf. *Landscape Units* = LU), according to the production potentialities of the ecosystems ;
- the spaces on which men apply their resource exploitation practices (cf. *Combined Practices Units* = CPU), as a function of social, political, juridical, and economic organisation of the societies ;
- the spaces on which the available resources are extracted, as a function of methods of utilisation and of regulation of the space and resources by societies (cf. *Spatial Reference Units* = SRU).

The ROSELT biophysical and socio-economic data are integrated into the Local Environment Information System (LEIS) using this spatial approach, thus allowing the development of spatially distributed balance analyses between resources and usages (man/milieu interactions) using space and resource use models, for the observation period considered (Loireau, 2005 ; Loireau *et al.*, 2005 ; ROSELT/OSS, SD3, 2005 ; d'Herbès *et al.*, 1997). In view of this integration in the LEIS, the methods of data collection and sampling are specific and adapted to their spatial distribution.

In this context, by consensus among the members of the network, this document describes the methods chosen for the evaluation and monitoring of renewable natural resource exploitation practices by rural populations at a local scale.

These methods allow a minimum of information to be collected to :

- describe the elements of the functioning of local societies for managing and exploiting the observatory's natural resources. These elements will be comparable from one observatory to another (synchronic analysis) and, on the same observatory, comparable between different dates (diachronic analysis : monitoring of changes) ;
- create processed data which feeds into the environmental models implemented in the LEIS, in particular for the construction of Combined Practices Units (CPU) and the spatial distribution of natural resource extraction on the observatory.

The whole set of data must be valid for each observation period in the ROSELT framework. To recap, the **ROSELT observation period** (cf. annex 1) is the period during which the whole set of ROSELT data (climate, vegetation, soil, water, socio-economy) is collected in the observatory according to a defined schedule, in particular for the establishment of a balance analysis and forecasts *via* the LEIS. Whatever the data collection date(s) may be in this period, these data must re-present a functioning that is as much biophysical as socio-economic, and must be relatively stable over this period. Notwithstanding possible revision, a duration of four years has been judged appropriate by the network, without exceptional events being observed which we must therefore be able to measure.

## *Methodology and organisation of the document*

The proposed method to achieve the objectives above consists of conducting several « nested » inquiries on the observatory at three levels : 1) observatory territory, 2) exploitation units, 3) fields/herds. The investigations must be conducted in order : first level, second, then third.

At the observatory territory level, the local authorities are the population target. At the second and third levels, these are essentially the exploitation leaders. The latter levels are sampled according to the information collected in the previous level.

As the diagram indicates (**Figure 1**), the collected data allow us to assess and monitor the populations and their spatial distribution at level 1, the exploitation units and their strategy at level 2, and the exploitation practices and natural resource extractions at level 3.

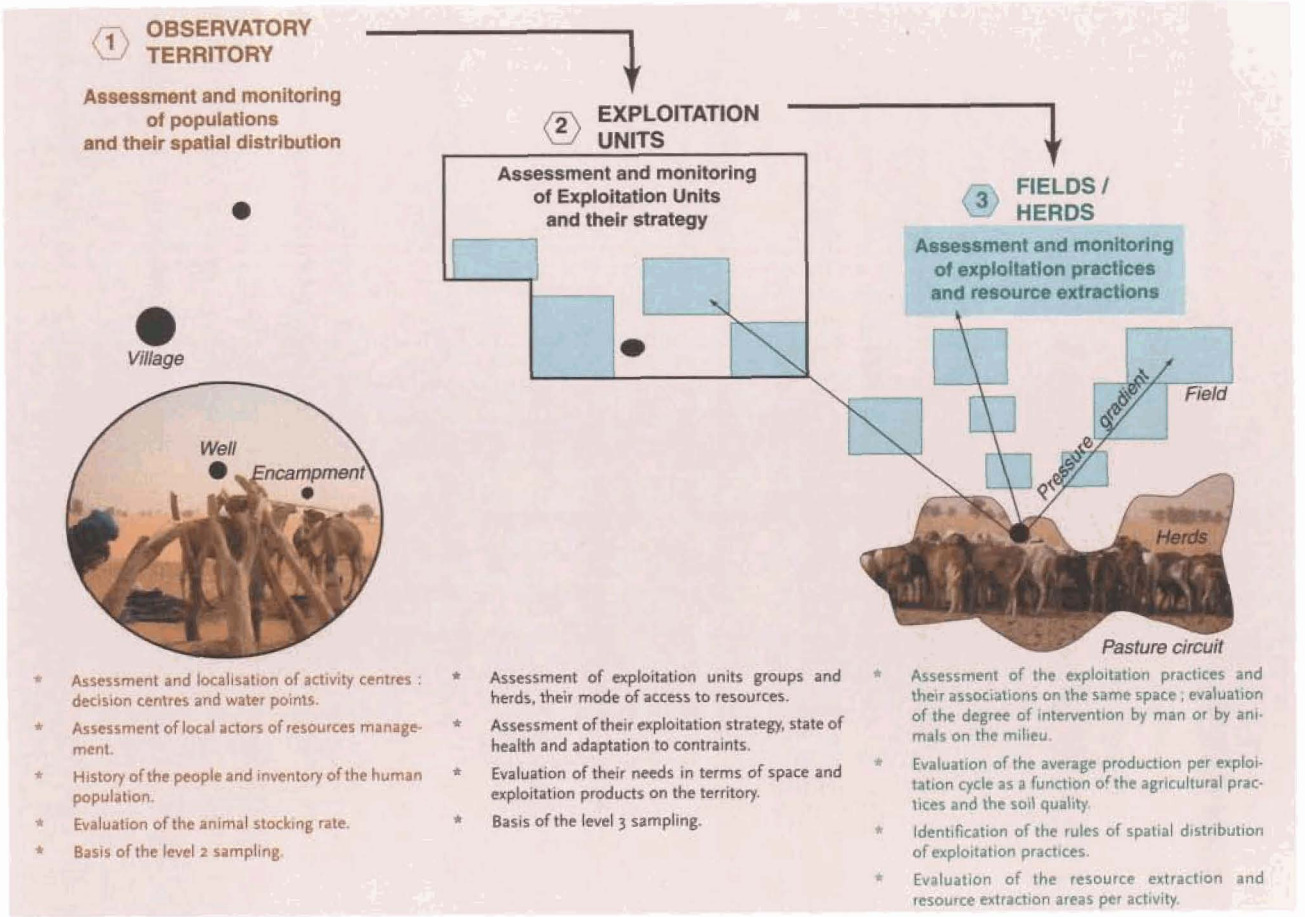


***Figure 1 :*** *Diagram of the three nested levels of inquiry for the evaluation and monitoring of natural resource exploitation practices in the ROSELT/OSS observatories.*

Each level is described in one of three parts of the document with respect to the following points :

- objectives,
- preliminary work in the field inquiries and sampling method,
- data to collect,
- method of data collection and monitoring,
- type of data processing and expected results,
- inquiry forms.

The **sampling methods** allow, for each level, the representation of the functioning of the system studied on the observatory, the extrapolation of the data collected over the whole observatory territory from a spatial distribution perspective, and the integration of the data collected in the ROSELT data processing system using a spatial approach (LEIS), in order to guarantee the nesting of the different inquiry levels.

The data are collected over one ROSELT observation period to establish a diagnosis of the functioning of exploitation systems on the observatory. They are updated at each ROSELT observation period (*surveillance*).

The **expected results** consist of four types :

- maps,
- typologies,
- general indicators,
- specific indicators to provide input to the Local Environment Information System (LEIS).

These expected results, in particular the specific indicators which provide input data to the LEIS, can be different according to whether the agricultural or pastoral activity is structuring from a spatial perspective.

In effect, (cf. ROSELT/OSS, SD3, 2005), when the observatory has an agro-pastoral vocation, the most extensive agricultural activity generally structures the observatory territory. Even if all the space is not occupied by the agricultural activity, it is potentially an extension zone for crops. The other exploitation activities therefore depend on the land use that results from this agricultural activity. On the other hand, if the agricultural activity is marginal from a spatial perspective, confined to very reduced spaces in terms of surface area, as a result of strong biophysical constraints (soil quality, access to ground water, etc.), it is the pastoral activity

that is structuring from a spatial perspective, at least so long as agricultural techniques do not allow the cultivation of zones undergoing strong constraints that prevent agricultural activity.

To recap (cf. ROSELT/OSS, SD2, 2004), an indicator must fulfil the following conditions :

- be a *processed data*, i.e. be linked to a collected data processing protocol, whether it be simple statistical processing and/or more or less complex mathematical models ;
- *be linked to the same processing protocol, whatever the network observatory* ;
- *indicate a state, a pressure or a response* of the system studied ;
- *be relevant* (provide a good idea of the situation), *sensitive* (reaction to changes), *reliable* (available, founded on reliable knowledge, preferably in correlation with an information system), *reproducible and useful (simple and accepted by the user)*.

A first list of « indicators », developed using a known collection and processing protocol, is proposed at the different inquiry levels. They indicate a state, a pressure or a response of the system studied. They are essentially proposed using ideas from NAP/CCD processes, from experience gained in this context by the members of the ROSELT/OSS network at the regional and national levels (Sghaier, 2001 ; Collectif ECOSSEN, 2000), from the PPZS LEAD/FAO programme, and from the « *Mémento de l'Agronome* » (1991, 2002). In the next phase of the programme, this list can be supplemented if necessary.

These indicators will be systematically tested on the whole set of ROSELT observatories in order to confirm their relevance, their reproducibility and utility, as much at the regional level as at the national level (integration in the national environment surveillance system).

With a general lack of repetitiveness with regards to the data collected, international experience in the domain of human and social sciences does not, *a priori*, easily provide knowledge of the sensitivity of the whole set of indicators, i.e. their reaction to change. ROSELT, with its long-term surveillance system, would allow these monitoring indicators to be tested and confirmed as being indicators, after having repeated the set of data collection and processing on a medium– and long-term basis. To accelerate this validation of the proposed indicators, the national teams are encouraged to use and exploit, where possible, the old data available on the approved observatories in particular for their scientific historical knowledge.

Moreover, with an analysis effort, the collected data, in particular at levels 1 and 2 of the investigation, allow the calculation at a local scale of the global indi-

cators, such as the indexes of poverty, human development, and standard of living (UNDP, 2002) that we can link to smaller scales, i.e. sub-national, national and regional. This should allow the integration of the ROSELT observation system with the national desertification evaluation and monitoring system of the NAP/CCD and the CCD international convention.

The **inquiry forms** contain different modules. In order that the inquiry system can be applied to an observatory, the scientists in charge of the assessment and monitoring the natural resource exploitation practices on the observatory must do an initial assessment of the suitability of the questionnaires, before going to collect the data. Each form must thus be carefully analysed according to local specificities. This analysis should lead to a customisation of the questions asked using appropriate terms specific to the observatory. It can also lead to removing modules from the questionnaires that are not appropriate to the local situation, after having verified that this does not penalise the nesting of the different scales.

# First level of investigation : assessment monitoring of human populations and their spatial distribution

## *Objectives and general principals of the data collection system*

These investigations concern the observatory territory scale. They are organised into two sets of inquiries :

- the first allows the collection of information necessary to characterise the history and dynamics of the human populations and their spatial distribution in the observatories, from the local authorities in **decision centres**. It consists of a single questionnaire, the « decision centre » questionnaire (cf. p. 28).
- the second allows the evaluation of the livestock stocking rate around characterised and localised **water points**. It consists of two types of questionnaire : the « water point », and the livestock inventory data sheet (cf. p. 39).

The **decision centres** are centres in the observatory in which individuals reside temporarily or permanently. These individuals take decisions and are local actors in the management and extraction of natural resources. In the interests of avoiding any ambiguity, it should be noted that the decision centres thus defined, present on the observatory territories, are not necessarily the only locations where decisions are made.

The decision centre may be a village, an encampment, etc. These decision centres, in the ROSELT network observatories, are *a priori* rural centres. Although certain observatories contain urban centres that are much larger than others (e.g. Linguère in Ferlo, Senegal). In this case, according to the needs of the LEIS models, this decision centre may be divided into districts ; each district is thus a decision centre in itself.

A **water point**, according to the objectives and methods developed in this document, is a pond, a traditional or cemented well, bore hole or a stream/wadi, which is used for watering breeding livestock (Lhoste, 1986 and 1987).

To recap (ROSELT/OSS, SD3, 2005), in the context of the LEIS, natural resource exploitation practices are spatially distributed around activity centres. An **activity centre** (cf. **annex 1**) is a fixed element of the territory around which one or more « agent groups » organise the exploitation of natural resources. Several types can be identified : village, encampment, well, pond, stream/wadi, etc. They have a lifespan and can be associated with one or more activities for a given period. A decision centre can be a point, a group of points (several isolated farms : « *douars* » ; several villages and hamlets around a single village leader ; wells along an wadi), a line (a stream/wadi, a road), a polygon (urban centre).

## *« decision centre » questionnaire*

### *Objectives*

The objectives are :

- To characterise and localise the decision centres (geographical coordinates), and establish their territorial relationships in order to define the activity centres. For each ROSELT observation period, these activity centres are used in the models implemented in the Local Environment Information System (LEIS), as a focal point around which the natural resource exploitation practices are spatially distributed.
- To characterise the actors of local natural resource management. The identification of these local actors allows local decision mechanisms to be identified and the decisions and actions of strategic groups to be positioned in relation to this local mechanism. To recap (ROSELT/OSS, SD3, 2005), a **strategic group** (cf. **agent group**) is a group of individuals with the same natural resource exploitation strategy (defined by the typology of the observatory exploitation units at investigation level 2 : cf. p. 41). Only the strategic groups and their natural resource exploitation strategy are currently used in the models implemented in the LEIS. Additional research on the set of actors and local governance have been initiated in the in the ROSELT/OSS network (Barrière, 1997, 2001 ; Kane and Khoulé, 2004 ; Ba, 2004). This should allow the set of local actors in natural resource management to be formalised and could lead in the future to the development of a new model (for example a multi-agent model) added on to the LEIS. This extension could allow the forecasting capacity of the LEIS to be increased.
- To describe the population history and inventory the human population for each ROSELT observation period.
  In the delimitation models of potential exploitation territories around

activity centres, data such as « number of inhabitants » ou « age of establishment » are generally determining factors and allow a weight to be given to the activity centres in relation to each other (ROSELT/OSS, SD3, 2005).

Furthermore, these data are themselves collected, if they do not exist elsewhere (see below), at each period, allowing the demographic population evolution of the observatory to be monitored, as well as its spatial distribution : territorial dynamics of populations. Finally, these data can contribute to interpreting the data collected in the observatory's other domains : vegetation, flora, fauna, soil, water, etc.

- To gather together the minimum dataset necessary to make a sample of Exploitation Units (UE *) in order to conduct the level 2 investigations for the assessment and monitoring of the exploitation units and their strategy.

***Preliminary work on field inquiries and sampling method***

All of the population who reside all or some of the year in locations geographically within the scope of the observatory territory must be known, as well as their social organisation. This information may already be available in the country, or it may be necessary to collect or supplement the information through investigation work.

Ideally, the « decision centre » questionnaire should be conducted using the « total cover » method, i.e. in all of the observatory's decision centres.

However, before conducting the field inquiries described in the following paragraph in all the decision centres, it is necessary, if this has not already been done, to make an inventory of the types of decision centres that exist on the observatory from existing data, i.e. obtain a preliminary list (of names) from the national or local technical services (census, electoral lists, etc.).

If the result of this analysis, at the local scale of the observatory (between 30,000 and 200,000 ha **) is a number of decision centres greater than 20, according to the material and human means available to conduct the inquiries, it may be necessary to make a pre-selection of the activity centres on which the level 1 questionnaire will be conducted.

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* The abbreviation of Exploitation Unit is «UE», derived from the French «*Unité d'Exploitation*».

** If the ROSELT/OSS-certified observatory is larger, it may be necessary to define observatory sub-elements, called « sub-observatories », or « modelling territory », adapted to local observation (cf. ROSELT/OSS, SD3, 2005).

To allow this pre-selection, whilst guaranteeing that the data collected in the inquiry can be extrapolated to the decision centres on which there won't have been an investigation, at least the following criteria should be used for establishing the first list :

1. type (village, neighbourhood, encampment, *douar*, isolated farm, etc.),
2. size of the population,
3. number of livestock (Tropical Bovine Unit, other),
4. age (optional),
5. position in relation to the main types of soil use (land use): cultivated areas, uncultivated areas (optional). This implies that a preliminary positioning was made from existing maps (typographic map type), aerial photographs or available satellite images.

An ascending hierarchical classification is thus conducted whilst respecting the order of the criteria cited above. The number of decision centres (DC) selected in each of the classes is calculated whilst respecting the distribution of the DCs within the total population. For example :

Total number of DCs = 100
Number of DCs in class A = 10
Therefore the proportion of this class in relation to the total population = 10%
Size of the sample of DCs wanted = 20
Number of DCs in class A selected = 20 x 10% = 2

When the observatory is a pastoral zone in which the pastoral activity structures the territory, the selection of decision centres is not desirable, due to the risk of not being able to identify the territorial relationships between the water points and the decision centres over the whole observatory territory (identification of the activity centres). This missing part of the data would prevent all of the pastoral practices from being spatially distributed in the models implemented in the LEIS. The pastoral zones are generally less populated than the agro-pastoral zones ; this constraint should not cause a problem with the collection of data at this level. However, it must be verified, with the test of this guide on the ROSELT observatories, that this exhaustive investigation is not too hard to implement, in which case specific sampling methods will need to be proposed.

***Data to collect***

The inquiry form is composed of five modules ; each one brings together several questions which allow a corpus of data to be collected, according to the specific objective.

### *1) Module I : Geo-administrative references*

This module contains information allowing the decision centre to be precisely located administratively and geographically. It identifies without any ambiguity, and assesses, the decision centre concerned by the inquiry.

### *2) Module II : Information on the locality leader*

Here, locality leader (or decision centre leader) means the leader elected by the local population. It is generally a traditional authority (village leader, encampment leader, etc., with a major role in the management of the natural resources). If there is no, or no longer, a traditional leader in the observatory, this set of questions will be addressed to the local administrative authority that was named by the State.

The information collected on the locality leader allows the local power structure to be identified. As well as the date (year, period) of his rise to power, the data also distinguishes his attributes, in particular his membership to ethnic, social and political groups, but also the history of his establishment, his main and secondary activities and his implication in projects involving actions for land development of the territory and natural resource management.

The objective is to get an idea of the position of the person, and to see in which social group and main production system he gives his allegiance ; to get an overall idea of the dynamics of the population residing in the decision centre in terms of actors on the natural resources, through an understanding of its elected leader. Certain criteria, such as the degree to which the local authority is implicated in territory development projects and natural resource management, may be selected for the Local Environment Information System (LEIS), as a parameter to use in the delimitation of potential exploitation territories around activity centres (cf. ROSELT/OSS, SD3, 2005 and p. 25). According to the project type, it is possible to identify a relationship between this criteria and the size of the potential exploitation territory.

### *3) Module III : Social organisation and local land tenure*

This module consists of two sets of questions :

The first set of questions allows us to show the territorial and land tenure relationships between different decision centres (villages, encampments, hamlets, etc.). This can show the dependence that a decision centre has on another decision centre from a social organisation perspective. In this case, the first type of decision centre is called the « **satellite decision centre** », the second is called the « **main decision centre** ». This can also lead to considering several dependant decision centres as a single activity centre (even if they are dispersed) in the LEIS delimitation models of the potential exploitation territory « group of points » geographical object).

The questions also allow us to identify the smaller or secondary (satellite) decision centres, which are dependant on the larger or main decision centres, particularly when there has been a pre-selection of decision centres to conduct this level 1 inquiry ; the larger decision centres generally being the only ones inventoried in the statistical databases and/or located on the maps. It may therefore sometimes be necessary to readjust the sample of decision centres *a posteriori*.

The second set of questions allows the identification of the ethnic distribution of the decision centre's population, the other traditional authorities or councils around the locality leader (e.g. village traditional council or encampment council), as well as their role, and also the other local actors of environment management.

These data related to local decision-makers allow us to bring the local decision mechanisms to the fore, to understand how and of what factors (main activity, ethnic group, etc.) possible strategic groups may be constituted, from the local advisors endowed with a decision-making power.

This second set of questions does not directly influence the LEIS in its current state of development but, as was mentioned (cf. p. 18), additional research is being conducted in the ROSELT/OSS network to make a formal set of local actors in the management of natural resources with a new model being added to the LEIS.

### *4) Module IV : History of the local population*

The questions posed in this module allow us to obtain precise information on the history of the introduction of social groups which currently share the space.

The first set of questions consists of establishing the period in which the *territory land tenure* * was founded, on which the first people to arrive have a power to allocate the land or rights to pasture (for example,and the period in which the decision centre was founded. The second set of questions consists of establishing the manner in which the **first occupiers** settled : who were the first to arrive, what were the reasons why they were in charge of settling, what is the order and the context of the establishment of other **lineages** (cf. p. 28), etc.

This investigation allows the collection of the information essentially necessary : 1) to orient the decision of whether to regroup several decision centres into a single activity centre, and 2) to choose whether to use the « age of the appearance of decision centres or the founding of land tenure territories » criteria, for the delimitation of potential exploitation territories around activity centres.

* This concept is similar to the « *terroir foncier* » (see Glossary definition) described in the *Mémento de l'Agronome* (1991) : the « *terroir foncier* » constitutes a spatial expression of land tenure rules and practices by which a given group marks its social mastery on its local natural environment.

### 5) *Module V : Inventory of the population*

An inventory is made of all the heads of families attached to the decision centre, and the information necessary is gathered together in order to allow the estimation of the total population per activity type, and the sampling of the Exploitation Units (UE) which will be queried using the level 2 inquiry forms. The UEs which do not conduct any resource exploitation activity are identified and will not be used for the level 2 and 3 inquiries.

This list is put together with the locality leader and can be completed in cooperation with rural notables and advisors (cf. data collection method below). N.B. the principle transhumants, who pass through and stay temporarily on the observatory territory, are a part of this inventory. The following are also identified :

- the patronymic of the head of the family ;
- his main activity ;
- his secondary activity(ies) (optional) ;
- the total number of people : this corresponds to the number of dependent people ;
- the number of adults between 18 and 64 years old (optional) ;
- the size of the exploitation unit (expressed as total agricultural surface area * if the main activity is agricultural and as a livestock number class if the main activity is breeding) ;
- the location of main residence : the same decision centre as that of the inquiry, or another in the observatory, or one outside the observatory ;
- period of presence in the « land tenure territory » linked to the decision centre (depends on previous information or seasonal migrations) ;
- the location of the secondary residence (optional) ;
- the water points used according to the season.

#### *Data collection and monitoring method*

*Diagnosis*

The collection of data is done *via* a questionnaire given to each of the observatory territory decision centres. It is conducted at any moment during the year and may require several field trips in order to cover the whole population.

* Total Agricultural Surface Area (SAT – *Surface Agricole Totale*) : includes all the land used (annual and perennial crops), plus fallow (*Mémento de l'Agronome*, 1991).

It is desirable that a scientist, used to conducting inquiries, takes responsibility himself for the collection of data, and train, supervise and accompany the technicians who can then be given the responsibility of conducting the inquiries and updating them for long-term surveillance.

Modules I to IV deal with more or less open questions that allow the situation to be described. Module V provides the possibility to evaluate the local population and establish the basis for sampling the exploitation units for the level 2 inquiry. The latter is implemented if, and only if, there has not recently been a census, either administrative or another (during the ROSELT observation period), or if the census does not provide the minimum information required for the level 2 sampling : the patronymic of the head of the family, the number of dependants, the size of the exploitation unit, the location of the main residence, and the period of presence.

As a minimum, the questionnaire is introduced to the local authority (designated or elected by the population : village leader, encampment leader, etc.) of each of the observatory's decision centres, or the decision centres selected according to local specifics. It is desirable that it also be introduced to a few notables, or « concils » (e.g. village traditional council), who are in a position to consolidate and supplement the information supplied by the local leader.

To obtain the answers to module V, if the social group is small, it is worthwhile and possible for the surveyors to also unite all of the decision centre's heads of family, in order to reinforce the information collected from the local authorities. If the social group is large and/or if the habitat is dispersed, the heads of family will only be united if financial and human resources are made available to the observatory, in addition to the minimum resources required for environmental surveillance, during the ROSELT observation period (cf. p. 28) in which the entire set of data are collected for a LEIS model (opportunity of other projects to provide data, for example). If this opportunity arises, the surveyors can then bring together the family heads in selective groups : by district, hamlet, etc.

*Surveillance*

The whole set of information collected using the « decision centre » questionnaire must be updated at each observation period.

However, the update of the collected information in modules I and IV can be considerably reduced if the locality leader and the local authorities in general haven't changed.

On the other hand, the information collected in module V must be systematically verified and supplemented in order to follow the evolution of the population and in order to adjust the level 2 sampling if necessary.

In a situation where a sub-sampling of the decision centres was conducted, it is necessary to verify at each of the following periods whether : 1) other decision centres were created, and 2) whether the decision centres identified in the previous period have changed class (in relation to the established typology) using the information

available from new administrative censuses or otherwise. If the new period is characterised by major changes in terms of new population settlements in the observatory, it may prove necessary to redo the typology of the decision centres.

***Data processing and expected results***

*Preliminary work : processing of the inquiry datas*

Firstly, the data obtained are integrated into a local (*Access*) database or (*Excel*) tables adapted to the structure of the collected information. The structure of this database is, for the moment (within the ROSELT network framework), left to each country to devise. It is possible, in the medium term, that a standard « usages » database be proposed, based on the experience of the network, and linked to the set of themes presented in this document.
To do this, it is however recommended that all the data collected from now on be codified, with a view to their data entry and processing. This work is meticulous and the codes selected must be scrupulously respected. To start with, all the questions are codified, preferably with an alphanumeric code. All the responses for each question are listed, then codified in binary if the response is a yes/no type (for example, yes = 1, no = 0), or codified using a list of specified numbers.

*Cartographic processing : maps*

- **Maps of the decision centres** : from pre-existing data and the data collected in modules I to IV, a map of the decision centres on the observatory is established. It contributes to the development of the map of activity centres which will be chosen to provide input to the LEIS models (cf. p. 34). At each observation period, this map must be verified as still being valid. If changes are observed, it is updated.
- **Map of the activity centres** : the drawing up of this map, from information collected in the « decision centre » et « water points » inquiries, is described p. 34.

*Classical Statistical Processing : typologies*

- **Typologie of decision centres** : established with an ascending hierarchical classification of all the parameters obtained from the existing databases and the « decision centre » inquiry (cf. p. 19).
- **Classification of the heads of family** : a factorial analysis of correspondences, followed by an ascending hierarchical classification of the charac-

teristics of the heads of family inventoried in module V allows the definition of family head groups and the preparation of level 2 sampling (cf. p. 43). In each family head group thus identified, the heads of family are listed with their identifier.

*Spreadsheet program processing or DBMS request : general indicators*

On each decision centre, simple calculations are made to characterise the different attributes of the activity centres which were defined. Most of the calculated parameters possible are in the following list :

- **demographic growth rate** ;
- **agricultural activity rate** (*sensu lato*) : relationship between the population with a natural resource exploitation activity (« agricultural population » *sensu lato*) and the total population ;
- **working agricultural activity** : relationship between the working agricultural population and the total agricultural population ;
- **density of the decision centres** : number of decision centres per $km^2$ ;
- **distribution of principal and secondary activities** (agricultural, pastoral, forestry, commercial, artisan, other) : diagram ;
- **distribution of the size of exploitation units** (total agricultural surface or livestock size class) : diagram ;
- **level of equipment (all services included)**.

These indicators are recalculated at each observation period.

When several temporal sets of inquiries have been conducted, the parameters collected in module V and the indicators calculated lend themselves to specific analyses as a function of time : evolution curves. These curves can be constructed at the scale of the whole observatory or at the scale of each decision centre.

In both cases, these « socio-economic » can help to interpret the results obtained in the set of biophysical themes processed on the observatories (ecological systems).

If they are scaled up to the scale of the whole observatory, « average values » can be intersected and interpreted : for example, the average working agricultural population and the average level of vegetation cover.

If they are calculated at the decision centre scale, they can be intersected with biophysical data from the station/plot scale or applied to the Landscape Unit (ROSELT/OSS, TC1, 2005). In this way, since each decision centre is located, it can be attached to a phyto-ecological measurement station or to a landscape unit.

*LEIS integrated data processing : specific indicators to feed into the LEIS*

The data collected must be transformed using the LEIS input data format (ROSELT/OSS, SD3, 2005) :

1) **Delimitation of potential exploitation territories** : certain parameters collected at this level of investigation can play a role in the size and spatial extension of the potential exploitation territories around the activity centres. They are selected by the specialist in charge of this theme according to local specifics, from the following collected data : characteristics of the local leader (module II), the number of social services, the number of agricultural infrastructures and services, ethnic distribution (module III), age of the decision centre (module IV), demographic parameters calculated from module V : population inventory.
All the decision centre parameters which are selected, other than population and age, must be applied to the activity centre map attribute table.

2) They allow us to calculate the **relative weight of the activity centres**, indicator used in the model of the delimitation of potential exploitation territories (cf. p. 34).

***Inquiry form : « decision centre » questionnaire***

This questionnaire should be analysed so that it may be adapted and the questions posed tailored precisely to local specifics (cf. Introduction).

ROSELT LOGO INSTITUT NATIONAL LOGO

OBSERVATORY NETWORK FOR LONG-TERM ECOLOGICAL MONITORING

« DECISION CENTRE » QUESTIONNAIRE

## MODULE I – GEO-ADMINISTRATIVE REFERENCES

1a) Inquiry date :
1b) Surveyor name :
2a) Observatory :
2b) Country :
3a) Region (or *gouvernorat* or *wilaya*, etc.) :
3b) *Département* (or province or delegation or gouvernorat or *daïrate*) :
3c) District (or sector or *immadat*) :
3d) Rural community (or commune or *douar*, etc.) :
4a) Decision centre name :
4b) Circle where appropriate : *village* *neighbourhood* *hamlet* *isolated farm* *encampment*
4c) Circle where appropriate : encampment (or isolated farm) *permanent* or *temporary*
4d) If temporary, indicate the months present and the periodicity (annual, perennial) :

## MODULE II – INFORMATION ON THE LOCAL LEADER

5) Spatial reference (GPS) of his dwelling : X (longitude) = Y (latitude) = Altitude (m) =
6a) First name and surname :
6b) Age :
6c) Level of education :
6d) Ethnic group :
6e) Religion / Brotherhood :
6f) Clan or tribe membership :
6g) Membership of an association, which ? :
7) Geographic origin : (local ?, migrant from where ?, arrived in this zone how long ago ?)
8) For how many years has he had this function ?
9a) What function(s) does he have in terms of land tenure power ?
Circle where appropriate : *authority over the land* *over the water* *over the pasture* *over hunting*
Give details of *others* :

9b) The leader's other functions of authority (imam, group leader, rural counsellor, etc.) :
9c) Main activity :
9d) Secondary activities :
10a) Is he involved in land transformation and natural resource management action plans ? *Yes* *No*
10b) If yes, which ? :
10c) Since when ? :
10d) Which actions ? :

## MODULE III – LOCAL LAND TENURE AND SOCIAL ORGANISATION

***In the case of an encampment (or isolated farm) :***

11a) Does it depend on a village or hamlet ? *Yes* *No*
11b) Which one ? :
11c) Approximate distance (in metres or in time) :

***In the case of a village :***

12) How many neighbourhoods does it have ? :
13a) What social services are available ? (hospital, health centre, school, etc.) :
13b) What technical and agricultural infrastructure services are available ? (agricultural products or livestock breeding storage and transformation centres, storage centres for agricultural inputs, vaccination centres, veterinary clinics, etc.)

***Whether it be an encampment, isolated farm, hamlet, neighbourhood or village :***

14a) Does the locality belong to a delimited « village land » (See definition in the Glossary) or « exploitation area » ? : *Yes* *No*
14b) If yes, is it in a land register ? *Yes* *No*
15) Within this village land, is the type of habitat : *grouped* *dispersed*
16a) Number of villages located on this village land :
16b) Their names and sizes :
17a) Number of hamlets situated on this village land :
17b) Their names and sizes :
18a) Number of isolated farms :
18b) Their names and sizes :
19a) Number of encampments located on this village land :
19b) Their names and sizes :
20a) What are the main ethnic groups represented in the total population :
20b) What other ethnic groups are present but in a minority :

21) Identification of the traditional authorities, actors of environment management ?

| First name and surname | Identification (Name or composition) | Acting on which resource ? | Type of action | What does he decide ? | Who follows him ? |
|---|---|---|---|---|---|
| Village authority | | | | | |
| Land authority | | | | | |
| Water authority | | | | | |
| Pastures authority | | | | | |
| Village traditional council or encampment council | | | | | |
| Others | | | | | |

22) Identification of the other local environment management actors :

| Identification (Name) | Place of residence | Acting on what resource ? | Type of action | What does he decide ? | Who follows him ? |
|---|---|---|---|---|---|
| Sub-Prefect | | | | | |
| Technical services | | | | | |
| Locally elected representatives | | | | | |
| Others | | | | | |

## MODULE IV – HISTORY OF THE LOCAL PEOPLE

23a) Founding period of the « land tenure territory » :

23b) Founding period of the decision centre :

24a) History of the founding of the « land tenure territory » : who were the first to arrive and why did they set up the other lineages little-by-little ?

24b) History of the founding of the decision centre :

## MODULE V – INVENTORY OF THE POPULATION

25)

| Patronymic of the head of family | Main activity | Secondary activity | Natural resource exploitation activity (Y/N) | Ethnic group | Place of main residence | Period of presence in the territory | Place of secondary residence | Total number of people | Nomber d'adults 18 to 64 years old | Exploitation unit size (total agricultural surface area or live-stock number classes) | Water points used according to the season |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |

## *Inquiries for the evaluation of the pastoral stocking rate and its spatial distribution*

### *Objectives*

Here the objectives are :

- To assess and localise the whole set of water points around which the pastoral stocking rate is distributed according to the seasons. This is done using the specific questionnaire introduced to the locality leader and some rural advisors and breeders (« water points » questionnaire, cf. p. 39).
- To evaluate the seasonal pastoral stocking rate (livestock inventory data sheet, cf. p. 39) per water point. This is done using different methods, which includes the seasonal water point counting, according to the specifics of the observatory.

The collected data are used to provide input to the potential pastoral exploitation territory delimitation models (in the case of observatories whose structuring activity is pastoral) or to spatially distribute the resource extractions directly (in the case of observatories whose agricultural activity is structuring). They are also used to monitor, in the long term, the livestock dynamics and its spatial distribution : livestock territorial dynamics.

Finally, these data can contribute in their own right to the interpretation of the collected data in the observatory's other domains : vegetation, flora, fauna, soil, water, etc.

### *Preliminary work on the field inquiries and sampling method*

At any given moment in the year, all of the livestock consuming on the observatory range land must be known, either from having been evaluated in the available national statistics, or if necessary from collecting or supplementing the information through this inquiry work. However, it is not enough in this case to know the number of livestock on the observatory per season; its spatial distribution must also be known.

Before conducting the field inquiries described in the following paragraphs, it is necessary, if this has not already been done, to make an inventory of the water points used for watering, from the existing data. More precisely, an initial list (of names) is drawn up using the data gained (type of water points, age, with or without management committee) from the national technical services : hydraulics services, veterinary services, etc.

The inventory of livestock for the water points that do not have a management committee requires a counting to be done at the water points (cf. p. 33). If the num-

ber of water points without a management committee is greater than ten over the whole observatory territory (cf. size of the observatory, p. 19), it may be necessary, according to the human means available to conduct inquiries, to make a pre-selection of the water points on which a counting of animals will be made.

For the water point typology classes (cf. p. 34) without a management committee, the number of water points selected is calculated whilst respecting the same distribution of the number of water points in the class, in relation to the total population, then applied to the number of water points desired in the final sample (cf. p. 19).

Before proceeding with the counting of animals at water points (the whole set of water points or a sample of them) in each season, it is of course first necessary to explicitly define the seasons that we will use to establish seasonal balance analyses of the available pastoral resources and the resource extractions within the LEIS framework.

When the climate is mono-modal, we can only make a distinction between the rainy season and the dry season. However, ideally we would distinguish as many seasons as exist the number of differences in the behaviour of animals at pasture and their use of water points. In Sahelian areas, five seasons can be distinguished : rainy season, post-harvest season, hot dry season, cold dry season, and lean season. Each season must be characterised by a start date and an end date, with an average number of days. This data is in effect a LEIS entry data. This decision, which precedes the counting of animals at water points, can only be made with a good understanding of the pastoral functioning of the area. This knowledge must come from an extensive use of the appropriate biographical documents.

***Data to collect***

The following are the data to be collected from the locality leader, and some rural advisors and breeders, for all the water points usable for the watering of herds in the observatory (cf. « water points » questionnaire, p. 39) :

- location of all the water points (using GPS coordinates) during a year.
- assessment of these water points according to the following criteria :
  - type of water point (pond : small, medium, large * ; traditional well ; cemented well ; bore hole ; stream/*wadi*) ;
  - permanent or temporary ;

* The size (and/or lifespan) of ponds can be specified if this criteria, which is quantitative at this level, is relevant in terms of attractiveness to herds.

- season(s) visited ;
- origin of the livestock (autochthonous, allochtonous, mixed) ;
- the level of attendance (by default the following classes can be chosen : < 100, 100-500, 500-1000, > 1000). According to the specifics of the observatory, these attendance classes can be adapted.

The livestock is evaluated at all the water points chosen, by taking the following information :

- the numbers present per species, distinguishing the adults from the young.
- the origin of the herds and their watering habits. When the count is made at the water points, these data are only obtained if the herds are accompanied by a herder.

### *Data collection and monitoring method*

*Diagnosis*

The collection of data is conducted through a succession of « water point » questionnaires given to certain people, followed by the completion of a « livestock inventory » data sheet. It is desirable that a scientist – a pastoral specialist used to conducting inquiries – takes charge of the collection of data, and trains, supervises and accompanies technicians who can then be given the responsibility of conducting the inquiries and updating them within the context of long-term surveillance.

With regards to the « water point » questionnaire, the questions are posed to the locality leader (decision centre leader) and some rural advisors and breeders during the ROSELT observation period. If the conditions are appropriate, i.e. if the locality leader is still available and the other local people are breeders in a position to respond to specific questions, this questionnaire can be conducted at the same time as the « decision centre » questionnaire (cf. p. 28).

When the water points have a management committee (for example the large bore holes of North Ferlo in Senegal), data on the numbers at the water points are collected directly from the manager of the water point and his attendance monitoring record and breeder subscription register. Use by livestock of this type of water point is much too high to envisage a count.

Sometimes, when the pastoral water points are in or on the immediate border of villages, even if there is no official management committee, the data collected by the local authorities and/or the technical services can be sufficiently reliable to be used without doing a count at the water points.

It is important to favour, as soon as is possible, the exploitation of data generated elsewhere in order to lighten the load on the ROSELT data collection system, and to help it perpetuate, through the involvement of local technical services.

If the water points are isolated, without a management committee, nor a structured social organisation which provides knowledge of the use of the water points by animals, a count is necessary to know the number of livestock and their spatial distribution. This count is conducted season-by-season, using the « livestock inventory » data sheet, on each water point chosen. It only takes account of breeding animals led to pasture which have a direct impact on the observatory's natural resources. The number of « house » animals staying in the decision centres (also called « sedentary » animals) is only evaluated at the « exploitation unit » inquiry level (cf. p. 61), and will mainly be used to identify the different exploitation units and their needs in terms of exploitation products.

The count is conducted over several pre-determined days at each season during the ROSELT observation period ; at least one day if the herd uses the water point daily, or over two consecutive days if the animals come to water only once every two days, or over three consecutive days when they only come once every three days. If the human and material means allow it, it is preferable that the count be re-run at least once in the same season. It is recommended that the seasonal data sheets be completed during the same year. If for logistical reasons, not all the seasons were covered, the data sheets for the missing seasons can be completed in another year within the same observation period, so long as the functioning of the season (climate, etc.) is relatively similar from one year to the next.

*Surveillance*

The set of data collected using the various methods described below must be updated at each observation period (cf. p. 39). However, the update of the collected data can be reduced if no water points were either created nor disappeared, and if no herds appeared or disappeared. It may thus simply require verification.

Where a sub-sampling of water points has been conducted, it is all the more important to verify, at each new period, not only whether any water points have appeared or disappeared, but also whether the water points identified in the previous period have changed class (in relation to the established typology) using data available from new administrative censuses or others censuses. If the new period is characterised by major changes in terms if new breeder settlements in the observatory, it may prove necessary to reconstruct the typology of water points.

***Data processing and expected results***

*Preliminary work*

- Processing of the inquiry data : see p. 25.

*Cartographic processing : maps*

- **Maps of water points**

  Using existing data and data collected in the « water points » questionnaire, a map of water points in the observatory should be established.

- **Activity centre map**

  Using data from the « water points » questionnaire and the « decision centres » questionnaire (cf. p. 28), a map of activity centres must be established to be input into the LEIS models, given that the exploitation practices are organised around these activity centres (cf. annex 1). A decision centre, or a water point, can itself be an activity centre. Several decision centres, or several water points, can represent a single activity centre according to whether their territorial relationships have been established and whether their density on the observatory territory is high (i.e. « group of points » in a GIS). Also, a water point and the decision centres attached to this water point can represent a single activity centre (this is the case in pastoral areas).

*Classical statistical processing : typologies*

- **Water points typology**

  A typology of water points in the observatory is established with an ascending hierarchical classification using the parameters collected in the « water points » questionnaire (cf. p. 32) : type ; permanent or temporary ; season(s) of use ; origin of the herd ; level of use ; position with respect to the main soil use types (land use) : cultivated areas, uncultivated areas (optional).

*Spreadsheet program processing : general indicators*

- **Anthropic pressure indicators**

  - Density of water points : number of water points per $km^2$.
  - Number of livestock per season (water point scale, activity centre scale, administrative unit scale or observatory scale) : number of TBU or CU / day.

  On each water point, simple calculations are made to evaluate, for each defined season, the use of the water point in terms of TBU (Tropical Bovine Unit) numbers per day, or the number of CUs (Cattle Units) per day, according to the units used on that observatory.

The TBU reference animal is a live bovine weighing 250kg. The equivalent TBU varies with the animal species, and its age category (cf. **table 1**). The CU reference unit is a live bovine weighing 600kg (INRA, 1989).

***Table 1 :*** *The values attributed to each animal species for calculations of the numbers of TBUs.*

| | | |
|---|---|---|
| Bovines | Adult | 0,8 to 1,2 |
| | Young | 0,4 |
| Sheep | Adult | 0,2 |
| | Young | 0,15 |
| Goats | Adult | 0,2 to 0,35 |
| | Young | 0,15 |
| Camelidae | | 1,2 |
| Equines | | 1 à 1,2 |
| Donkeys | | 0,3 |

Source : *Mémento de l'Agronome*, 1991.

The numbers present at a water point are known for a number of pre-determined days in the season ; an average value is thus calculated for the season. If certain water points were selected for the count, this average value is applied to the other water points that belong to the same class (cf. p. 31).

The same calculation can be made per activity centre, when the activity centres group together several water points, per administrative unit included in the observatory, or over the whole observatory territory (all the water points included).

- **Seasonal and annual livestock stocking rate** : (administrative unit or observatory territory scale) : number of TBU or CU per ha. This is the relationship between :
  - the total number inventoried on the water points included in the administrative unit or over the whole observatory territory, for a given season or year,
  - and the surface, in hectares, of the territorial boundaries.
- **Pastoral resource extractions** (water point scale, activity centre scale, administrative unit scale or observatory scale) : kg of dry matter ingested / day / TBU or CU. This value is calculated by converting the number of TBUs or CUs in kg of dry matter ingested (or consumed). For the Sahelian observatories, a range of values between 5.5 and 6 kg of dry matter consumed / day / TBU can be applied using the « *Manuel des pâturages sahéliens* » (Breman H.Y. and De Ridder N., 1991).

This figure corresponds to an average daily feed ratio necessary to maintain the physiological processes and movements of a TBU.

When several temporal sets of inquiries have been conducted, the parameters collected at the water points lend themselves to a specific analysis as a function of time : evolution curves. These curves (all species included, or per species) can be constructed at the scale of the whole observatory or at the scale of each water point.

In both bases, these « socio-economic » data can help in the interpretation of the results obtained in the biophysical theme processed on the observatories (ecological systems). If they are applied to the observatory scale, « average » values can be intersected and interpreted : for example, the average livestock stocking rate and the average rate of vegetation cover. If they are calculated at the water point scale, they can be intersected with biophysical data from the station scale or applied to the Landscape Unit (ROSELT/OSS, TC1, 2005). In this way, since each water point is localised, it can be attached to a phyto-ecological measurement station or to a landscape unit.

*LEIS integrated data processing : specific indicators to feed into the LEIS*

The data collected must be transformed using the LEIS input data format (ROSELT/OSS, SD3, 2005).

- **Delimitation of potential exploitation territories**

  An attribute table in the LEIS database is linked to each mapped activity centre. These attributes are used in the LEIS to calculate the **relative weight of the activity centres** and thus to delimit the potential agricultural or pastoral exploitation territories around these centres. According to the characteristics of the activity centres, the following attributes are obtained :

  - in the « decision centre » questionnaires : **characteristics of the locality leader** (module II), **number of social services, agricultural services and infrastructures, ethnic distribution** (module III), **age of the decision centre** (module IV), and **demographic parameters** calculated from module V.
  - in the « water points » questionnaires and « livestock inventory » data sheets : **number of seasons used, level of seasonal use** (average seasonal uses = average number of TBUS or CUS per season), **relationship between autochthonous and allochtonous**, **specific composition** (number of species and number of individuals from each species).

When the structuring activity in the observatory is agricultural, from a spatial perspective, the data collected at the water points (number of livestock per season, in number of TBUs or CUs / day) are used to spatially distribute the fodder resource extractions around water points or group of water points, per season. To recap (ROSELT/OSS, SD3, 2005), this calculation is carried out in the second step of the LEIS : integration of multi-usages on the Spatial Reference Units. The numbers of TBUs or CUs are transformed into quantities of resources extracted per day (multiplication of the number of TBUs or CUs by the consumption constant calculated or otherwise estimated, in kg dry material / TBU or CU / day), these quantities being then applied to the seasonal resource extraction area and multiplied by the number of days in the season.

When the structuring activity in the observatory, from a spatial perspective, is pastoral (ROSELT/OSS, SD3, 2005), the water points are used for the potential exploitation territories delimitation model (first step of the LEIS : structuring the observatory into Spatial Reference Units). Each water point is associated with one or more decision centres and constitutes an activity centre. The data listed above, collected in the « water points » questionnaires or the « livestock inventory » data sheets, can play a role in this step.

***Inquiry form : evaluation of the pastoral stocking rate and its spatial distribution over the observatory territory***

This questionnaire should be analysed so that it may be adapted and the questions posed tailored precisely to local specifics.

ROSELT LOGO — INSTITUT NATIONAL LOGO

OBSERVATORY NETWORK FOR LONG-TERM ECOLOGICAL MONITORING

« EVALUATION OF THE PASTORAL STOCKING RATE AND ITS SPATIAL DISTRIBUTION OVER THE OBSERVATORY TERRITORY » QUESTIONNAIRE

## 1) « WATER POINTS » QUESTIONNAIRE

Date : Conducted by :

| Name of the water point and place name (toponym) | Localisation (+ GPS ref.) | Type pound : P traditional well : TW cemented well : CW bore hole : BH stream/wadi : S | Permanent (P) or Temporary (T) | Existence of a management committee (Yes/No) | Age | | Attendance class per species (bovine, small ruminants, camels) | Livestock origin Exclusively autotochthnonous : AU Exclusively allochtonous : AL Both : AA |
|---|---|---|---|---|---|---|---|---|
| Water point 1 | | | | | | Saison a (to be specified) | | |
| | | | | | | Saison b | | |
| | | | | | | Saison c | | |
| | | | | | | Saison d | | |
| Water point n | | | | | | | | |

NB: the size of the ponds can be specified.

## 2) LIVESTOCK INVENTORY FORM

Date : Season Conducted by :

**Name of the water point** : **GPS references of the water point** :

X (longitude) = Y (latitude) = Altitude (m) =

**Other water points attended :**

| | | | | | | | **Questions to pose to the herder accompanying the herd** | | |
|---|---|---|---|---|---|---|---|---|---|
| **Time of arrival** | Bovine | Goats | Sheep | Camels | Horses | Donkeys | Watering rhythm every day : 1 every 2 days : 1/2 every 3 days : 1/3 | Originating from the observatory (Yes / No) | Decision centre identification (village, encampment) |
| | A Y T | A Y T | A Y T | A Y T | | | | | |
| | | | | | | | | | |

A = adult ; Y = young ; T = total.

**NB: Marked in grey are the items which will only be completed when the inventory is done by a count at the water points.**

# Second scale of investigation : assessment and monitoring of exploitation units and their strategy

The investigations described in this section are made at the scale of the agricultural exploitation unit. They are based on a single questionnaire : the « **Exploitation Unit** » questionnaire (cf. p. 61). This allows the information needed to assess the exploitation units to be collected from the exploitation unit leader, and their natural resource exploitation strategies on the observatory territory to be understood.

The **Exploitation Unit** (UE) is generally defined as « *the basic agent acting in the agricultural production process. It constitutes the family unit inside which priority is given to the implementation of the factors of production : land, labour force, means of production (...) and in which the process of utilisation and movement of the products obtained is carried out* » (translation from the *Mémento de l'Agronome*, 1991 ; Brossier, 1987). This concept establishes the essential link that exists between the familial structure and the social unit within which exploitation of the local environment is carried out.

From a methodological point of view, we can define the exploitation unit as the set of people who work on the same fields or look after the same herd, store together in a communal store house – but which does not exclude the existence of several individual store houses – and who are attached to the same decision centre with regards to the organisation and management of production. This UE, which is placed under the supervision of an UE leader, is sometimes spread over several residence units, particularly when it unites individuals from different generations.

## *Objectives*

The main objective is to assess the Exploitation Units for each LEIS modelling period, whilst linking them, where possible, to a recognised (national or international) typology of production systems. This linking is important to help extrapolate the information collected in the observatory, and the region that it represents, and to integrate them into a national and regional environmental surveillance system.

A **production system** is a combination of production and the factors of production (land tenure capital, exploitation work and capital) in the agricultural exploitation unit. It is a more or less coherent, organised combination of various production sub-systems : crops systems, breeding systems and transformation systems (*Mémento de l'Agronome*, 2002).

The general objective of the assessment of exploitation units is to identify their structure, the diversity of their production systems and exploitation practices, and the representation they make of the natural environment with which they must work in terms of usages and methods of management. Once they are combined together these elements allow us to identify the exploitation strategies the UES have, to satisfy their production objectives (cereal, market garden, animal, etc.).

This general objective can be broken down into the following specific objectives :

- To understand the **exploitation strategy** for the exploitation of natural resources on the observatory's exploitation units.
- To build a **typology of exploitation units** according to a selection of criteria which would have been considered indicators of their strategies. Within the LEIS framework, each typology class is a type of « **strategic group** » (cf. agent group, annex 1).
- To characterise the **state of health and stability** of the UES, their **capacity to adapt** to biophysical and human constraints on the observatory.
- To make a **typology of herds** from which it will be possible to make a selection for the level 3 pastoral inquiries.
- To evaluate the **anthropic pressure** on the natural resources linked to the activities of the UES. For the moment, in this document, only the pressure on the natural vegetation is addressed.
- To evaluate the **needs** (**expected production**) in terms of exploitation products according to the different uses of these products: self-consumption, commerce (sale, exchange, gifts), storage (re-investment, prevision for losses). This need is used in the spatial distribution models of agricultural exploitation practices. In all cases it is a monitoring parameter.
- To evaluate the **exploitation products**.
- To monitor the exploitation units in the long term in order to the understand their evolution and their structural changes that enable them to adapt to ecological and other changes.
- To assemble the minimum dataset in order to review the distribution of agricultural, pastoral, forestry and other practices at the observatory scale, and to evaluate the necessity to conduct more in-depth inquiries on these exploitation practices (level 3).
- To conduct sub-sampling of the Exploitation Units to provide part of the level 3 investigations for the assessment and monitoring of exploitation and resource extraction practices.

## *Preliminary work on field inquiries and sampling method*

The « exploitation unit » inquiry is conducted with a representative sample using a sampling rate that is variable according to the number of heads of family in the selected activity centres and the homogeneity of the total population (on the basis of the information collected at level 1). The size of the sample must meet the demands of the following two criteria : 1) accounting using the human and financial means available for long-term environmental surveillance on the observatories at the local scale, and 2) the guarantee of a size sufficient to be representative of the population and the different social groups, and in order to conduct the level 3 sampling (cf. p. 75).

The UEs are sampled either in all the decision centres inventoried (exhaustive inclusion of the spatial heterogeneity : cf. level 1), or in the pre-selected decision centres, in particular using spatial distribution criteria (positioning in relation to the main soil use types : cf. p. 19). At this stage, once the families who do not have a natural resource exploitation activity are identified and separated, whilst still respecting the set size of the sample, the selection of UEs is based on the following criteria of the social groups : sampling rate, representativeness, and spatial distribution.

### *Calculation of the adapted sample*

*Calculation method of the sample size*

- if the size of the community is less than 100 heads of family, the inquiry is exhaustive and all the UE family heads are selected ;
- if however, the community is made up of more than 100 heads of family, the size of the sample can be defined following normal statistical techniques (Javeau, 1971, etc.). If these calculations can not be made, a sample size of around 100 heads of household can be used.

*Taking into account the representativeness of social groups and their spatial distribution*

In order that the sampling takes account of the representativeness of the social groups and their spatial distribution, the following criteria are used, depending on the specifics of the observatories, from the list of parameters identified during the inventory of the population in the « decision centre » questionnaire, module V (cf. p. 28) :

- at least two criteria from the following list, with regards to the representativeness of social groups : main activity, secondary activity, ethnic

group, number of dependent people (total population), number of adults aged 18 to 64 years old (working population), size of the exploitation unit (in total agricultural surface area or the livestock number class), period during which they are present in the territory (permanent, seasonal) ;

- at least one other criteria regarding the spatial distribution of social groups: for example membership to a *satellite* or *main* decision centre (cf .p. 20) when the structuring activity is agricultural from a spatial perspective. When the structuring activity is pastoral, given the constraints of the delimitation models of potential pastoral exploitation territories being developed by the ROSELT network, it is necessary to make provision, from this point on, for the selection of at least one UE per main water point. In any case, it is recommended that care be taken that the selected UEs have a spatial distribution on the observatory territory that takes account of the landscape diversity (soil, vegetation, etc.).

From these criteria which will have been selected, a calculation of quotas, for example, is applied using the « Jensen » method (Jensen, *in* Grawitz, 1974).

***A simplified calculation example is given below, using these sampling principles and the « Jensen » method :***

*Imagine a community of 210 heads of family and that at least the criteria « ethnic group » and « main activity » were selected :*

1) *Out of the 210 heads of family inventoried, 38 are Fula and 172 are Songhai ;*
2) *Out of the 38 Fula heads of family, 10 are farmers and 28 are breeders ;*
3) *Out of the 172 Songhai, 120 are breeders and 52 are fishermen.*

*According to the stated sampling principles, the sample size will be, for example, 100 heads of family. Firstly, the proportion of UE leaders from each ethnic group to be surveyed will be calculated as follows :*

- *for the Fula, 38/210 = 0.18 x 100 (sample size) = 18 Fula UEs ;*
- *and for the Songhai, 172 / 210 = 0.82 x 100 (sample size) = 82 Songhai UEs.*

*Secondly, the proportion per ethnic group of UE leaders to be surveyed according to their main activity would be calculated as follows :*

- *Among the Fula UEs, 10/38 = 0.26, or 26% are farmers and 28/38 = 0.74, or 74% are breeders. This ratio, applied to the sample, gives 18 x 0.26 = 5.04, rounded to 5 farmers and 18 x 0.74 = 13.32, rounded to 13 breeders.*
- *Among the Songhai UEs, the sample is: 120/172 = 0.697 x 82 = 57.15 or 57 are breeders; and 52/172 = 0.30 x 82 = 24.6 or 25 are fishermen.*

*Final result : 18 Fula UEs of which 5 are farmers and 13 are breeders ; 82 Songhai UEs of which 57 are breeders and 25 are fishermen.*

*The calculation is made as many times as there are criteria selected.*

***Application test in Tunisia in 2005 on the Menzel Habib observatory :***

*The size of the total observatory population is 2 070 households according to a census conducted in 2004. The sampling method consisted of an inquiry at two levels. The first level is a stratified inquiry following the agricultural exploitation criteria (land tenure, number of fruit trees, and animal number) and spatial membership (administrative zoning by « Imadat ») ; the data are from the 1996 DYPEN inquiry* (Collectif de recherche DYPEN II, 2000). *The second level is a random proportional inquiry using a sampling rate of between 13% and 15%. The size of the sample therefore reaches 305 Exploitation Unit leaders (IRA 2005).*

***Application test in Senegal in 2004 on the Ferlo observatory, Ouarkhokh community :***

*Before selecting the UES, a sub-sampling of 15 out of 43 activity centres (33%) was conducted using the size of the population, accessibility to basic social services and the number of TBUS. A good spatial distribution of the activity centres (AC) takes account of the land vocation (agricultural, pastoral, etc.). The number of UES was determined according to the size of each AC selected (between 20% and 40%). The choice of which UES to survey took into account the ethnic group and the main activities. The sample size is thus limited to 93 Exploitation Units (Ba, 2004).*

## *Data to collect*

The inquiry form is composed of eight modules : each one groups together several questions which allow the corpus of the data to be collected according to a specific objective.

***Module I : Geo-administrative inquiry references***

- This module is for supplying all the geographical and administrative indications necessary for locating the exploitation units and linking them to a decision centre (village, encampments, etc.). Taking GPS coordinates is particularly useful in the encampments, village or hamlets, where the habitat is dispersed. Within the LEIS framework, this will allow the identification of which strategic groups are attached to which decision centre, and therefore which activity centre.
- A unique number called the inquiry identification number is attributed to each UE ; a numbering system must be found, like that of the INSEE numbering system (French National Institute for Statistics and Economic

Studies), which identifies the position of the UE. It could be composed as follows :

- a country code (three first letters) : MAR, ALG, TUN, NIG, ETH, MAU, KEN ;
- a number attributed to each observatory in the country, from 1 to n ;
- a village code (V1 to Vn) or an encampment code (C1 to Cn) ;
- followed by a number attributed to the UE (UE 15, UE 64, etc.) ;

This gives, for example, MAR-2-V11-UE 55.

This coded identification of the UE is essential since the UEs are verified and supplemented at regular intervals.

***Module II : Identification of the UE leader***

The forenames and surname of the UE leader are noted, along with his age, sex, ethic background and religion. These items of information allow, among other things, for him to be precisely identified to avoid confusion with any possible homonyms. His level of education and literacy is useful for the level 3 inquiries for which, for example, the people in the UE who are capable of completing the evaluation data sheets of wood fuel resource extractions need to be identified.

***Module III : Mobility and social function of the UE leader***

This corpus of information provides knowledge of the mobility of the UE leaders. It is devoted to specifying and taking account of the periodic migration movements of UE leaders during the previous four years, whether they originate from another region or not and whether or not they are in the habit of periodically migrating to other areas. These data allow a component of the migration dynamics to be shown (the migration of UE leaders), a component which is supplemented in module IV by the inclusion of the migration of other migratory members of the UE.

From the point of view of the strategic analysis of the UE, the **frequency of migratory movements** and the share (%) of the exploitation revenue that implies (cf. module IV) sheds light on the logic of the farmer, as well as his capacity for adaptation.

His participation in an associative life, whether professional or not, as well as the commitment of the UE leader in a role of authority, an actor in the management of the environment, all constitute elements which can be linked to the UE exploitation strategy (cf. p. 53 : typology of the UEs), and which, above all, allow the collected information to be dissected (refined) in the level 1 « decision centre » inquiry (module III : local social and land tenure organisation).

### *Module IV : UE composition, activities, labour force and equipment*

Once the main management member of the UE has been identified, and his characteristics have been listed, the other working and non-working members of the UE must be inventoried.

In order to obtain solid data and so long as the exploitation units have a familial basis, it is not only the members of the UE that must be listed but also their kinship to the UE leader and their status.

First of all, by listing the living members (ascendants and descendants) of the UE leader's lineage, a count is made of the people present in the exploitation unit ; their name, age and familial status are given.

Secondly, a review is conducted with the farmer, enumerating all the people cited and asking him to specify if each person works or not, i.e. if the person regularly conducts a task within the context of the UE, paid or unpaid, which contributes to the economy of the UE. In the case of working members, the activities conducted are specified, and in particular, how the activities are organised within the UE between men and women, and the share of the revenue that the complementary activities generate. It must also be specified whether the person only works in this UE or if he shares his work time with another UE. Finally, the fact of having been or being educated is noted for each person in the UE. This information is noted in a single table.

They are summarised by the surveyor in the following « working and non-working people per household » tables :

| | Household n°1 That of the UE leader | | Household n°2 | | Household n°3 | | Household n°4 | |
|---|---|---|---|---|---|---|---|---|
| | working | non-working | working | non-working | working | non-working | working | non-working |
| Nb of men | | | | | | | | |
| Nb of women | | | | | | | | |
| Nb of dependent children | | | | | | | | |
| Total per household | | | | | | | | |
| MAIN TOTAL | | | | | | | | |

*(cf. head of the household : annex 1 : p. 128).*

Complementary information is requested on the main and secondary activities, in particular the share of exploitation revenue. Whenever possible, the revenue is quantified.

Data are also collected on the migration of the UE members other than the UE leader. The share of exploitation revenue that represents is evaluated. Where pos-

sible, the revenue is quantified directly. To evaluate the labour force that is not familial, the possible use of exterior labour is assessed.

Finally, the equipment that the UE possesses (radio, television, etc.) is described. The set of data collected essentially allow us :

1) to build the typology of exploitation units following the key parameters (cf. p. 53) ;

2) to develop indicators of the « state of health » and stability of the UE, of its capacity for adaptation, the anthropic pressure that it exerts on the local natural environment and to monitor their evolution (cf. p. 53).

***Modules V to VI : Natural resource exploitation activities (agricultural, pastoral)***

Modules V to VI correspond to various local environment exploitation activities which may or may not concern the UE surveyed. The information collected at this second level of investigation can, according to the specifics of the UE, be specified in the questionnaires or information supplements incorporated in level 3. The information collected in these modules allow us (cf. p. 53) :

1) to build a typology of exploitation units using the key parameters /UE ;

2) to develop indexes of the state of health of the UEs and their capacity for adaptation, of anthropic pressure on the milieu, and to monitor their evolution ;

3) to develop LEIS entry parameters ;

4) to evaluate the value of conducting more detailed level 3 inquiries and to contribute towards the development of a sub-sample.

*Module V : Agricultural activity*

The module on agricultural activity allows us to collect data related to different aspects of the agricultural exploitation system :

- First of all, the surveyor does a **review of the agricultural equipment at the disposal of the UE** to conduct its work, and at the same time he notes the steps leading to their acquisition, thus showing the evolution of the UE's financial situation. He also records the **investments made in terms of agricultural development.**
  In parallel to the financial investment made by the UE, it is important to indicate whether its own financial resources were sufficient or whether the UE had to obtain a loan. In the case of a loan, the amount is establi-

shed along with the number of remaining monthly payments, in order to know **the UE's level of debt**. N.B. from now on, the loans undertaken by the same farmer in response to needs in other professional sectors will be taken into account in the relevant modules.

- Secondly, it is necessary to produce an account of the fields exploited and loaned out by the exploitation unit. For each of the fields exploited by the UE, the data collected allow it to be positioned generally in relation to the decision centre, and to evaluate its size and distance from the place of residence. When possible, the size is evaluated in hectares or equivalent units. Information on its method of acquisition, the date it was put into operation (the date on which the field was cultivated for the first time) and its type of land use allocation are also collected. This set of this information allows a link to be established between the type of right to the land, and the cultural practices.
  With regards to the cultural practices themselves, they are understood at a superficial level at this point (species cultivated, practice of crop rotation or not) and will be expanded on by way of the level 3 inquiries on the actual fields of the selected UEs.
  The fields loaned to other farmers and therefore exploited outside the UE do not figure in the table « Fields cultivated or left to fallow by the UE », and feature in a specific table that indicates the number of fields lent out, the duration of the loans and the reason for them (question 24b).

- A third step features the **agricultural production** and **needs** parameters and allows us to evaluate :
  - the entire production of the UE : production hoped for for the coming year and real production from the inquiry year ;
  - the use of harvested products : proportion self-consumed, sold, exchanged/given as gifts, stored and reinvested (sowing), losses ;
  - the feed intake needs covered by the production during the inquiry year ;
  - a four-year review which allows us on the one hand to see how this year's production compares with previous years, and on the other hand to measure the impact of the UE strategy in terms of the evolution of production.

This module also involves **outlining the factors which may have had an effect on this year's production**. Two types of causes are examined : firstly, the economic or familial constraints (lack of labour, death, illness, etc.), and secondly, the ecological conditions (swarm of locust, drought, flood, etc.).

Finally, a last **set of questions** allows an explanation of the refusal to cultivate certain species considered as exhaustive to the soil, or the refusal to indulge in the

use of certain practices which would expose the soil to degradation, and allows the development of certain soil recovery and agrarian area management practices to be justified.

*Module VI : Pastoral activity*

The pastoral activity module allows the collection of data relative to the different aspects of the pastoral exploitation system :

- The equipment linked to the pastoral activity and the methods of acquisition of this equipment.
- The types of animal that the UE possesses (cf. 31a, p. 66), distinguishing those that are never led to pasture (« house » or « farm » animals) and those led to pasture (range land animals) whatever the time of year. For each of these main types, the composition of the herd by species and age category (young/adults) is described, as well as the growth of the livestock during the year (acquisition, losses).
  For the range land animals, those led on a small transhumance, per species and per age category, are specified (i.e. in neighbouring exploitation territories within the observatory) followed by those which are led on a large transhumance (i.e. outside the observatory), noting in each case the season, the share of the livestock that is included, the location of the range land and if there is an « entrusting * » of livestock.
- For the range land animals, the **types of herds** that have not gone on (large or small) transhumance are identified in each season (one table per season : cf. 31b, p. 67) : composition per species and age category, association with other animals from other UES, the type of pasture exploitation : watched over or free to roam, the main criteria used for choosing the grazing circuit, the maximum distance covered, and the water points used. If it is a determining factor in terms of livestock management, the races of the animals per species can be specified. These descriptive elements will enable a typology of observatory herds to be established and a sample to be selected for the herd monitoring of the level 3 investigation.
- The significant losses suffered during the last three years and the reasons for these losses.
- The **products of breeding** and the **needs** of the UE.
  For each type of breeding product (young on the hoof, adults on the hoof, milk), the following information is collected :

* « Entrusting » refers to the animal owner entrusting the herd management of his animals to another herder. See the Glossary.

- the use of the products obtained : share (%) self-consumed, sold, exchanged/given away, stored and reinvested (for the renewal of livestock), lost ;
- the feed intake needs covered by the production from the inquiry year ;
- a review of the three previous years giving the possibility, firstly, to show how this year's production compares with the previous years, and secondly to measure the impact of the UE strategy in terms of the evolution of production ;
- the presence of a veterinary service and what it provides in relation to the expectations of the population ;
- the use of supplementary feed : this question is expanded in the level 3 inquiries to quantify it on a per season basis. At this level, it is an important criteria of UE strategy to take account of in the typology of exploitation units.
- the practice and methods of the manure agreement. This set of questions helps to identify the areas where agricultural and pastoral activities are combined. This information is in addition to the information collected at level 3.

In this module, we **define the factors which may have had an affect on this annual production**. Two types of cause are scrutinised : economic or familial constraints, and ecological conditions.

*Module VII : Forestry and gathering activities*

This is the assessment of the extraction of natural vegetation resources beyond the scope of agricultural and pastoral activities. The accent in this module is more on the assessment of resource extractions (species, quantity) and methods of these resource extractions (who by, with or without authorisation, in what period, using what technique, on what village land ?), than on the resource exploitation system (cf. modules V and VI). The objective is to give a relatively precise idea of the pressure that is exerted on certain plant resources, distinguishing the resources extracted for domestic purposes from those extracted for commercial purposes.

This information is also collected for the practices which are considered « prejudicial » to the conservation of these resources. This module enables :

- the completion of elements of the UE exploitation strategy and thus a better definition of the typology of the UES on the observatory (cf. p. 53) ;
- the calculation of indexes of anthropic pressure on plant resources ;
- the identification of cutting and gathering activities that are significant in

terms of their impact on the territory's resources. This information is applied to the LEIS to establish balance analyses of the available resources and the resource extractions : resource extraction radius, quantities extracted per season. When the extraction of wood fuel resources is identified as a major activity, more in-depth inquiries are proposed in level 3 to better quantify this resource extraction throughout the year.

***Module VIII : Representations of the environment***

This module provides information on :

- plants which have curative properties, and therefore need to be protected, or those identified as toxic ;
- domestic and wild animals which are harmful, or on the contrary which should be protected ;
- the UE leader's analysis of the ecological situation of his region, his awareness of his own specific problems, his integration as a local actor through the actions that he undertakes to « protect his local environment ».

## *Data collection and monitoring method*

***Diagnosis***

The collection of data is done through the use of a questionnaire given to the leaders of exploitation units who were preselected using the criteria chosen by the different observatories (cf. p. 43).

In the case of an agricultural activity which structures the observatory from a spatial perspective, this field investigation is preferably done during the last dry period of the year in order to :

1) avoid the period in which the fields are worked and thus benefit from greater availability of the UE leaders,
2) collect information on the past agricultural year.

If the pastoral activity structures the observatory from a spatial perspective, it is recommended that this investigation be concentrated into the periods of the year when the most breeders are present on the observatory (i.e. outside the period of the large transhumance). If the allochtonous breeders are present on the observa-

tory at a particular moment during the year, and constitute a type of Exploitation Unit on which the « exploitation unit » questionnaires should be conducted (« regular allochtonous breeders »), the inquiry period must be adapted to match the moment of their passage through the observatory.

According to the number of activities practised within the exploitation unit, the surveyor uses the appropriate modules. The questioning time that will be needed for each UE varies according to this multi-activity and the size of the UE. From one to two hours should be envisaged per UE.

To conduct this field work, it is desirable that one (or two) scientists who are used to conducting agro-economic inquiries are able to supervise and monitor a team of technicians (or work placement students) who would themselves be able to conduct the inquiries and update them in the context of long-term surveillance.

The time needed to then input the collected data must not be underestimated. The technicians or work placement students can also have this data input role, with the scientific supervisor controlling the input quality.

***Surveillance***

At each observation period, a tour of the area with the same exploitation leaders, and the original completed forms at hand, should allow verification of whether the data are unchanged, and allow the quick update of any data that might have changed. Since the UEs were selected, the following should be verified at each following period :

1) whether other UEs have since been created,

2) whether the UEs identified in the previous period have changed class (with respect to the established typology) according to the new data available at level 1 of the investigation.

If the new period is characterised by major changes in terms of the appearance of new types of exploitation on the observatory (cf. p. 43), it may be necessary to recalculate the sample. If this is the case, the maximum number of UEs already surveyed in the previous period will be used again, where possible.

## *Data processing and expected results*

***Preliminary work :*** processing of inquiry data ; providing input to a specific database (cf. p. 25).

### *Classic statistical data processing : typologies*

*Exploitation units typology*

The data collected in the first observation period in modules I, IV, V and VII lend themselves to specific statistical processing of the UE characteristics, with a view to building a typology of the UEs, with all or a subset of the following criteria :

- Territorial links of the UE leader (autochthonous, allochtonous) : module I.
- Number of people : number of working people, number of people having left on temporary exodus, number of people having left on permanent exodus, number of activities : module IV.
- Number of plots, mode of access to the land (% of plots acquired using the main observatory mode of access), equipment investment (yes/no) or loans taken out (yes/no) : module V.
- Number of TBUS (or other unit), number of species, % cattle, % small ruminants (goats, sheep), % Camelidae, % equines, % donkeys, use of supplementary feed for breeding animals (yes/no), mobility of animals : module VI. The mobility of animals can be characterised as follows :
  - none : « house » animals,
  - daily movements around the same decision centre throughout the year : « extensive sedentary system »,
  - daily movements around several decision centres according to the season : transhumants.
- Cutting and gathering for commercial purposes (yes/no), wood fuel resource extractions (light/medium/heavy) : module VII.
  N.B. the criteria of wood fuel resource extraction must always be used in order to make possible the sampling of the « wood fuel resource extraction practices » questionnaire (cf. p. 114).

Given that in certain modules the information may be quantitative or qualitative, it is recommended that the quantitative data be transformed into qualitative data (in the form of classes) and that a Factorial Analysis of Correspondences (FAC) be conducted. Next, using the main axes of the FAC, it is recommended that a Hierarchical Ascendant Classification be conducted. The latter has the advantage of not fixing the number of classes desired in advance ; it will depend on the analysis of the hierarchical tree obtained through classification. The set of exploitation units of the same type constitutes a strategic group, i.e. a group of individuals with the same exploitation strategy (ROSELT/OSS, SD2, 2004). This type of data processing is renewed at each modelling period only if new responses to the questions posed in the relevant modules appear in the acquisition of data in the field (cf. see indicators below).

N.B. the typology of UEs must be linked, where possible, to a recognised (national or international) typology of production systems in order to extrapolate the information collected to the decision centres which will not have been selected (cf. nesting of the level 1 and 2 inquiries : pp. 19 and 43), in order to help to extrapolate these data to the region represented by the observatory and integrate them into a national and regional environmental surveillance system. For the moment, the following typology is proposed. It may be adapted and refined in the coming years.

*Typology of the production systems*

- *Unique breeding systems* (Sere and Steinfeld, 1996), the « breeders » : systems in which more than 90% of the dry matter given to animals comes from the range land, pasture (cultivated meadow), annual fodder (from crops) and bought feed (and the remaining 10% is produced by agriculture on the farm : grains, etc.). The total value of the production from exploitation which results from activities linked to breeding is greater than 90%.
- *Mixed systems* (Sere and Steinfeld, 1996), the « farmer-herder » : systems in which the value of exploitation products which result from agricultural activities is between 10 and 90%.
- *Culture systems :* the « farmers » : systems in which the total value of exploitation production of activities linked to agriculture is greater than 90%.

*Typology of the herds*

A hierarchical ascendant classification with data collected during the first modelling period in module VI (question 31b, p. 67) enables a typology of the herds to be constructed : composition per species and age category, aggregation or not with animals from other UEs, grazing watched over or not watched over, maximum distance from a water point, types of water point used. It is recommended that this typology be simplified when the agricultural activity structures the observatory from a spatial point of view, in order to reduce the collection of data for herd monitoring (at a maximum between three and five types of herd ; cf. p. 103).

***Spreadsheet program data processing or DBMS request : general indicators***

By averaging over the whole set of observatory UEs (comparison between observatories) or over each class of the UE typology (strategic group : intra-observatory functioning), specific indicators can be calculated. A non-exhaustive list follows, which would benefit from being tested (cf. Introduction) and possibly supplemented within the ROSELT framework.

*Indicators of the « state of health » and stability of exploitation units*

*Module IV :*

- **Level of education** = relationship between the number of educated people and the total number of people ;
- **Global level of activity** = relationship between the number of working people and the total number of people (dependants) ;
- **Level of actual activity** = relationship between the number of working people and the total number of people of working age (18-64 years old) ;
- **Revenue per inhabitant** * ;
- **Revenue per working person** * ;
- **Agricultural revenue as a share of the familial revenue** ;
- **Amount of revenue from the principle activity as a share of the economy of the exploitation unit** ;
- **Relationship between familial labour and exterior labour** ;
- **Relationship between the number** ** **of fields loaned out** due to a surplus and **the total number of fields.**

*Module V :*

- **Relationship between the number of cultivated, non-loaned fields and the total number of fields** ;
- **Total agricultural surface area** = surface area of all the fields used, i.e. cultivated (annual or perennial crops) or in fallow.
- **Total agricultural surface area per inhabitant** ;
- **Surface area cultivated per inhabitant** ;
- **Agricultural revenue per total agricultural surface area.**

*Module VI :*

- **Relationship between the number of UES that use supplementary feed and the total number of UES** ;*Module VI :*
- **Relationship between the number of UES that use supplementary feed and the total number of UES** ;

* In the case of the revenue having been quantified during the inquiry.

** If the data collected allow, this conveys the number of fields in terms of surface area.

- **Relationship between the number of UEs that use supplementary feed and the total number of UEs** ;
- **Average number of livestock** (in TBUs or another unit) ;
- **Mortality rate of adults** (in TBUs or another unit) = relationship between losses of young animals and the total number of young ;
- **Mortality rate of adults** = relationship between losses of adult animals and the total number of adults.
- **Equipment level of households** = relationship between the number of UEs that have a specific piece of equipment (TV, radio, etc.) and the total number of UEs.

*Module V and VI* : the levels above can be calculated for the agricultural activity and the breeding activity separately or for both activities combined.

- **Level of self-consumption of exploitation products** (agricultural, from breeding, general) = share of self-consumed products ;
- **Level of debt** (agricultural, breeding, general) of the UEs = relationship between the number of UEs with a loan for equipment and the total number of UEs ;
- **Level of debt** (agricultural, breeding, general) **of the UE in debt** = number of UEs with a loan (amount borrowed/amount repaid) ;
- **Level of satisfaction of the exploitation unit needs** (agricultural, breeding, general) = relationship between the production realised and the production expected ;
- **Level of cover of feed intake needs** by agricultural (and/or breeding) = relationship between the value of the agricultural production and the value of the needs of the exploitation unit ;
- **Level of mechanisation** (agricultural, breeding, general) = relationship between the amount (number) of equipment used and the number of working people.

*Indicators of the UE's capacity for adaptation to biophysical and human constraints*

*Module IV :*

- **Relationship between the number of UE leaders that have a secondary activity and the total number of UE leaders** ;

- **Relationship between the number * of fields loaned out and the total number of fields** ;
- **Multi-activity level** = relationship between the UE's number of activities and the number of working people ;
- **Migration level** = (Number of people involved in migration / number of working people) x (number of months accumulated over the last four years / 4 x 12 months).

*Module VI :*

- **Level of diversity of animal species** = relationship between the number of animal species per UE and the number of heads of livestock ;
- **Level of mobility of the breeding animals** = relationship between the number of mobile breeding animals and the total number of heads of livestock ;
- **Level of agro-pastoral integration** = number of manure agreements per year ;
- **Level of entrusting** = share of the breeding animals entrusted (cf. Glossary) ;
- **Relationship between the number of UEs that use feed supplements and the total number of UEs.**

*Indexes of anthropic pressure on plant resources*

*Module V :*

- **Level of agricultural extension** = relationship between the number of fields newly put to use ** and the total number of fields.

*Module VI :*

- **Level of livestock growth** = (number of TBUs, or another unit, newly acquired) – (number of TBUs, of another unit, lost) / (total number of TBUs, or another unit) ;

* Where possible, this revenue is quantified.

** The fields newly put to use are those which were cleared on natural areas (range land or otherwise) during the inquiry year.

- **Level of extensive breeding** = relationship between the number of breeding animals led to pasture (TBU or another unit) and the total number of animals (TBU or another unit).

When several temporal sets of inquiries have been conducted, the indicators calculated from the UE inquiries lend themselves to specific analyses as a function of time: evolution curves (indexes). These curves can be constructed at the scale of the whole observatory (comparison between observatories) or at the level of each UE class (intra-observatory functioning).

In both cases, these « socio-economic » data can help to interpret the results obtained in the biophysical themes worked on in the observatories (ecological systems). Applied to the observatory scale, « average » values can be intersected and interprète : for example, the rate of agricultural extension and the average rate of vegetation cover. If they are calculated at the UE class scale, they can be intersected with the biophysical data calculated at the phyto-ecological station scale, or applied to the Landscape Unit (ROSELT/OSS, TC1, 2005). In effect, each type of UE is attached to one or more decision centres, which are also geographically referenced.

### *LEIS integrated data processing : specific indicators to provide input to the LEIS*

#### *Identification of strategic groups*

In the context of the LEIS, each class of the exploitation unit typology constitutes a type of « strategic group ». These strategic groups are linked to activity centres and natural resource exploitation practices.

To recap (cf. ROSELT/OSS, SD3, 2005), an agent group can be a group of individuals with a strategy for natural resource exploitation (= *strategic group defined by the typology of observatory exploitation units*) with different roles (*manage, exploit, reside, extract resources*) : it can also be a group of domestic animals (*domestic herds*) or wild animals (*fauna*) which extract natural resources from the observatory territory around one or more activity centres. It resides in one or more activity centres successively in time. It can use one or more activity centres to exploit the resources according to the different activities and periods.

The **number of strategic groups per observatory** can be selected as a specific indicator.

#### *Delimitation of potential exploitation territories*

*Module V :*

When the agricultural activity structures the observatory territory from a spatial perspective the attributes of the strategic groups which are linked to the activity centres can also be used to delimit the potential agricultural exploitation

territories : for example the **level of mechanisation** or other criteria playing a role in the extension of the potential exploitation territory. They therefore supplement the criteria already selected at level 1 of the investigation (cf. p. 25).

*Module V :*

When the pastoral activity structures the observatory territory from a spatial perspective, the criteria at this level which can supplement those already selected at level 1 (cf. p. 25) are : **the specific composition of the UE herds** (and the numbers), and the **distance from the place of residence.**

*Calculation of need in terms of exploitation products when the agricultural activity is structuring*

The **need in terms of exploitation products** expresses the production hoped for from the exploitation of natural resources from the observatory territory by the UEs attached to an activity centre. It can be expanded according to the different uses of the products : self-consumption, commercial (sale, exchange, gifts), storage (reinvestment, prevision of losses). This value is currently used in the LEIS to provide input data to the model of spatial distribution of exploitation practices when the agricultural activity is structuring. It can be obtained from the data collected in module V in two ways :

- either calculated directly from the production objectives by crop type (cf. module V, question 25d : p. 65) ;
- or as follows :
  - calculation of the quantity consumed (in monetary equivalent or in kg of dry matter : DM) per inhabitant and per year, in total or per cultivated species : figure known from elsewhere or calculated from the relationship between the past year's production (cf. question 23a, p. 65) and the share of feed intake needs satisfied during the past year (cf. question 25b, p. 65), with the total applied to the number of people per UE ;
  - the calculation of the quantity/inhabitant/year per type of harvest use is made from this value and from the proportions self-consumed, sold, exchanged/given away, stored and reinvested (sowing), and losses (cf. question 24a, p. 65).

*Spatial distribution of pastoral resource extractions when the agricultural activity is structuring*

To recap, when the agricultural activity is structuring, the resource extractions are spatially distributed around water points as a function of the livestock stocking

rate, the resource extraction radius, and the preference indexes (optional). They are then applied to the Spatial Reference Units (SRU : cf. ROSELT/OSS, SD3, 2005).

With the data collected at level 2 (livestock stocking rate, resource extraction radius), it is already possible to conduct this spatial distribution. The following calculations are made :

- **quantity of resource extractions per inhabitant and per season** for each UE class (strategic group),
- **resource extractions radius per season and per activity centre type** (or per strategic group).

To provide more detail to the models, it is however recommended that monitoring of the herds be conducted (level 3 inquiries) which would allow the resource extraction radius to be better quantified and above all to determine the preference indexes according to the different pastoral qualities or landscape units.

When the pastoral activity is structuring, the resource extractions are calculated directly in the Combined Practices Units (CPU) which were delimited.

## *Inquiry form : « Exploitation Unit » questionnaire*

This questionnaire should be analysed so that it may be adapted and the questions posed tailored precisely to local specifics.

ROSELT LOGO INSTITUT NATIONAL LOGO

OBSERVATORY NETWORK FOR LONG-TERM ECOLOGICAL MONITORING

# « EXPLOITATION UNIT » QUESTIONNAIRE

## MODULE I – GEO-ADMINISTRATIVES INQUIRY REFERENCES

1a) Inquiry date :
1b) Surveyor name :
2a) UE identification number :
2b) UE GPS ref. : X (longitude) = Y (latitude) = Altitude (m) =
3a) Observatory :
3b) Country :
4a) Region (or gouvernorat or *wilaya*, etc.) :
4b) « *Département* » (or *province* or *délégation* or *gouvernorat* or *daïrate*) :
4c) District (or *secteur* or *immadat*) :
4d) Rural community (or commune or *douar*, etc.) :
5a) Decision centre name :
5b) Circle where appropriate : *village* *neighbourhood* *hamlet* *isolated farm* *encampment*
5c) For encampment (or isolated farm), circle where appropriate : *permanent* or *temporary* :
5d) If temporary, indicate the months present and the periodicity (annual or multi-annual) :

## MODULE II – IDENTIFICATION OF THE UE LEADER

6a) First name and surname of the UE leader :
6b) Age :
6c) Sex :
7a) Ethnic group / tribe :
7b) Clan / fraction :
8) Religion : circle where appropriate : *muslim* *christian* *traditional* *none* *other*
*Specify which brotherhood, if the religion is muslim :*
9a) Level of education :
9b) If none, is he literate ? Circle where appropriate : *Yes* *No*

## MODULE III — MOBILITY AND SOCIAL FUNCTION OF THE UE LEADER

10a) Is the UE leader an immigrant ? Circle where appropriate : *Yes* *No*

10b) Geographical origin (country or region of origin) :

10c) Type of immigration ? Circle where appropriate : *seasonal* *annual* *several times per year*

11a) Has the UE leader migrated during the last four years ? Circle where appropriate : *Yes* *No*

11b) If yes, describe the migration (cf. table) :

| Year(s) | Season | Duration of the migration (number of months or years) | Place (country and region) | Activity(ies) practised (trade, artisan, agricultural worker, other) | Objectives aimed for : adaptation to ecological constraints, familial reasons, economic strategy of the UE specify | Share of the revenue of the exploitation unit (%) |
|---|---|---|---|---|---|---|
| | | | | | | |

12) Authoritative function of the UE leader :
Circle where appropriate : *village leader* *land leader* *water leader* *hunting leader* *pasture leader* *fishing leader* *elected representative* *technical service*
Specify if : *other*

13a) Is the UE leader a member of a group (association or economic interest group) ? Circle where appropriate : *Yes* *No*

13b) Specify the name and function of the group :

## MODULE IV — UE COMPOSITION, ACTIVITIES, LABOUR FORCE AND EQUIPMENT

14a) Composition of the UE and details of the activities of the working members of the UE (number the activities conducted in order of importance and evaluate the share of the exploitation revenue provided by the **complementary activities**)

| N° | Name and surname | Sex | Age | Relation-ship to the UE leader | Status (head of house-hold, wife of, son of, etc.) | Educated (Y / N) | Activity within the UE for the working members | | | | | | | | | | | | | | | | Share of his activity conducted in another UE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Agriculture | | Breeding | | Crafts | | Commerce | | Fishing | | Hunting | | Forestry | | Social aid | | Others | | |
| | | | | | | | I | R | I | R | I | R | I | R | I | R | I | R | I | R | I | R | I | R | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |

I = order of importance ; R = Share of exploitation revenue in % (where possible, this revenue is quantified).

15a) What is the UE's main activity ?

15b) Does a mutual help network exist for this activity (collective duties, cooperative mutual help work, loans of cooperation toward the same exploitation logic, etc.) ? :

15c) What share of the exploitation revenue is provided by this main activity (in %) ? :

11a) What is the secondary activity of UE ?

16b) Does a mutual help network exist for this activity (collective duties, cooperative mutual help work, loans of cooperation toward the same exploitation logic, etc.) ? :

16c) What share of the exploitation revenue is provided by this secondary activity (in %) ? :

17) Which people, other than the UE leader, have migrated during the last four years ? :

| N° (the same as the table above) | Year(s) | Season | Duration of the migration (number of months or years) | Place (country and region) | Activity(ies) practised (trade, artisan, agricultural worker, other) | Objectives aimed for | Share of the lexploitation unit's revenue (%) |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

18) Does the UE temporarily recruit external labour ? :

| Time of year | For which activity | Number of people involved | Share of the exploitation products used for payment (in bags of harvest product, heads of livestock, or other) |
|---|---|---|---|
| | | | |

19) Does the UE possess the following equipment ? :
Circle where appropriate : *Radio* *Television* *Telephone* *Drinking water*
Specify any others :

## MODULE V – AGRICULTURAL ACTIVITY

20) What led you to practise this activity ? (father's legacy, personal choice, economic constraints, profitability, etc.) :

21) What agricultural equipment do you have available to you ? :

| agricultural equipment | Number | General condition | Acquired in which year | Nature of acquisition | Amount (purchase and credit) | Repayment duration | Amount repaid |
|---|---|---|---|---|---|---|---|
| tractor | | | | | | | |
| plough | | | | | | | |
| cart | | | | | | | |
| work oxen | | | | | | | |

22) What major agricultural developments have you conducted during the last ten years ? :

23a) Cultivated fields (rain-fed or irrigated) or fallowed by the UE (table above) :

| Fields number (area cultivated all in one block / able to group several plots) | Village land where the field can be found | Date put to use | Size of the field | Distance from the place of residence : o mn (house fields) t < 30 mn, 30 mn< t < 1 hour, t> 1 hour | Farmer of the field : UE leader spouse of the UE leader, younger brother of the UE leader, etc. | Mode of access : inheritance, purchase security, exchange, loan, gift, agreement land clearing (free), etc. | Obtained from who ? (father, mother, brother, uncle, village leader rural community, etc. | Is this field cultivated or in fallow ? | Species cultivated (specify if combined) millet, sorghum (large millet), beans, fonio, rice, peanuts, orchards, market-gardening, etc. | | Do you conduct inter-annual rotation/ succession, which and since when ? |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Species | Yield | |
| Champ 1 | | | | | | | | | | | |
| ... | | | | | | | | | | | |
| Champ n | | | | | | | | | | | |

23b) Describe the conditions of the main mode of access to the land :

23c) Describe the conditions of the second type of mode of access to the land :

24a) How many fields are on loan by the UE leader ? :

24b) Duration of the loans of UE :

| Positioning of the field in the landscape : main geomorphological type, soil quality, distance | Duration of the loans (< 2years, / 2-4 years, 5-7 years / > 7 years ? | Reason for loan | To whom is the field on loan (relationship to the UE leader) |
|---|---|---|---|
| | | | |

25a) What are the harvested crops used for ? :

| Type of products | Proportion self-consumed (%) | Proportion sold, exchanged, given away (%) | Proportion stored and reinvested (%) | Proportion of losses (%) |
|---|---|---|---|---|
| | | | | |

25b) What feed intake needs have you satisfied during the past year with the product of your harvests ? (answers in %) :

25c) How has your production evolved during the last four years ? :

25d) What objectives, in terms of production, do you hope to achieve as a result of the next agricultural season ? :

| Type of products | Surface area (ha) | Production expected |
|---|---|---|
| | | |

26a) Have you suffered from economic or familial constraints which have caused problems in this agricultural season ? : *Yes* *No*

26b) If yes, what are they? (lack of man power, death, illness, etc.)? :

26c) What was your adaptation strategy during this last ecological event ? (migration, change of activity, etc. : specify) :

27a) Have you encountered major constraints linked to exceptional ecological conditions ? : *Yes* *No*

27b) If yes, what are they ? (swarm of locust, drought, etc.) ? :

27c) What was your adaptation strategy during these last ecological events? (migration, change of activity, etc., specify) :

28a) What, in your opinion, are the agricultural practices which expose the soil to degradation ? :

28b) Do you think that growing certain species particularly exhausts the soil ? Circle : *Yes* *No*

28c) If yes, which ones ?

28d) Do you know of techniques that allow the soil to be conserved ? Circle : *Yes* *No*

28e) If yes, which have you put into practice and since when ? :

## MODULE VI – PASTORAL ACTIVITY

29) What led you to practise this activity? (father's legacy, personal choice, economical constraints, profitability, etc.) :

30a) Do you have particular breeding equipment available to you ? Circle : *Yes* *No*

30b) If yes, which? (enclosure, etc.)

30c) Have you borrowed money to obtain it ?

30d) What amount remains to be repaid ?

31a) What types of animal does the UE possess, their number and mobility ? :

| | | Composition of the livestock | | | | | | | | | | Share of the livestock on small transhumance (in the neighbouring exploitation territories within the observatory | | | | Share of the livestock on large transhumance (outside the observatory) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Number of « house » or « farm » animals never led to pasture | | | | | Number of animals led to pasture at some point during the year (sedentary, small transhumance, large transhumance) | | | | | | | | | | | | |
| | | Total nb. | Nb. bought this year | Nb. born this year | Nb. acquired in another way (gift, etc.) | Nb. of losses this year | Total nb. | Nb. bought this year | Nb. born this year | Nb. acquired in another way (gift, etc.) | Nb. of losses this year | Season | Share of the total livestock (%) | Destination (place, name and estimate of distance) | Entrusting (Yes / No) | Season | Share of the total livestock (%) | Destination (place, name and estimate of distance) | Entrusting (Yes / No) |
| Sheep | Young | | | | | | | | | | | | | | | | | | |
| | Adults | | | | | | | | | | | | | | | | | | |
| Cattle | Young | | | | | | | | | | | | | | | | | | |
| | Adults | | | | | | | | | | | | | | | | | | |
| Goats | Young | | | | | | | | | | | | | | | | | | |
| | Adults | | | | | | | | | | | | | | | | | | |
| Camels | Young | | | | | | | | | | | | | | | | | | |
| | Adults | | | | | | | | | | | | | | | | | | |
| Equines | | | | | | | | | | | | | | | | | | | |
| Donkeys | | | | | | | | | | | | | | | | | | | |

31b) Composition of the herds present (not on transhumance) led to pasture, for each season (if the pasture circuit varies according to the seasons) :

**Season a** :

| Herd identification number | Composition (number) of the herd per species/race and age category (young / adults) | Led to pasture with animals from other UEs (Yes / No) | Type of pasture exploitation (watched over : W, divagation : D) | Main criteria for the choise of pasture circuit (pastoral availability, accessibility to range land, accessibility to water points) | Maximum distance from the water points used | Types of water points used (pond, well, bore hole, stream/wadi) |
|---|---|---|---|---|---|---|
| Herd 1 | | | | | | |
| Herd 2 to n | | | | | | |

**Seasons b to n** :

| Herd identification number | Composition (number) of the herd per species/race and age category (young / adults) | Led to pasture with animals from other UEs (Yes / No) | Type of pasture exploitation (watched over : W, divagation : D) | Main criteria for the choise of pasture circuit (pastoral availability, accessibility to range land, accessibility to water points) | Maximum distance from the water points used | Types of water points used (pond, well, bore hole, stream/wadi) |
|---|---|---|---|---|---|---|
| Herd 1 | | | | | | |
| Herd 2 to n | | | | | | |

32) What losses did the UE make over the last three years and why (epidemics, cattle theft, other) ? :

| Year | Reasons | Evaluation of animal losses | | | | | |
|---|---|---|---|---|---|---|---|
| | | Sheep | Cattle | Goats | Camels | Equines | Donkeys |
| | | | | | | | |
| n - 1 | | | | | | | |
| n - 2 | | | | | | | |
| n - 3 | | | | | | | |

33a) What is the annual animal production ? :

| Type | Young on the hoof | | | | | | Adults on the hoof | | | | | Milk | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Production this year | Self-consommed (%) | Sold, exchanged, given away (%) | Stored, reinvested, (%) | Lost (%) | Production hoped for | Production this year | Self-consommed (%) | Sold, exchanged, given away (%) | Stored, reinvested, (%) | Lost (%) | Production this year | Self-consommed (%) | Sold, exchanged, given away (%) | Stored, reinvested, (%) | Lost (%) |
| Sheep | | | | | | | | | | | | | | | | |
| Cattle | | | | | | | | | | | | | | | | |
| Goats | | | | | | | | | | | | | | | | |
| Camels | | | | | | | | | | | | | | | | |

33b) What share of the feed intake needs have you satisfied during the past year with products of breeding (%) ? :

33c) How has your production evolved during the last three years ? :

34a) Do you benefit from the support of a veterinary service ?

34b) If yes, which ? :

34c) What was the cost of the last vaccination campaign ? :

35) Do you use feed supplements for the breeding animals? (cattle, sheep, goats, Camelidae) ? Circle : *Yes* *No*

36a) Does the UE practise a manure agreement ? Circle *Yes* *No*

36b) If yes,

Where the agreements are systematically used, circle where appropriate : *Once a year* *several times a year (specify)*

Where the agreements are only sometimes used, specify the date of the last one :

37a) What was the last year that you practised the manure agreement ? :

37b) What was the last year that you practised the manure agreement ? :

| Season | With which farmers ? | | What was given in return ? | Estimation of the distance from the decision centre (15 mn, 1h, 1/2, 1day, +) |
|---|---|---|---|---|
| | Surname and first name | Decision centre (village, encampment, etc.) | | |
| | | | | |

38a) Have you suffered from economic or familial constraints which have caused problems in this breeding season ? : Circle *Yes* *No*

38b) If yes, which? (lack of man power, death, illness, etc.) ? :

38c) What was your adaptation strategy during this last event? (transhumance, change of activity, etc.: specify) ? :

39a) Have you encountered major constraints linked to exceptional ecological conditions ? : Circle *Yes* *No*

39b) If yes, what are they? (drought, cold rain, etc.) ? :

39c) What was your adaptation strategy during these last ecological events? (transhumance, change of activity, etc.: specify) :

## MODULE VII – FORESTRY AND GATHERING ACTIVITY

40) Products of gathering, picking and cutting for **domestic purposes** :

| Products extracted (including timber and dead wood) | Period of the extraction (month in the year) | Type of use | Quantity extracted for year (what measurement ?) | | Transformation or usages practised : fermented drink, fruit juice, cooking of meals, medicine oils, construction, lighting, other (specify) | Is authorisation necessary for the ? extraction *Yes / No* if *Yes*, supplied by which authority | Where is the extraction conducted ? | | Extraction technique : (gathering, cutting, picking) | Who is responsible for the extraction? Women, men children, indiscriminate, |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Quantity | Unit of measure | | | On what village land ? | Distance from DC (15 mn, 1h, 1/2 day 1 day, + ?) | | |
| | | | | | | | | | | |

41) Products of gathering, picking and cutting for **commercial use** :

| Products extracted (including timber and dead wood) | Period of the extraction (month in the year) | Type of use | Quantity extracted for year (what measurement ?) | | Transformation or usages practised : fermented drink, fruit juice, cooking of meals, medicine oils, construction, lighting, other (specify) | Is authorisation necessary for the ? extraction *Yes / No* if *Yes*, supplied by which authority | Where is the extraction conducted ? | | Extraction technique : (gathering, cutting, picking) | Who is responsible for the extraction? Women, men children, indiscriminate, |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Quantity | Unit of measure | | | On what village land ? | Distance walking (15 mn, 1h, 1/2 day 1 day, + ?) | | |
| | | | | | | | | | | |

42) What forestry practices expose the plants to degradation ? :

## MODULE VIII – REPRESENTATION OF THE ENVIRONMENT

43a) Do plant species exist which you would like to protect ? : Circle *Yes* *No*

43b) Put them in order of importance and specify the nature of their special interest :

| | Plants | What is their special interest ? |
|---|---|---|
| 1à n | | |

44) Does your family use plants to treat illness ? : *Yes* *No*

45a) Do you know of species that are dangerous for man or animal ? : *Yes* *No*

45b) If yes, specify which ? :

| | Plants | Poisonous for man | Poisonous for animals |
|---|---|---|---|
| 1 | | | |

46a) Are there animals (domestic or wild) which cause a problem for your exploitation unit ? : Circle *Yes* *No*

46b) If yes, specify which ? :

| | Which | What problem do they cause you ? |
|---|---|---|
| 1 | | |

47a) On the contrary, are there animals (domestic or wild) which you would like to protect ? : Circle *Yes* *No*

47b) If yes, which ? :

| | Which | For what reason ? |
|---|---|---|
| 1 | | |

48a) In the context of your activities, have you noticed an increased scarcity of certain resources ? : *Yes* *No*

48b) If yes, specify which ? :

| | Which (water, pasture, soil, etc.) ? | Since when ? |
|---|---|---|
| 1 | | |

49a) Have you already participated in a protection initiative, or surveillance or rehabilitation of certain resources ? : *Yes* *No*

49b) If yes, which ? :

| Date | Action conducted | Individual initiative (what motivated you ?) | Collective initiative (explain the context) |
|---|---|---|---|
| | | | |

50a) What questions about the environment are raised in the village (decision centre to which you are attached) ? :

50b) What types of answers are proposed? (projects, migration, village solidarity, etc.) :

# Third scale of investigation : assessment and monitoring of natural resource exploitation practices

Firstly, the ROSELT programme essentially proposes harmonised methods for the assessment of exploitation practices and resource exploitation practices of natural plant resources. Progressively, harmonised methods for the other types of natural resources (« soil » and « water ») will be proposed.

## *Objectives and general principles of the data collection system*

The investigations in this paragraph concern the **field** or **herd** scale (exploitation practice management units) from which the farmers will apply natural resource **exploitation practices** on the observatory territory. The general objectives of all the data collected at this level are as follows :

1) in-depth assessment of the natural resource exploitation practices in view of preparing their spatial distribution, and monitoring method ;

2) assessment of the associations of practices on the same space (combined practices) and the level of investment by man which ensues (typology of combined practices / degree of « artificialisation * ») ;

3) evaluation of the quantities of agricultural exploitation products according to exploitation practice and soil quality ;

4) identification of the rules of spatial distribution of exploitation practices ;

5) evaluation and monitoring method of natural vegetation resource extractions, and of the areas where the resource extractions are conducted according to the different activities.

The investigations at this level are organised into several sets of inquiries :

- The « main » inquiries on the agricultural activity and the pastoral activity. All the ROSELT observatories have an agro-pastoral vocation.

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* The word « artificialisation » is taken from the American English verb « artificialize » : to render artificial. In the context of ROSELT, the meaning can be found in the Glossary under « Degree of Artificialisation ».

- The inquiries of other natural resource exploitation activities which, in the arid and semi-arid zones covered by the ROSELT programme, never structure the landscape from a spatial point of view, but do have a significant impact in terms of natural resource extraction. In this document these « secondary » inquiries currently only concern the extraction of wood fuel resources.
  With this guide as a test in the ROSELT observatories over the next two years, other secondary activities can then be identified according to their importance in terms of quantities of natural resources extracted and of the number of network observatories concerned. It will therefore be necessary to propose a consensus of evaluation methods of these resource extraction activities.
  In any case, these secondary inquiries are only applied when the activity has been identified at the second level of investigation.

Practice, according to Teissier in 1979 (cf. Lhoste P., 1987) « *is the way in which the operator implements a technical operation... the technique is considered to be the set of operations which have a production purpose* ». The term **exploitation practice** refers to a concrete natural resource exploitation action (vegetation, soil, water) by an exploitation unit, according to :

- an exploitation strategy (commercial or self-subsistence),
- a production vector (species cultivated for the agricultural practice and species/races bred for the pastoral practice),
- the characteristics of the milieu (useful resources) where this action is applied,
- and an objective for the level of production.

This action is characterised (**table 2**) by the association of **technical means** (cultural techniques or breeding techniques: previous investments, techniques for working the field or livestock management, techniques of herd fertility or renewal management, management of risks and optimisation of production), and of **human and material means**.

If it is an agricultural practice, it is applied to a field. It will depend on the strategy of the exploitation leader, particularly in terms of risk management, in order to fulfil his production objective over all the UE fields. If it is a pastoral practice, it will be applied all along the herd grazing circuit.

The useful natural resources, and constraints, in arid and semi-arid zones are the soil and water for the agricultural activity, and grazing land and water for the pastoral activity.

***Table 2 :*** *Technical, human and material means for agricultural and pastoral practices.*

| Means | | Elements of agricultural practice | Elements of pastoral practice |
|---|---|---|---|
| **Technical means** | Previous investments to develop the useful resources (conservation, access). | • Terracing, building dykes ;<br>• Construction of irrigation channels ;<br>• Specific techniques of land clearing for an initial preparation of agricultural land ;<br>• etc. | • Improvement of range land with the slash-and-burn technique ;<br>• Installation of a fire wall ;<br>• Land clearing technique for herd access to new areas ;<br>• Enriching of fodder species (woody or herbaceous plants) ;<br>• Construction of wells, bore holes, artificial ponds ;<br>• Land division (fencing, hedges). |
| | Techniques for working the field or spatial techniques for livestock management. | • Preparation of the field (cutting of bushes after fallow or a dry season, plough) ;<br>• Techniques and frequency of sowing ;<br>• Techniques, frequency and duration of weeding ;<br>• Techniques and duration of harvests ;<br>• etc. | • Pastoral resource extraction method (grazing, pruning for animal consumption, scything, etc.) ;<br>• Type (or method) of pasture exploitation (free to roam, watched over, led to pasture, kept in an enclosure or individually attached) ;<br>• Technique of watering animals (rhythm, equipment). |
| | Techniques of soil fertility management or of renewal of the herd, of risk management and production optimisation. | • Fallow ;<br>• Agricultural inputs (Fertiliser, manure, use *in situ* of the residue of crops, etc.) ;<br>• Crops associated, in time and in space ;<br>• Insecticides ;<br>• etc. | • Allotment (or aggregation technique : setting up a group of animals led together) : mixed herds, mono-specific herds, etc. ;<br>• Feed supplement ;<br>• Treatment of animals : vaccination. |
| **Human means** | | Type of labour (familial, salaried), annual or seasonal work time. | Type of labour (familial, salaried), annual or seasonal work time. |
| **Material means** | | Tractor, plough, etc. | Water tanks, cesspools, etc. |

The term « **combined practices** » refers to the simultaneous or successive overlay, on a single space (landscape unit scale), at the scale of the season or year, of several natural resource exploitation practices, which mark the landscape in terms of the land use allocation that results. If the agricultural activity is structuring from a spatial perspective, each class of combined practices is constituted of an agricultural practice, associated or not with one or more other agricultural practices, plus possibly other non-agricultural practices. The reverse is true if the pastoral activity is structuring from a spatial point of view.

The **degree of artificialisation** refers to the level of investment by man on the milieu. It measures the effort made by man to exploit the milieu. The method used to develop this index is described p. 54.

The **field** refers to a space cultivated all in one block, by one or more farmers, possibly regrouping several agricultural plots.

The **herd** is a *set of animals homogeneously managed, in a single technical management unit* (Landais *et al.*, 1987 and Lhoste, 1987). This idea should be separated from that of « livestock », *the set of animals belonging to a single individual or a single group* (Lhoste, 1986). More precisely, the herd refers to a group of wild or domestic animals, whether mono-specific or not, which together exploit the natural resources using the same exploitation logic. At this moment in time, in the context of ROSELT, only methods of evaluation and monitoring of domestic herds are proposed.

## *(Main) « Agricultural practices » inquiries*

### *Objectives*

The « Agricultural practices » inquiries are only conducted if the agricultural activity structures the space in the observatory territory (cf. Introduction).

In which case, the main objectives of the « Agricultural practices » inquiries are the following :

1) The in-depth assessment of agricultural resource exploitation practices : development of the typology of agricultural practices which characterise it, with a description, for each practice, of the cultural techniques, and the human and material means used. From this point forward, specific indexes of agricultural productivity and agricultural pressure on the milieu can be calculated.

2) The information collected allows the agricultural production values evaluated in level 2 to be specified using measurements adapted to harvesting time. Furthermore, since the field is geographically located, it becomes possible to established a link between the agricultural exploitation practices, the quality of the soil and production.

3) With the data collected on the fields themselves, the places where the agricultural practices are applied are positioned in relation to the activity centres and the landscape units. These inquiries should make known the possible combinations of agricultural practices on the same spaces (at the landscape scale and not the field scale), and their possible spatial association with other non-agricultural practices, which do however mark the landscape from the point of view of land use allocation (pastoral activity, mining activity, etc.) : development of the typology of combined practices ; definition of the rules of spatial distribution of practices (in relation to the soil quality and to activity centres).
The LEIS allows, through its spatial distribution models of exploitation practices, the delimitation of the spaces on which the combined prac-

tices are applied, and the knowledge of their spatial extension. The other activities that to not specifically mark the landscape from a land use allocation point of view, but which have a significant impact on the resources, are taken into account in the spatial distribution models of resource extraction, applied to the SRU (ROSELT/OSS, SD3, 2005). All this is driven by the premise that in the arid and semi-arid zones, several uses of the same resource are often made simultaneously or successively in time, at the same place.

4) For each class of combined practices, a degree of artificialisation is calculated.

5) Finally, specific information is collected to evaluate the vegetation resource extractions conducted using the exploitation practices, with a view to their spatial distribution and monitoring.

Two « agricultural practices » inquiry forms are proposed in this guide, using a specific method of sampling (cf. below).

### *Preliminary work on field inquiries and sampling method*

#### *A dual sampling adapted to the spatial distribution of natural resource exploitation practices*

In order to achieve the objectives below, in particular with regards to the construction of Combined Practices Units, *via* LEIS spatial distribution models, it is strongly recommended that the two types of sampling be combined to select the fields on which the investigations will be conducted.

The **first type of sampling** should allow the selection of all the fields of a few selected exploitation units amongst which are those already surveyed in level 2. The data collected from the exploitation leader on this type of field allows expansion of the aspects concerning the exploitation practices themselves (typology of practices, production, degree of artificialisation) : type « a » fields.

The **second type of sampling** should allow all the fields situated along a kilometre gradient to be selected (anthropic pressure gradient) around the activity centres identified at level 1 : type « b » fields. The data collected from the local authorities and/or village traditional council allow the practices applied to these fields to be succinctly described (simplified questionnaire), and allow the link to be made with the typology of exploitation practices, and above all allows the spatial organisation of the practices to be understood : succession, from the centre of the activity to the periphery; and association/spatial combination.

In both cases, the fields must be located with the help of a GPS. The later cross-checking of activity centre and soil quality maps, with the help of GIS tools, helps to :

- determine the exploitation practice spatial distribution rules,
- calibrate the entry data and the parameters of the LEIS spatial distribution model of exploitation practices (ROSELT/OSS, SD3, 2005).

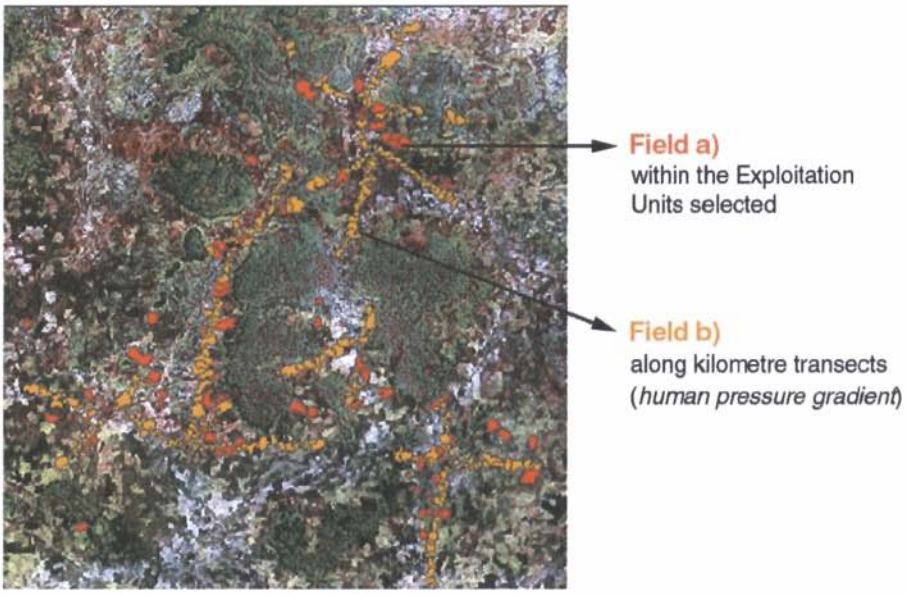


***Figure 2 :*** *Fields selected on the Banizoumbou (Niger) observatory using the dual sampling adapted to the spatial distribution of exploitation practices (Loireau, 1998).*

*A complementary sampling adapted to the validation of the Combined Practice Unit map*

In the context of the LEIS, the map of Combined Practices Units (CPU) developed *via* the models must be validated. The additional fields must be identified for a second set of simplified post-modelling inquiries (of « b » type fields).

This latter type of sampling should allow a spatial representativeness of CPUS to be obtained.

*Calculation of the adapted sample*

The final size of the fields sample should reach a maximum value of 100 to allow a statistically reliable validation of the map of Combined Practices Units. If the human and material means on the observatory allow it during a ROSELT observation period (for example a research project attached to the observatory), this sample may be greater than 100. In any case, attention must be made to ensure that the fields chosen are distributed over the observatory territory to cover all the landscape diversity. The greater number of fields are of type « b », given the spatial representation needs and the simplified inquiry on this type of field. The calculation of the sample and the identification of the fields are done as follows :

1) Once the exploitation units that do not have an agricultural activity have been separated, the « agricultural practices » inquiry on the type « a » fields is conducted on all the fields of the selected exploitation units. Each exploitation unit surveyed at level 2 belongs to a type of exploitation unit (cf. typology developed at level 2). In each class, the UES therefore generally have the same characteristics, including the average number of fields.
The sampling rate is therefore variable according to the number of fields per exploitation unit ; the total sample size of the fields should reach a quarter of the whole sample size (25).

*Example calculation of the size of the sub-sample of UES :*

$$\leq \frac{(1/4 \text{ of the number of the total sample}) \times (\text{number of UES from the class})}{(\text{total number of fields in the class})}$$

The UES are then selected in each UE class according to the availability and the involvement of the exploitation leader.

2) The agricultural inquiries on the type « b » fields are conducted on a number of fields that aims to approach half of the total sample (50). The selection criteria are then essentially linked to the number of transects and to their position in space.
Each transect starts from an activity centre selected at level 1 and moves away from it along an anthropic pressure gradient. All plots crossing the length of a transect are selected. It is preferable that there be no interruption along the length of a transect. The number of transects per activity centre depends on the landscape diversity around the activity centre. It is recommended that the number of transects and their direction be chosen following an analysis of the images avalasse : aerial photos or coloured composition of a satellite image. It is preferable that the image

used corresponds to the harvest season of the fields, the period when the land use allocation is best seen.
If possible, it is worth favouring the passing of the transect through the fields selected using the first sampling method (field of type « a »), in order to help the linking between the two sampling methods and in order to increase the sampling along the transects.

3) Finally, to validate the resulting CPU map, the total sample size is supplemented to the minimum value of 100, by attempting to have an equivalent number of fields (all sampling included) per CPU type.
Given that the number of CPU types obtained by the LEIS modelling is generally in the order of tens, at the scale of the ROSELT observatories, and that the size of the whole sample of fields is in the order of a hundred, the target should be around ten fields per CPU type, according to the number of CPU types.
If a selection of activity centres was made at level 1, the fields sampled can be relatively more concentrated on certain parts of the observatory. It is therefore even more possible that certain types of CPU be little represented from a spatial perspective. In any case, having less than ten fields per CPU type should be avoided for validation.

***Data to collect***

The data on the fields are collected by way of an inquiry questionnaire which varies according to the sampling method.

Beyond the specifics of modules I (geo-administrative inquiry references) and II (positioning of the field), the data collected on type « b » fields, and complementary fields for CPU validation, are less detailed in modules II (land use allocation), IV (history of land use allocation and production) and V (associated practices). Module VI on cultural techniques only concerns type « a » fields.

**1) Module I : Geo-administrative inquiry references**

The collection of geo-administrative information to :

- position the field within the observatory territory ;
- make the link with the sampling key : the UE when the field is of type « a », the transect when it is of type « b » ;
- identify the current farmer of the field, as well as his attachment to an identified activity centre. This in particular allows the validation of the potential exploitation territories map from the LEIS models.

2) **Module II : Geographic characteristics of the field**

This is for the collection of information necessary to locate the field *a posteriori* (GPS coordinates, size and shape, physical characteristic of the milieu) as precisely as possible, on maps and satellite images (GIS) (cf. p. 82) : soil quality and activity centres (definition of the exploitation practice distribution rules), Combined Practices Units (validation of the LEIS models). The information must be sufficiently precise to draw the contour of the field, *a posteriori*, on an image and to calculate the surface area for each field.

3) **Module III : Land use allocation and associated species cultivated**

The data collected in this module concern land use allocation (from a spatial and temporal perspective) in the field on a given year. Three main types of land use allocation are distinguished : cultivated fields, fallow, and abandoned land. For cultivated fields, according to the species cultivated, a distinction is made between monoculture, mixed farming and arboriculture. For fallow and abandoned land, their age is specified. The criteria for selection, and major past changes are only noted for type « a » fields.

4) **Module IV : Land use allocation and agricultural production history**

Here we determine the date of first use of the field and the inter-annual crop cycle within living memory (two generations), the succession of periods during which the same crop cycles are applied, and previous exceptional events. Each period corresponds to a type of exploitation practice. The criteria for changes in plot allocation are only required on type « a » fields.

For the last period (five years), precise information on land use allocation and agricultural production are only required for type « a » fields. For the current year at the time of the inquiry, it is not only about the measurement of agricultural production, but also the identification of crop residues as well as their use, to evaluate the standing epigeal phytomasses for pastoral use. The questions posed also provide knowledge of the evolution of the field in terms of production capacity.
For the type « b » fields, the module VI on cultural techniques does not exist. Only the question on the use of fertilisers during the last five years is asked in the module IV. The values of agricultural production are linked to the exploitation practices and the soil quality. The values of standing epigeal phytomass help to estimate the fodder available for the pastoral activity. The questions asked also help to provide knowledge of the field dynamics in terms of production capacity.

5) **Module V : Associated practices linked to other activities**

The information collected in this module help in the identification of non-agricultural exploitation practices (pastoral, forestry), which are associated with this field. This is useful for the construction of a typology of combined practices and thus takes account of the possible multi-usage of the natural vegetation.

6) **Module VI : Technical itinerary and associated practices in the last agricultural season**

This module only concerns the type « a » fields (UE). The questions asked help to :

- identify the technical itinerary steps ;
- describe the associated practices (for example, contribution from agricultural inputs) and the techniques used (for example, agricultural input type according to a particular technique) ;
- identify the reasons behind the choices of the UE leader ;
- qualify and quantify the investments realised (at each step, labour, work time, quantity of seed, of fertilisers, etc.).

This information allows us to precisely describe the agricultural exploitation practices and helps towards constructing the degree of artificialisation, as well as the soil degradation risk index, which are associated with this information.

***Data collection and monitoring method***

*Diagnosis*

The data are collected at the field scale. The surveyor must go to each of the fields selected, according to the different sampling methods, equipped with the questionnaires and a GPS.

The questions are posed to the UE leader (UE fields, type « a ») or to competent local authorities (fields on transects, type « b »), and the discussion takes place on the field itself. It may sometimes be necessary to supplement the information collected on the field, in the corresponding activity centres, in order to meet other resource people.

The inquiry of type « a » UE fields, takes place during the harvest (in particular in order to have complete information on module IV : land use allocation and agricultural production history). The weighing of the five elements of production (sheaf, bag, etc.) are conducted on the field itself (use of appropriate scales) or on return to the place of residence of the exploitation leader, distinguishing real agricultural production from the crop residues used as a feed supplement for animals

or other purposes (to be specified). The estimation of the standing epigeal phytomass may require collaboration with the phyto-ecologists responsible for the measurement of vegetation on the observatory. The measurements may be conducted by them during the harvests or by one (or more) people responsible for agricultural inquiries, but who are trained for this type of measurement by the specialists in charge of vegetation measurements or by agronomists. The main results are entered into the inquiry form.

For the other (type « b ») questionnaires on the fields along the transects or on the fields used to valid the CPU map resulting from the LEIS, they may, on the contrary, be conducted when the farmers are not too occupied with working the fields, i.e. more during dry seasons (from October to May for the Sahelian observatories with a bimodal climate, and between two rainy seasons for the North Saharan observatories). It is recommended that the start and end points be marked perennially (marker in concrete for example) in order to guarantee returning to the same point in the next period.

N.B. when the transect goes through an area without an agricultural field, i.e. which has never been cultivated (neither fallow, nor abandoned land), it should be noted as a field number whose only data are those concerning module I (questions 1 to 4), module II, module III (question 8), and module V.

For the realisation of this field work, it is desirable that one (or two) scientists who are used to conducting agronomic inquiries can supervise and monitor a team of technicians (or work placement students) who would themselves be able to conduct and update the inquiries in the context of long-term surveillance. It should be encouraged as much as possible, where this is feasible, that state agricultural technical services be given responsibility for this type of inquiry.

The time needed to then input the collected data must not be underestimated. The technicians or work placement students can also have this data input role, with the scientific supervisor controlling the input quality.

*Surveillance*

At each observation period, a tour of the area on the type « a » fields with the same exploitation leaders, and the original completed forms at hand, should allow verification of whether the data are unchanged, and allow the update of any data that might have changed. It is therefore important to be able to note the fields which may have left the exploitation unit, and to integrate possible new fields with a new questionnaire. It must also be verified whether the sampling from the previous period needs to be adapted as a result of any possible adaptations made at level 2 (cf. p. 52).

According to the (human and financial) means available for surveillance and the involvement of the farmer, an annual monitoring of agricultural production (module IV, questions 13 and 14 only) can be conducted on all the type « a »

fields). Since this data collection is highly simplified, it may even be envisaged that the number of observations from the exploitation units be increased.

For the type « b » fields, a visit should be systematically made once every four years. If a climatic or socio-economic event of exceptional amplitude is shown by the other observations on the observatory, it may be necessary to make a visit to the transects the same year as this exceptional event occurs, and then to verify the year afterwards whether the previous situation has returned or the practices have changed for the new period.

***Data processing and expected results***

*Preliminary work :* processing of the inquiry data; providing input to a specific database (cf. p. 25).

*Cartographic processing : maps*

From GPS field surveys, the set of fields on which the investigations were conducted are transferred to a vector layer « fields surveyed ». Next, with the help of satellite images (coloured adapted compositions) and/or aerial photos (scanned and geo-referenced) and with the help of other geographic references described on the field (module II), the contours of the fields are adjusted manually.

This « vector » layer is not strictly speaking a map, but useful geographic data for relating the intrinsic field characteristics (information collected in modules III to VI) to the geographic field characteristics (soil quality, distance from activity centres, typography).

*Classic statistical processing : typologies*

- **Typology of agricultural exploitation practices :**

  The data collected in modules III, IV and VI on each UE type « a » field lend themselves to a specific statistical data processing (in the same way as those described p. 53), with a view to developing a typology of agricultural practices, with all or some of the following criteria :

  - *Species cultivated (module III)* : species combination classes.
  - *Previous investments to develop the useful resources (module IV)* : capacity improvement of the soil resource (yes/no), land transformation for access to water (yes/no), global cost of the developments (qualitative or quantitative).
  - *Techniques for working the field (module VI)* :

- preparation of the field : clearing of woody plants (none, manual, motorised), clearing of herbaceous plants (none, manual, motorised), type of labour (familial, salaried, collective), quantity of labour [(number of days) x (number of people)] ;
- sowing : number of sowings/year, sowing method (manual, motorised), type of labour (familial, salaried, collective), quantity of labour [(number of days) x (number of people)] ;
- cutting of bushes : number of cuttings, type of labour (familial, salaried, collective), quantity of labour [(number of days) x (number of people)] ;
- weeding : number of weedings, type of labour (familial, salaried, collective), quantity of labour [(number of days) x (number of people)] ;
- ploughing : number of ploughings, type of ploughing (none, animal-drawn, motorised), quantity of labour [(number of days) x (number of people)] ;

- *Fertility management techniques, risk management and production optimisation techniques* :
  - intra-field blocking plan (one or several land use allocations), species association (none, two, more than two), rotation (none, intra-annual, inter-annual) : module III ;
  - duration of the last fallow (none, per age class) : module IV ;
  - type of fertilisers (none, organic, chemical), mode of transport (none, by foot, cart, motorised), type of acquisition (purchase, exchange, gift, other), use of insecticides (yes/no) : module VI.

*Spreadsheet processing or* DBMS *request : general indicators*

Through averaging over all the agricultural exploitation practices on the observatory (comparison between observatories) or over each class of the agricultural exploitation practice typology of one observatory (intra-observatory functioning), specific indexes can be calculated from the data collected on the UE type « a » fields : modules II, IV and VI.

A non-exhaustive list, which would benefit from being tested and possibly supplemented in ROSELT framework, is given below :

- ***Indicators of agricultural pressure on the resources :***
  - *Relative index of agricultural investment* on the milieu (degree of artificialisation per agricultural exploitation practice).

This agricultural investment index is calculated for each agricultural practice described using the classification of criteria listed below : it is the degree of artificialisation linked to agricultural practices.

To construct this index, it is recommended that a table be used, such as the following, with the main cultural techniques identified in a column, and each agricultural practice on a line. The column of criteria must be tailored according to the specifics of the observatories.

A value between 0 and 100 is given to each criteria according to the agricultural practice : the value 100 being the greatest investment that a farmer can make in the observatory, for that technique. This value can be evaluated using an assessment. However, it is recommended that it be calculated for the following criteria : using previous land management and techniques for working the field according to : 1) human means (for example, : [(number of days) x (number of people)] and 2) equipment (for example, number of motorised or animal-drawn equipment). In this way, the values are semi-quantitative and comparable from one criteria to another. For fallow, the value can be inversely proportional to the duration of the fallow. For the « input » criteria, the value 100 is given to the maximum number of inputs described in the observatory, the other values are calculated in relation to this maximum.

For crop combinations, if there is inter – or intra-annual crop rotation, or if there is crop association, the maximum value is given.

*Example of a table to calculate this index* :

| Agricultural practices | Previous land management | Field preparation | Sowind | Etc. | Fallow | Inputs | Crop combinations | Degree of artificialisation |
|---|---|---|---|---|---|---|---|---|
| A | 50 | | | | | | | 100 |
| B | 20 | | | | | | | 900 |
| .... | | | | | | | | |

The degree of artificialisation for each agricultural practice (A, B, etc.) is the sum of the values of all the criteria (columns) chosen. The value varies between 0 and (100 x the number of criteria chosen).

Within the ROSELT framework, it is envisaged that the calculation of this degree of artificialisation be standardised by fixing the criteria used and the maximum values. This step can only be done once the list of criteria for all the observatories is established. This will provide an improvement in the relative comparison of observatories between themselves and the integration of this indicator at the national level.

- *Absolute index of agricultural investment* on the milieu (degree of artificialisation at the observatory scale)

  This index is calculated using the following steps :

1. The type « b » fields are characterised *a posteriori* by the types of agricultural practices defined in the classification below (from type « a » fields) ;
2. The sum of the surface area of all the fields in the level 3 sample is calculated per agricultural practice type ;
3. The ratio between the surface area of the fields of each practice and the total surface area of all the fields (all agricultural practices together) is calculated ;
4. This ratio is multiplied by the degree of artificialisation for each agricultural practice ;
5. The sum of these intermediary indexes constitutes the absolute index of agricultural investment on the observatory.

This index is comparable from one observatory to another.

- *Index of contribution of agricultural activities to the risk of soil erosion*

The risk of soil erosion is linked to the intrinsic characteristics of the soil, and to climatic and anthropic factors. The index proposed evaluates the contribution of agricultural activities to the risk of soil erosion, distinguishing water erosion and wind erosion. Each agricultural activity is analysed according to processes linked to these 2 types of erosion, with the help of a table of appropriate criteria which integrate spatio-temporal dimensions (length, surface area, volume, frequency and duration). These criteria concern the cultural techniques in a strict sense of the term, and the land management for conservation of water and soil put in place at the field scale, taking account of their state and maintenance.

*Example of a table to calculate the index of the contribution of agricultural activities to the risk of water erosion*

| Criteria | | Agricultural practices | | |
|---|---|---|---|---|
| | | A | B | etc. |
| Land transformation | simple raising of the soil<br>dry stone barrage<br>line of stone on the ground | | | |
| Land preparation work/soil | mechanical ploughing (multi-disc plough)<br>animal-drawn ploughing<br>weeding<br>re-ridging<br>ridging | | | |
| Crop growth | density/cover<br>habit (erect or covering)<br>duration of the crop (from sowing to harvest or cleaning)<br>residues of crops left on the ground<br>mulching | | | |
| Index of water erosion risk | | | | |

To construct this index, it is recommended that a table be used for each type of erosion, with a line for the criteria identified as having a role in the processes concerned and each agricultural exploitation practice in a column.

In principle, a large number of these criteria can be quantified directly either by surface unit (ha), or by time unit (number of days / year, number of times / year).

*Example of a table to calculate the index of the contribution of agricultural activities to the risk of wind erosion.*

| Criteria | | Agricultural practices | | |
|---|---|---|---|---|
| | | A | B | etc. |
| Land transformation | mechanical windbreak<br>natural hedge | | | |
| Land preparation work/soil | mechanical ploughing (multi-disc plough)<br>animal-drawn ploughing<br>weeding<br>earthing-up<br>ridging | | | |
| Crop growth | density/cover<br>habit (erect or covering)<br>duration of the crop (from sowing to harvest or cleaning)<br>residues of crops left on the ground<br>mulching | | | |
| Index of wind erosion risk | | | | |

For each criteria, the set of values must be converted to a scale of 0 to 100, taking account of the impact of the season on the criteria (ploughing during the dry season does not have the same impact as ploughing done after the first rains). The value 100 being the highest risk of erosion for the criteria studied in the observatory. Each criteria can be weighted with a coefficient which allows the impact on the degradation processes to be structured into a hierarchy. The calculation method of the erosion index for each agricultural practice is the same for the degree of artificialisation (weighted sum).

- *Index of natural vegetation resource extraction linked to the agricultural activity* : modules III and IV

Natural vegetation resource extraction linked to the agricultural activity refers to the vegetation extracted : 1) when a new field is prepared for use, and 2) recultivation after years of fallow (crop rotation) or of abandoned land (abandoning the crop for various reasons: precipitation too weak, no labour, etc.).

This index is calculated, over the whole observatory or by UE type, by multiplying the **crop extension index** (cf. p. 59) by the **recultivation index** during the observation period, i.e. (number of field preparations) / (number of years of the observation period).

*Indicators of agricultural « profitability » of each agricultural exploitation practice*

*Module IV :*

- *Relationship between the growth rate of the agricultural population over the last five years and the degree of artificialisation* (cf. above)

When several temporal sets of inquiries have been conducted, the indexes calculated from the « field » inquiries lend themselves to specific analyses as a function of time : evolution curves. These curves can be constructed at the scale of the whole observatory (comparison between observatories) or at the level of each class of agricultural practices (intra-observatory functioning).

In both cases, these « agro-economic » data can help to interpret the results obtained in the biophysical themes worked on in the observatories (ecological systems). If they are applied to the observatory scale, « average » values can be intersected and interpreted : for example, the natural vegetation resource extraction index and the average rate of vegetation cover. If they are calculated at the scale of the agricultural exploitation practices class, they can be intersected with biophysical data calculated at the phyto-ecological station scale or applied to the Landscape Unit (cf. ROSELT/OSS, TC1, 2005). In this way, since each decision centre is located, it can be attached to a phyto-ecological measurement station or to a landscape unit.

***LEIS integrated data processing : specific indicators to feed into the LEIS***

*Typology of combined practices and associated degree of artificialisation*

When the agricultural activity is structuring on the observatory, the combined practices are characterised by two steps :

1) *Identification of spatial combinations of agricultural and non-agricultural practices*

   The set of type « b » fields are characterised, *a posteriori*, by a type of agricultural practice and attached to an activity centre. Certain fields can be characterised by a type of agricultural practice called « without agricultural practice » with an « other » activity described in module V. The analysis of their spatial organisation, in relation to a distance from the activity centres, should allow the identification of possible spatial associations between agricultural practices. It is recommended that the type « a » UE fields, which were able to be attached to an activity centre at the time of the inquiry (module I), also be taken into account in order to increase the sample on which the spatial organisation test is made.

To identify the spatial grouping together of agricultural practices, it helps to combine two types of analysis :

- A visual analysis : by GIS, the fields are coloured according to their agricultural practice. The visual analysis and their spatial organisation already allow the identification of agricultural practices which are isolated and those which may be associated with other agricultural practices.
- A statistical analysis of the spatial distribution of agricultural practices : for example the « **box plot** » method, with the types of agricultural practices on the vertical axis and the distance on the horizontal axis. The spatial distribution of each agricultural practice is visualised using a vertical box which presents the average distance, the upper and lower quartiles, and the maximum and minimum values for each agricultural practice.
  (cf. *http://www.netmba.com/statistics/plot/box/*).

Each association of exploitation practices identified constitutes a class of combined practices.

2) *Description of each group identified, of their association with pastoral activities and/or the collection of wood* (module V)

For each group of agricultural practices identified, the other possible pastoral and forestry practices are qualitatively described. It should be noted that, according to the specifics of the observatory, there may not be a spatial association with the agricultural practices identified. In this case, in the context of the LEIS, each agricultural practice constitutes a class called « combined practices », in association or not with pastoral practices and wood collection. The non-agricultural practices do not directly participate in the construction of the degree of artificialisation of the combined practices class that we will try to spatially distribute. However they do allow the functioning of these resource-spaces (Barrière, 1997) to be described, and the different types of land use allocation which follow from this combination of exploitation practices, to be justified.

According to the description of the agricultural practices themselves (land use allocation : module III) and the spatial combination of the surveyed fields (calculation of relative surface areas using GIS), a proportion of the relative surface area (%) is associated with each type of land use allocation which characterises the « combined practices ». In other words, these percentages should reflect the relative surface areas of each land use allocation type within the same space (spatial units that the LEIS

models will delimit : CPU), as much from their spatial combination on a given year as from their temporal succession over several years during the observation period.

The degree of artificialisation per class of combined practices is the combination of the degrees of artificialisation of each agricultural exploitation practice of which it is constituted.

*Effort calculation parameters*

To recap (cf. ROSELT/OSS, SD 3, 2005), the general principle of the spatial distribution model of exploitation practices in the LEIS consists of optimising the interest that one or more agent groups have in applying a class of combined practices at a given place. This interest is the relationship between the production hoped for (calculation in level 2, cf. p. 59) and the effort, E, supplied by one or more agent groups. This effort is a combination of the effort (investment) linked to the class of combined practices itself (PE) and the one linked to the place where the practice is applied : soil quality, accessibility (distance, land tenure, etc.).

- PE : the **degree of artificialisation of each class of combined practices** calibrated to the values 0 to 1, corresponds to the variable PE from the model of the spatial distribution of practices.
- CD : to recap, this parameter is the **coefficient of distance** (between one and ten). It gives an order of appearance of the combined practices classes as we move away from the activity centre. The higher the value, the further away from the activity centre the type of practice is applied : relevant in the case of a concentric circle organisation of practices around the activity centre. This parameter is calculated only if the analysis of the organisation of exploitation practices on the transect (transect fields of type « b ») causes the appearance of an organisation in concentric rings around the activity centres. The maximum value (10) is given to the class of combined practices the furthest away, and the value 1 to the class that is the closest to the activity centre. For the other combined practice classes, the value is calculated using these markers and the average values of distance at which we find them.
- TD : to recap, this parameter is the **threshold distance** (in meters). It is calculated only if there exists a distance from the activity centre beyond which it becomes very difficult to apply the combined practice classes which have a strong degree of artificialisation. This threshold distance is calculated either for all the activity centres, or by type of activity centre from the data collected essentially on the type « b » transect fields. It is measured in metres.

*Agricultural production according to soil quality and the combined practices class*

To provide input data to the LEIS spatial distribution model of exploitation practices, it is necessary to construct a two-entry table of the expected agricultural production as a function of the combined practices classes and the soil quality at the time of land cultivation. The expected production refers to the average annual production per exploitation cycle. In the context of the LEIS, when the agricultural activity is structuring from a spatial perspective, the total average production per exploitation cycle is evaluated. The values obtained at this level allow the calibration of more precise and localised data, collected in the level 3 inquiries on exploitation practices and their production according to soil quality (agricultural production). To recap, the spatial distribution model of combined agricultural practices aims to maximise the value of applying one type of combined practice rather than another, according to the relationship between the production hoped for by the strategic groups attached to the activity centres and the effort supplied to apply these combined practices to a given place. It is calculated from the data collected on the type « a » UE fields (module IV), as follows :

- For each agricultural practice, the average production (in kg of dry matter per hectare, or in the money equivalent per hectare) is calculated between the years when the fields are cultivated (annual yield) and the years when they are in fallow or abandoned (abandoned land) during the observation period (zero agricultural production).
- Next, the average production per land use allocation type is calculated. According to the combination of agricultural practices in the combined practices class, it is in effect possible that identical land use allocation types have a different level of production according to the agricultural practice. If this is not the case, this second calculation step is not necessary.
- Finally, a weighted average is calculated according to the relative surface areas of each land use allocation type.

*Example of table to construct.*

**Type of soil quality or pastoral quality**

| Classes of Combined Practices | | a | b | c |
|---|---|---|---|---|
| | 1 | Average annual production for the period considered | = 0 if no type of Combined Practice on this type of soil | |
| | 2 | | | |
| | 3 | | | |

*Soil quality map at the moment of land cultivation*

The definition of the construction method of the **soil quality map** at the moment of land cultivation has not yet reached consensus within the ROSELT network. Each type of soil quality described in this map must be discriminatory in terms of agricultural production according to the types of agricultural exploitation practices. The development of this map is the work of an agronomist, in collaboration with pedologists and GIS specialists. It can, depending on the specifics of the observatory, be the result of a combination of an agronomic interpretation of the geo-morpho-pedological characteristics of the unit, and the farmer's perception of the soil quality. Other purely physical criteria, such as the slope, can feature in determining these spatial units of soil quality at the moment of land cultivation according to the agricultural practice. Work will need to be done within ROSELT to propose an appropriate consensual method regardless of the observatory.

*Natural resource extractions linked to the agricultural activity*

The crop extension index and the recultivation index are used to calculate the agricultural resource extractions of natural vegetation. The epigeal phytomasses on fallow, abandoned land and natural vegetation are already known from vegetation measurements on the observatory. The quantity of vegetation extracted can thus be calculated.

*Validation of maps generated from LEIS spatial distribution models of exploitation practices*

- *Validation of the map of potential exploitation territories from LEIS models* :

  In module I, « fields » questionnaires for fields of type « a » or « b », and the identification of the UE leader and the decision centre to which he is attached, allow these fields to be used as polygons, usable in the validation module developed in the LEIS (cf. LEIS User Guide).

- *Validation of the Combined Practices Units map from the LEIS models* :

  The set of (type « a » and « b ») fields surveyed is used to validate the CPU map developed by the LEIS models (cf. validation module developed in the LEIS interface).

***Inquiry form : « : Agricultural practices » questionnaire***

This questionnaire should be analysed so that it may be adapted and the questions posed tailored precisely to local specifics.

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« AGRICULTURAL PRACTICES » QUESTIONNAIRE

## AGRICULTURAL PRACTICES questionnaire : UE fields (type « a »)

### MODULE I — GEO-ADMINISTRATIVE INQUIRY REFERENCES

1a) Inquiry date :
1b) Surveyor name :
2a) Identification number of the field in the UE inquiry :
2b) Name of the UE leader already identified in the UE inquiry :
2c) Name of the person who exploits the field this year (if different to the UE leader) :
2d) Name of the decision centre to which he is attached :
3a) Observatory name :
3b) Name of the territorial boundary concerned :

### MODULE II — GEOGRAPHIC ASSESSMENT OF THE FIELD

4a) Rough sketch of the field (general form with corners, position of elements visible in the landscape to locate the plot : road, path, bore hole, large trees, hedge) :
4b) GPS coordinates (x,y) of each corner of the plot :
a : b : c : d :
5a) Pedo-rural terminology of the field and description of the UE leader's perception of the soil quality :
5b) Geo-morpho-pedological description of the soil * :

### MODULE III — LAND USE ALLOCATION AND ASSOCIATED CULTIVATED SPECIES

6a) Does the field have a single type of land use allocation ? : *Yes* *No*

* The surveyor should be able to recognise the main geo-morpho-pedological types on the observatory.

6b) If yes, which ? :
- monoculture (specify the cultivated species) :
- mixed farming (specify the associated species) :
- arboriculture (specify the species cultivated) :
- fallow (specify the age) :
- abandoned land (specify the age) :

6c) If no, what are the different types of land use allocation and at what are the percentages of the surface area (blocking plan) ? :

| Land use allocation | |
|---|---|
| Types | Blocking plan (%) |
| | |
| | |
| | |

7) Where the field is entirely in fallow or abandoned, what species were cultivated during the last agricultural season ? :

8) What were the criteria for choosing the species cultivated? Can you put them into a species hierarchy ? (tradition, cost of the seeds, adapted to the soil quality, local pluviometry, etc.) :

| Species | Criteria for choosing, organised hierarchically |
|---|---|
| Species a | 1. |
| | 2. |
| | 3. |
| Species n | |

9a) Does inter-annual crop rotation of cultivated species take place ? : *Yes* *No*

9b) If yes, what is the succession of species ? :

10a) In living memory, has there been a major change in the type of species cultivated on this field ? : *Yes* *No*

10b) If yes, which ? :

## MODULE IV – LAND USE ALLOCATION AND AGRICULTURAL PRODUCTION HISTORY

11) At what date was the field put into use for the first time ? :

12a) Was the land on this field developed/transformed before ? : *Yes* *No*

12b) If yes, what was done ? :

| Types of land development / transformation | Objective (combat water erosion, combat wind erosion, soil creation, irrigation, etc.) | Who conducted this land development / transformation (UE, State, private enterprise, etc.) ? | Large equipment used | Total cost |
|---|---|---|---|---|
| Dykes | | | | |
| Terracing | | | | |
| Wells | | | | |
| Pumping station | | | | |
| Others | | | | |

13a) Precise land use allocation and agricultural production history over 5 years :

| Year | Land use allocation | | Agricultural production per cultivated species (in kg, or in sheaves, or other) |
|---|---|---|---|
| | Types | Blocking plan (%) | |
| Current year | | | |
| Year (-1) | | | |
| Year (-2) | | | |
| Year (-3) | | | |
| Year (-4) | | | |

13b) Weighing of the elements of the harvest for the current year (on the field or at the exploitation unit, weighing of 5 elements of production) :

| Production Unit (specify the type : sheaf, sack, etc.) | Equivalent of agricultural production in kg (specify the type : ear, seeds, etc.) | Equivalent of harvest residues in kg (specify the type : stalks, etc., and their use) | Use of harvest residues |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |

14) Estimation of the standing epigeal biomass after the harvest :

| Square number | Surface area of the square | Results of weighings conducted in the laboratory |
|---|---|---|
| | | |
| | | |
| | | |

15a) Precise history of the field in terms of land use allocation over the last 10 years (sequel to 13a) :

- year (-5) :
- year (-6) :
- year (-7) :
- year (-8) :
- year (-9) :

15b) What were the decision criteria for recultivation during these last 5 or 10 years : local biophysical indicators (vegetation state, soil recovery indicators), accessibility (distance from the place of residence), UE strategy (land tenure marking, rotative management of the different fields), constraints (availability of labour, rains expected, exhaustion of the UE's other fields, etc.) ? :
Can you organise them hierarchically ? :
• 1) • 2 • 3

15c) What were the decision criteria for letting the land lie fallow again during these last 5 or 10 years : local biophysical indicators (invasion of the weeds), accessibility (distance from the place of residence), UE strategy (rotative management of the different fields, increase in the number of fields), constraints (drop in yields, availability of labour) ? :
Can you organise them hierarchically ? :
• 1) • 2 • 3

15d) Have you always brought agricultural inputs to your field during the cultivation years ? :
Can you explain the reasons why ? :

16a) History in living memory (about two generations) of the field in terms of « crops, fallow and abandoned land » succession ? :

| Periods (start year - end year) | Land use allocation (crops, fallow, abandoned land) |
|---|---|
| | |
| | |

16b) Have you noticed a reduction in production capacity of the field ? : *Yes* *No*

16c) If yes, since when ? :

16d) Have you had to make a radical change in agricultural practices on this field, in living memory ? : *Yes* *No*

16e) If yes, in which period ? :

16f) For what reasons ? :

16g) In certain years (specify which), have you had to suddenly abandon your recultivation ? : *Yes* *No*

16h) If yes, specify which years ? :

16i) What were the criteria leading to this abandoning ? :
Can you organise them hierarchically ? :
• 1) • 2 • 3

## MODULE V – ASSOCIATED PRACTICES LINKED TO OTHER ACTIVITIES

17a) During the fallow or abandoned land periods, is wood collected ? : *Yes* *No*
17b) If yes, since when ? :
17c) Who by ? :
17d) How ? :
17e) For what use ? :

18a) Is your field grazed during the years of cultivation ? : *Yes* *No*
18b) If yes, since when ? :
18c) In what period of the year ? :
18d) By what types of animals ? :

| Species | Origins (observatory territory, elsewhere) |
|---|---|
| | |
| | |

19a) Is your field turned to pasture during the years of fallow ? : *Yes* *No*
19b) If yes, since when ? :
19c) By what types of animals ? :

| Species | Origins (observatory territory, elsewhere) |
|---|---|
| | |
| | |

19d) Conditions of access ? : *Free access* *Agreements*

## MODULE VI – TECHNICAL ITINARY AND ASSOCIATED PRACTICES OF THE LAST AGRICULTURAL SEASON

*(to be repeated as many times as there are agricultural plots in the field : cf. blocking plan)*

20a) At what time of the year did you prepare your field for growing crops ? :
20b) Is this the first cultivation of the field ? : *Yes* *No*
20c) What field preparation techniques did you use ? Can you explain the technique ? :
*Land clearing (cutting)* *Stump extraction* *Weeding* *Ploughing* *Slash-and-burn*
*Pruning trees* *Maintenance of dykes* *Clearing-cleaning* *Other*
20d) When ploughing takes place, what kind is it ? : *animal-drawn* *motorised*

20e) Is the ploughing done in the direction of the slope ? : *Yes* *No*

20f) When the wood is cut for the preparation of the field, what technique do you use ? :
*equipment used :* *cutting height :* *all or part of the trees and bushes :* *Other :*

20g) What do you use the cut wood for ? :
*collecting for energy* *burning on the spot* *leaving branches on the ground* *Other (specify) :*

20h) If you irrigate your field, what is the salinity of the water used ? :

20i) What irrigation method do you use ? : *submersion* *sprinkler irrigation* *drip irrigation*

20j) What type of labour (familial, salaried, collective, others) have you used ? Specify them according to the techniques used if necessary : (cutting, ploughing, etc.). :
*familial* *salaried* *collective* *others (specify)*

20k) How many people have you used for the last preparation of the field ? :
Detail them according to the techniques used if necessary (cutting, ploughing, etc.) :

21a) When did you first sow this year ? (not applicable in the case of arboriculture) :

21b) What criteria did you use to decide to sow your field for the first time ? :
*pluviometric events* *collective work* *availability of labour* *number of days after the preparation of the field* *others (specify)*

21c) Have you needed to renew the sowing ? : *Yes* *No*

21d) If Yes, how many times ? :

21e) Why ? :

21f What sowing techniques do you use ? : *drilling* *in rows* *other (specify) :*

21g) What amount of sowing have you used per species for the whole field ? :

| Species | Quantity sowed (in number of sacks, number of sheaves, in kg, etc.) |
|---|---|
| | |

21h Were the sowing seeds ? : *reserved from the previous harvest* *bought* *exchanged* *given* *other (specify)*

21i Which type of labour have you used ? : *familial* *salaried* *collective* *others (specify)*

21j) How many people have you used ? :

21k) During how many days ? :

22a) Have you brought products to your field to fertilise it ? : *Yes* *No*

22b) If Yes, what are these products ? : *chemical fertiliser* *organic manure* *other (specify) :*

22c) In which period of the year have you brought these agricultural inputs to your field ? :

22d In what way did you obtain this product ? : *purchase* *exchange* *gift* *collection of manure from the plots* *other*

22e In what way have you brought these products to your field ? :
*transport (specify which type )* *penning (specify if manure agreement or not)* *other*

22f For what reasons have you brought these fertilisers to your field ? :
*tradition* *impoverishment of the soil* *sufficient familial revenue* *distance from village*

| | | | | | | |
|---|---|---|---|---|---|---|
| 23a) | After preparation of the field, have you re-cut the bushes in your field ? : | | | | *Yes* | *No* |
| | 23b) | If yes, in what period ? : | | | | |
| | 23c) | Do you use the same technique for the preparation of the field ? : | | | *Yes* | *No* |
| | 23d) | If no, what technique do you use ? : | | | | |
| | 23e | What type of labour have you used ? : | *familial* | *salaried* | *collective* | *other (specify)* |
| | 23f) | How many people have you used ? : | | | | |
| | 23g) | During how many days ? : | | | | |
| 24a) | After preparation of the field, have you weeded your field again ? : | | | | *Yes* | *No* |
| | 24b) | If yes, in what period ? : | | | | |
| | 24c) | Do you use the same technique for the preparation of the field ? : | | | *Yes* | *No* |
| | 24d) | If no, what technique do you use ? : | | | | |
| | 24e | What type of labour have you used ? : | *familial* | *salaried* | *collective* | *other (specify)* |
| | 24f) | How many people have you used ? : | | | | |
| | 24g) | During how many days ? : | | | | |
| 25a) | After preparation of the field, have you ploughed your field again ? : | | | | *Yes* | *No* |
| | 25b) | If yes, in what period ? : | | | | |
| | 25c) | Do you use the same technique for the preparation of the field ? : | | | *Yes* | *No* |
| | 25d) | If no, what technique do you use ? : | | | | |
| | 25e | What type of labour have you used ? : | *familial* | *salaried* | *collective* | *other (specify)* |
| | 25f) | How many people have you used ? : | | | | |
| | 25g) | During how many days ? : | | | | |
| 26a) | Have you practised singling ? : | | | | *Yes* | *No* |
| | 26b) | If yes, in what period of the year ? : | | | | |
| | 26c) | For what reasons ? : | | | | |
| 27a) | Have you applied phytosanitary products to your field ? : | | | | *Yes* | *No* |
| | 27b) | If yes, what are these products ? : | | | | |
| | 27c) | In what period of the year ? : | | | | |
| | 27d) | For what reasons ? : | | | | |

## AGRICULTURAL PRACTICES questionnaire : fields on transect (type « b »)

### MODULE I — GEO-ADMINISTRATIVE INQUIRY REFERENCES

1a) Inquiry date :
1b) Surveyor name :
2a) Identification number of the field in the UE inquiry :
2b) Name of the UE leader already identified in the UE inquiry :
3a) Observatory name :
3b) Name of the territorial boundary :
4a) Identification of the transect (number or code) : (if the field is selected to supplement the whole sample with the goal of validating the CPUs which come from the LEIS models, the question should be replaced by : identification of the nearest decision centre) :
4b) Rank of the field along the transect : (question to be deleted if the field is selected to supplement the whole sample with the goal of validating the CPUs which come from the LEIS models) :
5a) Identification of the UE leader (optional) :
5b) Name of the person who is exploiting the field this year (if different from the UE leader) :
5c) Name of the decision centre to which he is attached :

### MODULE II — GEOGRAPHIC ASSESSMENT OF THE FIELD

6a) Description and GPS coordinates of the field entry and exit points : ? : *entry :* *exit :*
6b) Rough sketch of the field (general form with corners, topographical position, description of the elements visible in the lands cape : road, path, bore hole, large trees, hedge) :
7a) Pedo-rural terminology of the field and description of the UE leader's perception of the soil quality :
7b) Geo-morpho-pedological description of the soil :

### MODULE III — LAND USE ALLOCATION AND ASSOCIATED CULTIVATED SPECIES

8a) Does the field have a single type of land use allocation : *Yes* *No*
8b) If yes, which ? :
- monoculture (specify the cultivated species) :
- mixed farming (specify the associated species) :
- arboriculture (specify the species cultivated) :
- fallow (specify the age) :
- abandoned land (specify the age) :
- natural vegetation

8c) If no, what are the different types of land use allocation and at what are the percentages of the surface area (blocking plan) ? :

| Land use allocation | |
|---|---|
| Types | Blocking plan (%) |
| | |
| | |
| | |

9) Where the field is entirely in fallow or abandoned, what species were cultivated during the last agricultural season ? :

10a) Does inter-annual crop rotation of cultivated species take place ? : *Yes* *No*

10b) If yes, what is the succession of species ? :

## MODULE IV – LAND USE ALLOCATION AND AGRICULTURAL PRODUCTION HISTORY

11) At what date was the field put into use for the first time ? :

12a) So was the land on this field developed/transformed before ? : *Yes* *No*

12b) If yes, what type of development/transformation (dykes, terracing, etc.) ? :

13a) Precise land use allocation and agricultural production history over 5 years :

| Year | Land use allocation | | Use of fertilisers (none, light, average, heavy) |
|---|---|---|---|
| | Types | Blocking plan (%) | |
| Current year | | | |
| Year (-1) | | | |
| Year (-2) | | | |
| Year (-3) | | | |
| Year (-4) | | | |

13b) History in living memory (about two generations) of the field in terms of « crops, fallow and abandoned land » succession ? :

| Periods (start year-end year) | Land use allocation (crops, fallow, abandoned land) |
|---|---|
| | |
| | |

14a) Have you noticed a reduction in production capacity of the field ? : *Yes* *No* If yes, since when ? :

14b) Have you had to make a radical change in agricultural practices on this field, in living memory ? : *Yes* *No*

14c) If yes, do you know since when ? :

14d) For what reasons ? :

14e) In certain years (specify which), have you had to suddenly abandon your recultivation ? : *Yes* *No*

14f) If yes, specify which years ? :

14g) What were the criteria leading to this abandoning ?

## MODULE V – ASSOCIATED PRACTICES LINKED TO OTHER ACTIVITIES

15a) Is wood collected ? : *Yes* *No*

15b) If yes, since when ? :

15c) In which period ?:

15d) Who by ? :

15e) How ? :

15f) For what use ? :

16a) Is this field grazed ? : *Yes* *No*

16b) If yes, since when ? :

16c) In which period ? :

16d) By which types of animals ? :

| Species | Origins (observatory territory, elsewhere) |
|---|---|
| | |
| | |

## *(Main) « Pastoral practices » inquiries*

### *Objectives*

The « Pastoral practices » level 3 inquiry is systematically conducted if the pastoral activity structures the space on the observatory territory (cf. Introduction). It is also recommended if the agricultural activity is structuring, in particular in order to determine the preference indexes by type of pastoral quality, by way of the herd monitoring. The main objectives of the « Pastoral practices » inquiries are as follows :

1) To characterise in more detail the pastoral resource extraction practices : development of the pastoral practices typology with the description, per practice, of the herd management techniques, and the human and material means used which characterise it.

2) The pasture circuits allow the places where pastoral practices are applied, and their possible spatial overlays, to be identified : development of the typology of pastoral exploitation practices ; definition of the rules of spatial distribution of practices (in relation to the pasture quality and the activity centres). The LEIS, through models under development, will provide a delimitation of the spaces on which the pastoral exploitation practices are overlayed (cf. p. 108).

3) For each class of pastoral exploitation practices, a degree of artificialisation is calculated.

4) The information collected during herd monitoring (time passed on grazing activity for the different pastoral units) allow the vegetation resource extractions conducted to be evaluated according to the pastoral practice.

A single « Pastoral practices » inquiry form is proposed in this guide. It contains a set of questions to ask the exploitation leader and a herd monitoring data sheet (cf. p. 109). This questionnaire is conducted at least once per season type during the observation period.

### *Preliminary work on the field inquiries and sampling method*

The sampling of herds is done using the typology of herds developed in level 2 (cf. p. 53) on the following criteria : species composition and age category, aggregation or not with animals from other UES, grazing with or without surveillance, main criteria for choosing the grazing circuit, maximum distance from the water point, and types of water point used.

In order to lighten the collection system, the sampling method proposed aims to provide a sample that allows the monitoring of a minimum of two herds per herd class. When the agricultural activity is structuring (maximum five types of herds : cf. p. 53), the sample size does not exceed ten. When the pastoral activity is structuring, the sample can increase up to 20. If the human and material means (other than those of environmental surveillance) set up by the ROSELT team responsible for the measurement system allow it (for example if the research and development projects with a pastoral theme are attached to the observatory), it is recommended that the sample size be increased where possible.

To select the minimum two herds per typology class, it is recommended that :

- herds from the same Exploitation Unit be given preference ;
- all the types of herds identified around a single main point be represented ; generally, this means a selection of water points ;
- attention is paid to ensure that the decision centres to which they are attached be distributed across the space according to the different observatory landscape units.

The selection of herds should be renewed at each season since their presence or absence may depend on the season.

*Data to collect*

1) **Module I : Geo-administrative inquiry references**

The data collected provide a link between the herd, the main UE on which it depends, the location of its corral, and the person who manages the herd.

2) **Module II : Updated characteristics of the herd**

The allows the description of the herd composition per species and age category (young/adults) in order to update the data collected in the « exploitation units » inquiry from the level 2 investigation.

3) **Module III : Previous range land improvements**

This module is for knowing whether land improvements have been made (in terms of labour and time) to improve the plant resource of the range land, to improve or secure access to the pasture land, or develop new water points.

4) **Module IV : Other elements key to pastoral practice**

This module is to gain knowledge, for the current season, of :

- the types of land use allocation used ;
- the type of herd management ;
- the water points used ;
- resource access rights (range land, water) ;
- maximum distance from the corral ;
- resource extraction practices ;
- use of feed supplements for breeding animals ;
- care given to animals.

Some of these criteria have already been brought to light in the level 2 inquiries, module VI (care of animals, water points used), but are not detailed here.

5) **Module V : Herd monitoring data sheet**

The data collected for :

- knowledge of the types of pastoral units (vegetation units) used by the herd with a cartographic description of these units and a GPS position : land use allocation type ; geomorphological criteria ; vegetation cover of the different strata : herbaceous plants : H, Woody plants : L, Bare Soil : SN; dominant herbaceous and woody plant species ;
- measuring the time passed in each unit ;
- describing the main activity of the herd (browsing, rest, watering, etc.), whether or not there is an intention to manure the plot passed through, whether there are resource extraction techniques other than browsing ;
- specify the most palatable species grazed when the herd activity is browsing.

***Data collection and monitoring method***

*Diagnosis*

The « pastoral practices » questionnaires are conducted at least once per type of season during the observation period. Where possible, it is preferable that the seasonal inquiries be conducted during the same year.

Modules I to III are completed with the exploitation leader and/or herder.

The table from module IV (herd monitoring data sheet) is filled in from the observations of the surveyor himself. He follows each selected herd, during at least one day per season. If the human and material means allow it, it is preferable to do two days monitoring per season.

This monitoring requires the use of a chronometer that allows the entry and exit times of every pastoral unit passed through to be noted (in hours, minutes and seconds). It also requires the use of a GPS to note the coordinates at the heart of each pastoral unit passed through. To help with the transfer of the herd circuit into a GIS and to locate the pastoral units passed through, it is recommended that a pencil sketch of the grazing circuit be made, noting as many visual references as possible, such as hedges, paths, etc.

The person responsible for the monitoring of herds must preferably be a good cartographer in order to describe the units passed through. He should be able to recognise the plant species browsed by the animals and name them. If he is not an ecology expert himself, it is preferable that a time be reserved for training and coordination between the phyto-ecologists responsible for vegetation measurements on the observatory and the technician responsible for herd monitoring.

The data collected must be usable for the interpretation of the vegetation in terms of the pastoral quality of the units passed through, and for detailing of the resource extractions made by the herds.

*Surveillance*

At each ROSELT observation period, these « pastoral practices » inquiries are renewed, preferably with the same herds. However it must be verified whether the sampling per season does not need to be adapted using possible new data collected at the exploitation units level (level 2).

***Data processing and expected results***

*Preliminary processing* : processing of the inquiries data ; feeding of entry data into a specific database (cf. p. 25).

*Classic statistical data processing : typologies*

- Typology of pastoral exploitation practices

  The data collected on the set of « pastoral practices » modules lend themselves to classical statistical data processing (in the same way as

those described pp. 53 to 59), with a view to developing a typology of agricultural practices, with all or some of the following criteria :

- *entrusting* to a paid or unpaid herder (*module I*) ;
- *composition of the herd* per species and age category, *allotment* (*module II*) ;
- *previous improvements* to the range land (*module III*) ;
- *other pastoral techniques (module IV and V)* : types of grazing circuit and herd management, water points used and mode of access, resource extraction practices, and use of feed supplements.

*Spreadsheet processing or* DBMS *request : general indicators*

Averaged over the set of pastoral exploitation practices on the observatory (comparison between observatories) or over each class of an observatory's typology of pastoral exploitation practices (intra-observatory functioning), specific indexes can be calculated from the data collected during herd monitoring : module V.

A non-exhaustive list, which would benefit from being tested and possibly supplemented in the context of ROSELT, is given below :

*Indicators of pastoral pressure on the resources*

All the indicators below are calculated per season. Their value can be averaged over the year according to the number of days per season :

- *Relative index of pastoral investment in the milieu (degree of artificialisation per pastoral exploitation practice)*

  This pastoral investment index is calculated for each pastoral practice described using the classification of criteria listed below (typology of pastoral practices) : it is the degree of artificialisation linked to pastoral practices. The construction of this index is done using the same method described (cf. p. 82) for the calculation of the relative index of agricultural investment on the milieu.

- *Index of natural vegetation resource extraction linked to the pastoral activity* (per pastoral practice, cf. module V).

  The extraction of natural vegetation linked to the pastoral activity refers to the extraction : 1) linked to the animal browsing activity of naturally available species, and 2) the browsing activity of species made available to the animals by resource extraction techniques specific to the herder, such as pruning for animal consumption, and scything.

This index can be calculated in kg of dry matter per TBU (or another unit) per pastoral practice type and per season *via* the following steps :

1) Calculation of the quantity extracted as a function of the time spent browsing and the equivalent in dry matter consumed by the herd during the day of monitoring.
2) Average of the quantities extracted per herd type and therefore pastoral practice type.
3) Calculation of the number of herds implicated and selected, in TBU or another unit.
4) Ratio between the quantities extracted and the number of TBU.

The same index can be calculated with all the pastoral practices included. It can also be calculated per pastoral unit type.

*LEIS integrated data processing : specific indicators to feed into the LEIS*

When the agricultural activity is structuring, it is enough at this level to calculate the preferred resource extraction index per pastoral unit, the maximum distance from the corral, and to quantify the pastoral resource extractions per type of pastoral practice and per type of pastoral quality (cf. general indicators below).

- *Preferred resource extraction index per pastoral unit* : relationship between the time spent browsing by the herd in the unit, and the time spent browsing over the whole circuit.
- *Maximum distance from the corral* : the herd's circuit can be transferred to the pastoral units or landscape units map (based on the vegetation map developed in the context of ROSELT/OSS, TC1, 2005) to bring together the browsing time and the type of pastoral quality. This also allows us to calculate the maximum distance from the corral by GIS processing.

When the pastoral activity is structuring, the data calculated in this level 3 provide a delimitation of the units on which the pastoral exploitation practices are applied, provide knowledge of their possible spatial overlaying (delimitation of the combined practices units), identify the pastoral units which are « preferred », and finally quantify the pastoral resource extractions by pastoral practice type and pastoral quality type. The models specific to delimitation of the combined pastoral practices are currently being formalised.

***Inquiry form : « Pastoral practices » questionnaires***

This questionnaire should be analysed so that it may be adapted and the questions posed tailored precisely to local specifics.

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# « PASTORAL PRACTICES » QUESTIONNAIRE

## MODULE I – GEO-ADMINISTRATIVE INQUIRY REFERENCES

1a) Inquiry date :

1b) Surveyor name :

2a) Observatory name :

2b) Name of the territorial boundary :

3) Season :

4) Identification of the corral : Name : GPS coordinates :

5a) Name of the UE leader already identified in the UE inquiry, on which the herd depends entirely ? :

5b) Do you accompany the herd to the pasture yourself ? : *Yes* *No*

6a) Name of the herder if different to the UE leader (name, ethnic group, origin) :

6b) Link with the UE leader (son, uncle, exterior person, etc.) ? :

6c) If exterior person, what does he receive in return? (salary, animals, milk, etc.). Can you detail the terms of your agreement ? :

## MODULE II – GEOGRAPHIC ASSESSMENT OF THE HERD

7) Update of the herd composition :

| | | Variation in the animals owned compared to the UE inquiry (+1, -1, etc.) through purchase, birth, etc. | Livestock entrusted [0-10] [11-20], [21-30], etc. | Number born this season |
|---|---|---|---|---|
| Cattle | Young | | | |
| | Adults | | | |
| Sheep | Young | | | |
| | Adults | | | |
| Goats | Young | | | |
| | Adults | | | |
| Camelidae | Young | | | |
| | Adults | | | |

## MODULE III — PREVIOUS IMPROVEMENTS TO THE RANGE LAND

8a) Have you contributed to land improvements to improve the plant resource of the range land used by the herd (slash-and-burn, firewall, others) ? :
*Yes* *No*

8b) If yes, specify what and when ? :

8c) What type of labour (familial, salaried, collective, others) have you used ? :

8d) How much labour (number of people and number of days) have you used ? :

9a) Have you contributed to land improvements (clearing, enrichment of fodder species, dividing up, others) to improve or secure access to the range land ? :
*Yes* *No*

9b) If yes, specify which and when ? :

9c) What type of labour (familial, salaried, collective, others) have you used ? :

9d) How much labour (number of people and number of days) have you used ? :

10a) Have you contributed to the development of new water points for the herds during the last four years (wells, bore hole, artificial ponds, etc.).? :
*Yes* *No*

10b) If yes, specify which and when ? :

10c) What type of labour (familial, salaried, collective, others) have you used ? :

10d) How much labour (number of people and number of days) have you used ? :

## MODULE IV — OTHER ELEMENTS KEY TO PASTORAL PRACTICE

11a) Of the pasture land used by the animals this season, what are the types of land use allocation? (Cultivated plots, fallow of what age, abandoned land of what age, natural vegetation, etc.). Can you detail them ? :

11b) How is the herd managed ? Circle : *free divagation* *passive surveillance* *driven ranging*

11c) When the animals graze on the fields, what type of agreement do you have with the UE leader who manages the field (none, manure agreement, other) ? :

12a) To what water points will the herd go to water during the season ?:

| Type (pond, well bore hole, other) | Main or secondary | Local name | Period in the season | Frequency (every day, every two days) |
|---|---|---|---|---|
| | | | | |

12b) What are the access rules of the water points? (in order of arrival, duration, tax, etc.) ? Can you give détails ? :

13) To what maximum distance from the corral do you lead your herd (distance in walking time : 1 hour, 1/2 day, etc.) ? :

14a) Do you use the practice of pruning for animal consumption ? : *Yes* *No*

14b) If yes, on what land use allocation type ? :

15a) Do you use scything ? : *Yes* *No*

15b) If yes, on what type of land use allocation ? :

16a) Do you use other pastoral resource extraction techniques ? : *Yes* *No*

16b) If yes, specify which ? :

17a) Do you use feed supplements for your breeding animals ? : *Yes* *No*

17b) If yes, what proportion (%) of the daily feed intake according to the season ? :

| | Nature of feed supplement | Daily quantity | Method of acquisition (purchase, harvest, exchanged, gift, etc.) |
|---|---|---|---|
| Cattle | | | |
| Goats | | | |
| Sheep | | | |
| Camelidae | | | |

18a) Do you treat your animals ? : *Yes* *No*

18b) If yes, what is the nature of these treatments ? :

18c) How many people are involved in the treatments given to the animals ? :

## MODULE V — HERD MONITORING DATA SHEET

19) Monitoring data sheet :

| N° | | Cartographic description | | | | | | Resource extraction/grazing practices | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Land use allocation type | 100 % | | | Geomor-phology | Dominant woody plants | Dominant herbaceous plants | Time entered | Time left | GPS coordinates at the heart of the unit passed through | Dominant herd activity (browsing, rest, walking wathering) | Is there a intention to manure the unit (none, with/without manure agreement) | Is there a resource extraction practice other than natural browsing of the available species (pruning for consumption, scything, other) specify which : | Species grazed (in order of preference) |
| | | % L | % H | % SN | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

20) Rough sketch of the grazing circuit :

## *(Secondary) « Wood fuel resource extraction practices » inquiry*

*Objectives*

Trees are an important resource which is used in different ways by societies and according to different objectives. The tree is a pastoral resource : the leaves and the fruit are mainly consumed. The species of bushes the most consumed are generally short in number. Thus, the quantity of pastoral resources contributed by the woody plant stratum is low but the quality of this resource is high because it often constitutes, particularly in the Sahelian area, an essential supplement to the feed intake of dry season straw, poor in nitrogenous elements, vitamins and minerals.

Trees are also a structuring element of the landscape : they can be protected at the time of agricultural clearing, for its alimentary or other qualities, and generate landscapes of parks of trees. They can also be left at the boundaries of agricultural plots (formation of hedges) to delimit the different land tenure plots. In crop systems, the tree may be eliminated as being considered competition for the crops, or on the contrary it may be protected to supplement the crop (for example the *Acacia albida* with its fertilising ability, given that it can fix nitrogen).

Beyond these different mainly pastoral and agricultural roles of the tree, five other usage types can be distinguished :

- The **nutritive tree** : the tree can play a role in supplying food to people, who obtain the leaves, fruit, flowers or grains which can compensate for an insufficient agricultural production, especially during the lean season, or during dry periods.
- The **combustible tree** : especially in the Sahel, the tree represents an essential, often unique, source of energy for a rural community. The use of woody plants as fuel represents an important type of natural resource exploitation in the rural environment. This exploitation bares two aspects : the satisfaction of needs of rural communities and the provisioning of large commercial fuel networks mainly aimed at urban centres.
- The **tree, source of revenue** : the tree is traditionally an integral part of subsistence strategies, not only as a food supplement, but also as a financial resource. The commercialisation of wood (in particular to provision urban centres) or of the multiple forestry sub-products such as leaves, fruit, etc. obtain financial incomes that help to balance the finances of the functioning of rural exploitation units.

- The **tree in construction and in artisan life** : woody plants can be used as craft wood and as service wood. The wood, according to its size, diameter, solidity, straightness of the truck and branches, and flexibility, can be used for : carpentry, the framework for housing or store houses, posts for stabling or fencing, musical instruments, Koranic « boards », handles for ploughing tools, mortars, or drinking troughs.
- The **tree in traditional pharmacopoeia** : traditional pharmacopoeia is often of fundamental importance in rural environments. This is even more true when there are no modern health centres in the villages (or decision centres).

Thus, the tree in the traditional societies of arid and semi-arid zones, especially Sahelian, plays an important role. Of all the distinct roles of the tree, the most important in terms of the quantity extracted and therefore of the impact on the landscape is generally the wood fuel use.

The « wood fuel » module, developed in this section has a single tool, the wood fuel resource extractions form (cf. p. 118). The method proposed is a method which is intended to be practical, simple, and economical, particularly well adapted to Sahelian zones. Other methods may be proposed later.

When wood fuel is not the main use of the wood collected, other better adapted inquiry methods will need to be proposed. More precisely, the objectives of this « wood fuel » inquiry are :

- to characterise the wood extracted and the periods of extraction ;
- to evaluate the quantity and place of the extraction.

***Preliminary work on the field inquiries and sampling method***

As with the « agricultural inquiries », a sample of the UES surveyed at level 2 is conducted, essentially on the « wood fuel resource extractions » criteria (low/medium/high). This criteria is collected in module VII from the UE questionnaire.

The sample size is not limited in itself, given that the data collection method proposed consists of entrusting the inquiry data sheets to resource people from the observatory UES. It may be limited if the resource people are difficult to identify within the UES (low level of literacy).

The time needed to train these resource people should also not be underestimated, to ensure a reliable management of the inquiry data sheets. To select the UES by UE class, in addition to the main « wood fuel resource extractions » criteria (low/medium/high), is it recommended that :

- preference be given to the UEs which have already been selected for the « agricultural inquiries » ;
- care be taken to ensure that the decision centres to which the UEs are attached are distributed in space in relation to the observatory's different landscape units.

*Data to collect*

The questionnaire helps gain knowledge of the consumption of wood fuel consumed within the exploitation unit, or sold by the UE as an energy source. It is composed of two types of monitoring data sheets :

- one for the monitoring of wood fuel consumption within the UE and to thus evaluate the wood fuel resource extractions that are to satisfy the domestic needs of the exploitation unit ;
- one for the monitoring of wood fuel sales outside the exploitation unit and to thus evaluate the wood fuel resource extractions that are to satisfy a part of the economic needs of the exploitation unit.

**1) Module I : Geo-administrative inquiry references**

The data collected provide a link between the geo-administrative reference and the UE.

**2) Module II : Extraction for exploitation energy needs : daily consumption**

This module contains a single table which allows the gathering of information on :

- o the weighing dates (day, evening meal, midday, evening, other) ;
- o the weighing of wood effectively consumed at each meal ;
- o whether this wood was bought, exchanged, extracted ;
- o if it was extracted, the place of collection (direction, distance, etc.).

**3) Module III : Resource extractions for the satisfaction of energy needs other than those of the exploitation unit : sale of wood extracted**

This second table allows information to be gathered on :

- o the days of weighing ;
- o the weighing of wood actually sold ;
- o whether this wood was exchanged or extracted ;

- o if it was extracted, the place of collection (direction, distance, etc.).

***Data collection and monitoring method***

*Diagnosis*

The first data sheet is filled in daily by a person able to read and write the national language in each UE sampled. Certain data are qualitative, others require the handling of small equipment, such as a pair of scales, to weigh the wood consumed at each meal of the day. The second data sheet is filled in by the person responsible for selling, helped or not by the person identified for filling in the first type of data sheet, for each wood fuel sale.

The pair of scales can be entrusted for example to a child, generally dependent or contributing to the collection of wood fuel. If necessary, the protocol may be made easier by reducing the daily weighings to one or more per month.

In all cases, it is recommended that a technician from the ROSELT national team can regularly check the reliability of the weighing in each UE, calibration of the scales, the filling-in of the forms, etc. This monitoring and verification can be done at least once per season. During the visit to each UE selected, the inquiry data sheets are retrieved.

For the wood fuel sold, the estimation of quantities sold can be measured in steres or bundles, or any other unit of measure, when the quantities of wood sold become too great for normal weighing. The equivalent of this unit in kg must therefore be provided.

*Surveillance*

At each ROSELT observation period, these wood fuel extraction inquiries are renewed for at least a year.

***Data processing and expected results***

*Spreadsheet processing or DBMS request : general indicators*

Averaged by UE type or over the whole observatory, the following **indicators** are currently proposed in terms of the **pressure on the natural vegetation** linked to wood fuel resource extractions :

- **Extraction of seasonal wood fuel** (kg of dry matter / day / season) : sum of all the quantities from extraction, consumed for cooking or for heating (self-consumption), and the quantities sold.
- **Annual extraction of wood fuel** : ditto, for the year.

- **Level of wood extracted** : relationship between the wood extracted from the observatory's natural resources and the wood bought or exchanged.

*LEIS integrated data processing : specific indicators to feed into the LEIS*

**Spatial distribution of wood fuel resource extraction**

To recap (cf. ROSELT/OSS, SD 3, 2005), the quantity of wood extracted is applied to an extraction area around the decision centres. This extraction area is calculated from an extraction radius which can depend on the season, the type of decision centre and the type of UE. The total resource extractions of the decision centre UEs are applied to the resource extraction area homogeneously, or distributed by preference index.

The quantified wood resource extraction (cf. general indicators) is useful for the spatial distribution models of wood resource extraction developed in the LEIS. The other specific or complementary indicators to feed into the LEIS are as follows. They are calculated for each season, or over the whole year :

- **Wood access radius** : is calculated per UE type and/or per decision centre type. The average of the values obtained allows an indicator at the observatory scale to be obtained.
- **Preferred resource extraction index per land use allocation type** : (number of times where the land use allocation type is mentioned / number of distinct land use allocation types) / (number of days when the modules II and III data sheets were filled in).

*« Wood fuel resource extraction » inquiry form*

This questionnaire should be analysed so that it may be adapted and the questions posed tailored precisely to local specifics.

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« WOOD FUEL RESOURCE EXTRACTION » INQUIRY

## MODULE I – GEO-ADMINISTRATIVE INQUIRY REFERENCES

1a) Surveyor name :
1b) Age :
2a) Observatory name :
2b) Name of the territorial boundary :
3) Name of the UE leader already identified in the UE inquiry :

## MODULE II – EXTRACTION FOR THE EXPLOITATION UNIT'S ENERGY NEEDS : DAILY CONSUMPTION

4)

| Date (d/m/y) | | Consumption for cooking or for heating | | | Origin | | | Place of collection | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity (kg) consumed | Species used | Number of people | bought | exchanged | extracted | Direction | Distance in walking time (15 mn, 1h, 1/2d, 1d, +) | Type of land use allocation (fields, fallow, abandoned land, etc.) | On which « *terroir foncier* » |
| | morning | | | | | | | | | | |
| | midday | | | | | | | | | | |
| | evening | | | | | | | | | | |
| | other | | | | | | | | | | |
| | morning | | | | | | | | | | |
| | midday | | | | | | | | | | |
| | evening | | | | | | | | | | |
| | other | | | | | | | | | | |
| | morning | | | | | | | | | | |
| | midday | | | | | | | | | | |
| | evening | | | | | | | | | | |
| | other | | | | | | | | | | |

**MODULE III – RESOURCE EXTRACTIONS TO SATISFY ENERGY NEEDS OTHER THAN THOSE OF THE EXPLOITATION UNIT : SALE OF WOOD EXTRACTED**

5)

| Date (d/m/y) | Sale | | | Origin | | Place of collection | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity sold (kg) | Species sold | Place of sale | exchanged | extracted | Direction | Distance (in walking time or by the mode of transport used, to be specified) | Type of land use allocation (fields, fallow, abandoned land, etc.) | On which village land |
| | | | | | | | | | |
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# TABLE OF ILLUSTRATIONS

## Figures



## Tables

# ANNEX

# Annex 1
# Adopted terminology (Glossary)

**Activity centre** : this is a fixed element of the territory around which one or more agent groups organise the exploitation of natural resources. Several types can be identified : village, encampment (decision centres), well, pond, bore hole (water points), etc. A decision centre can be a point, a group of points (several isolated farms : *douars* ; several villages and hamlets around a single village leader ; wells along a wadi), a line (a stream/wadi, a road), a polygon (urban centre). They have a lifespan and can be associated with one or more activities for a given period.

**Agent group** : this is :

- **either a group of individuals with a strategy for natural resource exploitation** (= strategic group defined by the typology of observatory exploitation units) with different roles (manage, exploit, reside, extract) : it may be of several types (farmer, farmer-herder, herder, etc.).
- **or a group of domestic animals** ( = herd) or **wild animals** (fauna) **which extract the natural resources** of the observatory territory around one or more activity centres : it may consist of several types according the composition and size of the herds.
  It resides in one or more activity centres successively in time. It can use one or more activity centres to exploit the resources according to the different activities and periods.

**Agricultural exploitation unit** : The agricultural exploitation unit is the basic unit of agricultural production, whether the exploitation be agricultural, pastoral, forestry, or another.

**Combined practices** : The term « combined practices » refers to the simultaneous or successive overlay, of several natural resource exploitation techniques, on a single space, at the scale of the season or year. If the agricultural activity is structuring from a spatial perspective, each class of combined practices is constituted of an agricultural practice, associated or not with one or more other agricultural practices, plus possibly other non-agricultural practices. The reverse is true if the pastoral activity is structuring from a spatial perspective.

**Decision centre** : the decision centres are centres in the observatory in which individuals reside temporarily or permanently. These individuals take decisions and are local actors in the management or extraction of natural resources. These deci-

sion centres, in the ROSELT network observatories, are *a priori* rural centres. Although certain observatories contain urban centres that are much bigger than others (e.g. Linguère in Ferlo, Senegal). In this case, according to the needs of the LEIS models, such a decision centre may be sub-divided into neighbourhoods ; each neighbourhood is thus a decision centre in itself. A decision centre can also be an activity centre itself. Several decision centres may constitute a single activity centre if their territorial relationships have been established (« group of points » in a GIS).
When a « secondary decision centre » depends on another decision centre from a social organisation perspective, the first is called the « **satellite decision center** » the latter is called the « **main decision center** ».

**Decision system** : set of structured social and political organisms within which the choices are made, more or less rationally. The decision-making process can demonstrate the diverse steps covered, the rules followed and the more or less clear involvement of those who are involved in certain aspects of the decision-making.

**Degree of artificialisation** : the degree of artificialisation is the degree of investment by man on the milieu. It measures the effort made by men to exploit the milieu. In the context of the LEIS, it is calculated for each « combined practices ». Each element describing each practice which makes up the « combined practices » (techniques, human and material means) is evaluated in terms of the degree of artificialisation on a scale of 0 to 100. The degree of artificialisation of the « combined practices » is thus the combination of the degrees of artificialisation of the elements describing the practices of which it consists : sum or weighted sum according to the relative importance that we wish to give to the different elements.

**Ethnic group** : an ethnic group refers to a cultural identity with which the individual identifies himself. The ethnic group is a geo-cultural referent which groups together several clans.

**Entrusting** : « entrusting » refers to the animal owner entrusting the herd management of his animals to another herder.

**Exploitation practice** : practice, according to Teissier in 1979 (cf. Lhoste P., 1987) *is the way in which the operator implements a technical operation... the technique is considered to be the set of operations which have a production purpose.* More precisely and more adapted to the subject, the term **exploitation practice** refers to a concrete natural resource exploitation action (vegetation, soil, water) by an exploitation unit, according to :

- an exploitation strategy (commercial or self-subsistence) ;

- a production vector (species cultivated for the agricultural practice and species/races bred for the pastoral practice) ;
- the characteristics of the milieu (useful resources) where this action is applied ;
- and an objective for the level of production.

This action is characterised (cf. p. 74) by the association of cultural or breeding techniques, of human and material means, whether it be an agricultural or pastoral practice.

**Exploitation Unit :** The exploitation unit (UE, from the French *Unité d'Exploitation*) is generally defined as « *the basic agent acting in the agricultural production process. It constitutes the family unit inside which priority is given to the implementation of the factors of production: land, labour force, means of production (...) and from which the process of utilisation and movement of the products obtained is carried out* » (*Mémento de l'Agronome*, 1991 ; Brossier, 1987). This concept of the exploitation unit establishes the essential link that exists between the familial structure and the social unit within which exploitation of the local environment is carried out.
From a methodological point of view, we can define the exploitation unit as the set of people who work on the same fields or look after the same herd, store together in a communal store house – which does not prevent there existing several individual store houses – and who are attached to the same decision centre with regards to the organisation and management of production. The UE, which is placed under the supervision of an UE leader, is sometimes spread over several residence units, particularly when it groups together individuals from different generations.

**Field** : A space, cultivated all in one block, by one or more farmers, possibly grouping together several agricultural plots.

**First occuper** : This expression refers to the families who were the first to arrive on a given site and who founded a village, a hamlet or some other community. They may have come from the mountains or from a distant region to cultivate, to hunt or to graze their animals. The descendants of the first occupiers are often the land leaders.

**Fraction** : Subdivision within a tribe which corresponds to a segment of lineage.

**Head of the family** : This is the person responsible for and who manages the property of a polygamous family. In a patriarchal family, the man is always the head of the family, and the woman does not become head of family unless there is no man present.

**Head of the household** : The household constitutes the smallest social domestic family unit. It is composed either of a couple with or without children, or an adult without a partner and with children (at least one). The head of the household is the manager of this unit.

**Herd** : The herd is a set of animals homogeneously managed, in a single technical management unit (Landais *et al.*, 1987 ; Lhoste, 1987). This idea should be separated from that of « livestock », the set of animals belonging to a single individual or a single group (Lhoste, 1986). More precisely, the herd refers to a group of wild or domestic animals, whether mono-specific or not, which together exploit the natural resources using the same exploitation logic. At this moment in time, within the ROSELT framework, only methods of evaluation and monitoring of domestic herds are proposed.

**Land tenure territory** : territory on which the first to arrive have the power of land management or of grazing rights. This concept is similar to the « *terroir foncier* » described in the *Mémento de l'Agronome* (1991) : the « *terroir foncier* » constitutes a spatial expression of land tenure rules and practices by which a given group applies its social mastery on its natural environment.

**Land use allocation** : From the French, *affectation parcellaire de l'utilisation du sol*, refers to the consequence of land use in terms of plot allocation in space and time, i.e. a field of a particular species, fallow, abandoned land, etc., in a given year.

**Lineage** : Uni-linear exogamous descendant group, whose members claim either inheritance, or matrilinial rights of a known common ancestor. The members of the lineage are able to reconstruct the genealogical relationship which link them together as well as to common founder.

**Polygamous family** : Nuclear family composed of a husband, his wives and their children.

**Production system :** a production system is a combination of production and factors of production (land tenure capital, exploitation work and capital) in the agricultural exploitation unit. It is a more or less coherent, organised combination of various production sub-systems : crops systems, breeding systems and transformation systems (*Mémento de l'Agronome*, 2002).

**ROSELT observation period** : the ROSELT observation period is the period during which the whole set of ROSELT data (climate, vegetation, soil, water, socio-economy) is collected in the observatory according to a defined schedule, in particular for the establishment of a summary and forecasts via the LEIS. Whatever the data collection date(s) may be in this period, these data must represent a functio-

ning that is as much biophysical as socio-economic, and that is relatively stable over this period. *A priori*, without exceptional events being observed which we must therefore be able to measure, the duration of this period has been fixed at four years within the network.

**Terroir foncier** : the French « *terroir foncier* », constitutes a spatial expression of land tenure rules and practices by which a given group applies its social mastery on its natural environment. The land encompassed in the « *terroir foncier* » is under the jurisdiction of the village leader or land leader. Decisions regarding land use are taken at the individual level and at the village-leader level. The quantity of range land available on « *terroir foncier* » will, therefore, be the result of decisions at the household and community levels.

**Tribe** : A filiation group of herders which corresponds to the notion of a clan (attachment to a more or less mythical common ancestor).

**UE Strategy** : The strategies of the farmers consist of the implementation of all the means (human, technical, economic, etc.) that they have at their disposition, over a given period, and in a more or less unsure context, to achieve specific objectives of maintaining, growing and reproduction of their familial unit, etc.

**Village chieftainship** : may either be the single lineage within which the responsibility is passed on by inheritance (monolineage chieftainship), or alternates between several master lineages from the same clan (multi-lineage chieftainship) or from different clans (multi-clan chieftainship).

**Village land** : From the French, « *terroir villageois* », refers to a rural space managed by a community which affirms its right to exploitation and occupation in a defined socio-economic and cultural context.

**Water point** : water points are the activity centres to which animals come to water. This may be a pond, a traditional or cemented well, bore hole or a stream/wadi.

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## Technical Contributions

CT1 : Guide ROSELT/OSS pour l'évaluation et la surveillance de la végétation.

CT2 : Guide ROSELT/OSS pour l'évaluation et le suivi des pratiques d'exploitation des ressources naturelles.

CT3 : Manuel d'utilisation de l'outil SIEL - ROSELT/OSS (version 1.3).

CT4 : Application des indicateurs écologiques de la dégradation des terres à l'observatoire de Menzel Habib (Tunisie).

TC5 : Surveillance of ecological changes in the ROSELT/OSS observatory of El Omayed (Egypt) : first results.

CT6 : Recherche des indicateurs de changement écologique et de la biodiversité dans l'observatoire de Oued Mird (Maroc) : premiers résultats.

CT7 : Surveillance des changements écologiques dans l'observatoire ROSELT/OSS de Haddej-Bou Hedma (Tunisie) : premiers résultats.

CT8 : Espaces-ressources-usages : première application du Système d'Information sur l'Environnement à l'échelle Locale sur l'observatoire ROSELT/OSS de Banizoumbou (Niger).

CT9 : Recherche d'indicateurs de désertification par analyse comparative de quelques observatoires ROSELT/OSS.

CT10 : Une approche spatiale pour la surveillance de la faune – Étude de cas au sud du Maroc : la vallée de l'oued Mird.

CT11 : Guide pour l'évaluation et la surveillance des états de surface et des sols.

CT12 : Système de circulation de l'information ROSELT/OSS : définition des métadonnées et élaboration des catalogues de référence.

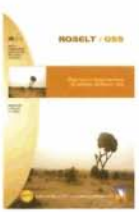
CT13 : Guide ROSELT/OSS pour la cartographie dynamique de la végétation et des paysages.

CT14 : Fiches techniques pour la construction de quelques indicateurs écologiques ROSELT/OSS.

CT15 : Synthèse comparative de quatre années de surveillance environnementale sur trois observatoires ROSELT/OSS du Nord de l'Afrique : El Omayed, Haddej-Bou Hedma et Oued Mird.

CT16 : L'approche foncière environnementale : droit et anthropologie à la rencontre des sciences écologiques.

## Scientific Documents




DS1 : Conception, organisation et mise en œuvre de ROSELT/OSS.

DS2 : Organisation, fonctionnement et méthodes de ROSELT/OSS.

DS3 : Concepts et méthodes du SIEL - ROSELT/OSS (Système d'Information sur l'Environnement à l'échelle Locale).

DS4 : Indicateurs écologiques ROSELT/OSS. Une première approche méthodologique pour la surveillance de la biodiversité et des changements environnementaux.

SD1 : Conceptual, organizational and operational framework of ROSELT/OSS.

SD2 : ROSELT/OSS organization, operation and methods, edition 2001, revised in 2004.

SD3 : Concepts and methods of ROSELT/OSS-LEIS (Local Environment Information System).

SD4 : ROSELT/OSS ecological indicators first methodological approach for the surveillance of biodiversity and environmental changes.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