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BIOBIO

Indicators for biodiversity in organic and low-input farming systems

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Selection and field validation of candidate biodiversity indicators, including field manual. Handbook for testing candidate indicators of organic/low-input farming and biodiversity

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Selection and field validation of candidate biodiversity indicators, including field manual. Handbook for testing candidate indicators of organic/low-input farming and biodiversity

Final Version of Report

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CONTENTS

1. GENERAL INTRODUCTION AND PURPOSE OF HANDBOOK

The aim of the BIOBIO project is to develop a series of measured indicators of biodiversity associated with organic and low input farming systems. These indicators can potentially be used to monitor the contribution that biodiversity makes to high quality food production as well as to measure the contribution of farming to the maintenance of biodiversity in areas of Europe under such farming systems. Agricultural production based on organic and low input farming systems is especially dependent on the organisms in healthy soils, natural enemies of pests, pollinators and dung-feeding invertebrates and often supports a rich wildlife (biodiversity).

Candidate biodiversity indicators for organic and low input farming systems were selected following a major review of indicator theory and existing biodiversity indicators carried out in 2009 (Dennis *et al.*, 2009). Direct indicators were chosen to represent livestock breeds, grassland and crop varieties (genetic diversity); domesticated and wild animal and plant species (species diversity); and the mixture of cultivated crops, pastures and semi-natural habitats on farmland (habitat diversity) (TABLE 1.1). The review included indirect biodiversity indicators based on farm management and farm accounts information where there is a proven connection between farm management information and the levels of genetic, species and habitat diversity (TABLE 1.1).

Indicators were ranked according to scientific criteria during the WP 2 workshop held in Aberystwyth, 9-10 September 2009. Subsequently, the remaining biodiversity indicators were assessed according to headline stakeholder 'usefulness' and 'cost-effectiveness' criteria. The 'usefulness' of the proposed biodiversity indicators was assessed by means of an online survey, where 18 stakeholder criteria were applied. The results of the survey were discussed and confirmed during the second Stakeholder Advisory Board workshop in Brussels, 21-22 October 2009. Candidate indicators to be tested in field studies in BIOBIO were then shortlisted, accounting for the effort which the project partners can allocate to this field survey in 2010 (described in Dennis *et al.*, 2009).

The purpose of this guidebook is to describe the methods required to measure the list of candidate direct and indirect indicators of biodiversity in the field or through farmer interviews on organic, low-input and conventional (control) farms during 2010. The practicality and suitability of these methods for sampling plants and selected animals on very different farm types and habitats across Europe and wider afield will be evaluated. In particular, to determine whether the methods are sufficiently sensitive to distinguish between conventional, low input and organic farming systems.

Full instructions are given to undertake the evaluation of candidate indicators under the following headings:

- Summary of selection procedure for farms in each of the Case Study partner countries (full details in Deliverable 3.1 "Descriptive case study report")
- Farm level habitat mapping and associated stratified sampling design
- Farm-level data collection
    - Field survey methods for vegetation, plant species and faunal indicators
    - Farmer questionnaires and interviews for genetic and farm management indicators
    - Cost of indicator measurement
- Indicator calculation, data analysis and scrutiny

Standardised procedures, apparatus and methods are described for each candidate indicator including sampling design, required equipment, data collection dates and the frequency and format of data for transfer to the co-ordinating centre for data recording and analysis. The evaluation will include a detailed economic assessment of the cost effectiveness of each of the indicator measurements. A comparison will be made between the costs of field sampling effort, equipment, data management and analysis and the perceived benfit of the information that is generated for farmers, conservationists, food industry and policymakers.

TABLE 1.1 CANDIDATE BIODIVERSITY INDICATORS SELECTED FOR EVALUATION IN 12 CASE STUDY REGIONS DURING 2010

Level of biological organisation	**Individual indicators**	**Source of data**
A. Genetic diversity indicators	**Animal husbandry**:	
	A1) Number and amount of different breeds per species (**Breeds**)	Farm questionnaire
	A2) Information on breeding practices ("on-farm" bull, artificial insemination,...) (**Liveprac**)	Farm questionnaire
	A3) Where available, pedigree of the herd (**LivePedi**)	Farm questionnaire
	Arable crops, legumes and trees	
	A4 + A5) Number, amount and origin of different cultivars / landraces / accessions per species (**CultDiv)**	Farm questionnaire
	A6) Information on seed propagation practices (on farm multiplication, sharing with neighbours, etc) (**seedmulti**)	Farm questionnaire
	A7) Where possible, description of the cultivars based on IPGRI descriptors (through the farmer) (**CropCuPheDiv**)	Farm questionnaire
	A8) Where available, pedigree information on the cultivars grown (**CropPedDiv)**	Farm questionnaire
	Grassland species	
	A9) Where available, number and amount of different cultivars (**GrassGenDiv**)	Farm questionnaire
	A10) Information on seed propagation practices and amount of re-seeding (**ReSeed**)	Farm questionnaire
B. Species diversity indicators	B2) Flowering plants of semi-natural habitats	X-plots (patches) or rectangular plots (linear features) of vegetation survey
	B4) Earthworms	Soil samples in vegetation plots

	B6) Bird species richness	No field validation for this candidate indicator
	B8) Araneae –spiders	Suction sampling in vegetation plots
	B9) Hymenoptera, wild bees	Walked transects and net capture in vegetation plots
C. Habitat diversity indicators	C1) Habitat Patch density (**HabDensity**)	Farm habitat mapping
	C2) Habitat richness	Farm habitat mapping
	C3) Habitat diversity (**HabDiv**)	Farm habitat mapping
	C4) Number of crops in rotation (**CropRot**)	Farm habitat mapping and farm questionnaire
	C5) Percentage area of arable land (**ArableArea**)	Farm habitat mapping
	C6) Percentage area of permanent grassland (**GrassArea**)	Farm habitat mapping
	C7) Percent of tree cover (**Tree**)	Farm habitat mapping
	C8) Cover of shrub layer (**Shrub**)	Farm habitat mapping
	C9) Availability of nitrogen, pH, moisture as Ellenberg values (**Ellenberg**)	X-plots (patches) or rectangular plots (linear features) of vegetation survey
	C10) Weeds in crops (**Weed**)	X-plots (patches) or rectangular plots (linear features) of vegetation survey
	C12) Vegetation composition: share of valuable habitats (**ValueHab**)	X-plots (patches) or rectangular plots (linear features) of vegetation survey
	C13) Linear elements: hedgerows, grassy strips between fields, streams, rivers and lakes, stone walls and terrace walls (**Linear**)	Rectangular plots (linear features) of vegetation survey
	C14) Multispecies grassland swards (**Multigrass**)	X-plots (patches) or rectangular plots (linear features) of vegetation survey
	C15) Grassland quality (**GrassQ**)	X-plots (patches) or rectangular plots (linear features) of vegetation survey
D. Farm management indicators	D1) Diversity of enterprises on the farm (**DivEnt**)	Farm questionnaire
	D2) Average stocking rates (grazing livestock units ha^{-1}) on farm (**AvStock**)	Farm questionnaire
	D3) Area of land without use of mineral-based fertilisers (**Minfert**)	Farm questionnaire
	D4) N input (**NitroIn**)	Farm questionnaire
	D5) Input or Direct and Indirect	Farm questionnaire

Energy for crop production (**Enerln**)	
D6) Certified as Organic (**CertOrg**)	Farm questionnaire
D7) IRENA Indicator 1: area under agri-environment support (**AgrEnv**)	Farm questionnaire
D8) IRENA Indicator 15: intensification/extensification (**IntExt**)	Farm questionnaire
D9) Pesticide Use – Treatment Frequency Indicator (**PestUse-TFI**)	Farm questionnaire
D10) Area of land without or with reduced use of chemical pesticides (**PestUse-Area**)	Farm questionnaire
D11) Frequency and timing of field operations (**FieldOp**)	Farm questionnaire
D12) Frequency and intensity of livestock grazing (**GrazInt**)	Farm questionnaire
D13) Productivity (cereal, milk or meat)	Farm questionnaire
D14) Irrigation (practiced or not?)	Farm questionnaire

2. PARTICIPATING COUNTRIES OF WP 3 CASE STUDIES

A total of twelve Case Study regions were proposed in 11 countries at the outset of BIOBIO (TABLE 2.1) to provide a wide variety of agricultural production systems across Europe with both organic options to conventional agriculture or enterprises based on low-input farming systems. Full details are given on the BIOBIO website (BIOBIO on line).

TABLE 2.1. EUROPEAN CASE STUDY COUNTRIES LISTED BY SHARED FARMING ENTERPRISE

CASE STUDY NO., REGION and COUNTRY	**FARMING ENTERPRISE/ SYSTEM**
1. Marchfeld Region, Austria	Organic arable farming
2. Gascony Valleys and Hills, France	
3. Southern Bavaria, Germany	Organic mixed farming
4. Rhodope mountains, Bulgaria	Semi-natural, low-input grasslands
5. Homokhatsag, Hungary	
6. Hedmark, Norway	Organic and low-input grassland with sheep
7. Swiss Alps, Switzerland	Organic mountain grassland with sheep, cattle or mixed livestock
8. Welsh hill and uplands, United Kingdom	
9. Extremadura, Spain	Mediterranean silvopastoral systems (Dehesa)
10. Extremadura, Spain	Organic olive plantations
11. Twickel area, The Netherlands	Organic horticulture

12. Veneto & Friuli Venzia Giulia Regions, Italy Organic vineyards

2.1. FARM SELECTION PROCEDURE WITHIN CASE STUDY REGIONS

Farm selection is separately determined within BIOBIO Work Package 3 and is reported in a separate output produced by BOKU (Deliverable 3.1, Arndorfer et al. 2010). Guidelines are provided to ensure that each of the 12 Case Studies is designed to focus upon the factor of interest, i.e., organic versus conventional or low-input versus intensive farming systems. Selection criteria are provided in the report to ensure that the factors of interest are not confounded with other factors known to potentially affect biodiversity. Two sets of potential confounding factors are recognized in BIOBIO:

1) Environmental conditions: biogeographical region, geomorphological and soil features, landscape situation, altitude.

2) Farm characteristics: type of farm (crops, forage, mixed farming, animal species), size, management intensity, uncultivated habitat types.

Examples of possible confounding effects and problems of interpretation caused by poor farm selection include:

a) all (or most) of the organic farms are selected at high altitude in a region while all (or most) of the conventional farms are selected at low altitude. An observed difference by biodiversity indicators cannot clearly be attributable to the farming system because altitude is correlated with the farming system. It is then difficult to determine whether an observed difference in measurements of biodiversity indicators is due to the farming system or to altitude (see FIG. 2.1).

b) all (or most) of the selected organic farms have crops while all (or most) of the selected conventional farms have mixed farming or vice versa. An observed difference by biodiversity indicators cannot clearly be attributable to the farming system because the type of farm is correlated to the farming system. In this example it is difficult to determine whether an observed difference in measurements of biodiversity indicators is due to the farming system or to the type of farm.

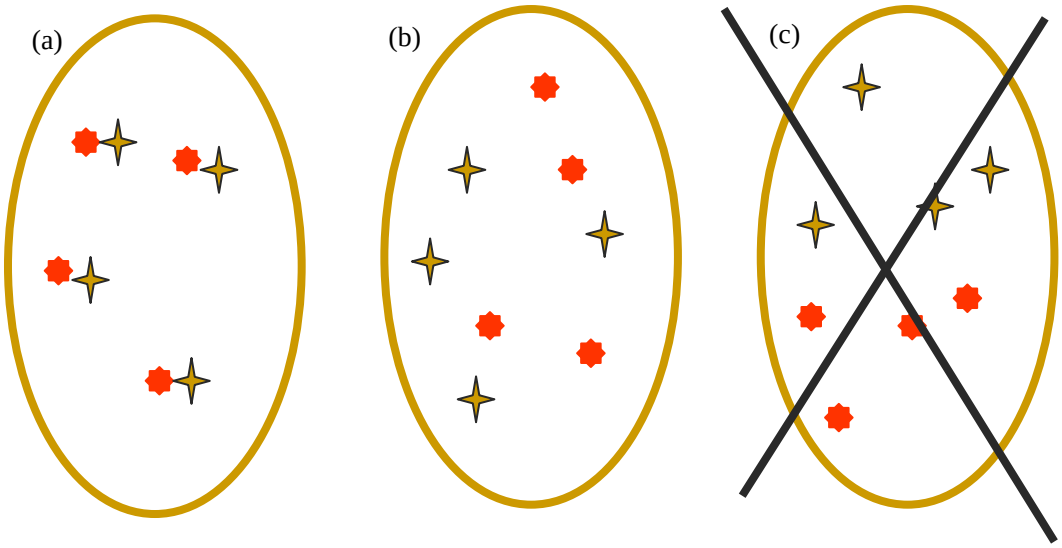


FIGURE 2.1. ACCEPTABLE PATTERNS OF FARM SELECTION FOR THE COMPARISON OF ORGANIC AND CONVENTIONAL FARMS (A) AND (B). THE SYSTEMATIC BIAS IN OPTION (C) MUST BE AVOIDED

In each case study region, 16–20 farms will be selected for the evaluation of candidate biodiversity indicators (TABLE 2.2).

TABLE 2.2. NUMBER OF FARMS TO BE INVESTIGATED IN INDIVIDUAL CASE STUDY REGIONS

Case Study country	**Farming system**	**No. of farms**
Organic farming		
A: Austria	arable	8-10 organic & 8-10 conventional
F: France	arable	8-10 organic & 8-10 conventional
D: Germany	mixed	8-10 organic & 8-10 conventional
W: Wales	grassland	8-10 organic & 8-10 conventional
CH: Switzerland	grassland	8-10 organic & 8-10 conventional
NL: Netherlands	horticulture	8-10 organic & 8-10 conventional
I: Italy	vine	8-10 organic & 8-10 conventional
E: Spain	olive	8-10 organic & 8-10 conventional
N: Norway	grassland	8-10 organic & 8-10 conventional
Low-input farming		
E: Spain	dehesa	10 dehesas[1]
BG: Bulgaria	grassland	16-20 low-input farms
H: Hungary	grassland	16-20 low-input farms
ICPC Partners		
TN: Tunisia	Olive	8-10 organic & 8-10 conventional
TN: Tunisia	Dehesa	10 dehesas
UA: Ukraine	Arable	8-10 organic & 8-10 conventional
EAU: Uganda	Arable	8-10 organic & 8-10 conventional

[1] Dehesas can be very large (1 sqkm or more). Heterogeneity is found within desesas rather than between. The number of dehesas to be sampled is reduced to 10 in order to limit the effort for fieldwork to the expenses as planned.

2.2. OVERALL SAMPLING STRATEGY FOR EACH FARM

Farm selection will be random assuming the consent of individual farmers is received to access and carry out sampling on their farm. Once the farms have been selected, the following operations will be carried out:

1) Carry out habitat mapping across the entire farm of all parcels of habitat, linear features and adjacent unfarmed features such as hedgerows and walls (described in Section 3).
2) Randomly select one example of each habitat type recorded on the farm (up to 15 different types; illustrated in FIG. 3.1).
3) Carry out surveys of vegetation, spiders, wild bees and earthworms on each example insular and linear habitat (described in Section 4.2).
4) Interview the farmer about genetic resources (described in Section 4.3) and management practices and inputs-outputs for 2010 reference year (described in Section 4.4).
5) Record the time spent on indicator measurements (described in Section 4.5).
6) Report the data to the central database (described in Section 5).

2.2.1. Convention agreed for farm area to be surveyed on case study farms

The farm size constitutes the area of land under agricultural management by the selected farmer, including dispersed fields but generally excluding communal grazing land. In Norway and Wales, communal grazing land will be included because it is critical to the livestock production systems practiced in those countries. All fields that are rented by the farmer will be included in the farm area but land that is let by the farmer to third parties will not be included in the farm area for investigation. There may also be a difference within the farm, especially where mountain grazing occurs in a separate location from the lowland area of the farm. The terms for this are as follows: in-fields and out-fields (Sweden and Norway), inbye and outbye (Northern England), fields and ffridd (Wales). In the context of BIOBIO, elements adjacent to the farm and affected by farming practices are also mapped, even if they are outside the actual farm property (category 6, Tab. 3-1; e.g. the side of a hedge facing the field belonging to the farm).

3. HABITAT MAPPING AND THE SELECTION OF VEGETATION PLOTS ON CASE STUDY FARMS

(Debra Bailey, Bob Bunce, Marion Bogers, Rob Jongman and Ilse Geijzendorffer)

BIOBIO has adopted a standard habitat mapping procedure for the European scale developed in the BioHab project (Bunce *et al.,* 2008). The method of habitat/land use classification is based on an appropriate generic system of habitat definitions, General Habitat Categories (GHC). The habitat qualifiers, which characterize individual habitats with respect to their ecological features and quality, can include categories specifically related to farming and High Nature Value farming areas. The method has been adapted with refined GHC definitions to deal with the assessment of organic/low-input farm holdings that may vary in size, may not be a contiguous land area, often intertwined with other farms. An initial classification of farmed and unfarmed land has been described (TABLE 3.1), which builds on the work developed within a research project on unfarmed features carried out for the EU in 2008 (Jongman & Bunce, 2008) and has been tested in the EU FP6 SEAMLESS project. The application of this typology of areal, linear and point features is essential because much biodiversity is restricted to linear features which are not directly managed by farmers but remain influenced by farming practices (Bunce *et al.,* 2005). A maximum of 15 species diversity recording plots will be assigned to each of the farmed categories and those categories indirectly affected by farming. Land uses such as urban and forestry will be excluded.

TABLE 3.1. OVERVIEW OF FARMED AND UNFARMED CATEGORIES. SPECIES DIVERSITY PLOTS IN BIOBIO WILL BE PLACED IN CATEGORIES **1,3,4,5** AND **6**

1. *Fields managed only for agricultural objectives.* Such fields are usually intensively used but may also involve extensive systems. Usually there is a division between:
    a. *Cultivated land used for arable (e.g., wheat) or perennial or woody crops (e.g., fruit trees, vineyards)*
    b. *Grasslands used directly (grazing) or indirectly (hay, silage) by livestock*

2. *Fields managed regularly for non-agricultural objectives.* Usually these fields are used for horses or donkeys held for recreational purposes but could also include fields and mesotrophic grasslands managed for nature conservation and landscape objectives.

3. *Unenclosed land used regularly by stock, usually sheep and goats but also cattle and horses for meat.* This category has a wide range of use intensity and varies in character both regionally and locally. It includes many upland grasslands and heathlands but also dehesas, montados and wood pastures elsewhere. There is a potential overlap here with forests grazed by domestic stock where the tree cover is over 30%, so such land should be included here as the structure and character of the ecosystems present are determined by grazing.

4. *Unenclosed land used occasionally by sheep or goats but not in regular agricultural use and minimally affected by grazing* (e.g., some blanket bogs and mountain summits in Britain).

5. *Linear or point features on, or adjacent to, farmland that are managed directly or are likely to be highly influenced by farming activities e.g., hedges on farmland and grass strips between fields*[2].

6. *Linear or point features on, or adjacent to, farmland that are indirectly influenced by current agriculture but are not managed actively* (e.g., field corners and small woodlands surrounded by agricultural land).

7. *Land not used by agriculture (usually urban herbaceous using the BioHab definition) and managed usually by mowing, e.g., roadside verges, recreation areas and sport fields.*

8. *Land not used by agriculture but maybe managed for forestry, nature conservation except where grazing is involved or urban objectives*
    a. *Abandoned fields and unenclosed land no longer used by agriculture.* Long term set-a-side could be included here. This category would also include habitats under nature conservation management e.g., wetlands, some salt marshes and heathlands.
    b. *Land which has never been used by agriculture or managed e.g., steep roadside banks, cliffs and scree.*
    c. *Forests.* These could be divided into three categories if a relationship was required with intensity of management
        (i) Forests managed regularly often for nature conservation objectives using active management e.g., coppice woods for vernal flowers and for firewood
        (ii) Commercial forests of planted species e.g., Sitka spruce in the UK and Norway Spruce in northern and central Europe. Small recent amenity plantations are not included here as they are still indirectly affected by agricultural practices
        (iii) Forests that have not been managed in recent times, say about 50 years
    d. *Urban land within the definition provided by the BioHab project (Bunce et al., 2005; 2008)*

[1] The separation of categories 5 and 6 is to some degree arbitrary. But was determined on the basis that class 5 actually had deliberately inputs from farmers, e.g.,cutting hedges. Class 6 will have only indirect effects from farming, e.g.,spray drift.

3.1. THE GENERAL HABITAT CATEGORIES (GHC) METHOD

The BIOBIO project has, like the EU FP7 EBONE project (EBONE online), three tiers of recording of biodiversity with small deviation in the top level:

A. The landscape level: km squares in EBONE = whole farms in BIOBIO.
B. The habitat level where complexes of habitats form landscapes = habitat level in BIOBIO.
C. The vegetation level; where different types of vegetation make up the habitats = vegetation level in BIOBIO.

TABLE 3.1 lists the farmed and un-farmed elements to which it is intended to assign vegetation & fauna plots. Testing this typology in SEAMLESS firstly showed that the different classes had inherently different vegetation present and that any comparison of biodiversity had to be carried out within relatively homogeneous units. In the BIOBIO project, biodiversity recording will be undertaken at the habitat (farmed/unfarmed categories) and vegetation & faunistic level with the landscape unit represented by the farm.

Prior to the mapping, the farm boundaries have to be obtained either from cadastral maps or from the farmer directly.

The structure of the BIOBIO field recording is shown in FIG. 3.1. Once the farm has been mapped, one "specimen" of each habitat category will be randomly selected and a vegetation and fauna plot will be installed. It is important to locate the vegetation and fauna plots precisely on the habitat map so that destructive sampling of other groups, e.g., earthworms can be carried out adjacent to but not inside any vegetation plots. Each plot can be recorded using a GPS unit and with field notes of the character and location related to adjacent landmarks. Vegetation plots in BIOBIO will only be recorded in the following types of land as defined TABLE 3.1.

1a) Cultivated land
1b) Enclosed grassland used by livestock
3) Open land used regularly by agriculture
4) Open land used occasionally by agriculture
5) Features directly affected by farming
6) Features indirectly affected by faming

Categories 2, (Grassland used for non-agricultural purposes), 7 (Land not used for agricultural purposes, usually urban) and 8 (Land not used for agricultural purposes, usually forestry, except in Fennoscandia) are excluded because they are not found on farms.

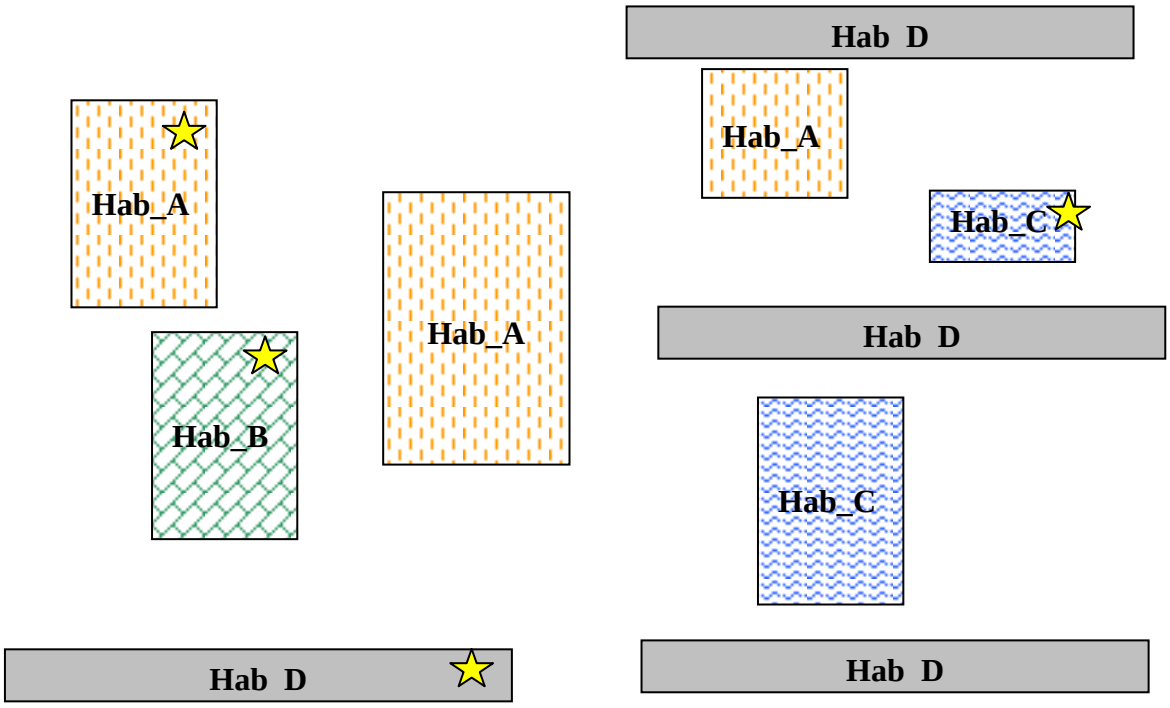


FIGURE 3.1. ON THIS SCHEMATIC FARM, 6 AREAL AND 4 LINEAR HABITATS HAVE BEEN MAPPED. THEY BELONG TO FOUR DIFFERENT HABITAT TYPES (A, B, C, D). FROM EACH HABITAT TYPE, ONE SPECIMEN HAS BEEN SELECTED FOR SPECIES DIVERSITY MEASUREMENTS (MARKED WITH AN ASTERISK).

3.1.1. Timing of habitat survey

According to Storkey *et al.* (2008), the timing of the sampling within a growing season will be determined by:

A. The stage in the life cycle of the indicator that is affected by the agricultural management activities;
B. The phenology and behaviour of taxonomic groups;
C. The heterogeneity of the life-histories in the taxonomic group: where species groups include a mixture of life-histories, multiple sampling dates across the growing season are required;
D. The potential long-term effect of the new agricultural practices, inducing a time lag in the response of the indicators. This point is particularly important in the present program both for the choice of the farms (how long have organic farming practices been conducted?) and the choice of indicators.

Directly measured management indicators such as land cover should be described when most of the crops and management activities are easy to identify. In practice as emphasised by Bunce et al. (2008) the best procedure is to sample at the height of the growing season.

3.2. HABITAT MAPPING: GENERAL RULES

Each field in the recording sheet is explained and decision rules are presented. The actual definitions are found in APPENDICES 7.1 and 7.2 and the GHC methodology manual (EBONE online).

3.2.1. Mapping of individual elements

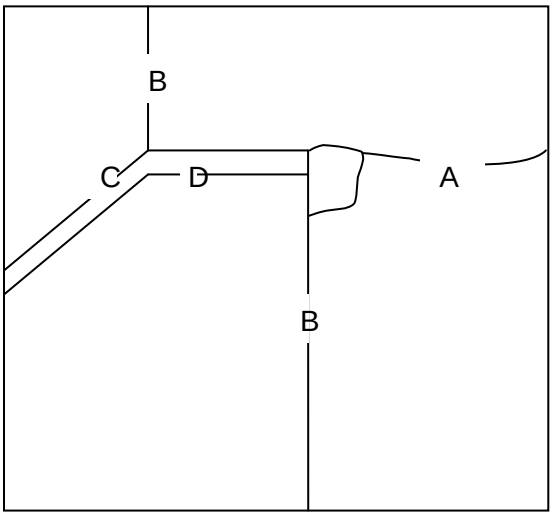
Separating map elements is based on strict rules. The mapping of areal elements adds to 100% of the land. The entire survey area defined by the farm property boundary must be mapped. It is important to consider that in general, larger elements should be mapped rather than attempting to map small patches which do not have distinct boundaries. GIS procedures for estimating the area of fields/parcels of habitat or the length of particular linear features are explained in APPENDIX 7.3.

To determine what an element is, the decision rules are as follows:

1. The Minimum Mappable Element (MME) for an areal element is 400 m^2 with minimum dimensions of 5 x 80 m.
2. If the element is smaller than 5 m it is recorded as a linear element with a Minimum Mappable Length (MML) of 30 m.
3. Elements that do not pass the MME or MML criteria can be mapped and recorded as point elements or as a stated proportion of a larger element.

Elements with a total extent that passes the MME criteria for an areal element and lie across the farm property boundary should be recorded as areal elements even if the part of the element that is within the survey farm is below 400 m^2

If a linear element has 20 m inside the target farm and at least 10 m on the adjacent farm (i.e. total length is >30 m) it should also be recorded. It is not uncommon for linear elements to form complexes, with several distinct linear elements adjacent to each other, such as a hedge next to a ditch next to a track. (e.g., FIG. 3.2)



α code	Linear element
A	HED
B	HST
C	LTR
D	VTR

FIGURE 3.2. MAP ILLUSTRATING POSSIBLE COMPLEXES OF LINEAR ELEMENTS

3.2.2. Recording of individual elements

The GHC methodology is based on Life Forms and Non Life form categories with specific qualifiers. For European coherence in data, environmental conditions must be considered at a continental scale: e.g., "dry" in Scotland may be "mesic" compared with southern Italy (definitions are provided on EBONE online). In order to avoid

inconsistency field surveyors should make as many decisions as possible in the field and not postpone them to the laboratory. The creation of new categories is not encouraged, but when a major survey is underway surveyors should contact a central bureau to assign new classes. There are two types of data to be recorded: (a) the GHCs and (b) various qualifiers.

Surveyors are provided with lists of GHCs (APPENDIX 7.1) and qualifiers, which should be used to describe each mapped element (area, line or point) in the survey area. Non-standard secondary codes can also be used for site and management qualifiers if the observed site or management qualification is not covered by the standard site and management qualifier code lists. If a non-standard code is used, its definition (i.e., description of the observed qualification it is being used for) must be noted in the field marked "unique codes" on the appropriate data recording sheet. Different sets of qualifiers can be developed for different regions and biomes.

The limited list of GHCs and specific rules to define them is designed to avoid a potential multiplicity of codes and mosaics and to provide a lowest common denominator for linking disparate datasets. The full spectra are recorded later. Elements are assigned **alpha codes** as identification codes that are the same on the map and on the corresponding recording sheet. All fields must have an entry in order to ensure that subsequent database management can identify that an entry has not been omitted in error. In order to give as much information as possible about a GHC and the dominant species of mapped elements, field five of the data recording sheet is reserved to record these details for each alpha code that is used.

3.2.3. Recording Form

A separate recording format and record sheet is to be used for areal, linear and point elements. The recording form for areal elements has an alpha identifier and eight subsequent recording fields (TABLE 3.2). The first entry is for the alpha code which links to the GHC. When recording, it is best to first fill in the alpha code, then fill in column 5 (full list of habitats) and then decide upon the GHC in column 2.

- The *first field* is for entry of the GHC.
- The *second field* is for entry of the global and the environmental qualifier, for expressing moisture regime and acidity variations between elements that otherwise may have the same GHC. Instruction on assessment of these qualifiers was included in the field training workshops (e.g., regional plant indicators).
- The *third field* is for entry of the site qualifiers to record other characteristics, e.g., geomorphology, geology, soil or archaeology, in order to express variation between elements that may have the same GHC.
- The *fourth field* is for entry of the management qualifiers to record managed characteristics, e.g., forest management, succession and recreation, expressing variations between elements that may have the same GHC
- The *fifth field* is for entry of the full list of habitats within the GHC together with the major species and percentages
- The *sixth field* is for entry of European Habitat classifications, including EUNIS, Annex I and other pan European classifications
- The *seventh field* is for entry of Farmed and Non-Farmed features, if appropriate.

TABLE 3.2. THE RECORDING FORM FOR AREAL ELEMENTS

Observers: **Date:** **Location:**

Code	**Field 1**	**Field 2**	**Field 3**	**Field 4**	**Field 5**				**Field 6**	**Field 7**
α	General Habitat Category	Global/ Env. Qualifier	Site Qualifier	Man. Qualifier	Habitats/Species				Annex I	Farmland Class
					Full list of Habitats	%	Species	%		
Additional codes/Comments										

BIOBIO has a simplified form for linear features (TABLE 3.3)

TABLE 3.3. THE RECORDING FORM FOR LINEAR ELEMENTS

Observers:		**Date:**		**Location:**	
code	**Linear Element**	**Farmland Class**	**code**	**Linear Element**	**Farmland Class**

Comments

3.3. MAPPING AREAL ELEMENTS

Areal elements are drawn on a separate map from the linear elements. Elements are assigned alpha codes as identification codes that are the same on the map and on the corresponding recording sheet. Capital letters of the Latin alphabet are used for the alpha code. "I", "O" and "X" and should not be used. Once all the letters of the alphabet have been used then double codes are used: e.g., AA, AB, AC etc.

The alpha code for an areal element should be placed as closely as possible to the centre of the element.

Separate mapping elements that have identical data coding (i.e. entries in Fields 1 – 8) have the same alpha code; otherwise a new alpha code is used. Both the areal element registration and the linear/point element registration use the full alphabetic sequence for their alpha codes, i.e., both registrations can use "A", "B", "C", etc. as their alpha codes. If using field computers the coding must be unique. In these cases the Codes A1, A2, etc.

3.3.1. Rules for separating map elements (i.e., new Alpha codes)

A new areal or linear element will be mapped and separated from adjacent or surrounding elements if any one of the following nine rules is true:

- A change in GHC.
- A change of more than 30% of a cover of a GHC.
- A change in environmental qualifier.
- A change in site qualifier.
- A change in the occurrence of point elements.
- A change in management qualifier e.g., a fence line or age of forest trees.
- A change of at least 30% in the cover of an individual species over the whole element
- A change of at least 30% in any of the vegetated tree/ shrub (TRS) layers, if they are being recorded under forest canopies.
- A change in any other specified European habitat, especially the habitats of Annex I of the Habitats Directive.
- A change in the proportion in the Annex I habitats.

In lowland landscape separate fields should be individually mapped, even though the boundaries may not be delimited by fence lines or grass strips. In most cases these will already be marked as separated elements on the Aerial Photograph. These data are required for subsequent spatial analyses.

3.3.2. Determination of the General Habitat Category

This section describes the rules for the determination of the GHC (i.e., the primary recording code) for areal elements. For the full list of GHCs see APPENDIX 7.1.

Determination of the GHC is based upon a sequence of five dichotomous divisions (FIG. 3.3) related to a set of six super-categories (Urban, Cultivated, Sparsely Vegetated, Tree and Shrubs,

Herbaceous wetland and other Herbaceous) which determine the series of Non Life Form Categories and Life Form Categories that can be used to identify the appropriate GHC.

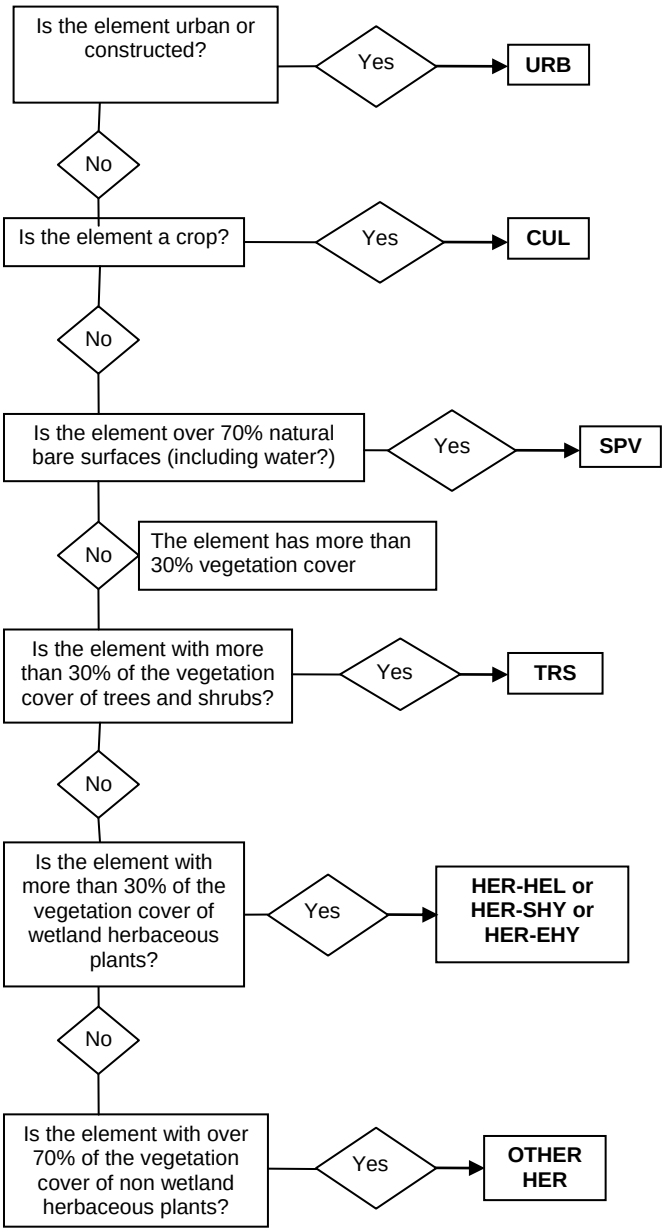


FIGURE 3.3. DECISION TREE FOR SUPER CATEGORIES

The percentage cover of land surface for a given habitat is estimated from a vertical perspective that is the land cover is as seen from above, e.g., not that observed beneath a tree or shrub canopy.

3.3.2.1. Percentage rules for determining the GHC

For determining the GHCs there are only two percentage rules: over 70% for single GHCs or 40-60% for GHC's that are combinations of two habitats. An element with >70% cover of a single life form or non life form category is a GHC with a single code e.g., ART= Urban/Artificial or

HEL= Herbaceous/Helophytes or a double code if the GHC belongs to the TRS supercategory e.g., FPH/CON and FPH/DEC.

Elements with 40-60% cover of two life forms or two non-life form categories belonging to the same super category of in case of TRS belonging to the same height category, are also GHCs, but with a double code, e.g., ROC/GVR or SHY/EHY or with a triple code if belonging to the TRS supercategory e.g. mixed Deciduous/Conifer Forest (FPH/DEC/CON). If there are equal proportions of life forms then rules to decide precedence are provided. The precedence will be given in the order of the GHCs as listed in FIG. 3.4, e.g., if an element has a coverage of ART 30/NON 30/VEG 30/GRA 10, the GHC would be ART/NON with full percentages in field 5.

3.4. SUBDIVISION OF GENERAL HABITAT CATEGORIES

3.4.1. Field one: Rules for determining GHCs

All codes are unique e.g., ART or GRA. This means that on the recording form the first identifier URB, CUL, SPV, HER and TRS can be omitted to save recording time and space. GHCs may be Life Forms or Non Life Form Categories, i.e., urban, cultivated or sparsely vegetated or combinations. A summary list of GHCs and habitat codes is given in APPENDIX 7.2.

Non Life Form Categories (Crops) will form an important part of the areal elements in the arable and horticulture areas. **Life Forms Categories** can be qualified by the list of **Life Form Qualifiers**. These life form qualifiers avoid a great increase in the number of GHCs and will express local variation. Note that the GHCs reflect the dominant plant cover. More complete information about the whole range of Life Forms can be obtained by analysis of the vegetation plots. Ellenberg values suggests that dominants can be more informative about the relationships between habitats and the vegetation. The Life Forms are based on the definitions available from plant morphology, a discipline now virtually absent from university courses. Most users will not therefore be familiar with the terminology involved so the descriptions have been made as general as possible. For example the "leaves" of some *Acacia* species are actually modified shoots. In some cases also the strict morphological definitions have not been used in order to be as close as possible to the regression concept of Life Forms. The most widely used modification is of rhizomes, which in general act as organs of vegetative reproduction rather than overwintering.

The division in Non Life Form Categories and Life form Categories as well as its subdivisions and qualifiers is presented in FIG. 3.4.

3.4.1.1. Urban/Constructed

The urban categories have aggregated life forms as a second tier, e.g., herbaceous includes all herbaceous life forms e.g. caespitose, hemicryptophytes and therophytes. The term urban applies to technically "urban" or "built-up" land, within the boundary of the land functionally related to buildings. The term is not based on life forms, but is a land-use division. Land is defined as urban, when it is *"an area of ground that is associated with a building and which has a use linked to that building e.g., garden"*.

The dominant function of the land should be considered, e.g. if an area is used as a camp site, recreation for two weeks a year and the other 50 weeks it is grazed by cattle and sheep then it is not urban.

In case of scattered holiday homes such as caravans within semi-natural vegetation then a boundary should be drawn around the whole area and the appropriate point element procedure used to record scattered buildings within the surrounding GHC.

Glasshouses and polytunnels are urban (ART) with the qualifier "horticultural use" (A5.7) regardless of what is actually inside the unit, because it is not possible see what is growing inside.

The grounds of some large country houses grade almost imperceptibly into woodland, in which case evidence of garden practice on the one hand, and forestry operations on the other, should be used to draw an arbitrary line. If necessary the justification for this line should be given using the global code for an indistinct boundary, so that repeating survey can check whether there has been real change.

Linear elements previously outside urban areas e.g., sunken roads and hedges that have subsequently been surrounded by urban development are not recorded.

Each group of super categories must be recorded with the highest value first or in the order given below.

The following GHCs have been defined to cover urban elements. Some constructed elements are also included in the global and linear codes. The sequence provides the precedence rules as described below.

- *Urban artificial (ART):* This category includes all built up land that is covered in buildings, tarmac, concrete or other artificial material. Street lights, electric pylons and telephone poles are not recorded.
- *Urban Non-vegetated (NON):* This category includes all non-vegetated land that is within an urban boundary, whether a construction e.g. a fence as an arbitrary boundary e.g. around a quarry. Mostly these categories are the result of urban activity rather than agriculture e.g. quarries, excavation sites and non-tarmac car parks, but water bodies in urban areas are also included here with appropriate qualifiers.
- *Urban Vegetables (VEG):* This category includes land that is under vegetables and/or fruit trees, such as black currents and gooseberries, within an urban area and includes, for example, allotments. These categories will rarely form over 400 m^2 as a pure category and will mainly be recorded as combinations. Fruit trees over 2m are included in TRE.
- *Urban Herbaceous (GRA):* This category includes land that is within the urban definition and covers less than 30% woody vegetation. This will include mainly grass e.g. playing fields, lawns and recreation areas, but also includes other herbaceous life forms.
- *Urban Woody (TRE):* This category includes land that is covered by woody vegetation over 2m (i.e. TPH + FPH) this category includes fruit trees such as apple, pear and plum, as well as tall shrubs and trees. This rule is because satellite images will not be able to separate any of these groups. It may form an area around large houses, but will often be recorded as combinations. Percentages below 30% are not recorded as separate GHCs.

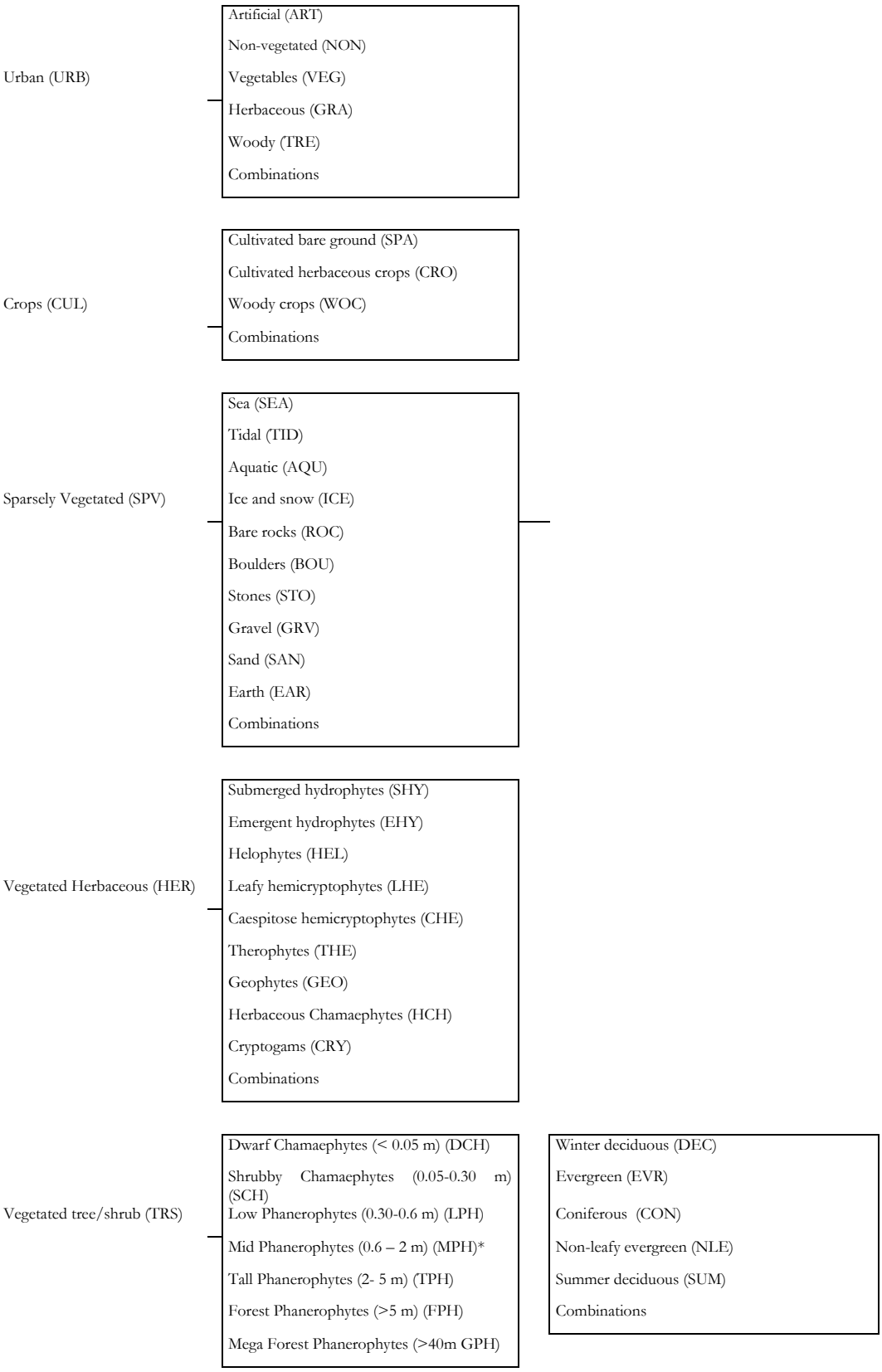


FIGURE 3.4. DIAGRAMMATIC REPRESENTATION OF THE BIOHAB KEY.

3.4.1.2. Cultivated

Crops are mainly the product of plant breeding and are usually readily separated from their wild counterparts. Some native species such as walnut and carob are not distinct but should only be included as crops if they show definite evidence of having been planted. Wild species collected from semi-natural vegetation are excluded.

- The individual crops are recorded in the same way as plant species in field five. The percentages are not necessarily cover, but rather the percentage of the crop plants. If it is just recently sown or germinated the cover is a nominal figure. The percentages are needed because sometimes there are mixed crops, e.g., oats and barley.
- Land currently occupied by crops, or bare land with less than 30% cover and evidence of cultivation is recorded within the crop category with appropriate qualifiers.
- Crop land management is not always synchronic with maximum biomass. Therefore if the crop has been harvested within the last month, but evidence of the actual crop is present, then it should be recorded as such. Dual cropping cannot therefore be recorded, but only the crop at the height of the season.
- Any plant cover after harvesting, e.g., stubble, is not recorded.
- If there is over 30% cover of native species or crops in orchards, vineyards or olive groves it should be recorded in field 5 using the standard life form codes.
- If there is still evidence of cut stems in a crop even if there is over 30% cover of vegetation then it should still be recorded as crop. If the colonizing vegetation has smothered the crop stems-usually 3-5 years then it should be recorded as life forms only with a qualifier that there was evidence of former cropping e.g., plough lines
- Vines are regarded as abandoned if there is no evidence of pruning in the last five years.
- Olives and orchards are regarded as abandoned (see agricultural & semi-natural vegetation state management qualifiers) if there is no evidence of pruning, recent use, or collection of fruit.

The following GHCs have been defined to cover crop elements. The sequence provides the precedence rules as described below.

- *Cultivated bare ground (SPA):* elements with no crops planted or less than 30% cover of vegetation, including volunteers (self-seeded crop plants). Includes therefore only bare fallow or recently ploughed land which otherwise is recorded as a qualifier (EBONE Field Manual) together with appropriate GHC. This code should only be used if the element has no woody crops.
- *Cultivated herbaceous crop (CRO):* The partners with arable farms in their case study have agreed upon four categories of herbaceous crops, hence, this can result in a maximum of four plots in herbaceous crops (TABLE 3.4). The list of crops is not complete, so species can be added to the list when encountered. The Netherlands will expect to have to add multiple vegetable and fruit crops as they come up on their horticulture farms. Within these categories it is important to sample randomly for the subsequent statistical analysis. BIOBIO focuses on biodiversity at farmscale and therefore all biodiversity should be represented. The categories are now as narrow as possible and should yield meaningful results for comparison.

TABLE 3.4. IN BIOBIO THE HERBACEOUS CROP CATEGORY IS SUB-DIVIDED INTO FOUR CATEGORIES AS THE ONE CRO CATEGORY WAS CONSIDERED TO BE TOO COARSE. THE DIVISION IS BASED ON TWO CRITERIA: SOIL TILLAGE AFFECTING EARTHWORM POPULATION AND CROPS ATTRACTING INSECTS

Annuals, not entomophilic and/or bee attracting		**Annuals, entomophilic and/or bee attracting**	**Perennials**
Winter crops	**Spring crops**		
Winter oats	Spring oats	Rape	Fodder crops
Triticale	Beans	Sunflower	Lucerne
Winter barley	Spring barley	Maize	Asparagus
Beans	Peas	Soya	
Winter wheat	Lettuce	Cucumber	
Rye		Tomatoes	
		Potato	
		Strawberries	

- *Cultivated woody crops (WOC):* includes all elements with trees or scrub, e.g., orchards, vineyards and olive groves. Cover cannot be used as a criterion to determine this GHC because of pruning. Therefore the rule is that there should be at least 20 trees/shrubs per ha, otherwise the scattered tree code can be used. The names of crops, both English and Latin are given in section 3.5. Any vegetation cover, below or beneath the woody crop, over 30% should be recorded with appropriate life forms in field five.

3.4.1.3. Herbaceous wetland

Examples of widespread species with short descriptions of all the following Life Forms are given in Annex 1 of the EBONE Field Manual

- **Submerged hydrophytes (SHY):** plants that grow in aquatic conditions (see 4.3.1) the whole plant in water. This category includes marine species and floating species which overwinter below the surface. Such plants are included as life form qualifiers to this GHC. The class excludes aquatic bryophytes.
- **Emergent hydrophytes (EHY):** plants that grow in aquatic conditions (category 1, see 4.3.1) with the main plant above water.
- **Helophytes (HEL):** plants that grow in waterlogged conditions (category 2, see 4.3.1).

The presence of over 30% of these three classes take precedence over SPV and Herbaceous Life Form categories.

Some species behave very differently in different situations. For example *Phragmites* if growing in water or waterlogged conditions would come within this class, but it can often grow outside waterlogged areas. In Israel it often grows away from water with permanent tall stems and is therefore a phanerophyte. In these cases it is therefore considered as MPH or TPH with the appropriate life form qualifier for bamboos and canes. The water level at the time of survey is that which is recorded. Whilst there may be differences between years experience in the GB-CS shows that this procedure works in practice. Exceptional conditions can anyway be recorded.

3.4.1.4. Herbaceous

Guidelines for the identification and further details of widespread species with short descriptions are given in Annex 1 of the EBONE Field Manual

- **Leafy hemicryptophytes (LHE)**: biannual or perennial broad leaved herbaceous species, sometimes termed forbs. Annual species are considered as **THE** (see below).
- **Caespitose hemicryptophytes (CHE):** perennial monocotyledonous grasses, sedges and rushes regardless as to whether they have rhizomes which in some floras are regarded as geophytes. Annual species are considered as **THE** (see below).
- **Therophytes (THE):** annual plants that survive during the unfavourable season as seeds. Small patches of therophytes of about 40m^2 will not feature as GHCs except for in desert areas. In other cases they will only be recorded in field five if over 10% cover of the total area in the element. Therophytes cannot be used to identify true deserts as where they may not be present for several years but are often characteristic of semi-deserts and true xeric conditions. The recording of Therophytes in deserts is linked to rainfall events.
- **Geophytes (GEO):** plants with buds below the soil surface. But not those with rhizomes-see further information in section Annex 1 of the EBONE Field Manual.
- **Cryptogams (CRY):** bryophytes and lichens that are growing on the soil surface and some aquatic bryophytes, e.g. *Sphagnum spp.* Cryptogams growing on rock surfaces are recorded as life form qualifier to the appropriate TER divisions.
- **Herbaceous Chamaephytes (HCH):** cushion plants usually with perennial leaves.

This sequence provides the precedence rules for equal proportions of life forms, i.e. CHE 30/THE 30/GEO 30/CRY 10. The General Habitat Category is CHE/THE. The full formation is recorded in column five. Other groupings e.g., carnivorous plants could be derived from analysis of the data from field 5 and the botanical plots.

3.4.1.5. Trees and shrubs

Most of the following habitats are woody – the term usually used in habitat classifications - but some Chamaephytes e.g. *Phagnalon* spp.*, Artemisia* spp. and *Asparagus* spp. do not have secondary ligneous woody thickening in strict botanical terminology. However these genera have a shrubby form and have perennating buds above ground level. Height is therefore the only consistent arbiter (see Annex 2 of the EBONE Field Manual for examples of plasticity). Note that all the classes below are rooted in the ground. See 3.1.7 for epiphytes.

The term trees and shrubs refers to individual plants and life forms. In the landscape groups of trees and shrubs combine to form **forest** and **scrub** habitats. The term shrub land is often used in the literature as land cover. E.g. in the manual for the CORINE land cover map, but it is not the correct English usage.

The first stage is the definition of the height categories and the second stage the definition of the biome (often termed phenological) categories as height alone is not an adequate descriptor and also will not link with other modelling procedures.

The global codes **SCA** and **OPE** can be applied if the cover of trees and shrubs is below 10%. Clumps of trees and shrubs below 400m^2 can recorded as points. Individual trees or shrubs can also be recorded as points if they are ecological significant (see 3.2.4). Do not record the GHC or species.

In young plantations the cover of GHCs should be recorded. There is an appropriate code in the forest qualifiers to show that it is a young plantation so that they can be extracted as forest land use later.

- **Dwarf Chamaephytes (DCH)** dwarf shrubs: below 0.05 m e.g. *Dryas octopetala, Salix herbacea.*
- **Shrubby Chamaephytes (SCH)** under shrubs: 0.05-0.3 m. e.g. *Thymus vulgaris, Lavendula stoechas.*
- **Low Phanerophytes (LPH):** low shrubs, buds between 0.30-0.6 m, e.g. *Myrica gale, Betula nana.*
- **Mid Phanerophytes (MPH):** mid shrubs, buds between 0.6-2.0 m, e.g. *Pistacia lentiscus, Cornus mas.*
- **Tall Phanerophytes (TPH):** tall shrubs, buds between 2.0-5.0 m, e.g. *Salix cinerea, Corylus avellana.*
- **Forest Phanerophytes (FPH):** trees between 5.0 and 40 m, e.g. *Quercus robur, Fagus sylvatica.*
- **Mega forest phanerophytes (GPH)** trees over 40 m e.g. *Sequoia gigantia*, *Sequia sempervirens*

The following leaf subcategories, are designed to fit into world biome systems and apply to the six shrubs and trees categories with over 70% being a single category and 40-60% being combinations. They are discussed by Raunkiaer, although he was more concerned with the position of buds, whereas these classes are linked primarily to phenological status.

The groupings below are mandatory and are the major categories forming GHCs, as they are the lowest common denominators for classifying trees and shrubs.

- **Winter deciduous (DEC):** e.g. *Quercus robur, Fraxinus excelsior.*
- **Evergreen (EVR):** *Quercus ilex*, *Laurus nobilis.*
- **Conifers (CON):** *Pinus nigra*, *Juniperus communis.*
- **Non-leafy evergreen (NLE):** e.g. *Sarothamnus scoparia, Ulex europea.* Some of these species have leaves which are short lasting *e.g. Cytisus and Ulex*
- **Summer deciduous (SUM):** *Acacia species, Zyziphus lotus*

The following precedence rules apply to **TRS** categories:

- The height categories are mutually exclusive i.e. if FPH reaches 30% it cannot be combined with other height categories, because of the character of tree/shrub vegetation and because by introducing combinations there would be an unmanageable number of GHCs. This decision fits with other habitat classifications.
- Where there are equal percentages of height categories then precedence is given to the tallest category with over 30% cover, because that expresses the environment optimally.
- In cases of even phanerophyte combinations, e.g. TPH 30%, MPH 30%, LPH 30, SCH 10, then the precedence is given to the tallest category.
- The order of precedence is set by the conceptual nutrient/environmental demands of the species groups i.e. winter deciduous species are generally in temperate conditions,

whereas summer deciduous are in xeric situations. The ranking is the same for all forest and scrub sub-categories. Precedence rules are used for combinations, e.g. MPH/DEC 30, MPH/EVR 30, MPH/NLE 20, LPH/CON 20 = MPH/DEC/EVR.

- In cases of even balance within a given class, e.g. TPH/DEC 30, TPH/EVR 30, MPH/CON 30, LPH/CON 10 then precedence is given to the ranking above i.e. TPH/DEC/EVR.
- These examples are designed to cover all eventualities, but in practice the majority of elements are not so complex. Also the GHCs are designed to link data sets and the full spectrum is anyway recorded in field 5. These data can be used for more detailed analysis of life forms and can also be linked to vegetation relevees which give complete spectra for samples.
- Where there is much bare ground then the percentages are taken of the actual vegetation cover to determine the GHC. Strictly the percentages should be recalculated but in most cases the GHC is clear without extra notes, For example, EAR 60, TPH/EVR 20, MPH/EVR 10, MPH/EVR 10 = TPH/EVR as it is over 30% of the vegetation cover.

The General Habitat Categories (GHCs) were designed as the lowest common denominator for integration of datasets of different national surveys. However it was realized when developing the EBONE protocols, that for correspondence with high spectral satellite imagery, some herbaceous categories needed further subdivision through information on environmental qualifiers, which is suitable and is also recorded in the standard EBONE procedure. It has been decided only to devide the pure grasslands (*Caespitose Hemicryptophytes* CHE) and the mixed-grasslands (*Caespitose* and *Leafy Hemicryptophytes*, LHE/CHE). This is not required for the other categories, because these have much more information on structure e.g. tall and dwarf shrub. The matrix is given in section 3.2.3 of the updated fieldhandbook. Potentially this means that there could be up to 140 separate divisions of these two GHCs. In practice, in a given km square or farm there are only likely to be three or four such subdivisions. These subdivisions will be very important for biodiversity for example mesic neutral mixed grassland will be very different in species composition from mesic basic mixed grassland. In the section below subdivisions of the GHCs will be considered as separate habitats and sampled accordingly.

3.4.2. Procedure for random sampling

3.4.2.1. Areal features

1. Preliminary identification of fields of the farm based on the areal photograph.
2. In the field, determine field boundaries and the GHCs of the fields.
3. For the GHCs that are only represented by one field, allocate the plot in the centre of the field or along the edge when a crop is present in the field.
4. If there are more fields of one GHC, number all the fields of one GHC, e.g. a_1, a_2, and a_3. This should be done for all GHCs with multiple fields.
5. Randomly select one field per category using a randomization method and allocate the plot.
6. If there are less than five GHCs, take progressive random samples until five plots are selected for each farm. If there are less than five fields, randomly allocate additional plots in the fields present until five aerial plots are allocated.

3.4.2.2. Linear features and point features

7. In BIOBIO linear features are mapped based on a predefined list (see next section).

8. The only point features that are identified in BIOBIO are ponds. They are marked in the field and marked with an X and a number.

3.4.3. Predefined list of linear elements and ponds

The list below defines the linear features to be recorded using the second procedure. The descriptions are based on the information in the field handbooks of the GB and Northern Ireland Countryside Surveys, supplemented by European experience:

- *Ponds:* includes small areas of water below 400m^2, both natural and artificial ponds. A tempory pond will have evidence of former water cover and is included in this category.

- *Walls (WAL):* includes dry stone, mortared and brick walls with or without capping, as well as earth walls and banks, but not levees. The walls may retain terraces or be free standing. Ruined walls are included in the category, as long as there some sections are still standing, but not lines of rocks from former constructed elements. Height may be variable, as may width and style, depending on local materials and traditions. Walls are dominant linear features in some upland landscapes and on terraced hillsides in the Mediterranean. Elsewhere, in lowland situations, they are often linked to large estates. Walls within woodlands are not recorded.

- *Watercourses/water bodies (WAT):* includes seepage and spring lines with standing water, streams, rivers, canals, ditches of variable width with free standing water, ponds (but not temporary ones), lakes (including artificial water bodies). It may contain wet land plants or be without vegetation (Aquatic). They are very variable, from the major rivers of Europe, to small alpine streams. Elements over 5m wide and 80m long or over 400m square will be mapped as areas, but the edges are linear features.

- *Lines of scrub (LSC):* includes lines scrub over 30 cm but under 5m high with no evidence of management. In some regions, these are widespread on unmanaged banks by streams or on hillsides. Elsewhere they occur along unmanaged field margins or terraces. Often they consist of Rubus, with *Arundo donax* being common in the Mediterranean.

- *Hedges (HED):* has below 5 woody species per 30m and includes lines of **woody tree and scrub vegetation** over 30 cm but under 5m in height (for definition see section 3.1.6) with evidence of positive management, whether coppicing, laying (in GB), flailing, cutting or pruning. There may be have gaps but these must not be more than 50% - otherwise they are patches of scrub. *Ulex ssp.* is not generally considered as a hedge species, except in south-west England where it may be flailed, as may lines of *Rubus spp.* occasionally; however, both should be considered scrub. Locally, hedges are often on banks of stone or earth but the hedge takes precedence. If a line of managed scrub fits the definition of a hedge, it takes precedence over lines of trees which form a canopy above it - a situation common in Northern Ireland and Austria. Hedges form the basis of distinctive landscapes, such as the bocage of western France, but they are also common in western Britain, southern Lower Saxony (northern Germany), the Auvergne (central France), eastern part of the Netherlands and locally elsewhere. Hedges around woodlands are recorded.

- *Species Rich Hedges (SRH):* The definition of a hedge is given above. Species Rich Hedges have 5 or more species per 30m length.

- *Lines of trees (LTR):* includes lines of **trees over 5 m** in height whether spontaneous or planted. There may be an under-storey, but if this is managed, it should be treated as a hedge. They may have developed along field margins, beside walls, on steep banks or occasionally may be relicts of the original forest cover. They may also be present beside water courses/water bodies - see precedence rules for recording plots in 2.11 and 2.12.

- *Herbaceous strips (HST):* includes grasses mixed with broadleaved plants or only broadleaved plants (LHE or THE) These comprise boundaries between crop fields as well as vineyards and olive groves. Strips of herbaceous vegetation under fences are included, if of a different GHC than the surrounding land. Otherwise fences are not recorded separately because they are primarily landscape features and of minimal importance for biodiversity-this saves much time in some situations. The edges of crops where there is perennial vegetation e.g. against woodlands are also included but lines of arable weeds are excluded, unless they are more than 5m wide and 80 m long when they are mapped as areas.

- *Grass strips (GST):* includes strips where grass is 70% of the vegetation cover as shown in 3.1.5. otherwise the information given in the section above equally applies.

- *Private roads and tracks with grass verges (TGS):* private roads and tracks are on farmland or within forests and are maintained by the owner. Temporary and tractor tracks are excluded, but could be included as a grass strip. If tracks are over 5m wide and 80 m long they are recorded as areas and the verges on each side would then be recorded, but only if the GHC was different from the surrounding land.

- *Private roads and tracks with herbaceous verges (THS):* the definition is as above, but in this case the verge consist of mixed grass and herbs.

Note that recording the length of the hard surface of tracks is optional and can be done as a GIS exercise. Lastly note that neither GST nor HST are included under the canopy of trees and hedges.

3.4.4. Field two: Environmental qualifiers

Environmental qualifier codes are to be entered into the second field of the habitat recording sheets for areal and for linear elements in order to express variation between elements that have the same GHC. They are not applied to urban/constructed, crop or sparsely vegetated elements. Global qualifiers may also be recorded in this field.

3.4.4.1. Moisture regimes

The categories below are based on the Concerted Action "Water regimes for forest productivity" coordinated by Graham Pyatt and published in 1999. The pF values are added for regional calibration of the used terms.

- *Aquatic* covered in water over 70% of the time. e.g. *Nuphar lutea*, *Sagittaria sagittifolia, Zostera* spp.

- *Waterlogged/water saturated:* water table at the surface with standing water for between 50 and 70% of the year or with the soil completely saturated, only small patches may become only wet in mid-summer. European soil moisture regimes: none. (pF 1.7 during over 50%

of the time). Peat lands or fenlands in the North, in the edges of water bodies in Central and Southern Europe e.g. *Potentilla palustris*, *Eriophorum angustifolum*, *Narthecium ossifragum*.

- *Wet:* water table with 40 cm of the surface and soil containing free water for most of the year. European soil moisture regimes: slightly wet to moderately wet. (pF 1.7 during less than 50% of the time). Mainly in the north, but around the margins of water bodies in Central and Southern Europe. e.g. *Juncus effusus, Carex panicea*, *Scirpus sylvaticus*.

- *Seasonally wet:* water table variable at the surface and waterlogged for the winter months or spring flooding season, becoming wet or mesic (categories 3 & 5) during the summer period. European soil moisture regimes: none. Besides large rivers throughout Europe or in temporary water bodies. Evidence of inundation is required through landscape context or evidence in the soil profiles (young alluvial soils). Variable species but typical examples are: *Phragmites australis, Phalaris arundinacea* and *Bidens tripatita.*

- *Mesic:* water table 40-100 cm of the surface, available water during most of the non summer period, may dry out during the mid-summer period. European soil moisture regimes: very fresh to very moist. (pF 3.0-4.2 during 10 to 55% of the time). The middle range of soils in Central and Northern Europe and besides water receiving areas and northern mountain slopes in the Mediterranean Zones. (e.g. *Geranium sylvaticum, Corylus avellana, Oxalis acetosella, Anemone nemorosa*).

- *Dry:* water table <100 cm of the surface, water available only during some periods, European soil moisture regimes: moderately fresh to slightly dry. (pF 3.0-4.2 during more than 55% of the time or/and pF >4.2 for less than 15% of the time). Can occur anywhere in Europe but only skeletal or very shallow soils in the north, or on south facing slopes in Central Europe. (e.g. *Helianthemum chamaecystis*, *Sesleria caerulea, Cirsium acaule, Agrostis setacea*). Widespread in the Mediterranean where it grades in to 3.2.1.7.

- *Very Dry:* water table <100 cm of the surface, dry throughout most of the year with only short mesic periods, European soil moisture regimes: Moderately dry. (pF > 4.2 during 15-30% of the time). Occurs throughout the Mediterranean Zone but only on shallow soils and is well indicated by the distribution of *Olea europea*, *Psoralea bituminosa* and *Euphorbia characias*. (e.g. *Cistus salvifolius, Helichrysum stoechas*). Such indicators must be dominant in the species com-position –one plant of a characteristic species is not enough to categorise soil as very dry.

- *Xeric:* water table <100 cm of the surface, dry throughout the year except in isolated rain events, European soil moisture regimes: dry (pF > 4.2 during over 30% of the year. As with 3.2.1.7 the balance of species must be considered and not one individual. In Europe Xeric soils are common in the Mediterranean south zone but the next category is restricted to two areas in southern Spain and Greece, although wider presence in Israel and North Africa.

Pyatt did not cover the two following categories and the divisions are provisional. Further literature research is required to provide more details but local knowledge will often provide reliable information.

- *Semi-desert soils:* these are where there usually is less than 10-30% vegetation cover and with very little organic matter incorporated into the soil profile. The rainfall is 200-300 mm, erratic but relatively regular.

- *Desert soils:* these are found where the vegetation cover is less than 10% and restricted to linear features where there is concentration of water. There is no organic matter present in the profile. The rainfall is below 200mm and may not for several years.

3.4.4.2. Other environmental conditions: Ellenberg Values

Ellenberg *et al.* (1992) developed environmental indicators for Central Europe; they can be searched on the internet (ÖKOLOGISCHE ZEIGERWERTE online). Ellenberg values have also been recalibrated for Britain (CENTRE FOR ECOLOGY AND HYDROLOGY online). Some species change their ecological behaviour in different climate regimes. For many regions Ellenberg values are not available, so local experience of the ecological amplitude of species is needed, especially in the Mediterranean. The following guidelines can be given:

- *Eutrophy*: Ellenberg Fertility values. Fertility is often localised along landscape elements e.g. rivers and around feeding troughs. Indicator species can be used to identify such elements e.g. *Urtica spp., Stellaria media, Galium aparine, Stachys sylvatica* and *Rumex alpinum*. The two highest levels of Ellenberg F values are combined because lower levels are too difficult to record consistently in the field without full species lists.
- *Acidity (acid-neutral-basic)*: The Ellenberg acidity value can be assessed in the following way:
    a. Plant indicators. Although some species have wide ranges, others are reliable indicators at the local level. They are often growing with widespread ubiquitous species that form the main vegetation cover. As stated above, some species differ in their requirements in different parts of their range. e.g. *Saxifraga tridactylites* is an obligate calcicole in Great Britain, but it is not selective in the Pannonian region.
    b. Soil type/rock. Knowledge of these characteristics can provide useful information although care has to be taken with its use, because some rocks with the same name can be acid, neutral or basic.
    c. In watercourses and lakes (i.e. GHC = AQU) the nutrient level can be determined only if indicator plant species are present. This is because clear water can be either basic or acid, but this can be determined only by chemical analysis if there are no indicators.
    d. Landscape context: Whilst not definitive, landscape features gradients along slopes such as surrounding vegetation, flush lines and outcrops of acid rock can be useful.
    e. Confirmation by soil testing equipment - this may well now be practical in terms of expense and time and could be done in different situations or to get experience in a particular site.
- *Salinity*: The Ellenberg salinity value can be assessed by the presence of halophytes e.g. *Salicornia spp., Puccinellia spp* and *Spartina spp*. Care is needed with some species e.g. *Armeria maritima* and *Plantago maritima* as they also grow in mountains but are often associated with saline conditions. Brackish conditions can be determined from the landscape context and the presence of some species that are some degree tolerant of salt e.g. *Agropyron repens* and *Zannichelia palustris*. Because Ellenberg values will not be available for most of the biomes it is probably more useful to use the levels of salinity taken from the soil map of Israel are as follows:
    a. Below 0 45 units of salt slight to **moderately saline**
    b. 0.45-0.8 **highly saline**
    c. Over 0.8 **very highly saline**

3.4.4.3. Determination of environmental qualifiers.

All the above classes must be determined by the balance of species not individuals. The majority are unlikely to change over time, so that when monitoring definitive evidence of change is required e.g. blocking of drainage ditches, before a change can be recorded.

TABLE 3.5. MATRIX AND UNIQUE CODING OF ENVIRONMENTAL QUALIFIERS. IN GENERAL, ACID IS BELOW PH 4.8; NEUTRAL IS BETWEEN PH 4.8 AND 6.0; BASIC IS OVER PH 6.0

	Ellenberg values	Aquatic	Water-logged	Seasonally wet	Wet	Mesic	Dry	Very Dry	Xeric	Semi dessert	Desert
Eutrophic	F > 7	1.1	2.1	3.1	4.1	5.1	6.1	7.1	8.1	9.1	10.1
Acid		1.2	2.2	3.2	4.2	5.2	6.2	7.2	8.2	9.2	10.2
Neutral		1.3	2.3	3.3	4.3	5.3	6.3	7.3	8.3	9.3	10.3
Basic		1.4	2.4	3.4	4.4	5.4	6.4	7.4	8.4	9.4	10.4
Saline low		1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5
Saline medium		1.6	2.6	3.6	4.6	5.6	6.6	7.6	8.6	9.6	10.6
Saline high		1.7	2.7	3.7	4.7	5.7	6.7	7.7	8.7	9.7	10.7

Note that the eutrophic row usually occurs in relatively small patches and overrides the other nutrient levels.

The matrix shown in TABLE 3.5 is the means of recording the environmental qualifier linked to a mapped element. The matrix consists of two primary axes, which largely determine vegetation composition i.e. humidity and nutrient content.

- The numbers in the matrix can be applied to all GHCs. Definitions of all categories are provided in this monitoring handbook. **It is essential to note that local use of terms, especially dry, may differ from the above matrix.** These terms must therefore be seen in the European context – that may be locally dry e.g. calcareous grasslands in Western Scotland may be wet compared with the situation of Southern Italy.
- Not all cells may apply to a given GHC. For example, broad-leaved evergreen tall scrub is not likely to be found in waterlogged conditions but all combinations have been included to cover all possible situations. Note that 10.1 is a theoretical value because there is virtually no organic matter in the desert. Nutrient levels should only be attached to aquatic elements if there is evidence from indicators e.g. halophytic species.
- The landscape context provide individual patches essential guidance in determining environmental qualifiers. Steppic elements with Stipa sp in Bohemia may appear very dry according to the species, but considered in the context of other species and trees growing nearby e.g. Fraxinus excelsior and Crataegus monogyna enables a decision to consider the element as dry.

3.4.4.4. Global codes

Global codes for height/depth and substrate are codes that can be used as qualifiers in field 2. They must be placed below the code to which they refer.

3.4.4.5. Absence of data codes

-1 = Not included in survey. The field has been excluded from a given survey, for example, in field eight, phytosociological units may be excluded from a specific survey (i.e. not included in a given field survey).

0 = No record made. No information was recorded for this field either because no qualifier applied or because the rules did not specify that an entry should be made - this entry is required to ensure that the entry in a field has not been merely forgotten i.e. if there is no qualifier to record, this code is used to show that it has not been merely forgotten.

-9 = Does not exist in this classification. A particular element has no match within a given classification e.g. arable fields are not a class in the Habitat Directive. -9 would therefore be entered in the sixth field if this classification was being recorded.

Lines may be drawn across several fields to indicate "absence of data" codes. –1 needs only to be entered at the top of fields 7, 8 and 9 because it is exclusive.

3.4.4.6. Other general codes

These codes can be applied to any GHC or element:

BUR = Burnt – can be applied to most life form categories. Use this code with the life form that was present according to residual material, e.g. forest trees or grasses.

SCA = trees/shrubs below 1% total cover but between 5 and 20 individuals/ha. Can also be applied to olives/fruit trees.

OPE = trees/shrubs 1-10% cover (e.g., *Dehesas, Montados* or parkland)

The appropriate GHCs should follow these codes. Note that cover of trees/shrubs over 10% but below 30% is included in field five.

Also note that where the vegetation cover is below 10% i.e., mainly in deserts then the percentage cover is of the actual cover present.

3.4.5. Field three: Site Qualifiers

The site qualifiers are to be entered into the third field of the habitat recording sheets for areal and for linear elements to record characteristics of geomorphology, geology, soil, archaeology and life form complexity of elements, in order to express variations in these between elements that have the same primary code. Part of the definitions are provisional and need to be carefully researched further for pan-European application.

Geomorphologic classifications are in general made according to their relevance to the understanding of the genetic and historical development of the site, area or region. These morphological forms give limited information for assisting the understanding of the relationship between climatic/environmental conditions and the composition and distribution of plant life as indicators of climatic change.

Habitat complex site qualifiers are for use with elements that are widely recognisable and comprise a mosaic of patches of several GHCs of which the extent might be less than 400m^2.

These are situations where it would be difficult and time-consuming to make detailed mapping of each individual LF patch. They include some situations where this is also precluded by difficulty of access as for example in mires and fens. The primary codes for all the GHCs that occupy >30% of the element must also be recorded in the first field.

The definition of "coastal" is that either there is a change in LF and management between the element next to the shore and inland or it is where the soil material has a recent marine origin. This definition separates coastal dunes from inland dunes and separates forests growing on rocks from those growing on marine sediments (sand, gravel and shingle). It is recognised that forests growing on bare rock surfaces would have to be covered by further qualifier e.g. wind pruned.

TABLE 3.6. SITE QUALIFIERS AND CODE NAMES.

Qualifier name	**Code**	**Description**
Geomorphological element	**1**	
Cliff	1.1	Vertical or near vertical area of rock
Rock outcrop	1.2	Isolated elements of rock emergent from surrounding vegetation
Scree	1.3	More or less unstable loose or shattered rock on slopes
Moraine	1.4	Glacial deposits of boulders, rocks and tile
Esker	1.5	Long winded ridges of glacial origin
Drumlin	1.6	Rounded or elliptical moraines
Roche moutonné	1.7	Ice eroded rounded rock outcrops
Kame terrace	1.8	Isolated or clustered mounds, derived from glacial outwash
Solifluction terrace	1.9	Terraces formed by trees/thaw
Splintered and shattered rock field	1.10	Invariably on mountain summits or in the arctic
Fjell field	1.11	Characteristic of high mountains in Scandinavia
Frost sorted stones/rocks	1.12	Evidence of frost sorting but not in patterns
Stones/rocks sorted into polygons or stripe	1.13	Distinct patterns of sorted rocks
Rock pavement	1.14	Rock pavements with over 30% vegetation cover
Bare rock pavement	1.15	Usually of limestone but occasionally other rocks under 30% of vegetation cover
Raised beach	1.16	Evidence of former beach line above high water mark
Peat hag	1.17	Includes any bare or eroding peat which is not vegetated and should be qualified by a percentage cover code
Soil erosion	1.18	Includes both human and natural erosion
Avalanche track	1.19	Self-explaining
Snow patch	1.20	Snow field
Glacier	1.21	Ice with some rock debris
Rock glacier	1.22	Glaciers covered by rock debris
Recent volcanic	1.23	Evidence of recent volcanic activity with ash and lava
Inactive volcanic	1.24	Old craters or calderas
Dune	1.25	
Canyon/gorge	1.26	Narrow rock valley

Wadi ("arroyo")	1.27	Intermittent 1-2m
Earth Pillar	1.28	Caused by erosion of soft material
Geological element	**2**	**Description for use of this qualifier**
Plutonic rock	2.1	e.g. granite, gabbro
Hypobyssal rock	2.2	e.g. dolerite, porphyry
Pyroclastic	2.3	e.g. ash, tuff
Volcanic	2.4	e.g. basalt, rhyolite
Unconsolidated clastic	2.5	e.g. sand, gravel, clay
Consolidated clastic siliceous	2.6	e.g. mudstone, shale
Calcareous	2.7	e.g. tufa, dolomite
Evaporite	2.8	e.g. gypsum, halte
Organic	2.9	e.g. peat, lignite
Residual	2.10	e.g. laterite, kaoline
Contact	2.11	e.g. horfeld, spotted slate
Cataclastic	2.12	e.g. cataclastic breccia, mylonite
Regional	2.13	e.g. slate, gneiss
Soil	**3**	
Permafrost	3.1	Soils with permanent frozen layer
Skeletal/Ranker	3.2	Soils with no profile development
Peat	3.3	Organic soils usually over 0.3 m deep
Peaty podzol	3.4	Peat material overlaying podzol (<0.3 m)
Peaty gley	3.5	Peat material overlaying gley
Gley	3.6	Anaerobic mineral soils usually grey or mottled
Brown earth	3.7	Free draining, fertile soil
Rendzina	3.8	Shallow calcareous soils
Chernozem	3.9	Soils of eastern Europe
Terra rossa	3.10	Red soils of the Mediterranean
Terra fusca	3.11	Mediterranean brown soils
Sandy soil	3.12	Soil formed from sand
Detritic soil	3.13	Soil containing a high percentage of detritus
Gypsum soil	3.14	Soils with high gypsum content
Alluvium soil	3.15	Soils formed from alluvial material
Hydromorphic soil	3.16	Water saturated but not peaty
Laterite	3.17	soils containing a high percentage of iron
Inland water	**4**	
Evidence of previous water cover	4.1	Evidence from flotsam and jetsam plus bare ground
Temporary running water	4.2	Evidence of previous running water
Films of water	4.3	Water running on the surface – usually over rocks
Spring	4.4	Point feature of emergent water
Flush	4.5	Lines of water flow not forming streams – wetland vegetation indicators present
Water course, running, non-tidal fast	4.6	River with water running over 10 m/s
Water course, running non-tidal slow	4.7	River with water running under 10 m/s
Water course, standing water	4.8	Linear feature with standing water
Canal	4.9	Waterways constructed for boat traffic
Irrigation canal	4.10	Constructed watercourse for irrigation
Canalised river	4.11	Rivers which have been modified (e.g. sections

		straightened, banks smoothed), but still follow the same direction as the natural watercourse
Tidal river	4.12	River influenced by tidal movement
Dry river bed	4.13	Temporary river bed usually with bare ground and signs of water flow
Dry ditch	4.14	Ditch more than 0.5 m deep with no water
Free standing water	4.15	Temporary standing water. Only record if evidence available.
Lake – natural	4.16	Inland water body over 400 m^2.
Lake – artificial	4.17	Usually distinguished by the presence of a dam or embankment
Pond – natural	4.18	Below MME record as point
Pond – artificial	4.19	Below MME record as point
Historical/archaeological element	**5**	
Barrow/burial mound	5.1	Burial mounds from prehistoric times
Ruin	5.2	Ruined buildings of archaeological interest
Marl pit	5.3	Pits for extraction of marl which is formed by a deposit of calcareous algae often filled with water
Cairn/Dolmen	5.4	Structures of rock from prehistoric times
Bank and ditch	5.5	Medieval structures around woods or boundaries
Hut circle	5.6	Remaining walls of prehistoric sites
Stone heap	5.7	Heaps of stone in fields from former agriculture
Castle/fortress	5.8	Self-explaining
Archaeological wall	5.9	Walls of archaeological interest
Ridge and furrow	5.10	Lines of old tilled land in W. Scotland
Aquaduct	5.11	Old (usually Roman) facility for transport of water made of stone
Sea/Marine element	**6**	
Submerged angiosperms	6.1	Cover of species such as *Posidonia*
Shipwreck	6.2	Self-explaining
Mussel bank	6.3	Habitat of mussel population
Sea weed bed	6.4	Cover of red, green and brown algae
Rock pool	6.5	Depression in rocks with remaining sea water in low tidal situations
Wave cut platform	6.6	Relatively level areas formed from wave action
Cultivated mussels/oysters	6.7	Lines of mussels/oysters in sea/tidal
Fish farm	6.8	Fish farm in sea/tidal
Coastal elements	**7**	
Yellow dune/white dunes	7.1	Young dune, highly mobile sand
Grey dune	7.2	Mature dune, podzolised, with acidic indicators
Dune slack	7.3	Wetlands in or behind the dunes
Salt marsh	7.4	Coastal wetland with saline soils
Strand line	7.5	Vegetation zone between dune or cliff and the sea
Maritime exposure	7.6	Vegetation affected by coastal winds but no halophytes
Bogs/mires/wetlands	**8**	
Palsa mire	8.1	Mires with frozen elements and pools
Aapa mire	8.2	Mires with frozen elements
Raised bog	8.3	Bogs with characteristic structure

Blanket bog	8.4	Bogs covering often a high proportion of the land surface, rain fed
Valley mire	8.5	Mires formed by high valley water levels
Poor fen	8.6	Nutrient poor wet organic soils, many sedges
Transition mire	8.7	Mires characteristic of continental regions
Fen	8.8	Nutrient rich, wet, organic soils, mixed vegetation
Reed beds	8.9	Element dominated by tall helophyte graminoids usually on the borders of lakes and rivers or because of high ground water levels
Wet heath	8.10	Acid soils, usually with dwarf shrubs/sedges
Snow patch vegetation	8.11	Vegetation often with DCH prominent but evidence of limits to snow line
Element with woodland or sparse trees	**9**	
Taiga	9.1	Open acid woodlands of Boreal/Nemoral regions
Riparian	9.2	Riverside woodlands
Gallery	9.3	Narrow forest strip beside a watercourse
Swamp woodland	9.4	Forest over helophyte vegetation
Bog woodland	9.5	Forest growing over acid bogs
Additional habitat complexes	**10**	
Terrace	10.1	Excavated level areas of land with retaining walls
Group of non-mappable terraces	10.2	Parcels with terraces that are less than 5 m apart that cannot be mapped individually

TABLE 3.7 SITE QUALIFIER CODES FOR LINEAR ELEMENTS

Qualifier name	Code	Description for use of this qualifier
Related to water(ways)	**11**	
Watercourse	11.1	Only use if not covered by global codes
Gully	11.2	Erosion feature covered by water
Levee	11.3	Natural raised river bank
Dyke	11.4	Artificial raised river bank
Paths and tracks	**12**	
Bicycle path	12.1	Evidence of use by bicycles only – not recorded along roads
Walking footpath	12.2	Evidence of use by people
Horse (Bridle way)	12.3	Evidence of use by horses
Tarmac	12.4	Metalled/tarmac surfaces
Constructed track	12.5	Track without tarmac but hardcore material brought in
Unconstructed track	12.6	Track with no external material brought in from outside
Tractor track	12.7	Tractor tyre ruts only
Excavated track – road vegetated	12.8	Track with excavated margins covered with vegetation
Excavated track – road sparsely vegetated	12.9	Track with excavated margins – vegetation cover less than 30%
Road and track – Sunken road	12.10	Traditional road excavated below general ground level

Road and track – Green lane	12.11	Sunken lane covered with vegetation
Walls	**13**	
Wall – Dry stone	13.1	Wall constructed with no additional material other than rock
Wall – Mortared	13.2	Walls held together with mortar
Retaining wall – Earth	13.3	Usually a terrace wall
Retaining wall – Rock	13.4	Usually a roadside, terrace wall or dam with over 30% rock
Wall with gaps	13.5	Walls with over 30% gaps
Fences	**14**	
Fence – Wood only	14.1	Fence of wood only
Fence – Iron only	14.2	Fence of iron posts/rails
Fence – Wire on posts	14.3	Fence with wire attached to wood posts
Fence – Wire with gaps	14.4	Fence with over 30% gaps
Fence – Wire on metal posts	14.5	Fence with wire attached to metal posts
Hedges	**15**	
Hedge – Trimmed hedge	15.1	Line of scrub below 5m with signs of regular management
Hedge – Austrian hedge	15.2	Hedge of trees with understory
Hedge – Stock proof	15.3	Hedge able to retain stock
Hedge – Not stock proof	15.4	Hedge with over 30% gaps
Hedge – Recently planted	15.5	Hedge planted in the last 5 years
Hedge – Uncut	15.6	No evidence of cutting in the last 5 years
Hedge – Derelict	15.7	No evidence of cutting and trees in poor condition
Hedge – Relict	15.8	Only isolated shrubs/trees remaining
Hedge – Laying	15.9	Traditional management by laying of single stems
Hedge – Coppiced	15.10	Cut at the base in the last 5 years
Hedge – Flailed	15.11	Cut with mechanical flail – much debris at base

3.4.6. Field four: Management qualifiers

The management qualifiers are organised in several levels, the first level being the time of the management, the second level are the general categories where management is taking place, e.g. forest or urban, and the third level is a more specific management activity. In some cases the third level is specified in a fourth level. This structure will be implemented in the Field Computer after the field season 2010.

TABLE 3.8. MANAGEMENT CODE NAMES FOR LEVEL 1

Qualifier name	**Code**	**Definition**
Active	A	Now
Recent	B	less than three years
Neglected	C	Evidence of undermanagement, 3-10 years
Abandoned	D	Over ten years, colonisation by shrubs
Ancient	E	Evidence of former use (>50years)
No Management	F	No evidence of any management

TABLE 3.9. MANAGEMENT CODE NAMES FOR LEVEL 2, 3 AND 4

Qualifier name level 2	**Code**	**Qualifier name level 3**	**Code**	**Qualifier name level 4**
Agricultural	1	Annual Crops	1.1	Indicated the crop name (see table below)
		Apiculture	1.2	
		Controlled Burning	1.3	
		Fallow	1.4	
		Farmyard Manure/Slurry	1.5	
		Grazed	1.6	Indicated grazing animal (see table below)
		Harrowed	1.7	
		Hay Cut	1.8	
		Irrigation	1.9	
		Mowned	1.10	
		Multiple Systems	1.11	
		Permanent Crops	1.12	Indicate the cultivation (see table below)
		Ploughed	1.13	
		Sillage Cut	1.14	
		Unidentified	1.15	
		Large terraces	1.16	
		Small terraces	1.17	
		Ridge and Furrow	1.18	
		Chaffed	1.19	
Semi-natural	2	Apiculture	2.1	
		Controlled burning	2.2	
		Deep ploughing	2.3	
		Field Margins	2.4	
		Hunting	2.5	
		Intermitent Grazing	2.6	
		Regular Grazing	2.7	
		Scrub clearing	2.8	
		Peat Working	2.9	
Forestry	3	Charcoal	3.1	
		Clear-Cut	3.2	
		Controlled Burning	3.3	
		Coppicing	3.4	
		Conservation Management	3.5	
		Dead wood	3.6	
		Deep ploughing	3.7	
		Animal Grazing	3.8	
		Group selection	3.9	
		Planting Exotic	3.10	

		Planting Native	3.11	
		Ploughing/Drainage	3.12	
		Pruning	3.13	
		Scrub clearing	3.14	
		Thinning	3.15	
		Underplanted	3.16	
Recreational	4	Beach Facilities	4.1	
		Boating Area	4.2	Open water used for storing sailing and rowing boats
		Fishing	4.3	Evidence on banks of fishing sites
		Game management	4.4	
		Golf course	4.5	
		Horse	4.6	
		Hunting	4.7	
		Motor sport	4.8	
		Occasional Camp site	4.9	
		Other Sport	4.10	
		Permanent Camp site	4.11	
		Pic-nic area	4.12	
		Playing field	4.13	
		Shooting range	4.14	
		Trampling	4.15	
Urban	5	Agricultural	5.1	Buildings used for agricultural purposes including the farmhouse if occupied by a farmer or farm worker
		Airport	5.2	Area used for landing taxiing and parking aeroplanes
		Commercial	5.3	Buildings for selling things, shops, garages, hotels, pubs, commercial offices
		Educational/Cultural	5.4	Includes schools, establishments of further education, museums, theatres and cinemas
		Fish Farm	5.5	Area confined for growing fish
		Ground Levelling	5.6	
		Horticulture	5.7	Includes glass houses and polytunnels in both open country side and garden centres, but not small green houses attached to residential houses
		Industrial	5.8	Used for the manufacture of goods and includes warehouses, workshops and associated buildings.
		Institutional	5.9	Buildings for public or private institutions, such as old people's homes, local government, central government buildings, prisons, research stations.
		Moutain refuge	5.10	

		Opencast mine	5.11	Open area for coal or lignite coal mined
		Port	5.12	Harbour area for commercial purposes
		Quarry	5.13	Area excavated for rocks e.g. marble, granites
		Railway	5.14	
		Recreational	5.15	
		Religious	5.16	Places of worship, churches, mosques, synagogues and monasteries and their cartilages e.g. graveyards, cemeteries
		Residential	5.17	
		Road	5.18	Include verges of the road
		Sand pit, gravel pit	5.19	Area excavated for gravel or sand; may contain water or be dry
		Spoil hips	5.20	
		Track	5.21	Includes verges of the track
		Waste-Domestic	5.22	Deposition localities for domestic waste
		Waste-Industrial	5.23	Deposition localities for industrial waste
Inland Water	6	Artificial Water body	6.1	
		Dams	6.2	
		Canal	6.3	
		Irrigation Canal	6.4	
		Digues	6.5	

TABLE 3.10. SPECIFICATIONS OF CROPS AND GRAZING ANIMALS (LEVEL 4)

Annual crops (1.1, 1.16, 1.17))	
Wheat (Triticum aestivum and associated species)	1
Barley (Hordeum sativum)	2
Oats (Avena sativa)	3
Rye (Secale cereale)	4
Triticale (Hybrids between wheat and rye)	5
Rice (Orysa sativa)	6
Sugar beet (Beta maritima)	7
Fodder crops (e.g. Brassica oleracea)	8
Potato (Solanum tuberosum)	9
Field bean (Vicia faba)	10
Peas (all types) (Pisum spp.)	11
Maize (Zea mays)	12
Oilseed rape (Brassica hybrid)	13
Sunflower (Helianthus annuus)	14
Flowers	15
Commercial horticulture	16
Vines	17
Cover crop	18
Forage crop	19

Permanent corps (1.12, 1.16, 1.17)	
Vines (Vitis vinifera)	31
Olives (Olea europea)	32
Cherries (Prunus spp.)	33
Apples (Malus spp.)	34
Pears (Pyrus spp.)	35
Walnuts (Juglans spp.)	36
Citrus fruit (Citrus spp.)	37
Hazelnuts (Corylus avellana)	38
Almonds (Prunus amygdalus	39
Prickly pear (Opuntia spp)	40
Pistacio nuts (Pistacia sativa)	41
Apricots (Prunus amygdalus)	42
Peaches/Nectarines (Prunus persica)	43

Domestic grazing animals (1.6, 2.7 and 3.8)	
Buffalo	1
Bulls	2
Camel	3
Chicken	4
Cow general	5
Cow beef	6
Cow dairy	7
Donkey	8
Field pig	9
Free range pig	10
Geese/Duck	11
Goat	12
Horses	13
Lamas	14
Mules	15
Ostrich	16
Red Deer	17
Sheep	18

Wild grazing animals (2.6, 2.7, 3.8)	
Moose	31
Munjack	32
Porcupine	33
Rabbit	34
Red deer	35
Reindeer	36
Rodents	37
Roe deer	38
Swans/Wildfowls	39
Wild Boar	40
Zebras	41
Elephant	42
Antilopes	43
Bison/Wisent/	44
Wild horses	45
Wild cattle	46

3.4.7. Field five: Detailed life form and species composition

Field five of the areal element and the linear element recording sheets is to be used for recording of the full Life Forms and main plant and crop species associated with each recorded alpha code.

All Life Forms and Non-Life Forms that constitute at least 10% of the alpha code should be recorded, one per row, in the first column of Field-5, with the appropriate % code in the second column. Taken together, all recorded Life Forms and Non-Life Forms within a layer should add up to a total of 100%.

If there are several covers with low % then decide which has the highest cover and record that. It is recognised that low covers will not be adequately represented but these can be derived from the vegetation plots if required.

The species that constitute at least 30% cover of the vegetation (as seen in vertical perspective) of each Life Forms that has been recorded in the first column of field five should be recorded in the third column of field five. If there is over 70% cover of the Life Forms by one species, just the one species is to be recorded. If more species have a cover over 30% then other species should be recorded. If no species reaches 30% then the two species with the highest cover should be recorded.

Separate rows in the recording sheet should be used for each species.

Flora Europaea nomenclature should be used if possible to name the species. (These can then be converted by database management into Flora Europea master codes (SynBioSys, www.synbiosys.alterra.nl).

If a plant species cannot be identified in the field, a specimen should be collected and later referred to an expert botanist for identification.

For crop types the codes be used. Latin names are not to be used for crops but only the codes since the same species may refer to wild plants e.g. *Beta maritima* (sugar beet).

Other species should be recorded using the first three letters of the Genus name and the first three letters of the species name, e.g. *Galium aparine* as "GAL APA", *Fraxinus excelsior* as "FRA EXC". Any ambiguities should be made clear by a comment in the "Species codes and non-standard site and management qualifier codes" section of the recording sheet. For instance *Pinus pinea* and *Pinus pinaster* should be distinguished as "Pin pin" and "Pin pi1". Cryptogams should be separated into percentage bryophyte and lichen cover.

The percentage cover of recorded species within each Life Forms or non life form habitat should be recorded in the fourth column of field 5. The % cover of the species should be given in each LF, i.e. **the percentages are of the Life Forms, not of the whole element.**

4. FARM-LEVEL MEASUREMENTS AND INFORMATION GATHERING 2010

4.1. CONVENTION FOR LABELING SAMPLES AND DATA RECORDS

(Michaela Arndorfer, Gisela Lüscher, Jerylee Wilkes)

A clear system for labelling all samples collected in the field survey under each protocol is essential. This will be hierarchical and requires the following elements:

- Date
- Summary code for each Case Study region and agricultural enterprise (TABLE 4.1).
- Farm code (unique identifier code to be provided by each CS partner)
- Habitat code based on description of farmland habitats in the EU (APPENDIX 7.1 drived from Jongman and Bunce, 2009)
- Sample code (abbreviated protocol names listed in TABLE 4.2)
- Name of personnel who collected the data

TABLE 4.1. COUNTRY CODES TO BE USED IN FIELD VALIDATION WITH ASSOCIATED IDENTIFIER FOR AGRICULTURAL ENTERPRISE.

Case Study country	**Country and enterprise code**
A: Austria	A_ ARA
F: France	F_ARA
D: Germany	D_MIX
W: Wales	W_GRA
CH: Switzerland	C_GRA
NL: Netherlands	L_HOR
I: Italy	I_VIN
E: Spain	E_OLI
E: Spain	E_DEH
BG: Bulgaria	B_ GRA
H: Hungary	H_GRA
N: Norway	N_GRA
ICPC Partners	
TN: Tunisia	T_OLI
TN: Tunisia	T_DEH
UA: Ukraine	U_ARA
EAU: Uganda	K_ARA

Key to agricultural enterprises - ARA: Arable; GRA: Grassland; MIX: Mixed farming; OLI: Olive; DEH: Dehesa; HOR: Horticulture; and VIN: Vineyards.

TABLE 4.2. SAMPLE CODES FOR ALL VEGETATION AND FAUNAL SURVEY SAMPLES AND RECORDS.

Protocol	**Sample and associated indicator code**
Flowering plants of semi-natural habitats	VEG - B2
Earthworms	EW - B4
Araneae –spiders	SPI - B8
Hymenoptera, wild bees	BEE - B9

4.1.1. Barcodes

In BIOBIO data for four indicators, such as vegetation (VEG), earthworms (EW), spiders (SPI), and bees (BEE), will be collected for sixteen case studies in different EU countries and beyond. Genetic (GEN) will only be collected in four countries (e.g., Switzerland, United Kingdom, Bulgaria and Hungary). The indicators will be identified centrally. In this sense and in order to be able to give each sample an ID, each sample will be encoded with a barcode (windows font code 39). Why barcode? Barcode is an international encoding system, which can easily be applied.

In the barcode the following information will be recorded: a unique ID number; country code (TABLE 4.1); farming system and/or agricultural enterprise (partner defined); number of farm (partner defined); code number of habitat patch, field or linear feature (APPENDIX 7.1); code for sample protocol (TABLE 4.2) and associated indicator type (TABLE 1.1); number of indicator samples (e.g., earthworms (EW) will be investigated in three samples in the same plot, in this example, a three samples from hand sorting and three from chemical extractant, a total of six samples will be taken) and date (see TABLE 4.3).

TABLE 4.3. BAR CODE COMPOSITION

A	Country
1	Farm number (1-20)
G	Plot(a-o)
S	Indicator name (B: BEE, S:SPI, E: EW, V:VEG, G:GEN)
1	Sample number (E:1-3, S:1-15, B:1-3, V:1, G:still open)
d1	Date (d1, d2, d3)
112	Unique ID number (1-8100, 1-26100)

4.2. SPECIES-LEVEL MEASUREMENTS

(Philippe Jeanneret)

On each habitat type selected for flora and fauna surveys, all species indicators will be sampled:

- flowering plants
- earthworms
- bees
- spiders

The spatial allocation for sampling aereal and linear plots is illustrated in FIGS 4.1 and 4.2, respectively.

FIGURE 4.1. FLORA AND FAUNA SAMPLING IN AEREAL PLOTS

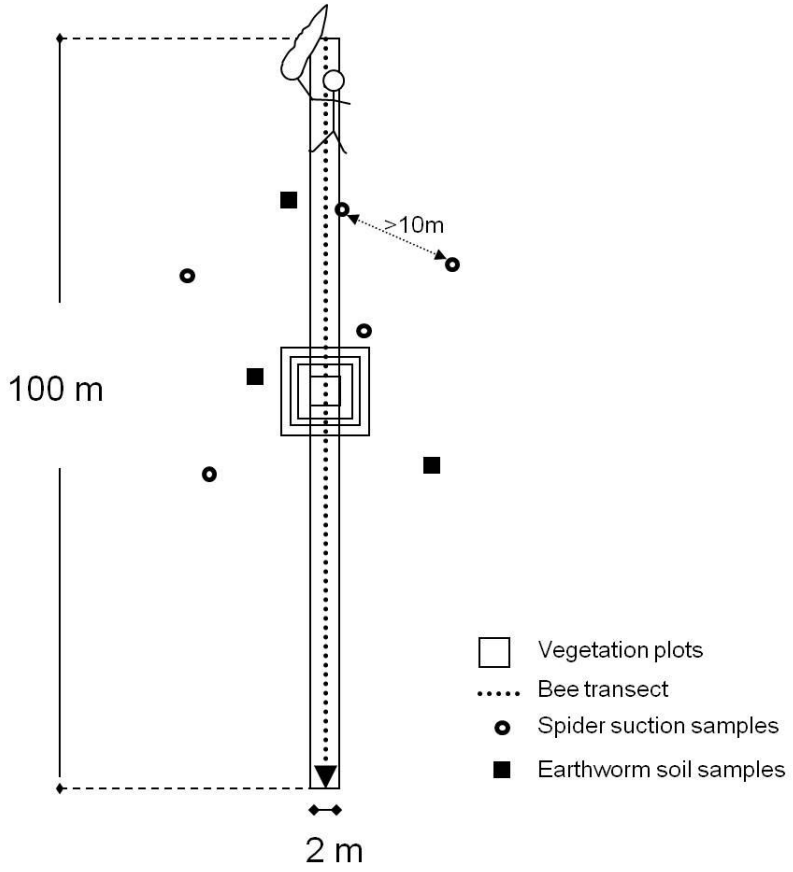
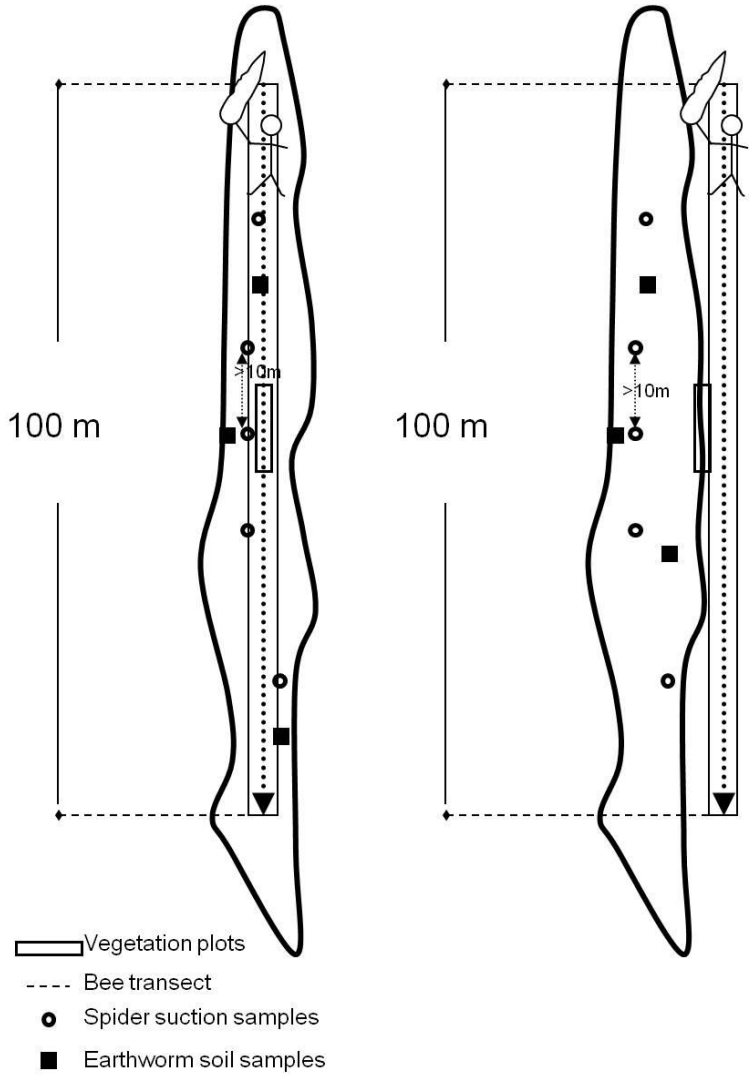


FIGURE 4.2. FLORA AND FAUNA SAMPLING IN LINEAR PLOTS



4.2.1. Flora

(Bob Bunce, Rob Jongman and Ilse Geijzendorffer)

4.2.1.1. Preparation for vegetation recording

The Case Study farm should first be mapped as described in Section 3 so that vegetation plots can be located. Preferably these are recorded immediately afterwards to save travelling time but in some situations may be delayed if the mapping has been carried out early in the season.

The procedure for recording vegetation plots used in the GB-Countryside Survey uses two types of plots, square and linear plots. Square X-plots are placed in areal and point features (FIG. 4.3) and linear L-plots are placed in linear features (FIG. 4.4). The procedure below provides basic information on the species composition of vegetation within the GHCs in the sample squares and also allows estimation of quality for assessing future change.

The principle for allocating vegetations plots is to place **one plot in each GHC, except in the case of** grasslands (CHE and CHE/LHE) which need to be **further subdivided according to**

the moisture and nutrient levels as indicated by the environmental matrix (see TABLE 3.5). There the environmental indicator also is decisive in deciding on plots.

The subdivision in the grasslands is because there are major differences in biodiversity between different types of grassland which therefore need vegetation data to define the detailed composition. In most squares there will be only one extra plot.

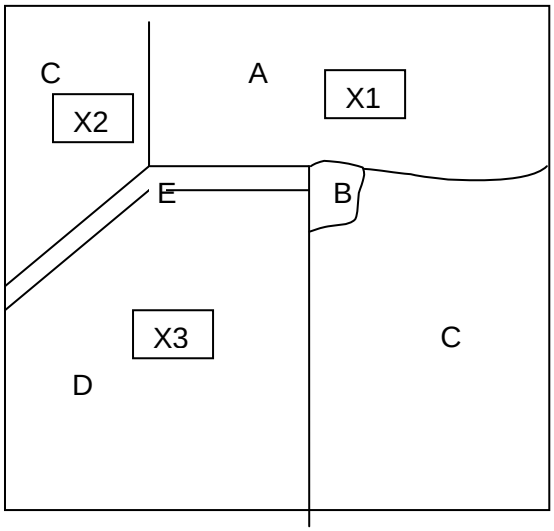
Dehesas can have ground vegetation dominated by Therophytes (THE) usually fallow, mixtures of LHE/CHE or herbaceous crops. Each one of these will be a different GHC if there is below 30% tree cover, but otherwise will be mapped as different elements because of different management. A separate X-plot should be put into each of such elements following the rules. See section Trees and Shrubs in 3.2.4.4. for global codes to cover scattered shrubs, cultivated woody trees and shrubs and other trees.

If the position of vegetation plots is in dangerous terrain, then there are two possibilities. One is to move the plot to the nearest safe location within the element and the other is to rerandomise and select a different patch.

4.2.1.2. Rules for allocating vegetation plots

The principle for allocating vegetations plots is to place **one plot in each GHC**, except in the case of grasslands (CHE and CHE/LHE) which need to be further subdivided according to the moisture and nutrient levels as indicated by the environmental matrix (see TABLE 3.5).

In every GHC one vegetation plot is made. The subdivision in the grasslands is mainly because there are major differences in biodiversity between different types of grassland which therefore need vegetation data to define the detailed composition. In most farms there will be only one extra plot.



Location of vegetation plots

Example of location of X main plots
X1: in CHE field
X2: random selecting from crop fields
X3: in LHE/CHE field.
E and B do not have plots because they are Non-Life form habitats

FIGURE 4.3. LOCATION OF X MAIN PLOTS

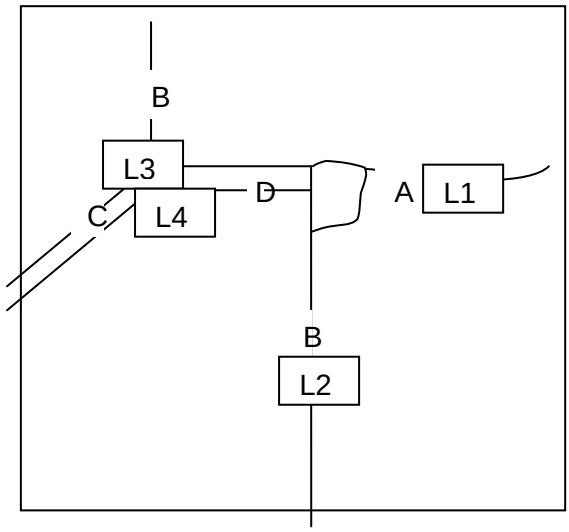
Dehesas can have ground vegetation dominated by Therophytes (THE) usually fallow, mixtures of LHE/CHE or herbaceous crops. Each one of these will be a different GHC if there is below 30% tree cover, but otherwise will be mapped as different elements because of different management. A separate X-plot should be put into each of such elements following the rules.

In the following linear features vegetation will be recorded, if they are wider than 1m:

a. Walls (including terrace walls)

b. Streams, rivers and lakes
c. Hedges
d. Grass strips between fields
e. Wood-hedges
f. Tracks on farmland

Vegetation plots are not recorded in point features for cost reasons. Plots should not be placed in any unfarmed land. Woodland grazed by domestic stock would therefore have plots but not ungrazed forest sites. Grazed woods will have a different alpha code from ungrazed woodlands as they are under different management regimes, so no further data will need to be recorded. This procedure is necessary to include grazed woodlands, which are integral features of many farm enterprises such as is the case in the UK and in Dehesas in Spain.



Example of location of L- Linear plots
L1: Hedge row
L2: Random selecting from two grass strips
L3: Line of trees
L4: Verge of a track

FIGURE 4.4. LOCATION OF L LINEAR PLOTS

4.2.1.3. Method for recording vegetation

The survey requires recording from different sizes of vegetation plots, depending on whether the plot is placed in an areal or a linear feature. The basic recording procedure is the same for all types of plots.

Samples are only included on land regularly or indirectly affected by farming as defined in TABLE 3.1. The location of the vegetation plots does not need to be recorded with GPS if monitoring is not part of the work schedule. Public road verges are excluded as they are not on agricultural land. Tracks on agricultural land are recorded and a plot should be laid out as in figure. From the following categories in TABLE 3.1 no vegetation plots are recorded: categories 2, (Grassland used for non-agricultural purposes), 4 (Open land with casual grazing). 6 (Land indirectly affected by farming), 7 and 8. These categories are excluded from vegetation recording because they are not part of the main farm enterprise.

4.2.1.4. Rules for setting up X main plots

The X main plots (see TABLE 4.5, FIG. 4.3) should be placed in the centre of the element concerned. The L linear plots (FIG. 4.4) should be placed in the centre of the linear feature. In both cases to avoid edge effects. Examples are given here below.

a. Header: information on the broad environmental and management attributes of the plot should be recorded using the environmental site and management qualifiers where appropriate.

b. All vascular plants should be recorded, but no lichens or bryophytes. Epiphytes on rocks or trees should not be recorded.

c. Species should be recorded using the first three letters of the genus and the first three letter of the species according to the Flora Europea.

d. On completion of recording of the whole plot, then the estimated cover % for the whole plot should be listed against each species, using 5% cover categories.

TABLE 4.4. VEGETATION PLOT SAMPLING STRATEGY

Code	**Name**	**Other names**	**Where**	**Size**	**BIOBIO**	
Areal plots					On Farmland	Not on farmland
X	Large	GHC plot	Centroid points in polygons	100 m^2	Yes	No
Linear plots						
A	Grass or herb strips		Arable field margins	10x1m	Yes	n.a.
H	Hedgerow		Alongside hedgerows	10x1m	Yes	No
S	Streamside		Alongside watercourses and water bodies	10x1m	Yes	No
T	Tracks		Alongside tracks on farmland	10x1m	Yes	No
O	Others: Walls		Alongside relevant features	10x1m	Yes	No

4.2.1.5. The main vegetation or X plot

A main vegetation or X plot is 100m^2 in the centre of the GHC and is set up using survey poles with the strings forming the diagonals of the square as shown in FIG. 4.5, PLATE 4.1 left. This procedure was developed in the GB-Woodland Survey in 1971 and guarantees that the plots have an accurate size. The diagonals should be orientated carefully at right angles and the plot should be orientated with the strings on the north-south and east-west axes. The different nested plots are shown in Figure 4.5.

The strings or tapes should be of medium grade polyester that are unlikely to stretch. The half diagonals are 1.42m, 3.54m, 5.00m and 7.07m. and these should be laid out in the directions as shown in the diagram below. The objective of this lay out is to ensure that the total area of the plots is always exactly correct, because trying to lay out square plots results in inaccuracies, as emphasised by Bunce and Shaw (1973).

All species should be recorded from the inner nested plot first. When the inner plot has been completed the second nested plot should be examined and any **additional** species should be recorded. Each additional nested plot is examined in this way. Cover estimates are **only made for the whole plot** when all sizes have been completed. All vascular plants, but not bryophytes or lichens are recorded. The standard practice in vegetation science is used i.e. only plants rooted in the plot are recorded, including trees and seedlings.

For estimates of cover it is necessary to constantly check between partners to avoid over estimates or under estimates. Total cover maybe over a 100% if several layers are present. E.g. *Pteridium* 100% over *Agrostis* 25%. Species with less than 5% cover are given a nominal cover of 1%. Bare ground includes leaf litter and rock.

If the plot falls in a field with a growing crop or hayfield, then the plot should be moved to the edge of the field. The new plot should be taken as a 100m^2, (but estimated not measured, because the plot cannot be laid out) starting 3m into the plot to avoid any edge effect. Access should be made using drill lines where possible and causing minimum disturbance to the crop or hayfield. A species list should be compiled from what can be seen in the crop.

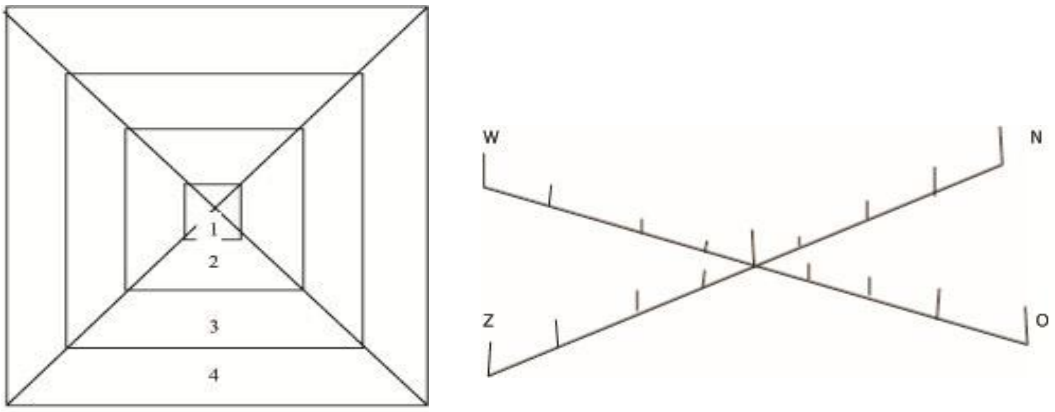


FIGURE 4.5. DESIGN OF THE X PLOT (AFTER GB COUNTRYSIDE SURVEY HANDBOOK 2007). THE LENGTH OF THE SIDES ARE INSQUARE 1: 2.00M, 2: 5.00M, 3: 7.07M AND 4: 10M. THIS PRODUCES NESTED PLOTS OF RESPECTIVELY 4 m^2, 25 m^2, 50 m^2 AND 100 m^2.

4.2.1.6. The linear plot

Plots from linear features are only recorded if the vegetation answers the criteria of a GHC which is different from the adjacent vegetation. For example, a strip of grass between crops could be LHE/CHE whereas the crop would be CRO. In the opposite case, a fence line between two grass fields would often have the same GHC as the fields themselves and will not be eligible for a linear plot, unless the strip of vegetation is different from the surrounding vegetation. Streams that do not have a different GHC from the surrounding vegetation should not have a vegetation plot. In streams in woodland, plots are not recorded if no ground vegetation is present at all.

The predefined list of linear features to be recorded is described in section 4.2.

If a linear feature is less than 0.5 m wide then no plot is placed (cf. mapping rules). In the case of a wall the width of the wall is not included.

In case of grass strips the plot is placed along the edge of the field and the plot is away from the crop edge into the strip. If the strip is over 2 m wide then the plot is placed as in a hedge plot.

The plot is placed according to the same randomization procedure as for the areal features. The side of the plot along the linear feature is determined according to the nearest large X- plot.

The plot is 1 x 10m and is laid out along the feature as shown in FIG. 4.6, PLATE 4.1 right. If the linear feature is less than 1 m wide, then the plot will extend into the field. In case of multiple

boundaries a plot is placed in each linear according to the appropriate rules. However, plots cannot overlap. In a complex of linear features, they should be placed 10 meters apart.

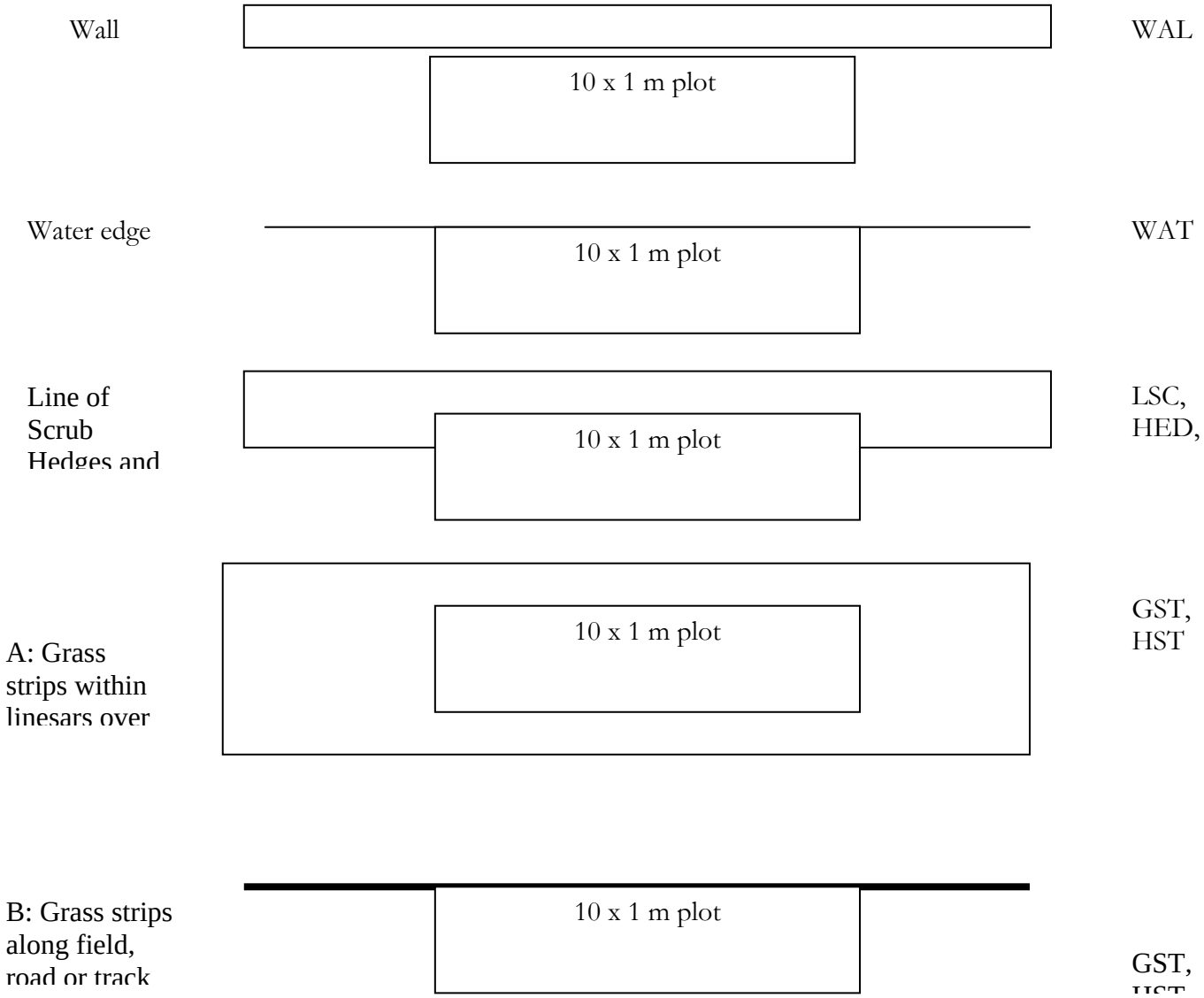


FIGURE 4.6. LOCATION OF PLOTS ALONG LINEAR FEATURES, A HEDGE, WALL, FENCE AND GRASS STRIP. THE PLOTS ARE 1 x 10 m

PLATE 4.1. X PLOT AND LINEAR PLOT MARKED OUT READY FOR BOTANICAL ASSESSMENT *(J.-P. Sarthou)*

4.2.1.7. Laboratory processing of samples

The GB-CS vegetation data has been analysed to produce a series of indicators which include some selected within BIOBIO. These are now reported in a series of refereed papers but the BOX 1.3 gives an indication of analyses of the field vegetation survey data to calculate these indices (Countryside Survey, 2007).

4.2.1.8. Format of data records

The format of the vegetation records will be an Excel spreadsheet with the following fields: code of the habitat/field plot according to the barcode composition, species list, cover of each species. In addition to the barcode composition, the surveyor name, the plot size (4, 25 and 100 m^2) and the date have to be integrated (APPENDIX 7.9).

The Excel sheet should get the name of the country, the farming system and include VEG (indicator). The vegetation data of each farm can be added on separate worksheets within the Excel file for quality control reasons. In that case all sheets should get a farm number. The unique identifier should be placed top row of the Excel sheet. Selection and analysis of the vegetation plots will then be done when all data have been collected.

4.2.2. Wild, domestic and bumble bees

(Philippe Jeanneret, Peter Dennis, Wendy Fjellstad, Thomas Frank, and Jean-Pierre Sarthou)

4.2.2.1. Introduction

Wild bees are widespreadly used as indicators of change in land use and habitat quality and are sensitive to the timing and species composition of flowering plants in habitats. In addition, bees have specific requirments for nesting sites, such as dead wood, bare soil, plant stems or small rock cavities which must be close to feeding sites. Bees provide crucial ecological service in the

agricultural landscape because they are considered to be the predominant and most economically important group of pollinators in most geographical regions. A full review of the characteristics of wild bees that makes them a suitable candidate biodiversity indicator is given in Dennis *et al.* (2009).

4.2.2.2. Summary of field sampling protocol

Sampling method: Transect walk with aerial netting.

Sampling location: In each habitat/field plots selected by the BioHab method of case study farms.

Sampling location within the habitat/field plots: 100 m long x 2 m wide transect crossing the middle of the location of the vegetation relevé (see BioHab method). When the plot is shorter than 100 m, 2 x 50 m (and 2 m wide) transects.

Sampling date: 3 surveys, dates depending on the CS region according to plant phenology.

Sampling procedure: Along the transect, bees are captured using a net during 15 minutes.

Timing: All habitat/field plots of the farms in each case study have to be sampled within 10 days.

4.2.2.3. Materials and methods

Bees will be captured with a net (PLATE 4.2). The aerial net method along transect ('belt') walks has been used for years in ecological studies (Banaczak 1980, Westphal et al. 2008). Each habitat/field plot is surveyed by a slow walk along a 100 meters long and 2 meter wide transect crossing the middle of the location of the vegetation relevé (see BioHab method, section 4.1). In case of shorter plots than 100 m, 2 x 50 m transects are surveyed. The transect walk lasts 15 minutes (the speed of walking should then be of about 6-7 m per minute). While walking, the collector catches all individual bees seen within the 2 m wide 'belt' with a standard entomological aerial net (PLATE 4.3). Captured specimens are immediately transferred into a kill jar, charged with ethyl acetate (or cooled rapidly in a cool-box if they can be transferred to a freezer within two hours; options detailed under section 4.2.4. Spiders). The most direct approach is to bring the open kill jar into the net and trap the bee against the netting[3]. The killing jar should be a reasonably wide (ca. 10 cm diameter) jar of ca. 15 cm height with a sealed scewcap lid. A layer of 0.5 - 1.0 cm of cotton wool or lint can be packed into the base. A small volume of 1-2 ml ethyl acetate can be added directly to the cotton and once absorbed, a Whatman filter paper of the same diameter as the jar can be added to the surface of the lint to avoid wetting specimens in the interior of the jar. With the lid sealed closed, a lethal vapour will occupy the chamber. The trick is to transfer specimens quickly and reseal the lid before the vapour disperses. The jar will occasionally need to be recharged. The filter paper can be removed and a further 1 ml ethyl acetate added to the cotton before replacing the filter paper and continuing work.

[3]for more details about removing bees from the net, etc., download
http://www.nbii.gov/images/uploaded/152986_1215796993084_Handy_Bee_Manual_Jun_2008.pdf

PLATE 4.2. ENTOMOLOGICAL AERIAL NET *("Student insect net", Source: Bioquip website)*

PLATE 4.3. AERIAL NET MOBILISED TO CAPTURE BEES ENCOUNTERED ON THE WALKED TRANSECT *(J. Wilkes)*

Specimens should be kept dry. When the transect is done, all bees are gathered in one jar with the label corresponding to the particular transect. In particular CS regions where collectors are trained to identify species in the field, bee species (e.g., bumble bees, domestic bees) will be recorded and then released. When bees cannot be identified immediately in the field or collectors are not willing to identify them or specimens resemble even vaguely bees, specimens will be brought to the laboratory and then accumulated before dispatch to a taxonomist for identification. Particular attention must be put on bee species of Anthophoridae and to a lesser extent Megachilidae because they are wasp-like in appearance.

4.2.2.3.1. Field sampling protocol

Sampling should only be carried out between 10.00 and 19.00 hours on days that are sunny, not too windy and a temperature higher than 15° C.

During the season, each plot of the farms will be surveyed three times, the timing depending on local conditions (e.g., the Netherlands in May, June and July/August). Each CS region partner should check with bee specialist the best three periods of sampling for bees in his CS region. Ideally, one habitat/field plot should be surveyed at different times of the day for each of the

three sampling dates (the start point of the route has to be changed for each survey). If the transect walks are done by more than one person, habitat/field plots should not be visited by the same person three times (removal of systematic errors).

Basically, transect walks have to be carried out in habitat/field plots when vegetation is present:
Grassland habitats: in hay meadows, transect walks should not be made shortly after meadows have been mown (> 15 cm vegetation height).

Crops, horticulture: transect walks should be made during the growing season of the cultivated plant.

The estimated time-effort is described in TABLE 4.5 for 20 farms.

TABLE 4.5. EFFORT PER PLOT, PER VISIT, PER FARM AND ESTIMATION OF TOTAL INDIVIDUALS COLLECTED FOR 20 FARMS.

BIOBIO Species indicators	Number of samples/ plot[1]	Effort/sample (hr)[2]	Effort/plot (8-hr d)	Number of visits	Number of plots/farm
B9) HYMENOPTERA, WILD BEES (BeeW)	1	0.33	0.041	3	15

BIOBIO Species indicators	Effort/farm (person.day)	N. of farms	Effort/visit (person.day)	Total (person.day)
B9) HYMENOPTERA, WILD BEES (BeeW)	1.85	20	12.3	36.9

BIOBIO Species indicators	N. of samples/CS	Sorting[3]	Identification/ CS[4]	Cost Identification[5]
B9) HYMENOPTERA, WILD BEES (BeeW)	900	14	3'600	2'340.

[1]One sample = wild bees collected along a transect walk of 100 x 2 m (or 2 x 50 x 2 m) during 15 minutes.
[2]Time allowance of 15 minutes + 5 minutes for transferring bees in vials.
[3]No sorting necessary
[4]Estimated with 4 individuals per transect walk (Banaczak 1980, Oertli et al. 2005)
[5]Estimated with 0.65 EUR per specimen.

4.2.2.4. Laboratory processing of samples

In the lab, preparation of bees has to be acknowledged by the bee identifier. Some prefers having bees pinned, other not. Bees can be pinned directly from the jar into collecting boxes. Specimens are best pinned through the scutum between the tegula. If at all possible the pin should be to one side or the other of the mid-line. The midline of the scutum often contains features that are very useful in identification and these can be destroyed by the pin. If specimens are too small to be

pinned they can either be placed on a point, glued to the side of a pin, or attached as minuten double mounts[4]. Bees have to be labelled so that the identification can be without doubt be attributed to the specific transect they belong to.

4.2.2.5. Format of data records

Two sets of records will be provided after the transect walks have been done. In case all specimens collected are centrally identified, the second set of record does not apply:

- The field protocol of transect walks in form of an Excel sheet with the following fields: transect walk code, observer's name, date, time of start of the netting, vegetation height, percentage cloud cover for that date, prevailing Beaufort wind code, Celsius temperature recorded, coverage of flowering plants (%) and main flowering species (APPENDIX 7.8).
- The identification protocol in case specimens have been identified in the field, in form of an Excel sheet with the following fields: transect code, date, identifier name, species list, abundance of each species (APPENDIX 7.9).

If all specimens collected are centrally identified, only the field protocol will be provided by individual case study partner. A collecting box is then prepared with all the bees of each transect walk separately.

4.2.3. Spiders
(Philippe Jeanneret, Peter Dennis and Thomas Frank)

4.2.3.1. Introduction

Spiders are widespread, abundant and form a species-rich taxon of predators which have been intensively investigated in agro-ecosystems because of their potential role in the control of agricultural pests. In agricultural fields, responses of farmland spiders to agricultural practices and management intensity are well known and documented. A full review of the characteristics of spiders that makes them a suitable candidate biodiversity indicator is given in Dennis *et al.* (2009).

4.2.3.2. Summary of field sampling protocol

Sampling method: Suction sampling with a modified vacuum shredder (Stihl SH 86-D, Andreas Stihl AG & Co. KG).

Sampling location: In each of the habitat/field plots selected by the BioHab method on the case study farms.

Sampling location within the habitat/field plots: Suction sampling comprises five sub-samples taken 'haphazardly' within each target vegetation plot. The sub-samples should be at least 20 m apart and ideally that distance but certainly no less than 5 m from a boundary with a different vegetation plot. The exception is for linear biotopes where sub-samples should be close to the mid-line but at least 10 m apart along the line feature .

Sampling date: Three surveys, two early summer and one late summer.

Sampling procedure: The sampling unit for comparison between vegetation plots is a single suction sample composed of material collected in five separate suctions or sub-samples that represent the extent of the vegetation plot. The ground area sampled by each sub-sample is 0.1 m^2 and material

[4]for more details about pinning bees etc., download
http://www.nbii.gov/images/uploaded/152986_1215796993084_Handy_Bee_Manual_Jun_2008.pdf

is collected with the modified leaf blower for 30 + seconds duration. The five suction sub-samples are collected in one gauze bag that is fixed into the end of the inlet nozzle to accumulate a single sample unit of total area 0.5 m^2. The material of each sample is transferred to a zip-seal polyethylene bag of 43 cm length x 27 cm width by inverting the gauze bag into it after switching off the leaf blower engine.

Timing: The ambition is to complete the sampling of all areal and linear habitat/field plots of the full set of farms within a particular case study region within 10 days for each of the three sampling periods.

4.2.3.3. Materials and methods

The method is adapted from Schmidt et al. (2005) and Schmidt-Entling and Dobeli (2009). Spiders will be caught with a modified vacuum shredder powered by a two-stroke engine (PLATE 4.4; Stihl SH 86-D, Andreas Stihl AG & Co. KG, D-64807 Dieburg, Germany, see Stewart and Wright 1995)(http://www.stihl.de/), each country has its own homepage, just substitute your country abbreviation as last two letters in the web address). A 50 cm long, tapering gauze bag (mesh < 0.5 mm) will be inserted into the 11 cm diameter intake nozzle to intercept the arthropods. This is retained by a ring of Velcro glued to the outside of the nozzle and also inside the hem of the bag. Please note that the nozzle end should be left at the angle provided by the manufacturer because the nozzle is held at an angle of ca. 35° when in operation.

PLATE 4.4. TWO-STROKE ENGINE *(Stihl SH 86-D).*

On each of three sampling dates, a suction sample composed of five sub-samples is taken in each of the (up to) 15 habitat/field plots selected from the BioHab habitat map of each farm. Each of the five suction sub-samples is taken within a sample ring of 0.357 m internal diameter pre-placed on the target vegetation haphazardly within the habitat/field plot (each sample has a suction area of 0.1 $m^2 = \pi \times [0.357/2]^2$, total area per plot = 5 x 0.1 = 0.5 m^2). The sample ring is 40 cm high[5]. In habitat/field plots with polygon form, the 5 suction sub-samples are located twenty meters apart from the border of the habitat/field plot and 10 meters apart from each other. In linear elements, the 5 suction sub-samples are taken along a line in the middle of the habitat and 10 meters apart from each other. The suction nozzle will be placed down firmly over the low vegetation, so as to sample from both the low vegetation and litter layers as far as possible for a minimum duration of 30 seconds. In hay meadows, samples will not be taken shortly after

[5] The ring can be made of a sheet of flexible plastic rolled. The length of the plastic sheet is then 1.222 m (0.4 m high) with 0.1 m overlap area to fix both ends of the plastic sheet together with A double row of pop rivets to produce the circle (the effective circumference of the circle is 1.122). Two sheets of aluminium of 0.1 x 0.4 m may be required to sandwich the overlap and to support the rivets.

mowing but when the vegetation height is > 15 cm or less if the aftermath is grazed. In crop fields, the first survey will be made when plants are already visible (see TABLE 4.7). No samples will be taken from bushes (edges) nor trees (orchards). The fabric net stays fixed to the nozzle of the leaf blower at all times unless wetted by rain or dew fall or torn from thorny vegetation or general wear and tear (PLATE 4.5).

PLATE 4.5. FITTING SAMPLING NET TO LEAF BLOWER NOZZLE PRIOR TO SAMPLING *(J. Wilkes)*

When a sample (consisting of the five pooled sub-samples) is completed, the engine is cut and the net contents inverted into a pre-labelled polyethylene zip-seal bag (PLATE 4.6) and stored in a cool-box. For the purpose of the evaluation of the suction sampling method and to answer the question whether all five or perhaps as few as three sub-samples effectively represent the diversity of spiders in a plot, the five sub-samples from each plot should be stored in separate polyethylene zip-seal bags on at least one of the three sampling dates. The consistency of spider material in samples can later be investigated for specimens in 3 to 5 pooled sub-samples. For this, the engine will need to be stopped and restarted after each sub-sample of 30 seconds. Spiders will be sampled on three occasions (TABLE 4.7).

Permanent habitats:
Sampling 1: spring; the first sampling period starts 2 weeks after 90% of *Taraxacum officinalis* flowers are in bloom[6] (or a similar species where it does not occur, e.g. in Spain);

Sampling 2: early summer; the second sampling period takes place 4 weeks[7] after sampling 1.

Sampling 3: late summer; the third sampling period takes place 18 weeks[8] after sampling 1.

[6] In the Swiss lowlands (500 m elevation), it corresponds to a period between 15th and 30th April.

[7] In the Swiss lowlands (500 m elevation), it corresponds to a period between 15th and 31st May.

[8] In the Swiss lowlands (500 m elevation), it corresponds to a period between 1st and 15th September.

Non permanent habitats:

Special sampling periods take place for crops due to non permanent vegetation occurrence. This should ensure that plants are already visible by the first survey:

- Cereals and rape ('early' crops): Sampling 1 and 2, like other habitat/field plots; Sampling 3, 8 weeks after sampling 1.
- Beet, potato and corn ('late' crops): Sampling 1, 6 weeks after 90% of *Taraxacum officinalis* flowers are in bloom; Sampling 2, 9 weeks after sampling 1; Sampling 3, 12 weeks after sampling 1.

Sampling will be carried out by dry, warm weather. To avoid effect of seasonal succession of spider species to occur during one sampling date in a region, spiders should be caught within 10 days in all fields/habitat plots of the 20 farms.

Suction sampling provides abundance data for spiders, but individuals in soil crevices or dense layers of vegetation or litter may be undersampled (Topping and Sunderland 1994). However, as the highest spider abundances will probably be observed in habitats with dense vegetation and litter, the results and conclusions could only be weakened by resulting bias (Schmidt and Tscharntke 2005).

PLATE 4.6. SUCTION SAMPLING WITHIN GUIDE RING AND TRANSFERRAL OF SPECIMENS FROM NET TO ZIP-SEAL POLYETHYLENE BAG *(J. Wilkes)*

The estimated time-effort for 20 farms is described in TABLE 4.6 and 4.7.

TABLE 4.6. TIMETABLE FOR 3 SAMPLING PERIODS OF SPIDERS IN DIFFERENT HABITATS.

Week	0 = 90% T. officinalis in bloom	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Permanent habitats			1				2														3
Cereals			1				2				3										
Rape			1				2				3										
Beet							1									2					3
Potato							1									2					3
Corn							1									2					3

TABLE 4.7. EFFORT PER PLOT, PER VISIT, PER FARM AND ESTIMATION OF TOTAL INDIVIDUALS COLLECTED.

BioBio Species indicators	N. of samples/plot[1]	Effort/sample in hr[2]	Effort/plot in d (8-hr d)	N. of visit	N. of plots/farm[3]
B8) ARANEAE -SPIDERS (Spid)	1 (of 5 sub-samples)	0.025	0.016	3	15

BioBio Species indicators	Effort/farm (person.day)	N. of farms	Effort/visit (person.day)	Total (person.day)	N. of samples/CS[4]
B8) ARANEAE -SPIDERS (Spid)	0.72	20	4.8	14.4	2'100

BioBio Species indicators	Sorting in d (8-hr d) [5]	Identifica-tion/CS[6]	Cost Identification /CS[7]
B8) ARANEAE -SPIDERS (Spid)	70	12'375	8'044.-

[1] a sample = spiders collected with a vacuum shredder with 30 seconds suction within a 35.7 cm diameter ring with the 11 cm diameter intake nozzle (sampled area = of 0.1 m^2, total area per plot = 0.1 x 5 = 0.5 m^2).

[2] estimated with 30 seconds suction and 60 seconds processing.

[3] estimated according to tests with the BioHab method.

[4] estimated with separate sub-samples on one of three sampling rounds.

[5] estimated with 7.5 minutes per sample.

[6] estimated with 27.5 individual per m^2 (Schmidt and Tscharntke 2005).

[7] estimated with 0.65 EUR per specimen.

4.2.3.4. Laboratory processing of samples

Back to the lab, the 5 samples (= 5 zip-seal bags) per habitat/field plot are kept separately all along the process of sorting the spiders out from the zip-seal bags. Adult and juvenile spiders are sorted out from the material that has been collected with the suction engine (plant material, sand, soil, etc.) and put in vials with 70% alcohol. A pencilled label with sample details can be added to the solution and the same information should be added to an external adhesive label.

4.2.3.5. Format of data records

If all specimen collected are centrally identified, only the field protocol will be provided by individual case study partners. The field protocol of the suction sampling in form of an Excel sheet contains the following fields: habitat/field code, observer's name, date, time of start of the first suction sub-sample (one record per plot), vegetation height and percentage cloud cover for that date, prevailing Beaufort wind code, Celsius temperature recorded (APPENDIX 7.8). If specimens are identified by individual case study partners, the identification protocol in the form of an Excel sheet with the following fields will be provided: sample code (5 different codes for each habitat/field plot and survey), date, identifier name, species list, abundance of each species (APPENDIX 7.9).

4.2.4. Earthworms

(Céline Pelosi, Philippe Jeanneret, Peter Dennis, Jurgen Friedel, O. Ehrmann, Max Kainz, Geraldo Moreno, Mauricio Paoletti, S. Papaja-Hülsbergen, Jean-Pierre Sarthou, Norman Siebrecht and Sebastian Wolfrum)

4.2.4.1. Introduction

Earthworms are key soil detritivores, essential for composting and recycling soil nutrients whilst contributing to the maintenance of soil structure. The role of earthworms in enhancing soil fertility is well known and farming practices have considerable effects on both earthworm abundance and species composition. Earthworms can be divided into three ecophysiological categories: (1) leaf litter/compost dwelling worms (epigeic), (2) topsoil or subsoil dwelling worms (endogeics); and (3) worms that construct permanent deep burrows through which they visit the surface to obtain plant material for food, such as leaves (anecic). Anecic species which are large, vertically burrowing earthworms building up stable burrows play an important role in conservation and improvement of soil structure. Earthworms form the base of many food chains and all these aspects which led to their selection as a biodiversity indicator are reviewed in Dennis *et al.* (2009).

Earthworm sampling should preferably be carried out during cool and wet seasons. Although earthworms can live in litter, soil, wet mud, submerged mud, organic manure, composts, dung, under bark and on rotted wood, most earthworm species are adapted to a particular habitat. One active collection system consists of hand sorting from soil cores of 25 x 25 or 30 x 30 cm^2 dug to a depth of 20–50 cm with a spade. Digging deeper than 20–30 cm into the soil yields few specimens but sometimes reveals interesting deep-burrowing species. To assess populations of deep-burrowing and larger specimens, irritant solutions can be used to stimulate the earthworms to come to the soil surface, thereby facilitating collection. One particularly effective technique involves the application of aqueous formaldehyde solution onto 50 x 50 cm^2 of soil.

4.2.4.2. Summary of field sampling protocol

Sampling method: extraction with an expellant solution (diluted allyl isothiocyanate: AITC) and then hand sorting.

Sampling location: In each habitat/field plots selected by the BioHab method on case study farms.

Sampling location within the habitat/field plots: 3 samples (30 cm x 30 cm x 20 cm deep) haphazardly.

Sampling date: One survey in spring when soil is moist.

Sampling procedure: 2 litres of a solution of AITC is poured into a metal frame (30 x 30 cm) twice at 5 minutes interval. Earthworms appearing at the surface are collected. A soil core of 30 cm x 30 cm x 20 cm deep is extracted and earthworms are hand sorted from the soil during 20 minutes by one person.

Timing: All habitat/field plots have to be sampled within a 40 day period during spring 2010.

4.2.4.3. Materials and methods - field sampling protocol

In spring, 3 samples of 30 cm x 30 cm x 20 cm deep (up to) each are taken in each of the habitat/field plots selected by the BioHab method of the farms. Soil needs to be humid. In habitat/field plots with polygon form, the 3 samples are located 20 meters apart from the border of the habitat/field plot and 10 meters apart from each other. In linear elements, the 3 samples are taken along a line in the middle of the habitat and 10 meters apart from each other. The 3 samples are located so that at least an area of 10 m x 10 m (linear elements: 1 x 10 m) in the habitat/field plot is not destroyed for future vegetation relevés.

Method is adapted after Zaborski (2003) and Pelosi et al. (2009). A combined method should be used to extract earthworms, namely an extraction with an expellant solution and a hand-sorting of earthworms from a soil core.

Activities to be carried on before field work:
- Prepare all materials needed (sampling equipment, depending on the number of persons; for 2 persons in the field: 3 metal frames, 2 scissors, 1 container to measure 2L, 2 spades or bar spades, containers with labels, 2 white plastic sheets, 2 plastic boxes (~60L), 2 tweezers, plastic gloves, 2 graduated rulers).
- Prepare an allyl-isothiocyanate (AITC) solution diluted with ethanol 70^0 to give a 5 g/l solution, shortly before going into the field (in the morning for instance, to prevent loss of irritating activity).

In the field,
- Locate plots and sampling sites (e.g., according to 'Placement of sampling sites' proposal, see below) but avoid trampling of sites.
- Dilute this solution with water to reach a concentration of 0.1 g/l (PLATE 4.7 top right).
- Clean sampling site from vegetation or leaves carefully (with scissors, not by uprooting; PLATE 4.7 top left).
- Place the metal frames (30 cm x 30 cm) on the soil and driven into the ground to a depth of approximately 1-2 cm to prevent the chemical from running off the sampling site. Avoid too much tremor if possible (PLATE 4.7 top right).
- Stir up AITC solution and apply 2 x 2L of AITC solution (2 applications with 2L at approx. 5 min. interval) per sampling site (PLATE 4.7 lower left).

PLATE 4.7. THE PROCESS OF SAMPLING EARTHWORMS BY CHEMICAL EXTRACTION *(P. Dennis and J. Wilkes)*

- Collect the earthworms that come to the surface during a 10 min. period after the first pouring. After the earthworm has left the soil completely use tweezers to put emerging specimens in a container with cold water to clean from AITC solution (PLATE 4.7 lower right). !!! Use one container for earthworms collected with expellant application and another for hand sorted earthworms (2 sub-samples).
- After 10 min. extract the soil cores of the sampling sites. Dig the exact dimension of the metal frame (30 cm x 30 cm) and a depth of 20 cm using a spade or bar spade (less damage to worms but more difficult to dig a straight hole; PLATE 4.8 top left and right). In case this depth cannot be reached (stones, etc.), the depth should be recorded.
- Put the core on a white plastic sheet that is big enough to prevent earthworms from crawling away.
- Earthworms are hand sorted during 20 min by one trained person (Schmidt, 2001).
- Specimens are put in containers with cold water to clean from dirt. Use one container for each sample site (each sample has to be kept separated; PLATE 4.8 lower left and right).
- Put specimens in labelled (name of the farm, habitat, sample, extraction method, name of collectors, notes if needed) containers with cold oxygenated water (Bartlett et al. 2006) or wet paper towels (Zaborski 2003) and take them to the laboratory in a polystirol container (no glass

containers have be used), two for each sample site (each sample site and extraction method has to be kept separated).

- Put soil cores back in place.

To save time, it is possible to work on 2 or more samples in parallel: put 2 metal frames on the soil simultaneously; cut vegetation in both, pour expellant in both; move from one sample to the other during the 10 minutes. After 10 minutes, start digging the site that was poured with AITC first, put the soil in a plastic box and begin to hand-sorted the second site.

PLATE 4.8. SOIL SAMPLING AND SORTING TO EXTRACT EARTHWORMS *(P. Dennis and J. Wilkes)*

The time-effort management is described in TABLE 4.8 for 20 farms.

Additional remarks

- It is generally better to be at least 2 persons in the field.
- Assessment of biomass can be performed depending on time each expert has.

4.2.4.4. Laboratory processing of samples

- Keep the sample in a refrigerator at 3-5 C°.
- Within one week after sampling each sample should be processed.
- The sampling has to be energetically washed using a kitchen colander under running water to remove remaining soil and gut content from the earthworms.
- Sorting, identification and counting is done under laboratory conditions by local experts.
- The surviving earthworms can be released but specimen copies should be kept for quality assurance.

- If earthworms are going to be identified by external taxonomist (centralized) 80% ethanol solution has to be used.

Adult earthworms can be identified to species level although it may not be possible to identify juvenile specimens with certainty. The numbers of each species will be aggregated for each part of the sample to achieve the best estimate of species richness but separate records of species and numbers will be kept to assess the efficiency of the combined method. So, each of the 3 "soil core" samples and 3 "AITC" samples per habitat/field plot will be labelled separately.

4.2.4.5. Format of data records

If all specimens collected are centrally identified, only the field protocol will be provided by individual case study partners. The field protocol of the extraction and the hand sorting in form of an Excel sheet contains the following fields: habitat/field plot code, observer's name, date, time of start of the AITC application of the first sub-sample in a habitat/field plot (one record per plot), digging depth of each sub-sample, vegetation height (on average for the habitat/field plot), observation of nutrient input (yes/no, for example liquid manure), optionally the soil temperature and humidity (APPENDIX 7.8).

If specimens are identified by individual case study partners, the idenification protocol in the form of an Excel sheet with the following fields will be provided: sample code (6 different codes for each habitat/field plot), date, identifier name, species list, abundance of each species. Sample data are transformed to record earthworm number (and biomass; optional) per square metre, so that comparison among different plots and farms can be carried out (APPENDIX 7.9).

TABLE 4.8. EFFORT PER PLOT, PER VISIT, PER FARM AND ESTIMATION OF TOTAL INDIVIDUALS COLLECTED.

BioBio Species indicators	N. of samples/plot[1]	Effort/sample in hr[2]	Effort/plot in d (8-hr d)	N. of visit	N. of plots/farm[3]
B4) EARTHWORMS (EW)	3	0.67	0.251	1	15

BioBio Species indicators	Effort/farm (person.day)	N. of farms	Effort/visit (person.day)	Total (person.day)	N. of samples/CS
B4) EARTHWORMS (EW)	3.77	20	75.3	75.3	900

BioBio Species indicators	Sorting in d (8-hr d) [4]	Identification/CS[5]	Cost Identification /CS[6]
B4) EARTHWORMS (EW)	9	16'200	10'530.-

[1] a sample = a subsample of earthworms collected with expellant application within a 30 cm x 30 cm and a subsample of earthworms hand sorted from an excavated core of soil 30 cm x 30 cm x (up to) 20 cm deep. Subsamples are kept separately.

[2] for 2 samples, 1 person: 10 min for installing + 15 min for chemical + 15 min to dig + 40 minutes for hand-sorting. Hand-sorting per sample = 20 minutes.

[3] estimated according to tests with the BioHab method.

[4] estimated with 5 minutes per sample.

[5] estimated with 18 specimen per sample (200 specimen per m2).

[6] estimated with 0.65 EUR per specimen.

4.3. GENETIC INDICATORS – QUESTIONNAIRE

(Luisa Last, Roland Kölliker)

A comprehensive set of indicators for the detection of biodiversity in organic and low input farming systems must include measures of genetic diversity within species. However, reliable detection of genetic diversity is generally laborious, often technically demanding and can be difficult due to the lack of information about breeding pedigrees and seed sources. Therefore, in the framework of the BioBio project, a detailed analysis of genetic diversity of all aspects concerning agricultural ecosystems is impossible. However, based on a PhD project we will evaluate the indicators outlined below mainly using on-farm surveys. The experimental part of the PhD thesis will focus on the detection of genetic diversity in grassland ecosystems based on a single model species (*Dactylis glomerata*) in order to provide information about the use of indirect indicators such as habitat diversity and / or management practices for estimating genetic diversity in grassland ecosystems.

4.3.1.Indicators for plant genetic diversity

A4 CultDiv-I	Number and surface covered by and origin of cultivars, landraces and wild species of arable crops, trees and vegetables grown on farm (Questionnaire)
A5 CultDiv-II	Number and surface covered by and origin of cultivars, landraces and wild forms of forage grass (grassland) grown on farm (Questionnaire)
A6 SeedMulti	Methods of seed management performed on the farm and to which crops it is applied (Questionnaire)
A7 CropCuPheDiv	Phenotypic diversity of selected crop species based on IPGRI descriptors (Questionnaire)
A8 CropPedDiv	Genetic diversity based on pedigree analysis (Questionnaire)
A9 GrassGenDiv	Molecular genetic diversity of model grassland species (Field and lab work)
A10 Reseed	Amount of reseeding of grassland (Questionnaire)

4.3.2. Sampling protocols

4.3.2.1. Questionnaire based evaluation of plant genetic diversity

Indicators A4-8 and A10 will be evaluated using the specific questionnaire for plant genetic diversity (APPENDIX 7.5) developed at the start of the PhD project in early 2010. Specific questions were developed and discussed with partners before they were included in the final questionnaire.

Questions for indicator A4 to A6 and A8 were developed as general as possible for all case studies areas, whereas questions for indicator A7 are specific for selected crops based on case study decriptions and crops grown on farms.

Initially, it was anticipated to evaluate this indicator not only based on a Questionnaire but also on surveys which could be performed by one or two persons in approximately two hours per crop, depending on the indicators selected. Since the indicators have to be selected for each crop species, it is not possible to determine these traits beforehand. However, due to lacking descriptors for all crop species and the time and labour required to assess phenotypic diversity of selected species directly on farm, the information for indicator A7 will only be collected for selected species and case studies areas and purely based on questionnaires.

Some crop species are very common in many of the case studies (e.g. wheat). Others are specific in single case studies areas (see **TABLE 4.9**.: Descriptors for A7).

TABLE 4.9. DESCRIPTORS FOR A7

Case studies	Descriptors for
Austria, Germany, France, (Ukraine)	Wheat
Italy	Grapes
Spain, (Tunesia)	Olives

The questionnaire for the assessment of plant genetic diversity based on farmers' knowledge is included in APPENDIX 7.5.

4.3.2.2. Molecular genetic analysis of a model forage grass species

Since evaluation of genetic diversity using molecular genetic or phenotypic markers is not suitable as an indicator routinely used to assess the quality of organic or low-input farming systems, habitat diversity may be used as an indirect indicator based on the following hypothesis:
"At a given location (farm), genetic diversity of a grassland species can be predicted by the number of distinct habitats in which the species occurs"
The main focus of the work on genetic diversity of grassland species will be on the validation of the above hypothesis. Genetic diversity will be evaluated in a subset of case studies, farms and habitats using molecular genetic markers and *Dactylis glomerata* as a model species. Molecular genetic analyses will be supplemented by phenotypic analyses of key agronomic traits of selected populations if time and resources allow for this. Since for a conclusive characterisation of genetic diversity of outbreeding populations a larger number of individuals have to be investigated and due to the limited resources available, a total of 1920 plants from 60 populations will be analysed as outlined in TABLE 4.10.

TABLE 4.10. SAMPLES FOR MOLECULAR GENETIC ANALYSIS

	Species	Case-Studies (species)	Systems (case study)	Farms (system)	Habitats (farm)	Number of plants (habitat)
Number	1	3	2	5	2	32
Description	*Dactylis glomerata*	CH, BU, NO	Organic (low input), conventional (high input)			
Total number of samples						1920

Sampling of 32 individuals per habitat will be performed at the occasion of farm visits for vegetation survey or as soon plant or leaf material is available. Since the outcome of the project largely depends on the quality of and the differences among grassland habitats present on individual farms, particular care has to be taken when selecting suitable populations.

Genetic diversity of populations sampled in different habitats, farms and case-studies will be analysed using molecular markers such as simple sequence repeats (SSRs or microsatellites).

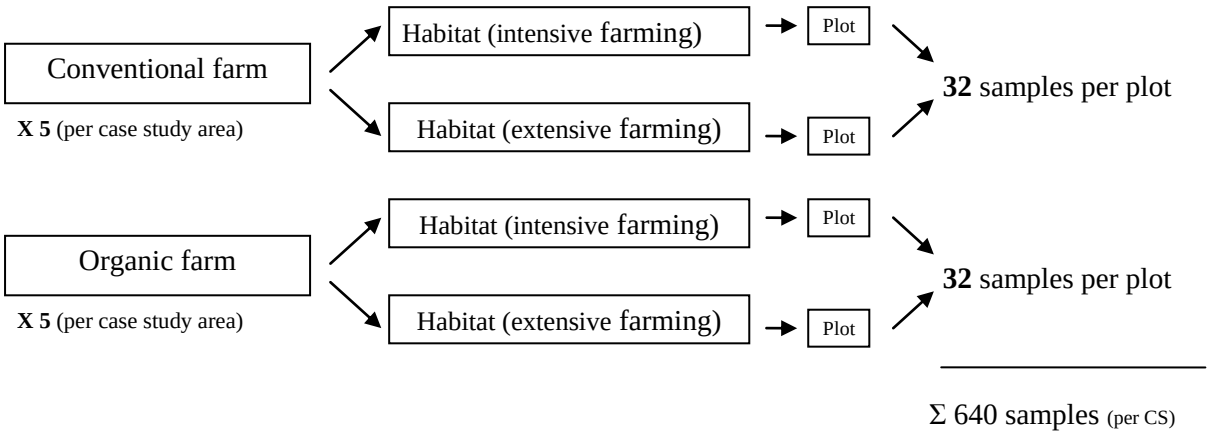
SSRs are repeated sequences of DNA and consist of 1-6 repeated base pairs forming simple sequence repetitions of two, three or four nucleotide units occurring in tandems and randomly (Park et al. 2009). The number of repeats shows a high level polymorphism defining genetic differences within and between species. In combination with PCR, these length-polymorphisms can be detected by gel electrophoresis or capillary electrophoresis. Especially in plant genetics, SSR have advantages over other molecular marker. For example, (i) they are co-dominant, (ii) require a small amount of DNA (PCR-based), (iii) are highly abundant in almost all species and distributed through the whole genome, (iv) the identification of many alleles at a single locus is possible, (v) they are highly reproducible and, (vi) primer sequences are easily exchanged and accessible (Gianfranceschi et al. 1998, Rupp et al. 2009). For *D. glomerata,* a considerable number of SSR primer sequences has been published (Xie et al. 2010). In addition, other marker systems such as sequence tagged site (STS) markers or single nucleotide polymorphism (SNP) will be evaluated and used if appropriate.

4.3.2.3. Summary of field sampling protocol

Sampling method: Rapid drying and preservation of plant tissue with silica gel as desiccating agent in sealable plastic tubes.

Sampling design: Plant samples of *Dactylis glomerata* have to be sampled on 5 organic and 5 conventional farms per case study area. On each of these 5 organic and 5 conventional farms, 2 sampling plots have to be prepared in two contrasting habitats[9] (FIGURE 4.7). The sampling plots can be the same plots which have been prepared for the vegetation survey.

FIGURE 4.7. SAMPLING DESIGN FOR MODEL GRASS SPECIES (FARM-SCALE)



Sampling location within the habitat/field plots: The sampling location within the habitat can be the same as selected for vegetation survey.

Sampling date: During vegetation survey or afterwards – when young leave material is available

Sampling procedure: 5 to 7 leaves with a length of 4 to 5 cm of a single *Dactylis glomerata* plant are harvested. The leaves have to be inserted into a sealable plastic tube which is filled with silica gel (containing a moisture indicator dye). 32 plants have to be sampled per sampling plot.

Timing: All habitat/field plots have to be sampled in 2010 whenever fresh leave material is available.

4.3.2.4. Materials and methods - field sampling protocol

Preparation in the laboratory: 15ml plastic tubes have to be filled will silica gel containing moisture indicator dye up to the mark "6ml". It is important to seal the tubes tightly.

→ Preparation for Bulgaria and Norway is completed in Switzerland. Prepared material (plastic tubes with silica gel, and barcode label) is sent by post.

Preparation in the office: After habitat mapping, *Dactylis glomerata* leave samples are collected in sampling plots within preselected habitats. These plots can be the vegetation plots prepared in

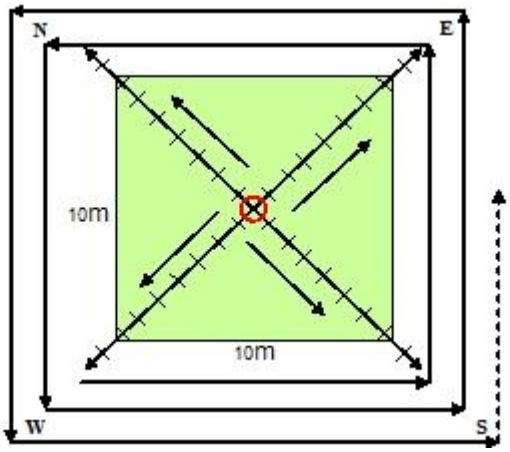
[9] Contrasting according to management practice applied in this habitat/area. The difference between intensive and extensive management should be as big as possible.

aerial elements for the vegetation survey as far as *Dactylis glomerata* is present. The choosen habitats have to be as contrasting as possible. One should be located in an intensive managed habitat. The other should be in an extensive managed habitat on the same farm.

Sampling in the field: Preparation of a 10 x 10 m sampling plot in a habitat (plots prepared for the vegetation survey, can be used as far as *Dactylis glomerata* is present).

Sampling of plant material starts two steps from the middle () of the 10 x 10 m plot toward the edges FIGURE 4.8 Plant samples are taken every second step toward North, South, West and East, resulting in 8 tissue samples per transect (N, S, E and W) and 32 tissue samples per plot.

FIGURE 4.8. SAMPLING DESIGN FOR PLANT TISSUE OF *Dactylis glomerata* (PLOT-SCALE)



Plants that will be sampled **don't** have to be directly on a straight line towards the edges. They can be up to 50 cm next to each side of this fictive line.

Sampled plants may be labelled with a marker (plastic stick ect.) to avoid duplicate sampling.

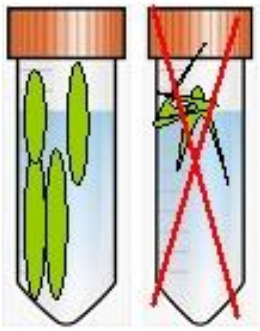
IF there are not enough plants within the sampling plot, the sampling will go on around the sampling plot. Walk around the plot in a spiral and go on collecting.

Make sure that distance between single plants is more than 1 m.

Do not collect plants next to buildings, roads or other human made facilities (those plants could be part of reseeding mixtures after construction), but from areas representing the habitat.

5 to 7 young leaves (4 – 5 cm) are harvested per sample. Harvested leave samples have to be straight in the tubes, **not** as a ball (FIGURE 4.9)

FIGURE 4.9. POSITION OF LEAVE SAMPLES IN THE TUBES.



The plastic tubes have to be **sealed tightly** to avoid further moisture penetrating into the tubes. Shaking the tube after filling provides homogenous mixture of silica gel and plant material inside the tubes. The tubes have to be labelled immediately and tubes sampled from the same plot are stored together in a labelled plastic bag.

4.3.2.5. Molecular marker analysis (tentative)

DNA of individual plants will be extracting using the NucleoSpin 96 Plant Kit (Marchery Nagel) and the Corbett X-tractor robot. After quantification DNA of individual plants will be used for PCR amplification of ~20 SSR loci. Amplified fragments will be separated on an ABI 3130xl genetic analyzer (Applied Biosystems) and analysed using GeneMarker software (SoftGenetics). Genetic diversity will be evaluated using multivariate statistics such as principle component analysis, cluster analysis and redundancy analysis (implemented in the Canoco software package).

4.3.3. Livestock genetic resources

The following livestock species and genetic diversity indicators will be evaluated:

A1) Number and amount of different breeds per species (**Breeds**)
A2) Information on breeding practices ("on-farm" bull, artificial insemination,...) (**Liveprac**)
A3) Where available, pedigree of the herd (**LivePedi**)

This will be assessed from completion of livestock genetic resources table (APPENDIX 7.6) during the farmer interview.

4.4. FARM MANAGEMENT INDICATORS – QUESTIONNAIRE

(*Jean-Philippe Choisis, Norma Choisis, Peter Dennis, Jürgen K. Friedel, Mariecia Fraser, Philippe Jeanneret, Max Kainz, Philippe Pointereau, Jean-Pierre Sarthou, Manuel Schneider, Norman Siebrecht, Sebastian Wolfrum*)

4.4.1. Introduction

The Farm Management Questionnaire ("BIOBIO Questionnaire 2" [10]) is the basis for data collection to assess farm management of BIOBIO Case study (CS) farms. The selection of

[10] This term was introduced earlier to distinguish between the questionnaire developed for the farm selection process ("Questionnaire 1") and the questionnaire documenting farm management practices ("Questionnaire 2")

parameters for the questionnaire is guided by the set of Farm Management Candidate Indicators, agreed at the PCC Meeting in Brussels. Additional parameters were subsequently included for the following reasons:

- To cover additional factors affecting direct indicator measurement on BIOBIO plots e.g., status of grassland (spontaneous vegetation or sown, rotational or permanent), winter soil cover and crop rotation in arable crops
- To quantify organic matter fluxes and facilitate the computation of nitrogen balances (fodder, manure, crop yield)

4.4.2. Defining requirements for the questionnaire

The diverse data needs for the variety of farming systems investigated by BioBio were a particular challenge in the compilation of the questionnaire. The questionnaire is designed to cover the management practices of farms with and without livestock and takes into account different land use types such as grassland, arable crops and permanent crops (olives and vineyards) as well as semi-natural habitats (field margins, hedges etc.). Furthermore, data are recorded on different scales of measurement: farm level, crop level ("standard operations for each crop"), field level (plots of BIOBIO survey).

It was a basic requirement that one common questionnaire should be used by all case studies and that data are kept as simple as possible. Complex datasets that need interpretation could not be analysed due to the large number of farms in BIOBIO.

As the data would be collected from interviews with farmers, additional practical criteria guided the questionnaire design.

The duration of interviews must be limited to a maximum of 2 to 3 hours (including Genetic Diversity Indicators). One farm visit must suffice to collect all the data for the questionnaire.

The level of documentation of farm management differs from farm to farm and from region to region. Some farmers may to keep environmental farm accounts on a routinely basis (e.g. due to cross-compliance obligations), whereas other farmers can only provide data from their daily routine and from basic documents (e.g. receipts on energy consumption).

An initial proposal to ask farmers to document specific management practices for BIOBIO was eventually rejected. There was the general notion that farmers would be reluctant to keep additional notes and that data would finally be incomplete. Thus, gaps in data collection would hamper statistical analysis.

Therefore, all data collected in the BIOBIO farm management questionnaire should be deducted from the interviews based on the farmer's operational knowledge of his or her farm and on basic farm accounting.

4.4.3. Structure of the farm management questionnaire

The Farm Management Questionnaire is divided into 4 main sections (A, B, C and D) and several subsections (TABLES 4.11 and 4.12).

Form A "General Farm Data" concerns aggregated data collected on the farm level such as energy consumption, agri-environmental measures, organic matter fluxes, etc.

Forms B1 and B2 survey parameters that describe the plant production system of the farm. Based on **"standard operations"** such as fertilisation practises, plant protection measures and mechanised field operations, data are collected for each crop or grassland type. Due to similarities in the structure of management practices, form B1 covers **"annual arable crops, olives and vineyards",** whereas form B2 focuses on **"grassland and perennial fodder crops".** Data from forms B1 and B2 will be used to calculate nitrogen input and nitrogen balances and to assess the farming intensity based on grazing management, plant protection measures and mechanised field operations. The total area of utilised agricultural area (UAA) will be calculated from these data. Therefore, the synthesis of data from forms B1 and B2 must completely reflect the plant production system of the farm.

Forms C1, C2 and C3 concern **specific management of BIOBIO plots** where faunistic and floristic indicator sampling took place. Additional data are collected beyond "standard operations", e.g. by estimating the timing of certain measures or by specifying grazing management and crop rotation. Forms are subdivided by categories used in BioHab: "**Areal Habitats**" (C1 "crops/olives/vineyards" and C2 "grassland/perennial fodder crops") and "**Linear Habitats**" (C3). Form C3 provides short information on the management of herbaceous and woody linear habitats.

Form D "**Livestock Management**" records numbers of livestock on the farm broken down by livestock categories. Livestock units will be calculated from this table. Additional parameters concern meat production (indicator for productivity), use of pastures and common grazing land.

Due to the limited time available during the interviews, it is recommended that farmers are informed about certain data needs before the visit. Depending on the farming system, the farmer can be asked to prepare certain documents (e.g., on agri-environmental measures, energy consumption, purchase and sale of organic matter).

TABLE 4.11. GENERAL RELEVANCE OF QUESTIONNAIRE SECTIONS FOR EACH BIOBIO CASE STUDY

	A	B1	B2	C1	C2	C3	D
A_ARA	X	X	(X)	X	(X)	X	
F_ARA	X	X	(X)	X	(X)	X	
D_MIX	X	X	X	X	X	X	X
B_GRA	X		X		X	X	X
H_GRA	X		X		X	X	X
N_GRA	X		X		X	X	X
C_GRA	X		X		X	X	X
W_GRA	X		X		X	X	X
E_DEH	X		X		X	X	X
E_OLI	X	X		X		X	
L_HOR	X	X		X		X	
I_VIN	X	X		X		X	

Remark: the "x"-mark indicates that the respective section of the questionnaire is compulsory for the case study. Depending on the specific crops on a farm, additional sections may be relevant. e.g., a grassland farm may also grow annual fodder crops (form B1). Lucerne on arable farms will be recorded in form B2 ("perennial fodder crops"). A horticulture farm may also keep livestock, therefore form D must be filled.

4.4.4. Data processing

In order to facilitate standardised data entry and calculation of indicator values, BIOBIO CS partners are provided with Excel-sheets for digitalisation of questionnaire data. The Excel-Sheets will then be imported to a central database. Calculations of indicator values will be done in the central data base.

BIOBIO case study partners are free to collect additional data and perform more detailed in-depth studies (e.g. REPRO, Germany; SALCA – Life cycle assessment, Switzerland; DIALECTE, SOLAGRO, France)
The following aspects could be studied in more detail:

- Energy balance
- Treatment frequency index (based on standard doses of active ingredients)

TABLE 4.12. CANDIDATE FARM MANAGEMENT INDICATORS AS RELATED TO SECTIONS OF THE QUESTIONNAIRE

Code	Factsheet	Candidate Indicator	Unit of measurement	Questionnaire Form	Level of measurement
D1	DivEnt	Diversity of Enterprises	Number and relative land area of enterprises at the farm level	B and D	Farm
D2	AvStock	Average Stocking Rate	Livestock units per ha UAA	D	Farm
D3	MinFert	Area without Use of mineral fe	% UAA without use of mineral-based fertilisers	from data in B	Farm
D4	NitroIn	Nitrogen - input or N-balance	kg Nitrogen per ha	B C	Crop Management BioBio Plot
(D4)		Manuring & Green Manure	Tonnes per ha and year	Manure: B + C Green Manure: A	Crop Management + BioBio Plots Farm
D5	EnerIn	Energy Input	GJ/ha	Direct Energy Input A	Farm
D6	CertOrg	Organic farming	Certified as organic yes/no	A	Farm
D7	AgrEnv	Area under agri-environment support	Agri-environmental measures and area covered	A	Farm
D8	IntExt	Intensification/Extensification Expenditures on fertiliser, crop protection and concentrate feed stuff	€ Euro per ha	A	Farm
D9	PestUse-TFI	Pesticide use	Treatment Frequency Indicator (TFI)	B + C [1]	Crop Management & BioBio Plots
D10	PestUse-Area	Reduced use of chemical pesticides	Area of UAA without or with reduced use of chemical	B	Crop Management
D11	FieldOp	Field operations	Frequency and timing of field operations (by operation type)	B + C	Crop Management & BioBio Plots
(D11)		Mowing	Frequency and timing of operations	C	BioBio Plots
(D11)		Mechanical weeding	Frequency and timing of operations	C	BioBio Plots
(D11)		Soil cultivation	Tillage system, timing and frequency	C	BioBio Plots
D12	GrazInt	Grazing Intensity	Frequency and intensity	C	BioBio Plots
D13	Prod	Productivity (cereal, milk or meat)	tonnes per ha or per LU per year	C + D	Farm, Crops
D14	Irrig	Irrigation	Practiced yes/no	A	Farm
Indicators also to be derived from other Candidate Indicators					
(B1)		Presence/ Percentage of grass-clover and legumes in	Percentage of crop rotation	from data in B	Farm
(B1)		Intercropping and Undersowing	Area and percentage of UAA cover	A+C	Farm + BioBio Plots
(B1)		Crop Diversity	Number and relative land area of crops at the farm level	B	Farm
		Relative proportions of livestock species on farm	Percentage of species	D	Farm

[1] Due to the demanding data needs for the Treatment Frequency Indicator (standard doses of specific substances) and the insufficient documentation on the farms, the TFI will not be tested in the BioBio case studies. A simplified version based on frequency of pesticide treatments is applied, instead.

4.4.5. Questionnaire Interview Sheet

Refer to APPENDIX 7.4 "BIOBIO Farm Management Questionnaire".

4.5. ASSESSMENT OF COSTS OF MEASURING BIODIVERSITY INDICATORS IN BIOBIO PROJECT

(S.Targetti, D. Viaggi)

4.5.1. Objective

The objective of this document is to develop a preliminary framework and an operational protocol for the evaluation of the costs of measurement of biodiversity indicators in the project BIOBIO. UNIBO's activity cuts across project's work packages and concerns WPs 2, 3, 4 and 5. The main responsibilities fall specifically under Work Package 3 (Deliverable 3.3) and comprise the reporting of time consumed, as well as effort, costs and the practicability of data collection in twelve (12) case studies (CS). In the description of work it is specified that the delivery date for this component of the project is month 24. In Work Package 4, UNIBO will contribute to the elaboration of Deliverable 4.1 (Report on scientific analysis) by providing an indication of the cost of indicator measurement. The background literature is reviewed and justification of the methods of cost assessment and benefit assessment presented in Dennis *et al.* (2009).

4.5.2. Methodological proposal

4.5.2.1. *Rationale*

Following the few existing examples, we propose a simple data collection approach based on the periodic (monthly) notation of resources used. The main categories of expenditure (i) considered are the following:

- Labour
- Equipment
- Travel
- Consumables
- Others (e.g. income forgone if the test requires damaging some production, using land).

We propose data collection based on the distinction of physical information and associated unitary prices. In addition, an important point is the need to identify *fixed costs*. Fixed costs in economics are usually those that do not depend on the quantity of good produced by a production unit. In our case, fixed costs are those that do not vary with the "quantity of measures" performed. For example, some cost items can be fixed with respect to:

- Several indicators measured: e.g. a transport expense may serve an inspection in a site to collect data for several indicators;
- Several data collections for the same indicators (e.g. the initial planning of the sampling/transects);

- Several analyses for the same indicator (e.g. the cost of machinery for laboratory analysis, purchased at the beginning and used several times).

This will enable the testing of adjustments that could be necessary and/or the performance of a sensitivity analysis of the results on some variables (e.g., labour costs), in order to:

- check how costs would change in different geographical areas (e.g., due to different labour costs);
- check how the costs would change moving from experiments to routine measures (e.g., where fixed costs for preliminary operations are already paid for);
- check if there are economies of scale and scope in the number of trials or data collection point;
- adapt to real life (e.g., substituting fp7 salaries with everyday activities of a monitoring agency);
- prevent/evaluate uncertainties in costs assessment.

An important point to be defined is the *Unit for cost calculation*. The obvious candidate is the single indicator per site. However, this may not be completely satisfactory in light of the previous concerns, e.g., when there are common fixed costs across indicators. Alternatives may concern disaggregations (single transects related to the same indicator) or aggregations (e.g. bundles of indicators).

4.5.2.2. Data collection & organisation

The general workflow for data collection and organisation is presented in FIG. 4.10. We propose to split data collection into two main parts: on one hand (a) we record the activities carried out and their use of resources in physical terms; on the other hand (b) we prepare an inventory of the typologies of the main cost items, where descriptions and unitary costs are given. This will include the four main categories of costs discussed above. Other costs, such as income forgone due to indicator measurement will be considered separately as they will likely not follow the same structure.

UNIBO will prepare Excel (or Access) sheets to support data collection for components a), b) and possibly c). Preliminary forms for a, b1, b2, b3, b4 are available in APPENDIX 7.7 and in an Excel document which will be provided to the WP 3 workshop participants in Vienna . **It will be the responsibility of the leader of each case study to assiduously fill in these forms on a weekly basis and to send them to UNIBO.**

UNIBO will be in charge of step d). This will first include data verification and the setting up of an aggregated database in Access. This will be used for cost calculation and, at a later stage, for cost simulation and sensitivity analysis (if relevant). This should allow for an easy recording of activities and related costs over time and a clear database allowing for simulations, i.e. calculation of costs adapted to different conditions.

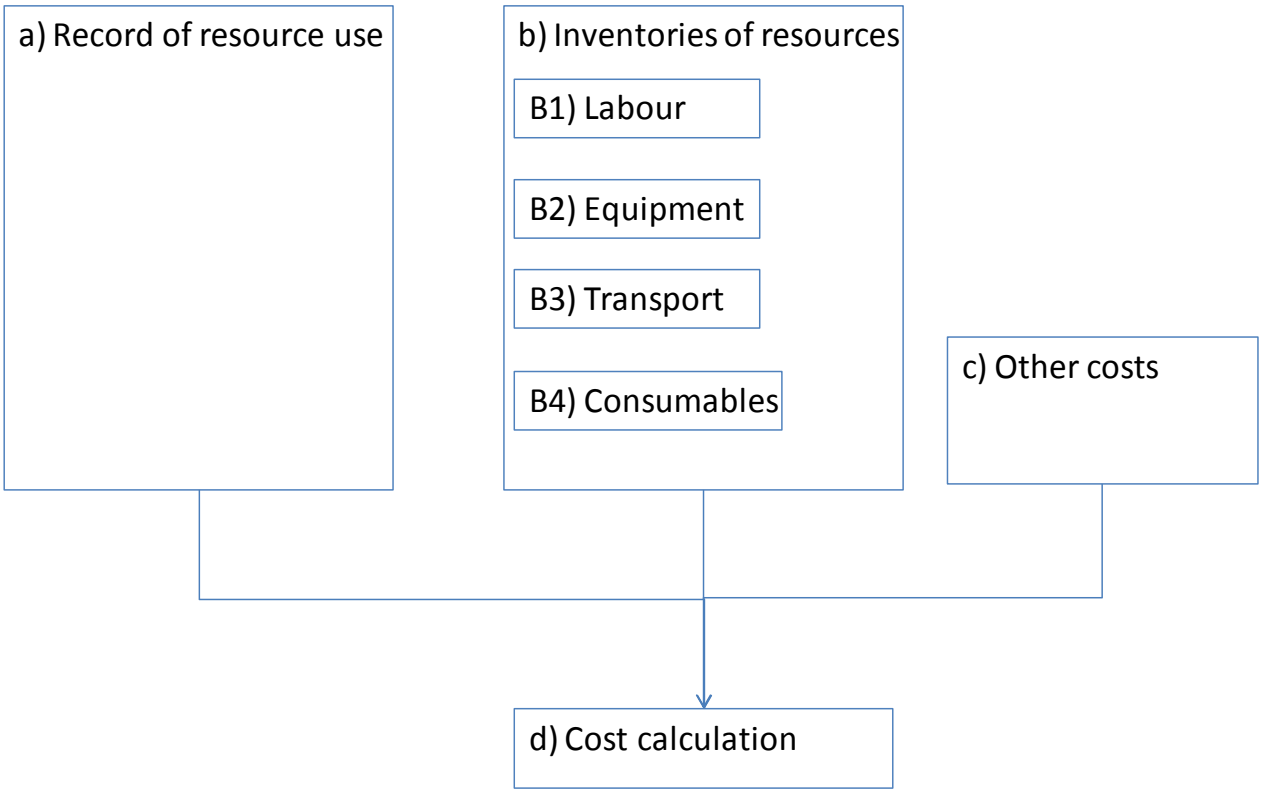


FIGURE 4.10. ORGANISATION OF DATA COLLECTION AND COST CALCULATION

4.5.3. Discussion

This paper provides a preliminary analysis of the problem of the evaluation of costs in the measurement of biodiversity indicators, and an overview of the operational estimation of costs in BIOBIO. We found very limited literature and based on this, and on the general cost theory, we have provided a preliminary proposal for data collection and analysis.

In order to complete instructions for data collection related to costs, this preliminary discussion highlights the need for us to have more explicit information regarding the data collection protocols, the type of operations and resources to be used for the specific indicators to be measured in BIOBIO.

Secondly, we considered a number of sensitivity analyses/simulations in order to check the relevance of our cost measures for "real life" measures of indicators and for conditions different from those of the BIOBIO case studies. The present set-up allows the use BIOBIO information for a wider range of cost evaluation. Finally, we will verify the possibility of relating costs with the value of information obtained. This will potentially allow us to explore matching with the economic analysis of benefits.

5. DATA PROCESSING

5.1. DATA TRANSFER AND ORGANISATION

(Philippe Jeanneret)

Transfer of data from case studies to ART (responsible for the data management) will depend on the indicators in terms of material, format and layout.

5.1.1. Farm management indicators

Data collected from questionnaires will be transferred to the central database in form of Excel sheets. Each case study gathers the questionnaires of its farms, digitilize them into Excel sheets before transferring them to the central database. There will be one Excel file per farm. The first sheet contains the questionnaire data with respect to the whole farm. Each line in this table is a recorded indicator with its corresponding value (for instance "Livestock units per ha UAA"). In a second sheet are then data on standard operations of the habitat/field plots selected from the BioHab method for botanical and faunistic investigations. In thi table again, each line is a recorded indicator with its corresponding value (for instance Nitrogen – input (or N-Balance) in kg nitrogen per ha), and columns are the habitat/field plots.

5.1.2. Genetic diversity indicators

Data on genetic diversity indicators assessed with the farm questionnaires will be transferred together with the farm management indicators to ART (see section 7.1.1). In 3 case study regions (CH, B, N), genetic diversity of particular plant species will be investigated. Molecular genetic analyses will be performed at ART. The diversity of molecular markers of each plant specimen will be provided in form of an Excel sheet. The Excel sheet will have the same basic layout as for the species indicators.

5.1.3. Species diversity indicators

Data collected in the field on field conditions encountered during the field work (field data sheet) will be digitized in Excel sheets and transferred to ART (details are given in corresponding sections of specific indicators). These Excel sheets will be integrated in a central Access database so that they can be linked to the species indicators for further analysis (if applicable). Either from individual partners in case of identification of species at case study level (decentralized identification) or from specialist identifying species for the consortium (or part of it, centralized identification), species lists will be established in form of Excel sheets and transferred to ART (details are given in corresponding sections of specific indicators). These Excel sheets will be integrated in a central Access database so that data can be analysed at the different levels, i.e. habitat type, farm, case study region, and all case study regions together.

5.1.4. Habitat diversity indicators

The basic dataset for the calculation of the habitat diversity indicators will be provided by the habitat mapping of the farms in each case study region. The maps will be digitized by individual partners and data transferred to NFLI for analysis (NFLI jointly with ART).

To calculate the habitat indicators it is necessary to have the spatial data that were collected during the habitat mapping exercise. An image interpretation of the habitats surrounding those elements on the farm that were selected for the species sampling is also necessary. The digital

maps will enable the calculation of area and length data for the habitats recorded on the farms. The image interpretation will provide a list of habitats that surround the sampled elements together with an estimate of their percentage covers.

5.1.5. Cost of indicator measurement

The data is collected on a monthly basis in the forms provided in Annex 7.7 and transferred to Bologna University (UNIBO), where it will be analysed.

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6. APPENDICES

APPENDIX 7.1. LIST OF GENERAL HABITAT CATEGORIES

GHC (vernacular name)	**Primary code**
URBAN	**URB**
Artificial (buildings and tarmac)	ART
Non Vegetated (cleared land)	NON
Crops (Vegetable gardens)	VEG
Herbaceous (garden, parks and recreation)	GRA
Woody (trees/shrubs in gardens and parks)	TRE
Artificial / Non-Vegetated	ART/NON
Artificial / Crops	ART/VEG
Artificial / Herbaceous	ART/GRA
Artificial / Woody	ART/TRE
Non Vegetated / Crops	NON/VEG
Non Vegetated / Herbaceous	NON/GRA
Non Vegetated / Woody	NON/TRE
Crops / Herbaceous	VEG/GRA
Crops / Woody	VEG/TRE
Herbaceous / Woody	GRA/TRE
CULTIVATED	**CUL**
Bare Ground (ploughed land and bare fallow)	SPA
Herbaceous Crops (crops)	CRO
Woody Crops (orchards, vineyards, olive groves)	WOC
Herbaceous/Woody Crops	CRO/WOC
SPARSELY VEGETATED	**SPV**
Sea (sea)	SEA
Tidal (exposed marine substrates)	TID
Aquatic (fresh/brackish water)	AQU
Ice and Snow (glaciers and snow fields)	ICE
Bare Rock	ROC
Boulders	BOU
Stones	STO
Gravel	GRV
Sand	SAN
Earth, Mud	EAR
Rock/Boulders	ROC/BOU
Rock/Stones	ROC/STO
Rock/Gravel	ROC/GRV
Rock/Sand	ROC/SAN
Rock/Earth	ROC/EAR
Boulders/Stones	BOU/STO
Boulders/Gravel	BOU/GRV
Boulders/Sand	BOU/GRV
Boulders/Earth	BOU/EAR
Stones/Gravel	STO/GRV

GHC (vernacular name)	Primary code
Stones/Sand	STO/SAN
Stones/Earth	STO/EAR
Gravel/Sand	GRV/SAN
Gravel/Earth	GRV/EAR
Sand/Earth	SAN/EAR
HERBACEOUS WETLAND	**HER**
Submerged Hydrophytes (submerged aquatics)	SHY
Emergent Hydrophytes (emergent aquatics)	EHY
Helophytes (marsh plants)	HEL
Submerged Hydrophytes / Emergent Hydrophytes	SHY/EHY
Submerged Hydrophytes / Helophytes	SHY/HEL
Emergent Hydrophytes / Helophytes	EHY/HEL
HERBACEOUS	**HER**
Leafy Hemicryptophytes (herbs/ forbs)	LHE
Caespitose Hemicryptophytes (grasses and sedges)	CHE
Therophytes (annuals)	THE
Geophytes (bulbs, rhizomes)	GEO
Chamaephytes (cushion plants)	HCH
Cryptogams (mosses, lichens)	CRY
Leafy Hemicryptophytes / Caespitose Hemicryptophytes	LHE/CHE
Leafy Hemicryptophytes / Therophytes	LHE/THE
Leafy Hemicryptophytes / Geophytes	LHE/GEO
Leafy Hemicryptophytes / Herbaceous Chamaephytes	LHE/HCH
Leafy Hemicryptophytes / Cryptogams	LHE/CRY
Caespitose Hemicryptophytes / Therophytes	CHE/THE
Caespitose Hemicryptophytes / Geophytes	CHE/GEO
Caespitose Hemicryptophytes / Herbaceous Chamaephytes	CHE/HCH
Caespitose Hemicryptophytes / Cryptogams	CHE/CRY
Therophytes / Geophytes	THE/GEO
Therophytes / Herbaceous Chamaephytes	THE/HCH
Therophytes / Cryptogams	THE/CRY
Geophytes / Herbaceous Chamaephytes	GEO/HCH
Geophytes / Cryptogams	GEO/CRY
Chamaephytes / Cryptogams	HCH/CRY
TREES/SHRUBS	**TRS**
Dwarf Chamaephytes Winter Deciduous (dwarf deciduous)	DCH/DEC
Dwarf Chamaephytes Evergreen (dwarf evergreens)	DCH/EVR
Dwarf Chamaephytes Coniferous (dwarf conifers)	DCH/CON
Dwarf Chamaephytes Winter Deciduous / Evergreen	DCH/DEC/EVR
Dwarf Chamaephytes Winter Deciduous / Coniferous	DCH/DEC/CON
Dwarf Chamaephytes Evergreen / Coniferous	DCH/EVR/CON
Shrubby Chamaephytes Winter Deciduous (low shrubby deciduous plants)	SCH/DEC
Shrubby Chamaephytes Evergreen (low shrubby evergreen)	SCH/EVR
Shrubby Chamaephytes Coniferous (low shrubby conifers)	SCH/CON
Shrubby Chamaephytes Non-Leafy Evergreen (low shrubby Brooms/gorse)	SCH/NLE
Shrubby Chamaephytes Summer Deciduous and/or Spiny Cushion	SCH/SUM
Shrubby Chamaephytes Winter Deciduous / Evergreen	SCH/DEC/EVR

GHC (vernacular name)	Primary code
Shrubby Chamaephytes Winter Deciduous / Coniferous	SCH/DEC/CON
Shrubby Chamaephytes Winter Deciduous / Non-Leafy Evergreen	SCH/DEC/NLE
Shrubby Chamaephytes Winter Deciduous / Summer Deciduous	SCH/DEC/SUM
Shrubby Chamaephytes Evergreen / Coniferous	SCH/ EVR/CON
Shrubby Chamaephytes Evergreen / Non-Leafy Evergreen	SCH/EVR/NLE
Shrubby Chamaephytes Evergreen / Summer Deciduous	SCH/EVR/SUM
Shrubby Chamaephytes Coniferous / Non-Leafy Evergreen	SCH/CON/NLE
Shrubby Chamaephytes Coniferous / Summer Deciduous	SCH/CON/SUM
Shrubby Chamaephytes Non-Leafy Evergreen / Summer Deciduous	SCH/NLE/SUM
Low Phanerophytes Winter Deciduous (low deciduous scrub)	LPH/DEC
Low Phanerophytes Evergreen (low evergreen scrub)	LPH/EVR
Low Phanerophytes Coniferous (low coniferous scrub)	LPH/CON
Low Phanerophytes Non-Leafy Evergreen (low gorse/broom scrub)	LPH/NLE
Low Phanerophytes Summer Deciduous	LPH/SUM
Low Phanerophytes Winter deciduous / Evergreen	LPH/DEC/EVR
Low Phanerophytes Winter deciduous / Coniferous	LPH/DEC/CON
Low Phanerophytes Winter deciduous / Non-Leafy Evergreen	LPH/DEC/NLE
Low Phanerophytes Winter Deciduous Summer	LPH/DEC/SUM
Low Phanerophytes Evergreen / Coniferous	LPH/ EVR/CON
Low Phanerophytes Evergreen / Non-Leafy Evergreen	LPH/EVR/NLE
Low Phanerophytes Evergreen / Summer Deciduous	LPH/EVR/SUM
Low Phanerophytes Coniferous / Non-Leafy Evergreen	LPH/CON/NLE
Low Phanerophytes Coniferous / Summer Deciduous	LPH/CON/SUM
Low Phanerophytes Non-Leafy Evergreen / Summer Deciduous	LPH/NLE/SUM
Mid Phanerophytes Winter Deciduous (deciduous scrub)	MPH/DEC
Mid Phanerophytes Evergreen (evergreen scrub)	MPH/EVR
Mid Phanerophytes Coniferous (coniferous scrub)	MPH/CON
Mid Phanerophytes Non Leafy Evergreen (gorse/broom scrub)	MPH/NLE
Mid Phanerophytes Summer Deciduous and/or Spiny Cushion	MPH/SUM
Mid Phanerophytes Winter Deciduous / Evergreen	MPH/DEC/EVR
Mid Phanerophytes Winter Deciduous / Coniferous	MPH/DEC/CON
Mid Phanerophytes Winter Deciduous / Non-Leafy Evergreen	MPH/DEC/NLE
Mid Phanerophytes Winter Deciduous / Summer Deciduous	MPH/DEC/SUM
Mid Phanerophytes Evergreen / Coniferous	MPH/EVR/CON
Mid Phanerophytes Evergreen / Non-Leafy Evergreen	MPH/EVR/NLE
Mid Phanerophytes Evergreen / Broadleaved / Summer Deciduous	MPH/EVR/SUM
Mid Phanerophytes Coniferous / Non-Leafy Evergreen	MPH/CON/NLE
Mid Phanerophytes Coniferous / Summer Deciduous	MPH/CON/SUM
Mid Phanerophytes Non-Leafy Evergreen / Summer Deciduous	MPH/NLE/SUM
Tall Phanerophytes Winter Deciduous (tall deciduous scrub)	TPH/DEC
Tall Phanerophytes Evergreen (tall evergreen scrub)	TPH/EVR
Tall Phanerophytes Coniferous (tall coniferous scrub)	TPH/CON
Tall Phanerophytes Non-Leafy Evergreen (tall gorse/broom scrub)	TPH/NLE
Tall Phanerophytes Summer Deciduous	TPH/SUM
Tall Phanerophytes Winter Deciduous / Evergreen	TPH/DEC/EVR
Tall Phanerophytes Winter Deciduous / Coniferous	TPH/DEC/CON
Tall Phanerophytes Winter Deciduous / Non-Leafy Evergreen	TPH/DEC/NLE
Tall Phanerophytes Evergreen / Coniferous	TPH/EVR/CON
Tall Phanerophytes Evergreen / Non-Leafy Evergreen	TPH/EVR/NLE

GHC (vernacular name)	Primary code
Tall Phanerophytes Evergreen / Summer Deciduous	TPH/EVR/SUM
Tall Phanerophytes Coniferous / Non-Leafy Evergreen	TPH/CON/NLE
Tall Phanerophytes Coniferous / Summer Deciduous	TPH/CON/SUM
Forest Phanerophytes Winter Deciduous (deciduous forest)	FPH/DEC
Forest Phanerophytes Evergreen (evergreen forest)	FPH/EVR
Forest Phanerophytes Coniferous (coniferous forest)	FPH/CON
Forest Phanerophytes Summer Deciduous	FPH/SUM
Forest Phanerophytes Winter Deciduous / Evergreen	FPH/DEC/EVR
Forest Phanerophytes Winter Deciduous / Coniferous	FPH/DEC/CON
Forest Phanerophytes Evergreen / Coniferous	FPH/EVR/CON
Forest Phanerophytes Evergreen / Summer Deciduous	FPH/EVR/SUM
Forest Phanerophytes Coniferous/ Summer Deciduous	FPH/CON/SUM
Mega Forest Phanerophytes Deciduous	GPH/DEC
Mega Forest Phanerophytes Evergreen	GPH/EVR
Mega Forest Phanerophytes Conifer	GPH/CON
Mega Forest Phanerophytes ummer deciduous	GPH/SUM
Mega Forest Phanerophytes Winter Deciduous / Evergreen	GPH/DEC/EVR
Mega Forest Phanerophytes Winter Deciduous / Coniferous	GPH/DEC/CON
Mega Forest Phanerophytes Evergreen / Coniferous	GPH/EVR/CON
Mega Forest Phanerophytes Evergreen /Summer Deciduous	GPH/EVR/SUM

APPENDIX 7.2. SHORT LIST OF HABITAT CATEGORIES

- Urban (URB)
  - Artificial (ART)
  - Non-vegetated (NON)
  - Vegetables (VEG)
  - Herbaceous (GRA)
  - Woody (TRE)
  - Combinations
- Crops (CUL)
  - Cultivated bare ground (SPA)
  - Cultivated herbaceous crops (CRO)
    - Cultivated herbaceous crops, forage (CFO)
    - Cultivated herbaceous crops, without flowers (CAN), e.g. potatoes, wheat, barley, sugarbeet
    - Cultivated herbaceous crops, with flowers (CFL), e.g. sunflowers, beans, rapeseed, peas
  - Woody crops (WOC)
  - Combinations
- Sparsely Vegetated (SPV)
  - Sea (SEA)
  - Marine (MAR)
  - Aquatic (AQU)
  - Terrestrial (TER)
  - Ice and snow (ICE)
  - Combinations
- Vegetated Herbaceous (HER)
  - Submerged hydrophytes (SHY)
  - Emergent hydrophytes (EHY)
  - Helophytes (HEL)
  - Leafy hemicryptophytes (LHE)
  - Caespitose hemicryptophytes (CHE)
  - Therophytes (THE)
  - Geophytes (GEO)
  - Herbaceous chamaephytes (HCH)
  - Cryptogams (CRY)
  - Combinations
- Vegetated tree/shrub (TRS)
  - Dwarf chamaephytes (< 0.05 m) (DCH)
  - Shrubby chamaephytes (0.05-0.30 m) (SCH)
  - Low phanerophytes (0.30-0.6 m) (LPH)
  - Mid phanerophytes (0.6 – 2 m) (MPH)
  - Tall phanerophytes (2- 5 m) (TPH)
  - Forest phanerophytes (>5 m) (FPH)
    - Winter deciduous (DEC)
    - Evergreen (EVR)
    - Canes and tree grasses (CAN)
    - Coniferous (CON)
    - Non-leafy evergreen (NLE)
    - Summer deciduous (SUM)
    - Succulents (SUC)
    - Combinations

Linear and pond elements	Pond (x)
	Walls (WAL)
	Water edges (WAT)
	Lines of scrub (LSC)
	Hedges (HED)
	Species rich hedges (SRH)
	Lines of trees (LTR)
	Herbaceous strips (HST)
	Grass strips (GST)
	Private track grass strips (TGS)
	Private track herbaceous strips (THS)

APPENDIX 7.3. BIOBIO HABITAT MAPPING - DIGITISING PROTOCOL

To calculate the habitat indicators it is necessary to have the spatial data that were collected during the habitat mapping exercise. An image interpretation of the habitats surrounding those elements on the farm that were selected for the species sampling is also necessary. The digital maps will enable the calculation of area and length data for the habitats recorded on the farms. The image interpretation will provide a list of habitats that surround the sampled elements together with an estimate of their percentage covers.

The goal of this protocol is to enable you to produce standardised digital maps of the data collected during the habitat mapping exercise and to undertake a standardised image interpretation of the surrounding 250 m of the sampled elements on your farms. As the GIS programs are likely to vary between countries the protocol is unable to define the sequence of specific GIS operations.

To help you undertake this task Excel templates (template_arealElements.xls, template_lineElements.xls) have been provided with this protocol for the entry of the habitat mapping data collected in the field.

The following products will result:

1. One digital map of the areal habitats found on each of the farms
2. One digital map of the linear habitats found on each of the farms
3. A photo interpretation (excel format) of the habitats surrounding each of the elements selected for species sampling on your farms.

General Requirements

Ortho aerial or satellite images: Ideally to digitise your maps you require ortho aerial images or ortho satellite images of your farm locations. If possible the images should already be geo-referenced using the projection system of your country (detailed further below). Ortho images are aerial or satellite images which have been freed of their distortions and therefore show a uniform scale over their entire surface.

Other useful digital data: Other data that may be useful (if available) are digital topographical maps and digital farm parcel information. For Spain see for instance: http://sigpac.mapa.es/fega/visor/ or for Austria you can look at the site of BEV: http://www.austrianmap.at/amap/index.php?SKN=1&XPX=637&YPX=492. They can help you to locate your farms and the different parcels belonging to the farm. These data are not essential; however, it may be possible to use them instead of aerial or satellite images if none are available for your region.

Spatial resolution *(pixel size)* of aerial or satellite images: Ideally, the spatial resolution of your images should be below the minimum mapping unit to be digitised. The minimum mapping unit to be digitised is defined by the smallest areal and linear elements that are recorded in the BIOBIO field mapping:

1. For areal elements the minimum mapping unit is 400m^2. The element must have a minimum width of 5m.
2. The minimum mapping unit of the linear elements is 30m length.

This means that the spatial resolution of your aerial photographs, if possible, should be below 5m because of the minimum width of the areal elements. If using satellite images rather than aerial photographs, only high resolution images can be used.

Spatial extent of the ortho aerial or satellite images (area covered by the image): The extent of the images should cover the entire area of your farm including any scattered fields plus at least 250m of the land surrounding your farms and scattered fields.

Production of Digital Maps

When digitising the habitat data collected during the field habitat mapping exercise, you will produce two digital datasets. One dataset will contain all the areal elements found on your farms and the other all the linear elements. For both datasets you will need to provide metadata.
Metadata: The following metadata should be provided along with the digital maps.

1. The Projection (projected coordinated system) used in your country and the EPSG number from http://www.epsg-registry.org/.

2. The contact details of the person responsible for the maps.

3. Is the map based on satellite images or on aerial photographs?

4. Which GIS software was used

Projection: Map projection systems allow the transformation of a three-dimensional image to a flat map sheet image. Their purpose is to provide a common basis for communication about a particular place or area on the earth's surface.
For the production of the digital maps please use the projected (not geographical) coordinate system of your country[11]. In a projected coordinate system, locations are identified by x, y coordinates on a grid rather than latitude and longitude coordinated in a geographical coordinate system. Later we may transform your maps into a common European projection system to conform to the INSPIRE Directive**.**
When dealing with coordinate systems it is essential to know what the projection is and to have the correct coordinate system information associated with the dataset. **Please remember the projection metadata is essential (see metadata above).** For example the projected coordinate system of Switzerland is CH1903_LV03. The EPSG number is EPSG 21781 and can be found by searching under query by filter in http://www.epsg-registry.org/ using the search terms Type = Projected CRS and Area = Switzerland. The following information is attached to this system:
Projection: Hotine_Oblique_Mercator_Azimuth_Center
False_Easting: 600000.000000
False_Northing: 200000.000000
Scale_Factor: 1.000000
Azimuth: 90.000000
Longitude_Of_Center: 7.439583
Latitude_Of_Center: 46.952406
Linear Unit: Meter (1.000000)
To conform to the INSPIRE Directive; it should be possible to convert your national projection system to the projected coordinate system ETRS 1989 LAEA (Lambert Azimuthal Equal Area). This system is recommended "for pan-European spatial analysis and reporting, where true area representation is required". More information can be found under: (http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/INSPIRE_Specification_CRS_v3.1.pdf). Thus, it may be easier if you use directly the ETRS 1989 UTM system. This is not compulsory but you should check that it is possible to convert your data into this system. ETRS 1989 LAEA is divided into different zones, for example in Norway it is ETRS 1989 UTM32N. If you use this system please make sure that you use the ETRS 1989 datum (other versions exist) as

[11] In ArcGIS the standard folder for the installation of the projection is at: C:\ArcGIS\Coordinate Systems\Projected Coordinate Systems\National Grids

this is the European geodetic datum which was introduced to uniform national reference systems. For those of you that are ArcGis users, the ETRS 1989 UTM zones can be found under the Projected Coordinate Systems - UTM - Other GCS. ETRS 1989 LAEA is an option amongst the predefined projected coordinate systems under "Continental" and "Europe".

Digitising Areal Elements:

1. The areal elements are to be digitised as polygons. The minimum size of the polygons is 400m^2 with a minimum width of 5m.

2. The polygon dataset should be exported as a polygon shape file including attribute table and projection. (Files: .shp, .shx, .dbf, .prj).

3. Care should be taken to avoid gaps between polygons that adjoin each other. This can be achieved by setting the snapping environment in your GIS program. The flexibility of your snapping environment may vary with your GIS program. Generally, the snapping tolerance defines the distance within which the feature that you are digitising will be snapped to an existing digitised feature. In ArcGIS, the snapping properties allows you to choose which part of the other feature the newly digitised feature should snap to whilst the snapping priority allows you to set the layer you want your feature to snap to (here the map that you are digitising).

4. FIG. 7.3.1 provides an example of digitised areal elements.

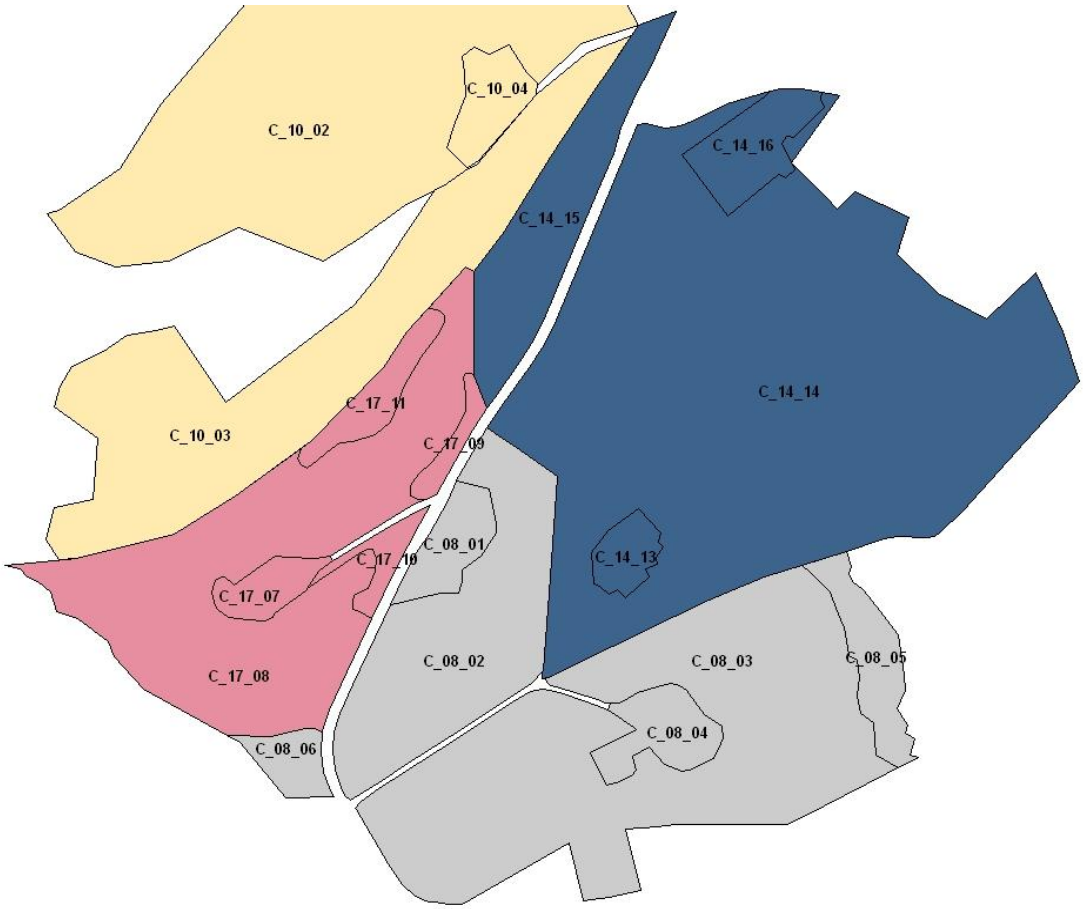

FIGURE 7.3.1. AN EXAMPLE MAP COMPRISED OF DIGITISED AREAL ELEMENTS, LABELLED USING THE ELEMENTID FOR PARTS OF FARMS 8, 10, 14 AND 17 IN SWITZERLAND

Areal Attribute Table:

Each element must be attributed with certain data that you collected in the field. This information will be documented in the attribute table in the GIS environment (See example in TABLE 7.3.1). TABLE 7.3.2 details the columns that are required in the attribute table and how they should be defined. **It is essential that all partners use the same columns and column definitions.**

The ElementID in the areal attribute table is a unique number/letter combination for each areal element in your map. It is formed from the country code, the farm number and a habitat number, e.g., Country_FarmNr_HabNr. The country codes are listed in TABLE 7.3.3. The farm numbers in the ElementID should be written as 01,02,03,04,05,06,07,08,09,10 to ……20. The HabNr is a number that should be applied consecutively to all the elements that were found on your farm, starting with 01 through to X, i.e. corresponding to the number of elements that you found on the farm. TABLE 7.4.4 provides examples of ElementIDs and how they were formed.

TABLE 7.3.1. EXAMPLE OF THE AREAL ATTRIBUTE TABLE RELATED TO FIG. 7.3.1

ElementID	Country	FarmNr	HabNr	Alpha_Code	GHC	Glob	Env	Site	Man	Man2	Annex1	Farml_Cl	Selected	PlotID	Shape_Leng	Shape_Area
C_14_14	C	14	14	K	LHE/CHE	OPE	5.1	0	A 1.5.2	0	0	1	0		1348.87	46606.31
C_14_15	C	14	15	G	LHE/CHE	0	5.1	0	A 1.5.2	0	0	1	1	C14g	473.40	5841.73
C_17_08	C	17	08	B	LHE/CHE	SCA	5.1	0	A 1.5.2		0	1	0		1018.30	17773.74
C_08_02	C	08	02	B	LHE/CHE	OPE	5.1	0	A 1.5.2	0	0	1	0		520.22	10032.19
C_08_03	C	08	03	C	LHE/CHE	SCA	5.1	0	A 1.5.2	0	0	1	0		1060.65	23323.03
C_14_13	C	14	13	A	ART	0	0	0	0	0	0	0	0		132.60	1064.39
C_14_16	C	14	16	A	ART	0	0	0	0	0	0	0	0		220.60	2326.16
C_08_01	C	08	01	A	ART	0	0	0	0	0	0	0	0		187.65	1706.08
C_08_04	C	08	04	A	ART	0	0	0	0	0	0	0	0		227.16	2004.61
C_08_05	C	08	05	D	FPH/DEC	LCO	0	0	A 3.15		0	8	0		286.43	2289.44
C_08_06	C	08	06	E	LHE/CHE	0	5.1	0	A 1.5.2	0	0	1	0		152.66	1108.85
C_17_07	C	17	07	G	ART	0	0	0	0		0	0	0		157.30	1186.00
C_17_10	C	17	10	I	WOC	0	5.1	0	A 1.12	A1.5.2	0	1	1	C17i	229.37	853.40
C_17_11	C	17	11	J	LHE/CHE	0	5.1	0	A 1.5.2		0	1	0		232.76	1552.85
C_17_09	C	17	09	H	LHE/CHE	0	5.1	0	A 1.5.2		0	1	0		161.74	681.25
C_10_02	C	10	02	B	LHE/CHE	0	5.1	0	A 1.5.2	0	0	1	0		965.10	35211.24
C_10_04	C	10	04	D	ART	0	0	0	0	0	0	0	0		173.67	1670.88
C_10_03	C	10	03	C	LHE/CHE	SCA	5.1	0	A 1.5.2	0	0	1	1	C10c	940.36	17001.57

TABLE 7.3.2. ATTRIBUTE COLUMNS TO BE DEFINED IN THE GIS ATTRIBUTE TABLE FOR THE AREAL ELEMENTS. PLEASE STICK TO THIS SEQUENCE

Column Heading	Data Specification	Example	Description of column
ElementID	Text	C_01_01	This is a unique ID for each polygon element and will comprise the country, farm number and habitat number. See text above.
Country	Text	C	The Country code
FarmNr	Long Integer	01, 02, 03….20	The Farm Number
HabNr	Long Integer	01, 02, 03, ...X	This is the continuous numbering system of the mapped elements within each farm
Alpha_Code	Text	A, B, C	The alpha code that was given to the different GHC that you identified in the field.
GHC	Text	LHE, FPH/CON	The GHC classification.
Glob	Text	ope	The Global Qualifier
Env	Double	5.1	The Environmental Qualifier
Site	Text	1.1	The Site Qualifier
Man	Text	A1.5	The Management Qualifier
Man2	Text	A1.6	In case the element had more than one management qualifier, e.g. Al.5 and A1.6
Annex1	Long Integer	See mapping manual	Annex 1 habitat
Farml_Cl	Text	1	The Farmland Class
Selected	Short Integer	1 or 0	1 for selected (sampled) elements, 0 otherwise
PlotID	Text	PlotID part of the bar code used for the species sampling, e.g. C1a, C1b	For those elements which are sampled: PlotID which appears on labels for the species sampling

TABLE 7.3.3. COUNTRY CODES

Country	CODE
Austria	A
Bulgaria	B
Switzerland	C
Germany	D
Spain (Dehesa)	Ed
Spain (Olive)	Eo
France	F

Wales	W
Hungary	H
Italy	I
Norway	N
Netherlands	L
Tunisia(Cork)	Tc
Tunisia (Olive)	To
Uganda	U
Ukraine	K

TABLE 7.3.4. EXAMPLES OF ELEMENT ID'S FOR AREAL ELEMENTS IN SWITZERLAND

ElementID	Country	FarmNr	HabNr
C_01_01	C	01	01
C_01_02	C	01	02
C_01_03	C	01	03
C_02_01	C	02	01
C_03_01	C	03	01
C_03_02	C	03	02
C_03_03	C	03	03
C_03_04	C	03	04

Areal Attribute Data entry

The data can be either entered by joining the attribute table to your existing data table. The joining technique will depend on your GIS environment. An empty excel table is provided for the entry of your areal data. This excel table includes columns related to the Habitat/Species data collected in Field 5. It is necessary to record this data in the excel file but it is not required in the areal attribute table. To join an existing data table (preferably MS Access format) with your polygon dataset both datasets will require the unique ElementID. The ElementID should be assigned to each element in the data table (in Excel/Access) and correctly attributed to appropriate polygons in the polygon dataset.

Digitising Linear Elements

1. The linear elements are to be digitised as lines which have a minimum length of 30 m.

2. The line dataset will be exported as a shape file including attribute table and projection. (Files: .shp, .shx, .dbf, .prj).

3. If several linear elements are connected to each other, e.g. a linear element such as a hedge (HED) ends and becomes a grass strip (GST), care should be taken to avoid gaps between these adjoining lines (FIG. 7.3.2a). This can be achieved by setting the snapping environment in your GIS program (see digitising areal elements).

4. Linear Elements that are part of a complex of linear elements can be digitised as a series of lines next to each other, e.g. a hedge (HED), then a water edge (WAT) and finally an herbaceous strip (HST). See FIG. 7.3.2b.

Linear Attribute Table

Each element must be attributed with certain data that you collected in the field. This information will be documented in the attribute table in the GIS environment. TABLE 7.3.5 details the characteristics of the attribute table. **It is essential that all partners use the same definitions.** The data in the attribute table can be added by joining your data table to the GIS attribute table as described above (Area Attribute Data Entry). An empty excel table has been provided with the protocol for data entry.
The ElementID in the linear attribute table is a unique number/letter combination for each linear element. It is formed from the country code, the farm number and a habitat number, e.g.

Country_FarmNr_HabNr. The country codes are listed in TABLE 7.3.3. The farm numbers in the ElementID should be written as 01,02,03,04,05,06,07,08,09,10 to ……20. The HabNr is a number that can be applied consecutively to all the elements that were found on your farm. **The numbering should start at 101 thus 101, 102, 103, 104 through to X**, i.e. corresponding to the number of elements that you found on the farm. The numbering here starts at 101to make it unique from the areal elements. TABLE 7.3.6 provides an example.

FIGURE 7.3.2. AN EXAMPLE OF DIGITISED LINEAR ELEMENTS. A. LINEAR ELEMENTS THAT ADJOIN EACH OTHER AND B. AN EXAMPLE OF A COMPLEX OF LINEAR ELEMENTS

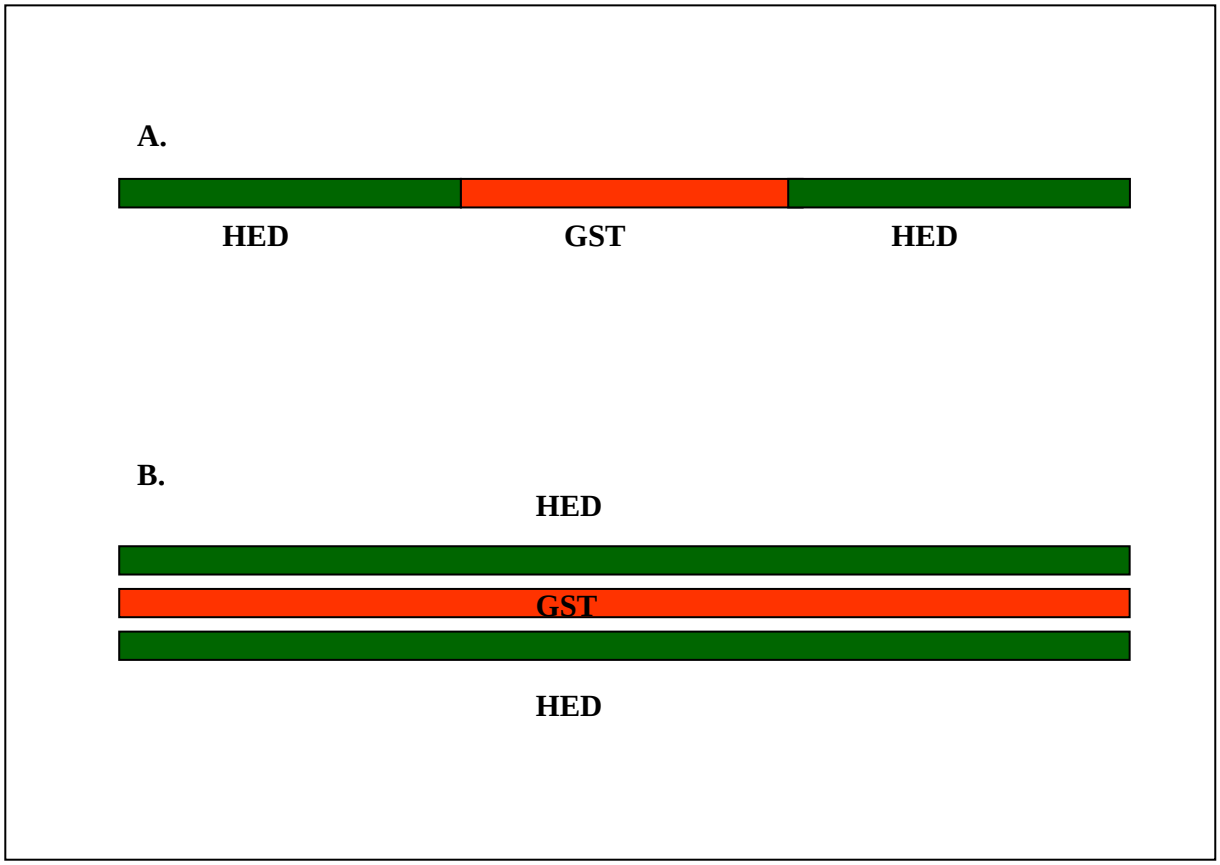

TABLE 7.3.5. ATTRIBUTE COLUMNS TO BE DEFINED IN THE GIS ATTRIBUTE TABLE FOR THE LINEAR ELEMENTS. PLEASE STICK TO THIS SEQUENCE

Column Heading	Data Specification	Example	Description of column
ElementID	Text	C_01_101	This is a unique ID for each linear element and will comprise the country, farm number and a habitat number. See Table 5
Country	Text	C	The Country code
FarmNr	Long Integer	01….20	The Farm Number
HabNr		101, 102, 103...X	This is the continuous numbering system of the mapped elements within each farm. The habitat number will start with 101, 102, 103 instead of 1, 2 and 3.
Alpha_Code	Text	A	The alpha code given to the different linear elements.
Line_Elem	Text	HED, GST	The linear element classification.
Farml_Cl	Text	5	The Farmland Class for linear elements
Selected	Short Integer	1 or 0	1 for selected elements (sampled), 0 otherwise
PlotID	Text	Bar code used for the species sampling	For those elements which are sampled: PlotID which appears on labels of species sampling

TABLE 7.3.6. EXAMPLES OF ELEMENTID'S FOR LINEAR ELEMENTS IN SWITZERLAND

ElementID	Country	FarmNr	HabNr
C_01_101	C	01	101
C_01_102	C	01	102
C_01_103	C	01	103
C_02_101	C	02	101
C_02_102	C	02	102
C_03_101	C	03	101
C_03_102	C	03	102
C_03_103	C	03	103
C_03_104	C	03	104
C_03_105	C	03	105

Image Interpretation of the landscape surrounding the farm

The image interpretation does not require digitised maps. Instead, you will need to provide a data table (preferably Excel format) that contains:

1. A list of the habitats that are within the surrounding 250m of the boundary of the elements on your farm which were selected for species sampling.

2. Percentage cover estimates for each of the habitats listed which have a cover ≥ 10%.

To do the image interpretation you will need to:

1. Generate 250m buffers (e.g. in the GIS environment) around the elements where species sampling was undertaken.

2. Use aerial or satellite images, list the habitats that you observe within each buffer (see list below of the habitats that should be identifiable on the image). The GHCs that you record should have a minimum coverage of 10% within the buffer.

3. Estimate by eye the percentage cover of these listed habitats. Taken all together the coverage of habitats in the buffer should add up to 100%.

4. The table in which you record the data should include the ElementID of the areal or linear element (see TABLES 7.3.1, 7.3.3, 7.3.4 & 7.3.5) and then a list the observed habitats with percentage estimates (See TABLE 7.3.7).

It should be possible to recognise the following habitats from aerial or satellite images. The exact definitions of these habitats can be found in the Monitoring handbook (sections 4.1.1 to 4.1.6, pages 34 to 42).

- ⇨ URB (Urban, e.g. ART, NON, VEG, GRA,TRE and combinations)
- ⇨ CUL (Cultivated herbaceous crops)
- ⇨ WOC (Woody crops)
- ⇨ AQU (Aquatic)
- ⇨ SPV (Sparsely vegetated)
- ⇨ FPH (Forest phanerophytes)
- ⇨ TPH/MPH/LPH (Scrub)
- ⇨ SCH (Heathland)
- ⇨ EHY/HEL (Emergent hydrophytes/Helophytes)
- ⇨ HER (Vegetated herbaceous, e.g. CHE/LHE)

TABLE 7.3.7. IMAGE INTERPRETATION TABLE: AREAL ELEMENTS IN A 250 BUFFER AROUND TWO SAMPLED ELEMENTS IN SWITZERLAND (C), ON FARM 1 FOR HABNR 1 AND 9

ElementID	PlotID	GHC	Percentage
C_01_01	PlotID label of species sampling	WOC	10
C_01_01	As above	FPH	30
C_01_01	As above	HER	60
C_01_09	As above	URB	10
C_01_09	As above	FPH	90

APPENDIX 7.4. FARM MANAGEMENT QUESTIONNAIRE VERSION 5

Farm Management Questionnaire

v. 5.0 July 2010

BioBio Farm Code

Date of the Interview	Name of person performing the interview

Checklist of BioBio plots on the farm

Specific management practises on BioBio plots must be recorded on one of the forms: C1, C2 or C3. The following checklist provides a table for listing BioBio plots on the respective farm. Each plot is attributed to one corresponding farm management form. Before and after the interviews the table should be used to guarantee that for each BioBio plot the appropriate form has been prepared and completed.

	Areal Habitat		**Linear Habitats**	
	Annual Arable, Olives or Vineyards	Grassland or Perennial Fodder Crops	Herbaceous	Woody Habitat
Questionnaire Form	**C1**	**C2**	**C3 (in parts)**	**C3 (in parts)**
BioBio plot ID				

Farm Management Questionnaire **General Farm Data** BioBio Farm Code: _____

Form A

Organic Farming	
Do you practice certified organic farming? **1- yes 0-no**	
When was the first harvest year under conversion to organic farming? [calendar year]	
….if the farm is split into organic and conventional farm enterprises, indicate which parts are under organic management[1]:	

Agri-environment measures on the farm[2]	**AgriEnv (IRENA No.1)**					
Do you participate in agri-environment schemes? (Year of reference: 2010)						
	Attributable environmental objective [3] *mark with an* ✖ Insert hectarage on the farm					
	Input Reduction		Crop rotation	Extensi-fication (livestock)	Landscape/ nature conservation	Rare plants & breeds
National agri-environment scheme	Fertiliser	Pesticides				
Scheme 1						
Scheme 2						
Scheme 3						
…add a list of specific measures from national agri-environment programmes. Indicate correspondence of each measure to one or more categories of environmental objectives						

Intensification/Extensification years of reference: **2007, 2008, 2009** **Int/Ext (IRENA No.15)** *Expenditure on Fuel, Fertiliser & Pesticides and Concentrate fodder*				
	2007	**2008**	**2009**	
Diesel Fuel				€ total per year
Fertiliser and Pesticides				€ total per year
Concentrate fodder				€ total per year

Energy Consumption (Direct Energy Input) for running the farm year of reference: **2009**		
Electricity		kWh
Diesel Fuel consumed by farm machinery		litres
Diesel Fuel consumed by external operators [4]		litres

In case fuel consumption by external operators cannot be quantified from farm accounts, collect data on the use of external machinery as follows.
Specify by operation type the amount of hectars managed by external operators on the farm.

Soil cultivation		ha
Mechanical weeding		ha
Pesticide and Plant Treatments		ha
Combine harvester		ha
Mowing		ha
Other operations: specify ….		
Other operations: specify ….		

Farm Management Questionnaire **General Farm Data** BioBio Farm Code: _____

Form A

Irrigation or Drainage	Area (ha)
Total area of irrigated land on the farm	
Total area of drained land on the farm	

Catch crops and Undersowing [5]	Area (ha)
Catch crops (preceding a main crop) Area of frost-sensitive catch crops	
Area of frost-resistant or over-wintering catch crops	
Area of leguminous catch crops	
Undersown Crops (mixed cropping with main crop)	
Total area of undersown crops	
Area of leguminous undersown crops	

Soil Tillage System [6]	Area (ha)
Conventional tillage (e.g. mouldboard plough, disc plough)	
Conservation tillage (low tillage e.g. by cultivator)	
Zero tillage (no soil cultivation, direct seeding)	

Import and export of organic matter	**Import/ Purchase (tonnes per year)**	**Export/ Sale (tonnes per year)**
Bedding straw		
Cattle solid manure		
Cattle liquid manure		
Cattle slurry		
Sheep manure		
Poultry manure		
Poultry liquid manure		
Pig liquid manure		
Compost		
Other ..... specify		

If solid manure is used on the farm ..... Which type of manure is applied to crops or		**livestock housing system**
fresh manure	O	**sloping floor system** *manure removed on a daily or weekly basis*
rotted manure (stockpiled without turning)	O	
composted manure (stockpiled, periodically turned)	O	
deep litter manure	O	**deep litter system** *manure removed in monthly intervalls*
fresh solid manure	O	**..if housing system is unknown ...**
any type of solid manure - specify under comments	O	

Comments

[1] If the farm is split into organic and conventional production, it must be made clear that all data recorded during the interview refer to the organically managed parts of the farm.

[2] The purpose of this set of questions is to estimate the extent of involvement in agri-environment schemes and its potential relation to biodiversity observed on the particular farm. Each case study should list measures according to existing schemes on

[3] **Classification adapted from IRENA Indicator No. 1 Fact sheet**

Each of the listed measures should be attributed to at least one environmental objective.

Input reduction measures include reductions in fertilisers and plant protection products and the "integrated farming approach"

Crop rotation: includes rotation measures eg. conversion of land (arable, grassland) and set-aside areas for the benefit of wildlife.

Extensification of farming systems. e.g. limitations in livestock

Landscape and nature conservation measures: concerns all nature conservation/protection, restoration and creation actions e.g. maintenance of biotopes and wetlands, establishment of buffer areas, postponing mowing dates.

Protection of rare plant varieties and breeds in danger of extinction.

[4] Often, farm accounts document diesel consumption on the farm and by external operators on an annual basis to receive reimbursement of taxes on petrol.

Where farms do not keep such accounts, try to quantify the extent of external machinery use by breaking it down by operation type.

[5] For the purpose of the BioBio Farm Management Questionnaire we use the terms in the following sense.

Catch crop is a crop preceding a main crop. It is cultivated during the autumn and winter period, most often for reasons of soil conservation to prevent erosion and leaching of nutrients. Catch crops are either overwintering (i.e. winter-hardy) or frost-sensitive (non winter-hardy).

Undersowing involves growing two or more different crop species in the same area at the same time. A main crop is combined with a cover crop that performs ecological functions (erosion control, pest management). Examples: cover crops in vineyards; clover as cover crop in cabbage or maize.

[6] Classification from EU Regulation (EC) No 1166/2008 on farm structure surveys and the survey on agricultural production methods

Farm Management Questionnaire | Standard Operations | BioBio Farm Code: _____

ARABLE CROPS, OLIVES and VINEYARDS

Form B1

	Crop 1	Crop 2	Crop 3	Crop 4	Crop 5	Crop 6	Crop 7	Crop 8	Crop 9
Crop Species (Name) Record only main crops									
Total Area (ha)									
Number of parcels									
Mineral N Fertiliser [1]									
Mineral N Fertiliser Type	*Option 2* [2]								
N-content %	Option 2								
Total Fertiliser Quantity applied (kg/ha)	Option 2								
kg N-Min per ha (total per crop)	*Option 1* [2]								
Organic Fertiliser - solid [3] (Solid Manure, Compost)									
Organic Fertiliser Type *SM- solid manure, C - compost, O - other*									
Fertiliser Source: Livestock Species									
Total Quantity Organic Fertiliser applied (**tonnes**/ha)									
N-Content Estimate (kg/ tonnes)	Reference Values will be provided in central database								
kg N-Org per ha (total per crop)	**Calculation will be performed in central database**								
Organic Fertiliser - liquid [3] (Liquid Manure, Slurry)									
Organic Fertiliser Type *LM - Liquid Manure, S-Slurry, O - other*									
Fertiliser Source: Livestock Species									
Quantity Organic Fertiliser applied (**litres**/ha)									
Concentrated or Diluted with water? 100% = concentrated, 50% diluted 1:1									
N-Content Estimate (kg/ tonnes)	Reference Values will be provided in central database								
kg N-Org per ha (total per crop)	**Calculation will be performed in central database**								

Farm Management Questionnaire | Standard Operations | BioBio Farm Code: _____

ARABLE CROPS, OLIVES and VINEYARDS

Form B1

	Crop 1	Crop 2	Crop 3	Crop 4	Crop 5	Crop 6	Crop 7	Crop 8	Crop 9
Crop Species (Name) Record only main crops									
Pesticide Treatments[4]									
Herbicide – Number of Treatments									
Fungicide – Number of Treatments									
Insecticide – Number of Treatments									
Retardant – Number of Treatments									
Molluscicide– Number of Treatments									
Nematicide– Number of Treatments									
Other Measures - specify under comments									
Number of Treatments Total	**Calculation will be performed in central database**								
Number of mechanised field operations by operation type *How many passages of machinery are necessary? [5]*									
Soil cultivation, preparing seed bed, seeding									
Mechanical weeding									
Pesticide and Plant Treatments									
Mowing & Harvesting Operations									
Other operations - specify under comments									
Total number of operations per crop	**Calculation will be performed in central database**								
Harvest Yield (kg per ha) [6]									
yield in 2010									
Estimated long-time average yield (farmer's estimate)									
Destination of the harvest (in %)									
Marketing									
Intraconsumed on the farm									
Remaining on the field (green manure)									

ARABLE CROPS, OLIVES and VINEYARDS

Form B1

	Crop 1	Crop 2	Crop 3	Crop 4	Crop 5	Crop 6	Crop 7	Crop 8	Crop 9
Crop Species (Name) Record only main crops									
Management of above-ground crop residues I - incorporated into the soil, R - removed from the field									
Comments									

The recording period for all operations is **the growing season of the main crop** from sowing to harvesting. Soil cultivation and seed bed preparation are included.

[1] Only nitrogen fertilisers should be recorded.
[2] Mineral N fertilisation
Data Recording **Option 1**: many farmers can tell directly how much pure nitrogen (kg N-Min per ha) they apply to a particular crop.

Data Recording **Option 2**: when option 1 is not possible, the indicator has to be calculated from
* Type of Mineral N Fertiliser used
* the N-content of this fertiliser (in %). The content of pure nitrogen can be found on the labels of fertiliser bags.
* the amount of fertiliser applied to one hectar. Separate treatments per growing season must be summed up to a total amount.

[3] Solid Manure = Farm yard manure: mixture of faeces and urine absorbed into bedding material such as cereal straw.
Liquid Manure = liquid runoff from farm yards containing urine and water
Slurry = faeces and urin mixed. Higher dry matter content than liquid manure.
Compost = plant compost
IMPORTANT: "Other" types of organic fertilisers should be specified under comments!

[4] In organic farming the use of pesticides is restricted by regulations. A list of permitted pesticides can be found in an annex to forms B. In case of doubt whether a certain substance applied (e.g. as "plant strengthener") qualifies as pesticide try to get information about the content or active component of the product and clarify it with BOKU.

[5] Consider that one operation type may require a sequence of different operations e.g. hay harvest: mowing, swathing, making bales, removal from the site. Each harvest cycle may be repeated several times during the season, depending on the number of cuts. Indicate the total number of all operations per field throughout one growing season.

[6] Refers only to the marketable yield component. E.g. for cereals note the grain yield but not the crop biomass.

GRASSLAND and PERENNIAL FODDER CROPS [1]

Form B2

	Grassland 1	Grassland 2	Grassland 3	Grassland 4	Grassland 5	Grassland 6	Grassland 7	Grassland 8
Grassland Official Parcel Number(s) [2]								
Total Area (ha)								
Number of parcels								
Grassland Type								
1=spontaneous vegetation, 2=sown								
Duration of grassland								
1=rotational or 2=permanent grassland [2]								
...if rotational: duration in years								
Mineral N Fertiliser								
Mineral N-Fertiliser Type	*Option 2* [3]							
N-content (%)	Option 2							
Fertiliser Quantity applied (kg/ha)	Option 2							
kg N-Min per ha	**Calculation will be performed in central database**							
Organic Fertiliser - solid [3] (Solid Manure, Compost)								
Organic Fertiliser Type *SM- solid manure, C - compost, O - other*								
Fertiliser Source: Livestock Species								
Total Quantity Organic Fertiliser applied (**tonnes**/ha)								
N-Content Estimate (kg/ tonnes)	Reference Values will be provided in central database							
kg N-Org per ha (total per crop)	**Calculation will be performed in central database**							
Organic Fertiliser - liquid [3] (Liquid Manure, Slurry)								
Organic Fertiliser Type *LM - Liquid Manure, S-Slurry, O - other*								
Fertiliser Source: Livestock Species								
Quantity Organic Fertiliser applied (**litres**/ha)								
Concentrated or Diluted with water? 100% = concentrated, 50% diluted 1:1								
N-Content Estimate (kg/ tonnes)	Reference Values will be provided in central database							
kg N-Org per ha (total per crop)	**Calculation will be performed in central database**							

SEVENTH FRAMEWORK PROGRAMME THEME KBBE-2008-1-2-01
Development of appropriate indicators of the relationship between organic/low-input farming and biodiversity
www.biobio-indicator.org

GRASSLAND and PERENNIAL FODDER CROPS [1]

Form B2

Management of Grassland								
Number of cuts per year								
Date of the first cut								
Days of grazing								

Pesticide Treatments [4]								
Herbicide – Number of Treatments								
Insecticide – Number of Treatments								
Number of Treatments Total	**Calculation will be performed in central database**							

Number of mechanised field operations by operation type *How many passages of machinery are necessary? [5]*								
Seeding/ Overseeding								
Weed and Pest Management								
Mowing or Harvesting Operations								
Other operations - specify under comments								
Total number of operations per crop	**Calculation will be performed in central database**							
Comments								

[1] The management of crops like clover or lucerne is better reflected by Forms B2 and C2, and should therefore be recorded with these forms.

GRASSLAND and PERENNIAL FODDER CROPS [1]

Form B2

[2] **Procedure for recording grassland management in the BioBio Farm Management Questionnaire**

Recording standard management practices is straightforward for crops, because crop species provide a natural system of units for data recording. This is more difficult for grassland. The basic question is: how to identify differences in grassland management and quantify the spatial extent of the different management practices.

2 Methods are suggested. Each case study must decide individually, which method works best.

Method 1

Take each parcel, identified by its unique official internal number, and record its management.
Advantages: parcels are clearly defined units. communication with farmer about management is easy.
Possible disadvantages: Parcel numbers do not exist on the farm. Too many parcels to record.

Method 2

From an initial discussion with the farmer, you must identify the major differences in management between different areas of the farmland. Criteria are the parameters used in form B2 i.e.

* "Naturalness" of grassland
* Duration of grassland
* Frequency of manure applications
* number of cuts
* grazing intensity
* combinations of grazing and mowing

A map of the farmland will help in the discussions with the farmer. Define zones with different management and quantify the area of each zone.
If applicable, attribute each of the parcels (based on parcel numbers) to one management zone. Record management practices in each zone in Form B2. Management zones can be addressed as "grassland 1", "grassland 2" etc.

[3]Mineral N fertilisation

Data Recording Option 1: many farmers can tell directly how much pure nitrogen (kg N-Min per ha) they apply to a particular crop.

Data Recording Option 2: when option 1 is not possible, the indicator has to be calculated from

* Type of Mineral N Fertiliser Used
* the N-content of this fertiliser (in %). The content of pure nitrogen can be found on the labels of fertiliser bags.
* the amount of fertiliser applied to one hectar. Separate treatments per growing season must be summed up to a total amount.

[4] In organic farming the use of pesticides is restricted by regulations. A list of permitted pesticides can be found in an annex to forms B. In case of doubt whether a certain substance applied (e.g. as "plant strengthener") qualifies as pesticide try to get information about the content or active component of the product and clarify it with BOKU.

[5] Consider that one operation type may require a sequence of different operations e.g. hay harvest: mowing, swathing, making bales, removal from the site. Each harvest cycle may be repeated several times during the season, depending on the number of cuts. Indicate the total number of all operations per field throughout one growing season.

ANNEX II

Pesticides — plant protection products referred to in Article 5(1)

Note:

A: authorised under Regulation (EEC) No 2092/91 and carried over by Article 16(3)(c) of Regulation (EC) No 834/2007
B: authorised under Regulation (EC) No 834/2007

1. **Substances of crop or animal origin**

Authorisation	Name	Description, compositional requirement, conditions for use
A	Azadirachtin extracted from *Azadirachta indica* (Neem tree)	Insecticide
A	Beeswax	Pruning agent
A	Gelatine	Insecticide
A	Hydrolysed proteins.	Attractant, only in authorized applications in combination with other appropriate products of this list
A	Lecithin	Fungicide
A	Plant oils (e.g. mint oil, pine oil, caraway oil).	Insecticide, acaricide, fungicide and sprout inhibitor.
A	Pyrethrins extracted from *Chrysanthemum cinerariaefolium*	Insecticide
A	Quassia extracted from *Quassia amara*	Insecticide, repellent
A	Rotenone extracted from *Derris* spp. and *Lonchocarpus* spp. and *Terphrosia* spp.	Insecticide

2. **Micro-organisms used for biological pest and disease control**

Authorisation	Name	Description, compositional requirement, conditions for use
A	Micro-organisms (bacteria, viruses and fungi)	

3. **Substances produced by micro-organisms**

Authorisation	Name	Description, compositional requirement, conditions for use
A	Spinosad	Insecticide Only where measures are taken to minimize the risk to key parasitoids and to minimize the risk of development of resistance

4. **Substances to be used in traps and/or dispensers**

Authorisation	Name	Description, compositional requirement, conditions for use
A	Diammonium phosphate	Attractant, only in traps

Authorisation	Name	Description, compositional requirement, conditions for use
A	Pheromones	Attractant; sexual behaviour disrupter; only in traps and dispensers
A	Pyrethroids (only deltamethrin or lambdacyhalothrin)	Insecticide; only in traps with specific attractants; only against *Bactrocera oleae* and *Ceratitis capitata* Wied.

5. **Preparations to be surface-spread between cultivated plants**

Authorisation	Name	Description, compositional requirement, conditions for use
A	Ferric phosphate (iron (III) orthophosphate)	Molluscicide

6. **Other substances from traditional use in organic farming**

Authorisation	Name	Description, compositional requirement, conditions for use
A	Copper in the form of copper hydroxide, copper oxychloride, (tribasic) copper sulphate, cuprous oxide, copper octanoate	Fungicide. up to 6 kg copper per ha per year For perennial crops, Member States may, by derogation from the previous paragraph, provide that the 6 kg copper limit can be exceeded in a given year provided that the average quantity actually used over a 5-year period consisting of that year and of the four preceding years does not exceed 6 kg
A	Ethylene	Degreening bananas, kiwis and kakis; Degreening of citrus fruit only as part of a strategy for the prevention of fruit fly damage in citrus; Flower induction of pineapple; sprouting inhibition in potatoes and onions
A	Fatty acid potassium salt (soft soap)	Insecticide
A	Potassium aluminium (aluminium sulphate) (Kalinite)	Prevention of ripening of bananas
A	Lime sulphur (calcium polysulphide)	Fungicide, insecticide, acaricide
A	Paraffin oil	Insecticide, acaricide
A	Mineral oils	Insecticide, fungicide; only in fruit trees, vines, olive trees and tropical crops (e.g. bananas);
A	Potassium permanganate	Fungicide, bactericide; only in fruit trees, olive trees and vines.
A	Quartz sand	Repellent
A	Sulphur	Fungicide, acaricide, repellent

7. **Other substances**

Authorisation	Name	Description, compositional requirement, conitions for use
A	Calcium hydroxide	Fungicide Only in fruit trees, including nurseries, to control *Nectria galligena*
A	Potassium bicarbonate	Fungicide

ANNUAL ARABLE CROPS, OLIVES and VINEYARDS
Form C1

BioBio Plot ID (e.g. A1a, A1b, A1c etc.)	
Crop species	

Refer to Form B1 for this crop species.

Does the management of the crop on this field in 2010 conform with the standard operations described on Form B1?

	yes	no	specify deviations from standard operation
Mineral N Fertiliser Application			
Organic Fertiliser Application			
Pesticide Treatments			
Mechanised field operations			
Harvest: Yield and destination			

Soil Cover in Winter	1 Normal Winter Crop	2 Catch / Intermediate Crop: Species Name	3 Plant Residues
			4 Bare Soil

Undersown Crop	0 no	1 yes	Undersown leguminous crop - species name:

Preceding main crops	
Main crop 1 year ago (previous year)	
Main crop 2 years ago	
Main crop 3 years ago	
Main crop 4 years ago	

Mineral N-Fertiliser	**Mineral N-Fertiliser Type**	**N-content**	**Fertiliser Quantity (kg/ha)**	**kg N per ha**
Date or Period of Application[1]				calculations in central
Date or Period of Application				

Organic Fertiliser	**Organic Fertiliser Type (Solid Manure, Liquid Manure, Slurry, Compost)**	**Fertiliser Source: Livestock Species**	**Organic Fertiliser Quantity applied (kg/ha)**	**kg N per ha**
Date or Period of Application[1]				calculations in central database
Date or Period of Application				
Date or Period of Application				
Date or Period of Application				

N_2 Fixation	Legume Species 1	Legume Species 2	Legume Species 3	Legume Species 4
Species Name				
% on the parcel (from data of vegetation survey)				
Estimated N-Fixation kg/ha[2] **(pure stand)**	*Reference values will be provided in central database*			
Total Estimated N-Fixation kg/ha	*Calculation will be performed in central database*			

Pesticide Treatments	**Herbicide**	**Insecticide**	**Fungicide**	**Retardant**	**Nematicide**	**Molluscicide**	**Other**
Date or Period of Application[1]							
Date or Period of Application							
Date or Period of Application							
Date or Period of Application							
Date or Period of Application							

ANNUAL ARABLE CROPS, OLIVES and VINEYARDS
Form C1

Methods and Timing of selected field operations by operation type	Method applied	Date or Period of Application[1]	Depth of soil cultivation (cm)
Soil cultivation before seeding [3]			
Seeding	xxxxxxxxxxxxxxxxxxxxxxxxxxx		
Harvesting	xxxxxxxxxxxxxxxxxxxxxxxxxxx		
Mechanical weeding			
Mechanical weeding			
Mechanical weeding			

Comments

[1] Timing Data Format: Give either exact date (if documentation available) or approximate periods (within period of 2 calender week
[2] 1 = once a year, 2 = every 2 to 3 years, 5 = once in 5 years, 10 = once in 10 years
[3]Codes for Soil cultivation: **CT** - Conventional tillage (ploughing), **LT** - Low Tillage/Conservations Tillage (e.g. cultivator), **ZT** - Zero Tillage/No soil cultivation + direct seeding

AREAL HABITATS (Grassland, Perennial Fodder Crops)

Form C2

BioBio Plot ID (e.g. A1a, A1b, A1c etc.)	

Refer to Form B2 - Standard Operations

Corresponding Grassland Number in Form B2 *Grassland 1, Grassland 2 etc.*	

Does the management on this plot in 2010 conform with the standard operations described on Form B2?

	yes/no	specify deviations from standard operation
Grassland Type & Duration		
Mineral N Fertiliser Application		
Organic Fertiliser Application		
Management of Grassland		
Pesticide Treatments		
Mechanised field operations		

Establishment	
1 spontaneous vegetation 2 sown or planted	
...if rotational: when was the parcel established (e.g first date of sowing)	
....calculate: age of the grassland (years)[1]	

Mineral N-Fertiliser	**Mineral N-Fertiliser Type**	**N-content**	**Fertiliser Quantity (kg/ha)**	**kg N per ha**
Date or Period of Application[1]				calculation in central database
Date or Period of Application				

Organic Fertiliser	**Organic Fertiliser Type (Solid Manure, Liquid Manure, Slurry, Compost)**	**Fertiliser Source: Livestock Species**	**Organic Fertiliser Quantity applied (kg/ha)**	**kg N per ha**
Date or Period of Application[1]				calculation in central database
Date or Period of Application				
Date or Period of Application				
Date or Period of Application				

N_2 Fixation	Legume Species 1	Legume Species 2	Legume Species 3	Legume Species 4
Species Name				
% on the parcel (from data of vegetation survey)				
Estimated N-Fixation kg/ha[2] **(pure**	*Reference values will be provided in central database*			
Total Estimated N-Fixation kg/ha	*Calculation will be performed in central database*			

AREAL HABITATS (Grassland, Perennial Fodder Crops)

Form C2

Grazing Management	
Grazing Animals (livestock species)	
Number and type of livestock [3]	
Grazing – beginning (calendar week)	
Grazing – end (calendar week)	
Days of grazing	calculation in central database

Pesticide Treatments	Herbicide	Insecticide
Date or Period of Application[2]		
Date or Period of Application[2]		

Mowing/ Harvesting	
Number of cuts per year	
Date of cut 1 [2]	
Date of cut 2	
Date of cut 3	
Date of cut 4	
Date of cut 5	

Mowing technique	1 Hand Scythe	3 Hand Motor Bar Mower	4 Rotary Mower (combined with tractor)
	2 Hand Brush Cutter/ Gras Trimmer (motor driven)		5 Rotary Mower (combined with tractor) with Conditioner

Comments

[1] As for precision of data: also consider number of months, e.g for lucerne: 1 year + 6 months = 1,5 years.
Timing of the BioBio vegetation survey should be the reference for calculation. E.g. vegetation survey in June 2010.
[2] Give either exact date (if documentation available) or approximate periods (within period of 2 calender week)
[3] Use livestock categories from Form D - reflecting the age of animals / livestock units

LINEAR HABITATS

Form C3

BioBio Plot ID (e.g. A1a, A1b, A1c etc.)								
Habitat Type (General Habitat Category-GHC)								
Establishment of the habitat 1-sponaneous vegetation 2-sown or planted								
Herbaceous or Crop GHCs								
Mineral N Fertiliser applied? 1- yes 0-no								
Date or Period of Application[1]								
Date or Period of Application								
***Organic Fertiliser* applied?** 1- yes 0-no								
Type of organic fertiliser								
Date or Period of Application[1]								
Date or Period of Application								
Pesticide Treatments applied? 1- yes 0-no								
Herbicide - Date or Period of Application[1]								
Insecticides - Date or Period of Application								
Other pesticides - Date or Period of Application								
Number of Pesticide Treatments - Total								
Mowing 1- yes 0-no								
Number of cuts per year								
Date of cut 1[1]								
Date of cut 2 [1]								
Mowing technique [2]								
Destination of the swath 1 removed from the site 2 remains on the site								
Grazing: **Is the plot influenced by grazing? 1- yes 0-no**								

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Development of appropriate indicators of the relationship between organic/low-input farming and biodiversity
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LINEAR HABITATS

Form C3

Woody GHCs "Trees & Shrubs"								
9.8 Pruning of hedges, trees etc.								
Time interval for pruning (number of years) [3]								
Date of the last cut								
Comments								

[1] Give either exact date (if documentation available) or approximate periods (within period of 2 calender week)
[2]Mowing Techniques
1 Hand Scythe
2 Hand Brush Cutter/Gras Trimmer (motor driven)
3 Hand Motor Bar Mower
4 Rotary Mower (combined with tractor)
5 Rotary Mower (combined with tractor) with Conditioner
[3] 1 = once a year, 2 = every 2 to 3 years, 5 = once in 5 years, 10 = once in 10 years

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Livestock Category [1] ***year of reference: 2010***	***Number of animals present*** *(annual average)* [2]	***Number of produced animals*** [3]	***Average live weight*** *(kg)*	***Livestock Unit Equivalent*** *(per animal)*	***Livestock Units***	***Time on Common Grazing Land*** (number of days)	***Time on the farm*** *(number of days)* [4] *excl. Common land*	***Time on farm pastures*** *(% of presence time on farm)* [5]
Calves for fattening				0,4	calculated in central data base			
Other Cattle < 1 year				0,4				
Male cattle 1-2 < years				0,7				
Female Cattle 1-2 < years				0,7				
Male cattle >= 2 years				1				
Breeding Heifers[6]				0,8				
Heifers for fattening				0,8				
Dairy cows				1				
Other cows				0,8				
Goats				0,1				
Sheep				0,1				
Breeding Sow (including piglets)				0,5				
Pigs for fattening and other pigs				0,3				
Piglets				0,027				
Table chickens				0,007				
Laying hen				0,014				
Other poultry				0,03				
Equines				0,8				
				Livestock Unit Total				

Milk Yield	
Livestock Species	kg milk per animal per year

Purchase or Import of Forage and Concentrate Fodder [7] in 2010			
Forage	tonnes	**Concentrate Fodder**	tonnes
Pasture		Wheat	
Grass silage		Barley	
Silage corn		Corn for grain	
Hay from natural or temporary pasture		Triticale	
Lucerne		Oats	
Barn dried hay		Sorghum	
Beet feed		Soya	
Green rape		Pea	
Sorghum feed		Rape	
Fodder Kale		Sunflower	
Dehydrated beet pulp		Soya oil cake	
Squeezed beet pulp		Rapeseed cake	
Sugar beet molasses		Sunflower cake	
Squeezed brewing dregs		Milk powder	
Dehydrated lucerne		Other _____	
NHs processed straw		Other _____	
Pea straw			
Non treated straw			
Other: _____			

[1] The survey method for farm livestock was adopted from DIALECTE http://dialecte.solagro.org.
[2]Livestock numbers at the time of the interview (autumn/winter period) may not be representative when the herd has diminished and animals have been sold off to the market.
[3] Produced = leaving the farm. Sold or slaughtered animals.
[4] Subtract days on common land
[5] Percentage is calculated in separate table. Results are transfered to this column.
[6] Heifer: young female cow before having the first calve.
[7] Adopted and modified from survey of DIALECTE http://dialecte.solagro.org.

Calculation of Time on Farm Pastures
part of Form D

Calculation of Time on Farm Pastures

Livestock Category	**hours** per day on the farm pastures [1]												Time on farm pastures (% of presence time on farm)[2]	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Calves for fattening													*0*	
Other Cattle < 1 year													*0*	
Male cattle 1-2 < years				*3*	*3*	*8*	*14*	*14*	*14*	*8*			*22,2222222*	*example*
Female Cattle 1-2 < years													*0*	
Male cattle >= 2 years													*0*	
Breeding Heifers[6]													*0*	
Heifers for fattening													*0*	
Dairy cows													*0*	
Other cows													*0*	
Goats													*0*	
Sheep													*0*	
Breeding Sow (including piglets)													*0*	
Pigs for fattening and other pigs													*0*	
Piglets													*0*	
Table chickens													*0*	
Laying hen													*0*	
Other poultry													*0*	
Equines													*0*	

[1] Strictly limited to time on a pasture. Not to be considered: time moving around on the farmyard or in loose-housing systems. Limited to time spent on pastures belonging to the farm. Time on common grazing land is recorded in Form D.

[2] Formula: ((3+3+8+14+14+14+8)/24hours/12 months)*100

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APPENDIX 7.5. QUESTIONNAIRE FOR AGRICULTURAL PLANTS' GENETIC DIVERSITY

How to fill the questionnaire

The following questionnaire is divided into two different parts.

The first part contains detailed questions about genetic diversity of arable crops, vegetable crops, tree crops and forage crops that are on each farm (PART 1, 2, 3 and 4). Here, questionnaire form has to be filled as presented by an example.

The second part (PART 5), concentrates on selected characteristics of individual species which are named as landraces or others (e.g. name of cultivar is not known)

The questionnaire only has to be filled for crops and species that exist on farm.

Case study Region: ……add CS Number, Country and Region…..

Date of the Interview	**Name of person performing the interview**

BioBio Farm Code:

PART 1: ARABLE CROPS

Do you cultivate arable crops? ☐ **Yes** ☐ **No, go on with PART 2, p. 6**

Any herbaceous plant grown annually in cultivated fields under a system of culture, including crops of primary importance such as **cereals** (durum wheat, common wheat, spelt wheat, barley, oat, maize, rye, millet, sorghum and rice), **oil seeds** (colza, sunflower, rape) and **potatoes**.

1.1 Cultivar diversity (A4), origin of arable crops (A8) and on-farm seed multiplication (A6)

A4 + A5 *--> Compose a list of arable crop varieties on the farm. List species (e.g. wheat (wheat, barley, rye...) and list specific names of varieties that are grown per species (subdivide by seasonality). Note whether, they are cultivars[12], landraces[13] or others and the acreage they cover. Start with the main crop species.*

A8 *--> Add information about the origin of arable crop accessions cultivated. Note, where do cultivars and landraces originate from by writing the commercial name and the selling company of seeded arable crops. Details on landraces and others (e.g. unknown cultivars) are to be given in PART 5.*

A6 *--> Do you perform on-farm seed multiplication (management and re-use of own seed material) or not? Note for each listed cultivar, landrace, what percentage of seeds (per variety) is used for reseeding and what acreage the reseeding covers. Additionally, note the average amount of years which you are prppagating/re-using seed material of one variety (**if** you are performing seed-managment)..*

	A4 + A5				A8		A6		
Species	**Cultivar**	**Landrace**	**Others**	**Area cover (unit)**	**Commercial name**	**Company**	**Seed management**	**Area of reseeding (unit)**	**Years (ø)**
Example									
Common Wheat (species)							***Yes / No***		
Arina (winter wheat)	*x*	☐	☐	*100ha*	*Arina*	*DSP*	*x* ☐	*40ha*	-

If one of your cultivated varieties (belonging to species wheat, barley or potatoes) is a landrace (local variety, not commercial available) or other , please specify detailed characteristics in PART 5. If the variety/cultivar name is not known, please give detailed information (for wheat, barley and potato) in PART 5, too.

[12] A **Cultivar** is a variety (accession) of a plant species that has been created or selected intentionally and maintained through cultivation (traditional and modern breeding methods) for specific desirable characteristics.

[13] **Landrace** refers to domesticated plant accessions often developed naturally over a longer period of time with minimal assistance or guidance from humans using traditional breeding methods. They are local varieties (in a region or just on one farm (family/farm heritage)) which are usually not commercially available.

(species)							Yes / No		Years (ø)
	☐	☐	☐				☐ ☐		
	☐	☐	☐				☐ ☐		
	☐	☐	☐				☐ ☐		
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(species)							Yes / No		Years (ø)
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(species)							Yes / No		Years (ø)
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(species)							Yes / No		Years (ø)
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(species)							Yes / No		Years (ø)
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(species)							**Yes / No**		Years (ø)
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(species)							**Yes / No**		Years (ø)
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(species)							**Yes / No**		Years (ø)
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	☐	☐	☐				☐ ☐		

PART 2: VEGETABLE CROPS

Do you cultivate vegetable crops? ☐ **Yes** ☐ **No, go on with PART 3, p. 9**

Vegetable crops are herbaceous plants grown as annuals or biennials and occasionally as perennials that have edible parts. Examples of edible parts include the root (sweet potato, carrots, turnips, and swedes), tuber, young shoot (asparagus), leaf (spinach, lettuces), flower buds (cauliflower), fruit (tomato), and seed (pea).

2.1 Cultivar diversity (A4), origin of vegetable crops (A8) and on-farm seed multiplication (A6)

A4 + A5 *--> Compose a list of vegetable crops on the farm. List species (e.g. carrots, tomato...) and list specific names of varieties that are grown per vegetable crop (e.g. Roma). Note whether, they are cultivars, landraces or others and their acreage cover. Start with the main crop species.*

A8 *--> Add information about the origin of the vegetable crop accessions cultivated. Note, where do cultivars and landraces originate from by writing the commercial name and the selling company of seeded vegetable crops. Details on landraces and others (e.g. unknown cultivars) are to be given in PART 5.*

A6 *--> Do you perform on-farm seed multiplication(on-farm propagation and re-use of own seed material) or not? Note for each listed cultivar, landrace, what percentage of seeds is used for reseeding and what acreage the reseeding covers. Additionally, note the average amount of years which you are prppagating/ re-using seed material of one variety (**if** you are performing seed-managment).*

	A4 + A5				A8		A6		
Species	**Cultivar**	**Landrace**	**Others**	**Area cover (unit)**	**Commercial name**	**Company**	**Seed management**	**Area of reseeding (unit)**	**Years (ø)**
Example									
Tomato (species)							*Yes / No*		
Roma	*x*	☐	☐	*3ha*	*Roma Olivate F1 DÜ H*	*UFA*	*x* ☐	*0,25ha*	*5years*

If one of your cultivated varieties (belonging to species allium, tomato or carrots) is a landrace or other, please specify detailed characteristics in PART 5.

If the variety/cultivar name is not known, please give detailed information (for tomato, carrot and allium species) in PART 5, too.

(species)							Yes / No		Years (ø)
	☐	☐	☐				☐ ☐		
	☐	☐	☐				☐ ☐		
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(species)							Yes / No		Years (ø)
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(species)							Yes / No		Years (ø)
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(species)							Yes / No		Years (ø)
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(species)							Yes / No		Years (ø)
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(species)							Yes / No		Years (ø)
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(species)							Yes / No		Years (ø)
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(species)							Yes / No		Years (ø)
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	☐	☐	☐				☐ ☐		

PART 3: TREES AND GRAPES Do you cultivate Trees and/or Grapes? ☐ Yes ☐ No, go on with PART 3, p. 12

A perennial woody plant with one main trunk and a rather distinct and elevated head.

3.1 Cultivar diversity (A4), origin of trees and grapes (A8) and on-farm propagation (A6)

A4 + A5 *--> Compose a list of tree crop and grape varieties on the farm. List* ***species*** *(e.g. apple, cherry, plum...) and list specific names of varieties that are grown per tree species. Note whether, they are cultivars, landraces or others and their acreage cover. Start with the main crop species.*

A8 *--> Add information about the origin of the accessions. Note, where do cultivars and landraces originate from by writing the commercial name and the selling company of trees.*

A6 *--> Note, whether on-farm propagation is performed or not. If yes, please note the average amount of years which you are prppagating/ re-using seed material.*

	A4 + A5				A8		A6	
Species	Cultivar	Landrace	Others	Area cover (unit)	Commercial name	Company	On-farm propagation	Years (ø)
Example								
Apple (species)							*Yes / No*	
Golden Delicious	*x*	☐	☐	*3ha*	*Golden Delicious Reinders*	*LANDI*	☐ *x*	*-*

If one of your cultivated varieties (belonging to species apple, cherry or grape) is a landrace/ other, please specify detailed characteristics in PART 5.

If the variety/cultivar name is not known, please give detailed information (for apple, cherry, olive and grape) in PART 5, too.

(species)							Yes / No		Years (ø)
	☐	☐	☐				☐	☐	
	☐	☐	☐				☐	☐	
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(species)							Yes / No		Years (ø)
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(species)							Yes / No		Years (ø)
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(species)							Yes / No		Years (ø)
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(species)							Yes / No	Years (ø)
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(species)							Yes / No	Years (ø)
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(species)							Yes / No	Years (ø)
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(species)							Yes / No	Years (ø)
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	☐	☐	☐				☐ ☐	
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	☐	☐	☐				☐ ☐	

PART 4: Forage crops

D0 you cultivate forage crops? ☐ **Yes** ☐ **No, go on with PART 5, p. 16**

Forage refers to plants consumed by animals, particularly livestock. Forage may be preserved by drying the plants to produce hay, it may be fermented to produce silage, and dried material is also compressed to produce compacted hay, pellets, and cubes. **Within this questionnaire, "forage crops" is only used for grass, herb and legume species in forage production.**

4.1 Grassland diversity (A5)

Do natural, semi-natural or sown (cultivated) grassland exist on the farm? Note, whether this kind of grassland is absent (No) or present (Yes). Additionally, if type of grassland is present, note total acreage cover.

	No	Yes	Area cover (unit)
Permanent grassland (≥10 years)	☐	☐	
Interuptual grassland (continuously re-seeded)	☐	☐	
Rotational grassland (in rotation)	☐	☐	

4.2 Origin (A8) and on-farm seed multiplication (A6) of forage crops (grassland)

A8 --> *Compose a list of forage crops cultivated. Note the commercial name and the selling company. Give detailed information about all species (varieties and their breeders where possible) and species proportion of the product.*

A6 --> *Note, whether seed management (on-farm propagation) is performed or not. If yes, , please note the average amount of years which you are prppagating/re-using seed material.*

A8					A6	
Forage crop product (Commercial name)	**Company**	**(ALL Species**	**Seed composition (varieties)**	**and percentage (%)**	**Seed management**	**Years (ø)**
Example					***Yes / No***	
Tarda 33 Schweizer	*Agro Mittelland GMBH*	***Bastard Raigrass*** ***Dactylis glomerata*** ***Festuca pratensis***	*(LEONIS, REDUNCA)* *(PIZZA, INTENSIV, BELUGA),* *(……..*	*, 20%;* *17%;*	*X* ☐	*4 years*
					☐ ☐	
					☐ ☐	
					☐ ☐	
					☐ ☐	

			☐ ☐	
			☐ ☐	

4.3 Amount of forage crops reseeding (grassland) (A10)

A10 *--> How often do you reseed forage grass cover (Note, 1-6) and what percent of harvested seeds was used for reseeding?*
(1 = yearly, 2 = every second year, 3 = every third year, 4 = every fourth year, 5 = every fifth year, 6 = > 5 years)

A10

Forage crop product (Commercial name)	Amount of reseeding (1, 2, 3, 4, 5 or 6)	Percentage of reseeding (%)	Area reseeded (unit)

PART 5: Phenotypic diversity (A7)

A phenotype is any observable characteristic or trait of an organism: such as its morphology, development, biochemical or physiological properties, or behaviour. Phenotypes result from the expression of an organism's genes as well as the influence of environmental factors and the interactions between the two.

The following characteristics are a small selection of descriptors developed and promoted by the IPGRI (International Plant Genetic Resources Institute[14]) in Rome, Italy. The given list of is just a small extract of characteristics which can be used to detect phenotypic diversity of arable crops, vegetable crops and tree crops.

The IPGRI is an autonomous international scientific organization operating under the aegis of the Consultative Group on International Agricultural Research (CGIAR). IPGRI's mandate is to advance the conservation and use of plant genetic resources for the benefit of present and future generations. IPGRI work in partnership with other organisations, undertaking research, training, and the provision of scientific and technical advice and information and has a particularly strong programme link with the Food and Agricultural Organization of United Nations.

The following questions will lead you directly to species (landraces or others[15]) concerning your farm. Please, answer detailed questions about <u>each</u> species (e.g. durum wheat) you marked with <u>YES</u>.

<u>Did you cultivate landraces (or regional varieties, varieties not commercially available)</u>				
	1. WHEAT	Yes ☐ →	5.1, Page 17	☐ No

[14] Biodiversity International Homepage, URL: http://www.bioversityinternational.org/ (27.05.2010)

[15] Cultivars include landraces and accessions within PART 5

of…?

2. BARLEY	Yes ☐ →	5.2, Page 19	☐ No
3. POTATOES	Yes ☐ →	5.3, Page 21	☐ No
4. TOMATOES	Yes ☐ →	5.4, Page 23	☐ No
5. CARROTS	Yes ☐ →	5.5, Page 25	☐ No
6. ALLIUM SPP.	Yes ☐ →	5.6, Page 27	☐ No
7. APPLE	Yes ☐ →	5.7, Page 30	☐ No
8. CHERRY	Yes ☐ →	5.8, Page 32	☐ No
9. OLIVE	Yes ☐ →	5.9, Page 34	☐ No
10. GRAPES	Yes ☐ →	5.10, Page 36	☐ No

5.1 WHEAT

		Accession	Accession	Accession	Accession	Accession
Species						
Synonyms						
Origin of variety						
1.) Growth class (Seasonality)	winter (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	facultative (intermediate) (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	spring (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
2.) Spike density (Fig. Appendix 6.1.2*)	very lax (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	lax (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	intermediate (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	dense (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4

* Descriptive figures are in PART 6: Appendix should be used as decision support.

	very dense (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
3.) Awnedness	awnless (0)	☐ 0	☐ 0	☐ 0	☐ 0	☐ 0
	awnletted (short awns) (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	awned (conspicuous awns) (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
4.) Glume colour (Observed on the outer glume)	white (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	red to brown (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	purple to black (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
5.) Glume hairiness (Measured on the outer side of sterile glume)	absent (0)	☐ 0	☐ 0	☐ 0	☐ 0	☐ 0
	low (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	medium (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	high (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3

NOTES

5.2 BARLEY

		Accession	Accession	Accession	Accession	Accession
Species						
Synonyms						
Origin of variety						
1.) Growth class (Seasonality)	winter (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	facultative (intermediate) (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	spring (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3

2.) Spike density (Fig. Appendix 6.2.2*)	very lax (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	lax (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	intermediate (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	dense (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	very dense (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
3.) Lemma awn/hood (Fig. Appendix 6.2.3*)	awnless (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	awnleted (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	awned (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	sessile hoods (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	elevated hoods (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
4.) Glume colour	white (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	yellow (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	brown (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	black (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4

NOTES

5.3 POTATO

		Accession	Accession	Accession	Accession	Accession
Species						
Synonyms						

* Descriptive figures are in PART 6: Appendix should be used as decision support.

* Descriptive figures are in PART 6: Appendix should be used as decision support.

Origin of variety						

1.) Predominant tuber skin colour	white-cream (1), yellow (2) orange (3), brownish (4), pink (5), red (6), purplish-red (7), purple (8), dark purple-black (9)	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9	☐ 1 ☐ 2 ☐ 1 ☐ 2 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9	☐ 1 ☐ 2 ☐ 1 ☐ 2 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9	☐ 1 ☐ 2 ☐ 1 ☐ 2 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9	☐ 1 ☐ 2 ☐ 1 ☐ 2 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

2.) Predominant tuber flesh colour	white (1) cream (2) yellow cream (3) yellow (4) red (5) violet (6) purple (7) other (specify) (8)	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8_________	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8_________	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8_________	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8_________	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8_________

3.) General tuber shape (Fig. Appendix 6.3.3*)	compressed (oblate) (1) round (2) ovate (3) obovate (4) elliptic (5) oblong (6) long-oblong (7) elongate (8)	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8

4.) Tuber size	very small (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1

* Descriptive figures are in PART 6: Appendix and should be used as decision support.

	small (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	medium (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	large (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	very large (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
5.) Pollen production	none (0)	☐ 0	☐ 0	☐ 0	☐ 0	☐ 0
	little (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	abundant (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2

NOTES

5.4 TOMATO

		Accession	Accession	Accession	Accession	Accession
Species						
Synonyms						
Origin of variety						
1.) Leaf type (Fig. Appendix 6.4.1*)	dwarf (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	potato leaf type (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	standard (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	peruvianum (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	pimpinellifolium (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
	hirsutum (6)	☐ 6	☐ 6	☐ 6	☐ 6	☐ 6
	other (specify) (7)	☐ 7_____	☐ 7_____	☐ 7_____	☐ 7_____	☐ 7_____

* Descriptive figures are in PART 6: Appendix and should be used as decision support.

2.) Exterior colour of mature fruit	green (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	yellow (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	orange (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	pink (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	red (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
	other (specify) (6)	☐ 6__________	☐ 6__________	☐ 6__________	☐ 6__________	☐ 6__________

3.) Predominant fruit shape (Fig. Appendix 6.5.3*)	flattened (oblate) (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	slightly flattened (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	rounded (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	high rounded (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
(Recorded after the fruits turn colour)	heart-shaped (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
	cylindrical (long oblong) (6)	☐ 6	☐ 6	☐ 6	☐ 6	☐ 6
	pyriform (7)	☐ 7	☐ 7	☐ 7	☐ 7	☐ 7
	ellipsoid (plum-shaped) (8)	☐ 8	☐ 8	☐ 8	☐ 8	☐ 8
	other (specify) (9)	☐ 9__________	☐ 9__________	☐ 9__________	☐ 9__________	☐ 9__________

4.) Fruit size (At maturity)	very small (<3 cm) (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	small (3 - 5 cm) (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	intermediate (5.1 - 8 cm) (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	large (8.1 - 10 cm) (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	very large (>10 cm) (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5

5.) Seed colour	light yellow (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	dark yellow (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	grey (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	brown (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	dark brown (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5

* Descriptive figures are in PART 6: Appendix and should be used as decision support.

NOTES

5.5 CARROT		Accession	Accession	Accession	Accession	Accession
Species						
Synonyms						
Origin of variety						
1.) Stem hairiness	very sparse (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	sparse (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	Intermediate (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	dense (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	very dense (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
2.) Root size uniformity in accession	very low uniformity (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	low uniformity (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	moderate uniformity (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	high uniformity (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	very high uniformity (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
3.) Root branching (Fig. Appendix 6.5.3*)	absent (0)	☐ 0	☐ 0	☐ 0	☐ 0	☐ 0
	very sparse (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	sparse (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	intermediate (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3

* Descriptive figures are in PART 6: Appendix and should be used as decision support.

	dense (4) very dense (5)	☐ 4 ☐ 5	☐ 4 ☐ 5	☐ 4 ☐ 5	☐ 4 ☐ 5	☐ 4 ☐ 5
4.) Root shape (Fig. Appendix 6.5.4*)	round (1) obovate (2) obtriangular (3) oblong (4) tapering (5) other (specify) (6)	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6_____	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6_____	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6_____	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6_____	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6_____
5.) Root skin colour	white (1) yellow (2) orange (3) red (4) purple (5) other (specify) (6)	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6_____	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6_____	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6_____	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6_____	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6_____

NOTES

5.6 ALIUM SPP		**Accession**	**Accession**	**Accession**	**Accession**	**Accession**
Species	**Onion, garlic, chive, leek, shallot**					
Synonyms						
Origin of variety						
1.) Density of leaves	very low (1)	☐ 1				

* Descriptive figures are in PART 6: Appendix and should be used as decision support.

			☐ 1	☐ 1	☐ 1	☐ 1
	low (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
(Fig. Appendix 6.6.1*)	intermediate (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	high (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
LEEK	very high (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5

2.) Foliage attitude	very prostrate (or spreading) (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	prostrate (or spreading) (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	intermediate (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
ONION, GARLIC,	erect (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
CHIVE, LEEK	very erect (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5

	very week (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
3.) Degree of leaf	weak (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
waxiness	medium (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
ONION,	strong (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
CHIVE, LEEK	very strong (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5

	flat (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
4.) Shape of mature	flat globe (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
dry bulbs	rhomboid (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
(Fig. Appendix	broad oval (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
6.6.4*)	globe (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
	broad elliptic (6)	☐ 6	☐ 6	☐ 6	☐ 6	☐ 6
ALL ALIUM SPP	ovate (elongated oval) (7)	☐ 7	☐ 7	☐ 7	☐ 7	☐ 7
	spindle (8)	☐ 8	☐ 8	☐ 8	☐ 8	☐ 8
	high top (9)	☐ 9	☐ 9	☐ 9	☐ 9	☐ 9
	other (specify) (10)	☐ 10________	☐ 10________	☐ 10________	☐ 10________	☐ 10_______

* Descriptive figures are in PART 6: Appendix and should be used as decision support.

* Descriptive figures are in PART 6: Appendix and should be used as decision support.

5.) Population uniformity of bulb shape **ONION, GARLIC**	uniform (homogeneous) (1) variable (2) highly variable (3)	☐ 1 ☐ 2 ☐ 3	☐ 1 ☐ 2 ☐ 3	☐ 1 ☐ 2 ☐ 3	☐ 1 ☐ 2 ☐ 3	☐ 1 ☐ 2 ☐ 3

6.) Bulb skin colour **ONION**	white (1) yellow (2) yellow and light brown (3) light brown (4) brown (5) dark brown (6) green (chartreuse) (7) light violet (8) dark violet (9) other (10)	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10________	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10________	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10________	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10________	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10________

7.) Bulb skin colour **GARLIC**	white (1) cream (2) beige (3) white stripes (4) light violet (5) violet (6) dark violet (7) other (8)	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8________	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8________	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8________	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8________	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8________

8.) Ability to flower	**GARLIC, ONION, SHALLOT, CHIVE**	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

NOTES

5.7 APPLE						
		Accession	**Accession**	**Accession**	**Accession**	**Accession**

Species						
Synonyms						
Origin of variety						

1.) Habit of tree branches (Natural habit of an un-trained, non-juvenile tree)	upright (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	spreading (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	drooping (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	weeping (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
2.) Season of flowering (Date of full flower)	very early (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	early (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	intermediate (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	late (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	very late (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
3.) Fruit size	very small (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	small (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	medium (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	large (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	very large (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
4.) Fruit shape (Fig. Appendix 6.7.4*)	globose 1.0	☐ 1.0	☐ 1.0	☐ 1.0	☐ 1.0	☐ 1.0
	globose-conical 1.1	☐ 1.1	☐ 1.1	☐ 1.1	☐ 1.1	☐ 1.1
	short-globose-conical 1.2	☐ 1.2	☐ 1.2	☐ 1.2	☐ 1.2	☐ 1.2
	flat 2.0	☐ 2.0	☐ 2.0	☐ 2.0	☐ 2.0	☐ 2.0

* Descriptive figures are in PART 6: Appendix and should be used as decision support.

	flat-globose (oblate) 2.1	☐ 2.1	☐ 2.1	☐ 2.1	☐ 2.1	☐ 2.1
	conical 3.0	☐ 3.0	☐ 3.0	☐ 3.0	☐ 3.0	☐ 3.0
	long-conical 3.1	☐ 3.1	☐ 3.1	☐ 3.1	☐ 3.1	☐ 3.1
	intermediate – conical 3.2	☐ 3.2	☐ 3.2	☐ 3.2	☐ 3.2	☐ 3.2
	ellipsoid 4.0	☐ 4.0	☐ 4.0	☐ 4.0	☐ 4.0	☐ 4.0
	ellipsoid-conical (ovate) 4.1	☐ 4.1	☐ 4.1	☐ 4.1	☐ 4.1	☐ 4.1
	oblong 5.0	☐ 5.0	☐ 5.0	☐ 5.0	☐ 5.0	☐ 5.0
	oblong-conical 5.1	☐ 5.1	☐ 5.1	☐ 5.1	☐ 5.1	☐ 5.1
	oblong – waisted 5.2	☐ 5.2	☐ 5.2	☐ 5.2	☐ 5.2	☐ 5.2
5.) Ground colour (Ground colour of the skin of fully mature fruit)	red (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	orange (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	cream-white (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	yellow (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	green-yellow (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
	green (6)	☐ 6	☐ 6	☐ 6	☐ 6	☐ 6

NOTES

5.8 CHERRY

		Accession	Accession	Accession	Accession	Accession
Species						
Synonyms						
Origin of variety						
1.) Habit of tree branches (Natural habit of an un-	upright (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	spreading (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	drooping (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3

trained, non-juvenile tree)	weeping (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
2.) Season of flowering (Date of full flower)	very early (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	early (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	intermediate (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	late (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	very late (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
3.) Fruit size	very small (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	small (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	medium (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	large (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	very large (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
4.) Fruit shape (Fig. Appendix 6.8.4*)	kidney-shaped (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	flat-round (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	round (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	elongate (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	cordate (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
5.) Fruit flesh colour	cream-white, cream-yellow (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	pink (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	red (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	dark red (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	black red (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
	other (specify) (6)	☐ 6_____	☐ 6_____	☐ 6_____	☐ 6_____	☐ 6_____

NOTES

* Descriptive figures are in PART 6: Appendix and should be used as decision support.

5.9 OLIVE

		Accession	Accession	Accession	Accession	Accession
Species						
Synonyms						
Origin of variety						
1.) Plant vigour	very weak (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	weak (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	medium (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	strong (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	very strong (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
2.) Leaf size	very small (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	small (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	medium (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	large (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	very large (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
3.) Leaf ratio length/ width	short and narrow (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	short and broad (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	long and narrow (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	long and broad (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
5.) Leaf shape	lanceolate (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	elliptic-lanceolate (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	elliptic (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3

6.) Leaf glossiness	absent (0) low (1) medium (2) high (3)	☐ 0 ☐ 1 ☐ 2 ☐ 3	☐ 0 ☐ 1 ☐ 2 ☐ 3	☐ 0 ☐ 1 ☐ 2 ☐ 3	☐ 0 ☐ 1 ☐ 2 ☐ 3	☐ 0 ☐ 1 ☐ 2 ☐ 3
7.) Fruit shape	lanceolate (1) elliptic-lanceolate (2) elliptic (3)	☐ 1 ☐ 2 ☐ 3	☐ 1 ☐ 2 ☐ 3	☐ 1 ☐ 2 ☐ 3	☐ 1 ☐ 2 ☐ 3	☐ 1 ☐ 2 ☐ 3
8.) Stone size	very small (1) small (2) medium (3) large (4) very large (5)	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
9.) Time of flowering	very early (1) early (2) intermediate (3) late (4) very late (5)	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
10.) Oil content	high (1) medium (2) low (3)	☐ 1 ☐ 2 ☐ 3	☐ 1 ☐ 2 ☐ 3	☐ 1 ☐ 2 ☐ 3	☐ 1 ☐ 2 ☐ 3	☐ 1 ☐ 2 ☐ 3
11.) Purpose	oil (1) table (2) double purpose (3)	☐ 1 ☐ 2 ☐ 3	☐ 1 ☐ 2 ☐ 3	☐ 1 ☐ 2 ☐ 3	☐ 1 ☐ 2 ☐ 3	☐ 1 ☐ 2 ☐ 3

NOTES

5.10 GRAPE		Accession	Accession	Accession	Accession	Accession
Species						
Synonyms						
Origin of variety						
1.) Young shoot: form of tip (Fig. Appendix 6.10.1*)	closed (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	slightly open (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	half open (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	wide open (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	fully open (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
2.) Shoot attitude (habit) (Fig. Appendix 6.10.2*)	erect (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	semi-erect (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	horizontal (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	semi-dropping (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	dropping (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
3.) Mature leaf: size of blade (Fig. Appendix 6.10.3*)	very small (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	small (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	medium (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	large (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	very large (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5

* Descriptive figures are in PART 6: Appendix and should be used as decision support.

4.) Mature leaf: shape of blade	cordate (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	wedge-shaped (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	pentagonal (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	circular (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	reniform (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
	other (specify) (6)	☐ 6	☐ 6	☐ 6	☐ 6	☐ 6

5.) Berry size	very small (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	small (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	medium (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	large (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	very large (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5

6.) Berry shape	oblong (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	narrow elliptic (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	elliptic (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
	round (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	oblate (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
	ovate (6)	☐ 6	☐ 6	☐ 6	☐ 6	☐ 6
	obtuse-ovate (7)	☐ 7	☐ 7	☐ 7	☐ 7	☐ 7
	obovate (8)	☐ 8	☐ 8	☐ 8	☐ 8	☐ 8
	arched (9)	☐ 9	☐ 9	☐ 9	☐ 9	☐ 9

7.) Berry: presence of seeds	seedless (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	rudimentary (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	well developed (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3

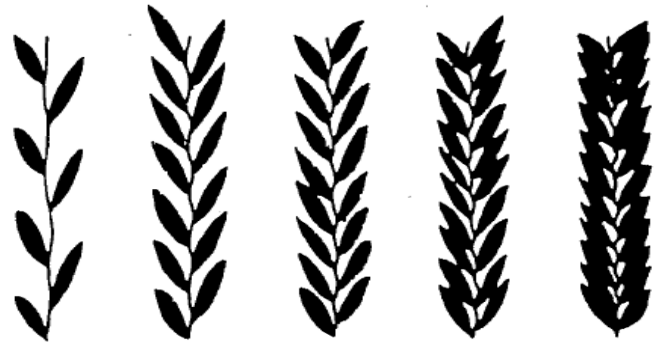
8.) Berry skin colour	green-yellow (1)	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
	rose (2)	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
	red (3)	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3

	red-grey (4)	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
	dark red-violet (5)	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
	blue-black (6)	☐ 6	☐ 6	☐ 6	☐ 6	☐ 6
	other (specify) (7)	☐ 7_____	☐ 7_____	☐ 7_____	☐ 7_____	☐ 7_____

NOTES

PART 6: Appendix (A7)

6.1.2 Spike density (wheat)

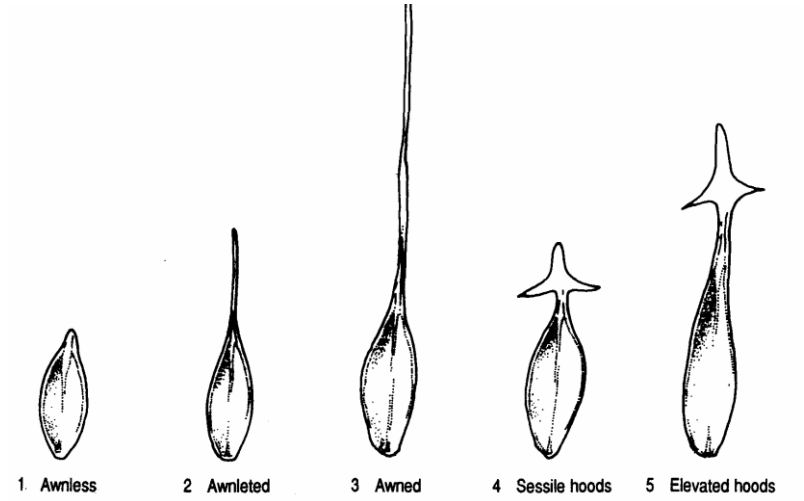


1 2 3 4 5

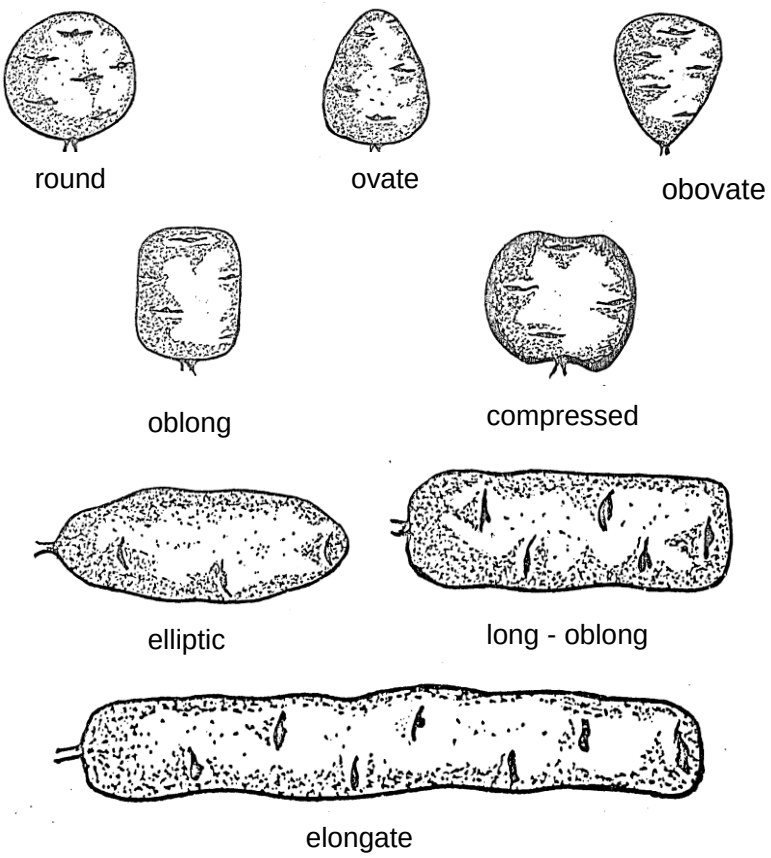
6.2.2 Spike density (barley)

1 3 5

6.2.3 Lemma awn/hood (barley)

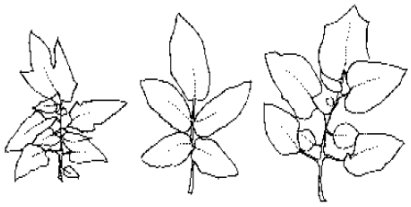


6.3. General tuber shape (potato)

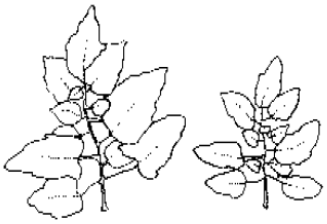


6.4.1 Leaf type (tomato)

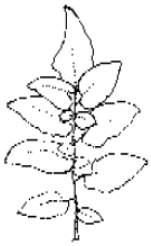
dwarf (1)



potato leaf type (2)

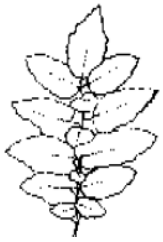


standard (3)



peruvianum (4)

pimpinellifolium (5)

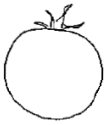


hirsutum (6)

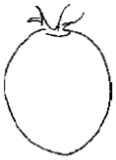
6.4.3 Predominant fruit shape (tomato)

flattened (oblate) (1)

slightly flattened (2)



rounded (3)



high rounded (4)

heart-shaped (5)

cylindrical (long oblong) (6)

pyriform (7)

ellipsoid (plum-shaped) (8)

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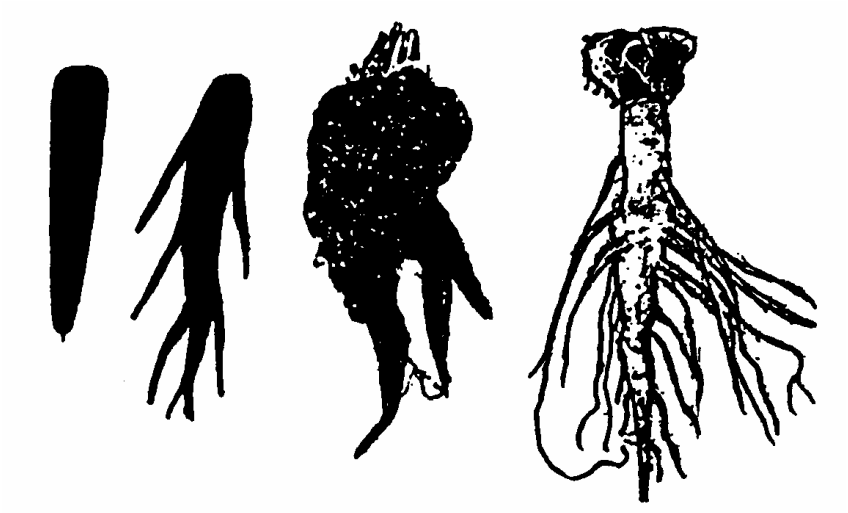
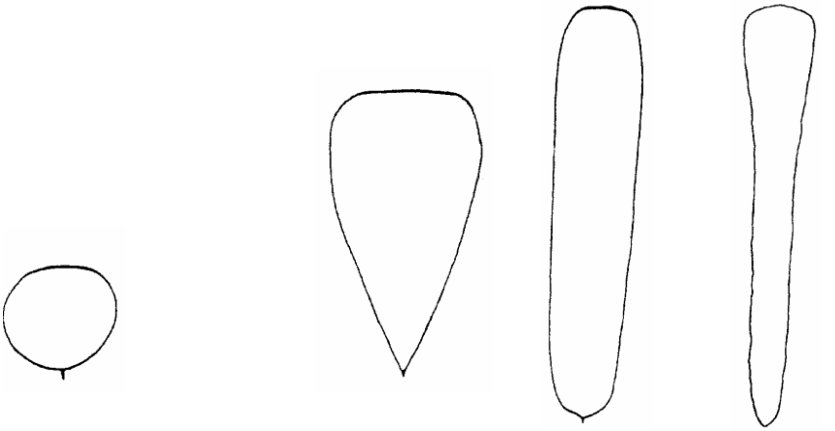
6.5.3 Root branching (carrot)



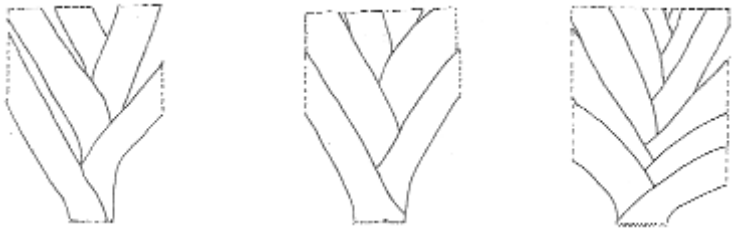
absent (0) sparse (2) intermediate (3) dense (5)

6.5.4 Root shape (carrot)



round (1) obovate (2) obtriangular (3) oblong (4) tapering (5)

6.6.1 Density of leaves (allium spp)



low (2) medium (3) high (4)

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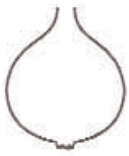
6.6.4 Shape of mature dry bulbs (Allium spp)

flat (1)

flat globe (2)

rhomboid (3)

broad oval (4)



globe (5)

broad elliptic (6)

ovate (elongated oval) (7)

spindle (8)

high top (9)

6.7.4 Fruit shape (apple)

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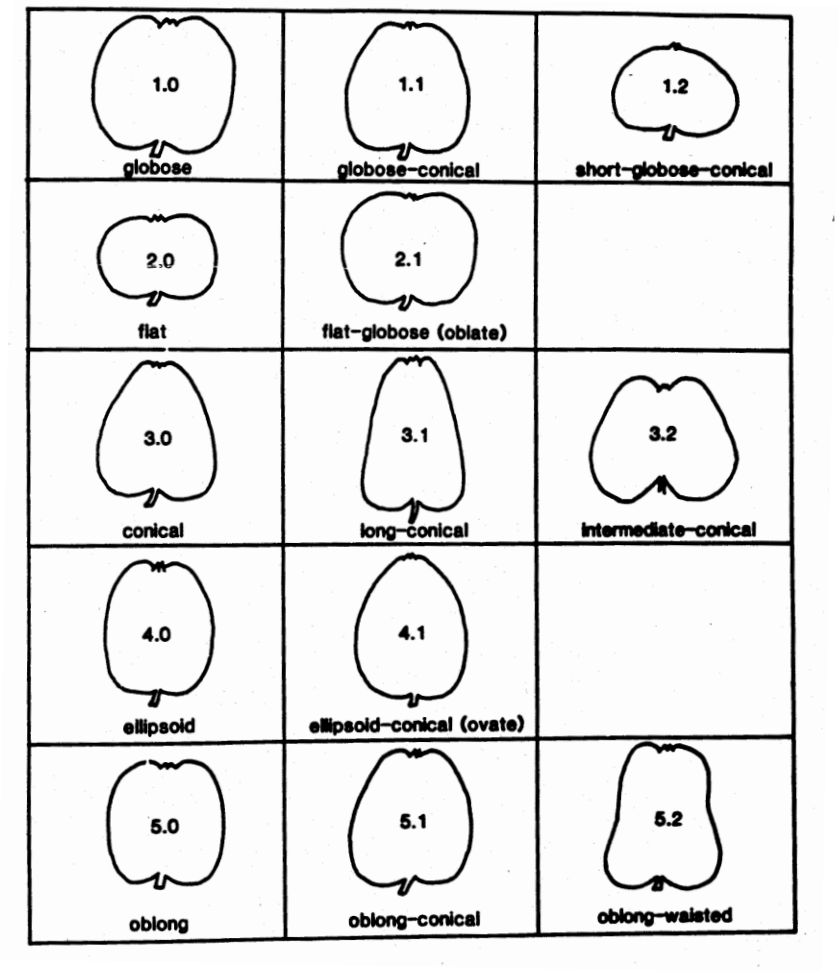
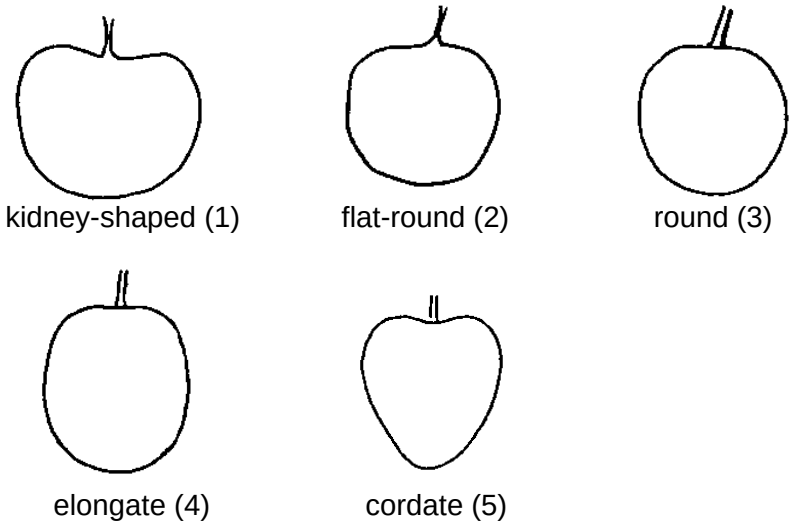
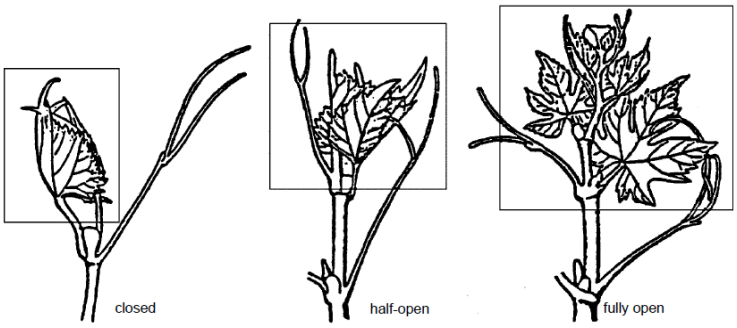


6.8.4 Fruit shape (cherry)

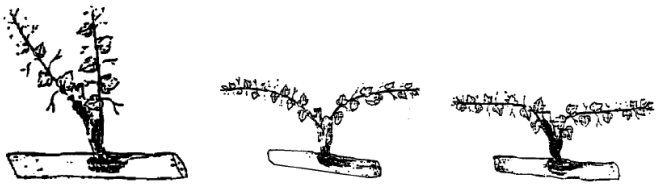


6.10.1 Young shoot: form of tip (grapes)



closed (1) half open (3) fully open (5)

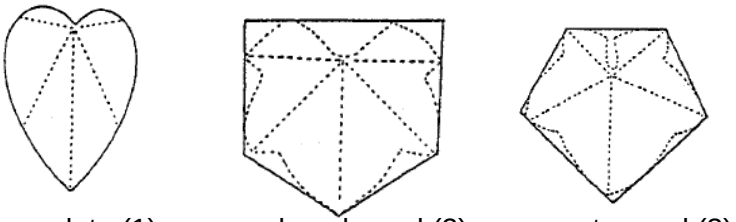
6.10.2 Shoot attitude (habit) (grapes)



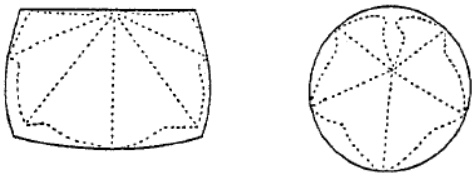
erect (1) semi-erect (3) horizontal (5)

semi-dropping (7) dropping (9)

6.10.4 Mature leaf: shape of blade (grapes)

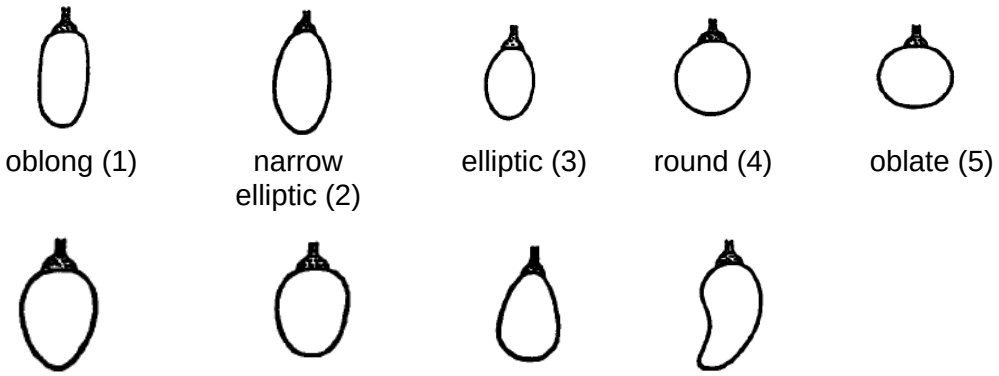


cordate (1) wedge-shaped (2) pentagonal (3)



circular (4) reniform (5)

6.10.6 Berry shape (grapes)



oblong (1) narrow elliptic (2) elliptic (3) round (4) oblate (5)

APPENDIX 7.6. QUESTIONNAIRE FOR THE EVALUATION OF LIVESTOCK GENETIC RESOURCES ON THE FARM

(Pip Nicholas, Basil Wolf, Mariecia Fraser and Peter Dennis)

Livestock genetic resources in 2010 *Indicate the numbers of each species and breed on the farm*										
Species	**Applicable?**		**Breeds**	**Numbers**	**Office Use Only**			**Key**		
	Yes	*No*	*List the breed/s*	*How many in June 2010?*	*Breed origin*	*Breed status*	*Rare breed status*	*Breed origin*	*Breed status*	Categories of rare breed status
Dairy cows								N: Native E: Exotic	M: Mainstream D: Distinctive L: Locally adapted R: Rare	1. Critical 2. Endangered 3. Vulnerable 4. At Risk 5. Feral 6. Imported 7. Traditional
Dairy replacement calves										
Dairy x beef calves for fattening										
Beef cows										
Store cattle										
Sheep breeding flock										
Lambs for breeding flock										
Lambs for fattening										
Lambs for sale and finishing off farm										
Dairy goats										
Dairy replacement kids										
Goat breeding herd										
Kids reared for meat										
Kids for sale and finished off farm										
Ponies/ horses										
Pig breeding herd										
Fattening pigs										
Broiler chickens										
Laying fowl										
Other poultry										

APPENDIX 7.7 COST EFFECTIVENESS DATA COLLECTION FORM

Form a – Record of resource use

Date	Case study	Farm code	Person in charge	Indicator (group)	Operation description	Resource type	Description	Measure unit (MU)	Resource amount (MU)	notes

Form b1 - Labour

N.	Description	Gross salary (euro/hour)	Net salary after taxes (euro/hour)

Form b2 - Equipment

N.	Description	Cost (new)	Measurement unit for use (MU)	Life time (in the same MU)

Form b3 - Transport

N.	Description	Measurement unit (MU)	Cost/MU (euro/km)

Form b4 - Consumables

N.	Description	Measurement unit (MU)	Cost/MU

APPENDIX 7.8. FIELD DATA SHEET FOR FAUNISTIC INDICATORS

By going into the field for the observation and sampling of faunistic indicators, data about conditions have to be recorded during the survey.

Earthworms

For every habitat/field plot where earthworms are collected, the following data have to be recorded on a sheet of paper (or on the field computer):

Code:(stick on the label)	
Observers:	
Date:	
Time:	= start time of the AITC application of the first sub-sample in a habitat/field plot
Digging depth:	For each sub-sample
Height of vegetation (in cm):	For the habitat/field plot on average
Observation of nutrient input (yes/no):	For the habitat/field plot
Optional:	
Soil temperature:	
Soil humidity:	

Spiders

For every habitat/field plot where spiders are collected, the following data have to be recorded on a sheet of paper (or on the field computer):

Code:(stick on the label)	
Observers:	
Date:	
Time:	= start time of the first suction sub-sample
Height of vegetation (in cm):	
% cloud cover:	
Beaufort wind code:	
Temperature:	

Wild, domestic and bumble bees

For every habitat/field plot where bees are collected, the following data have to be recorded on a sheet of paper (or on the field computer):

Code:(stick on the label)	
Observer:	
Date:	
Time:	= start time of the transect walk
Height of vegetation (in cm):	
Cloud cover (%):	
Beaufort wind code:	
Temperature:	
Coverage of flowering plants (%):	
Main flowering species:	

APPENDIX 7.9. ELECTRONIC FORMS FOR FORMAT OF SPECIES DATA RECORDS

A) Excel spreadsheet for VEGETATION X and L plots. The form shows as example the data records for plots ***a*** and ***b*** of farm 1 in Wales, with 15 and 13 species, respectively. For L plots (linear) the column "Plot" is 10 m^2 everywhere.

Habitat/field plot code (bar code composition)	Identifier name	Date	Plot	Species name	Cover (%)
W1a_V_1	J. Template	05.05.2010	4m2		
W1a_V_1	J. Template	05.05.2010	4m2		
W1a_V_1	J. Template	05.05.2010	4m2		
W1a_V_1	J. Template	05.05.2010	4m2		
W1a_V_1	J. Template	05.05.2010	4m2		
W1a_V_1	J. Template	05.05.2010	4m2		
W1a_V_1	J. Template	05.05.2010	4m2		
W1a_V_1	J. Template	05.05.2010	4m2		
W1a_V_1	J. Template	05.05.2010	4m2		
W1a_V_1	J. Template	05.05.2010	25m2		
W1a_V_1	J. Template	05.05.2010	25m2		
W1a_V_1	J. Template	05.05.2010	25m2		
W1a_V_1	J. Template	05.05.2010	25m2		
W1a_V_1	J. Template	05.05.2010	100m2		
W1a_V_1	J. Template	05.05.2010	100m2		
…	…	…	…	…	…
W1b_V_2	R. Example	15.05.2010	4m2		
W1b_V_2	R. Example	15.05.2010	4m2		
W1b_V_2	R. Example	15.05.2010	4m2		
W1b_V_2	R. Example	15.05.2010	4m2		
W1b_V_2	R. Example	15.05.2010	4m2		
W1b_V_2	R. Example	15.05.2010	25m2		
W1b_V_2	R. Example	15.05.2010	25m2		
W1b_V_2	R. Example	15.05.2010	25m2		
W1b_V_2	R. Example	15.05.2010	25m2		
W1b_V_2	R. Example	15.05.2010	25m2		
W1b_V_2	R. Example	15.05.2010	100m2		
W1b_V_2	R. Example	15.05.2010	100m2		
W1b_V_2	R. Example	15.05.2010	100m2		
…	…	…	…	…	…

B) Excel spreadsheet for EARTHWORMS. The form shows as example the data records for plot ***a*** of farm 1 in Wales, for the 3 sub-samples (1-3) with AITC method (x) and hand-sorting (y). For example, 4 species were captured in plot ***a*** of farm 1 in the second sub-sample with hand-sorting (bold and italic). "Date" is the date of sampling (the same as on the field data sheet).

Habitat/field plot code (bar code composition)	Identifier name	Date	Species name	Abundance
W1a_E1x_16	J. Template	05.05.2010		
W1a_E1x_16	J. Template	05.05.2010		
W1a_E1x_16	J. Template	05.05.2010		
W1a_E1x_16	J. Template	05.05.2010		
W1a_E1x_16	J. Template	05.05.2010		
W1a_E2x_31	J. Template	05.05.2010		
W1a_E2x_31	J. Template	05.05.2010		
W1a_E2x_31	J. Template	05.05.2010		
W1a_E2x_31	J. Template	05.05.2010		
W1a_E2x_31	J. Template	05.05.2010		
W1a_E3x_46	J. Template	05.05.2010		
W1a_E3x_46	J. Template	05.05.2010		
W1a_E3x_46	J. Template	05.05.2010		
W1a_E3x_46	J. Template	05.05.2010		
W1a_E3x_46	J. Template	05.05.2010		
…	…	…	…	…
W1a_E1y_16	R. Example	05.05.2010		
W1a_E1y_16	R. Example	05.05.2010		
W1a_E1y_16	R. Example	05.05.2010		
W1a_E1y_16	R. Example	05.05.2010		
****W1a_E2y_31****	***R. Example***	***05.05.2010***		
****W1a_E2y_31****	***R. Example***	***05.05.2010***		
****W1a_E2y_31****	***R. Example***	***05.05.2010***		
****W1a_E2y_31****	***R. Example***	***05.05.2010***		
W1a_E3y_46	R. Example	05.05.2010		
W1a_E3y_46	R. Example	05.05.2010		
W1a_E3y_46	R. Example	05.05.2010		
W1a_E3y_46	R. Example	05.05.2010		
…	…	…	…	…

C) Excel spreadsheet for SPIDERS. The form shows as example the data records for plot ***a*** of farm 1 in Wales, for the 5 suction sub-samples of the 3 surveys ((1-15 and d1-d3). For example, during the 2nd survey, 2 species have been captured in the 4th suction sub-sample of plot ***a*** in farm 1 (bold and italic). "Date" is the date of sampling (the same as on the field data sheet).

Habitat/field plot code (bar code composition)	Identifier name	Date	Species name	Abundance
W1a_S1d1_106	J. Template	05.05.2010		
W1a_S1d1_106	J. Template	05.05.2010		
W1a_S1d1_106	J. Template	05.05.2010		
W1a_S2d1_151	J. Template	05.05.2010		
W1a_S2d1_151	J. Template	05.05.2010		
W1a_S3d1_196	J. Template	05.05.2010		
W1a_S3d1_196	J. Template	05.05.2010		
W1a_S4d1_241	J. Template	05.05.2010		
W1a_S5d1_286	J. Template	05.05.2010		
…	…	…	…	…
W1a_S6d2_121	J. Template	10.06.2010		
W1a_S7d2_166	J. Template	10.06.2010		
W1a_S8d2_211	J. Template	10.06.2010		
W1a_S8d2_211	J. Template	10.06.2010		
****W1a_S9d2_256****	***J. Template***	***10.06.2010***		
****W1a_S9d2_256****	***J. Template***	***10.06.2010***		
W1a_S10d2_301	J. Template	10.06.2010		
W1a_S10d2_301	J. Template	10.06.2010		
W1a_S10d2_301	J. Template	10.06.2010		
…	…	…	…	…
W1a_S11d3_136	J. Template	15.08.2010		
W1a_S12d3_181	J. Template	15.08.2010		
W1a_S13d3_226	J. Template	15.08.2010		
W1a_S14d3_271	J. Template	15.08.2010		
W1a_S15d3_316	J. Template	15.08.2010		
…	…	…	…	…

D) Excel spreadsheet for BEES. The form shows as example the data records for plot ***a*** and ***b*** of farm 1 in Wales for the 3 transect surveys (d1-d3). For example, during the 2nd transect survey in plot ***b*** of farm 1, 3 species have been captured (bold and italic). "Date" is the date of sampling (the same as on the field data sheet).

Habitat/field plot code (bar code composition)	Identifier name	Date	Species name	Abundance
W1a_Bd1_331	J. Template	05.05.2010		
W1a_Bd1_331	J. Template	05.05.2010		
W1a_Bd1_331	J. Template	05.05.2010		
W1a_Bd2_346	J. Template	12.06.2010		
W1a_Bd2_346	J. Template	12.06.2010		
W1a_Bd2_346	J. Template	12.06.2010		
W1a_Bd2_346	J. Template	12.06.2010		
W1a_Bd2_346	J. Template	12.06.2010		
W1a_Bd3_361	J. Template	20.07.2010		
…	…	…	…	…
W1b_Bd1_332	J. Template	05.05.2010		
W1b_Bd1_332	J. Template	05.05.2010		
W1b_Bd1_332	J. Template	05.05.2010		
W1b_Bd1_332	J. Template	05.05.2010		
W1b_Bd1_332	J. Template	05.05.2010		
W1b_Bd1_332	J. Template	05.05.2010		
****W1b_Bd2_347****	***J. Template***	***12.06.2010***		
****W1b_Bd2_347****	***J. Template***	***12.06.2010***		
****W1b_Bd2_347****	***J. Template***	***12.06.2010***		
W1b_Bd3_362	J. Template	20.07.2010		
W1b_Bd3_362	J. Template	20.07.2010		
W1b_Bd3_362	J. Template	20.07.2010		
…	…	…	…	…