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BIOBIO

Indicators for biodiversity in organic and low-input farming systems

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Report on the potential applicability of BIOBIO indicators beyond Europe – exemplified for three ICPC case study regions (Ukraine, Tunisia and Uganda)

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Report on the potential applicability of BIOBIO indicators beyond Europe – exemplified for three ICPC case study regions (Ukraine, Tunisia and Uganda)

Final Version of Report

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CONTENTS

1. GENERAL INTRODUCTION

BIOBIO is a European project, which aims at the conceptualization of criteria for a scientifically based selection of biodiversity indicators for organic and low-input farming systems. In a first phase, candidate biodiversity indicators are tested in representative case studies across Europe. In a second phase, the applicability and usefulness of the resulting indicator set is tested in three International Cooperation Partner Countries (ICPC; Uganda, Ukraine and Tunisia). The main output of the BIOBIO project will consist of guidelines for the implementation of biodiversity indicators for organic and low-input farming systems for Europe and beyond.

Organic and low-input farming systems have been shown to benefit farmland biodiversity although a generic indicator system to assess these benefits at the European level is lacking. The BIOBIO project will therefore pursue the following objectives:

1. Conceptualization of criteria for a scientifically-based selection of biodiversity indicators for organic/low-input farming systems in Europe (Work Package WP2) and beyond (WP2, this report);
2. Assessment and validation of a set of candidate biodiversity indicators in representative case studies across Europe (WP3) and in ICPC countries (WP5);
3. Preparation of guidelines for the implementation of biodiversity indicators for organic/low-input farming systems for Europe and beyond (WP6).

Existing indirect farm management indicators as well as direct indicators for genetic, species and habitat diversity will be assessed for their scientific soundness, practicality, geographic scope and usefulness for stakeholders. Candidate indicators are now being tested in a standardised design in twelve case studies across Europe (WP3). Based on the experience from the European case studies, they will then be tested in three ICPC countries (WP5). Stakeholders (farming communities, conservation NGOs, administrators) are integrated at critical stages of the indicator selection process (WP7). A handbook with factsheets will be produced for validated indicators (WP2, WP6) together with a sampling design for biodiversity monitoring in organic and low-input farming systems across Europe and beyond (WP2).

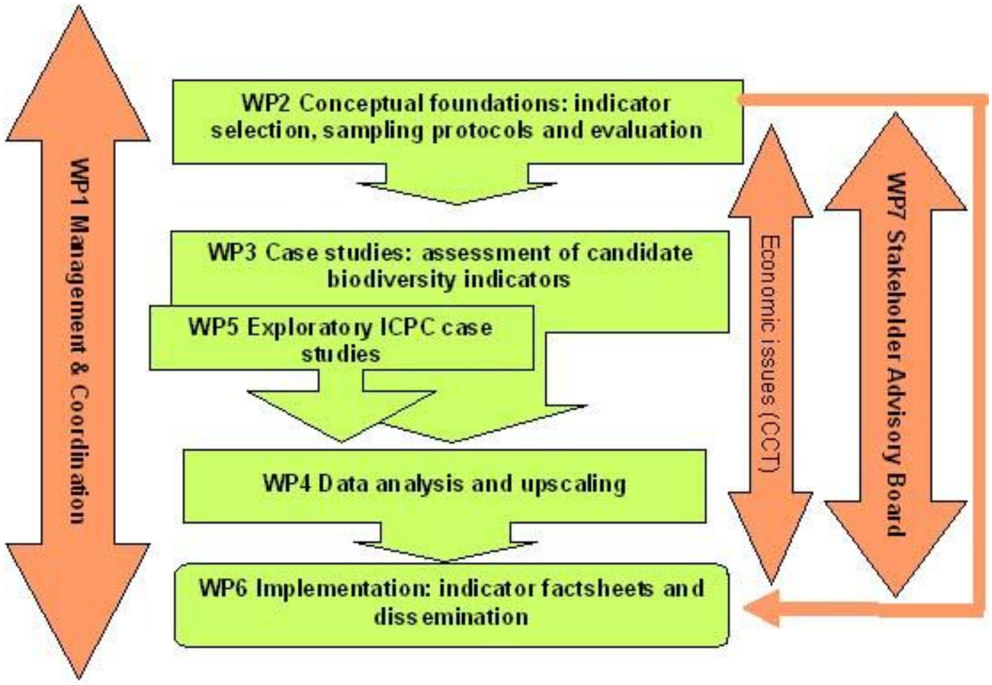

Fig. 1: BIOBIO OBJECTIVES AND WORKING PACKAGES

This report summarises the status of the project at a stage where candidate indicators have been selected and are currently tested in 12 European case studies. The ICPC case studies are presented and the potential application in Uganda, Ukraine and Tunisia is discussed in order to prepare the field work to be carried out.

2. INDICATOR SELECTION PROCESS

Candidate biodiversity indicators[1] for organic and low input farming systems in Europe were selected following a major review of indicator theory and existing biodiversity indicators (Dennis *et al.* 2009). The review included indirect biodiversity indicators based on farm management and farm accounts information and direct biodiversity indicators based on measurements of plants and animals at the genetic, species and ecosystem level. 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 results of the survey were discussed and confirmed during the second Stakeholder Advisory Board workshop in Brussels, 21-22 October 2009 (Pointereau 2009). The candidate indicators to be tested in field studies in BIOBIO were then identified, accounting for the effort which the project partners can allocate to this field survey in 2010. This list was delivered as D2.2 (Dennis *et al.* 2010) The applicability of these candidate indicators beyond Europe was discussed within the WP5 members during the meetings in Vienna, 15-16 December 2009, and Placencia, 24-25 March 2010. Following this discussion each ICPC partner provided an individual assessment of the applicability of the selected candidate biodiversity indicators for their own case study regions.

3. BIOBIO INDICATORS

3.1. Habitat indicators

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 (see Bunce *et al.* 2010). An initial classification of farmed and unfarmed land has been described, 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 and linear 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).

3.2. Species indicators

Standard methods to survey plants, vertebrates and invertebrates in terrestrial ecosystems are known and have been used under several circumstances. However, their applicability, cost and effectiveness to reveal the linkage between organic/low-input farming and biodiversity and nature conservation have to be critically assessed. A full review of the characteristics of species groups that makes them suitable candidate biodiversity indicators is given in Dennis et al. (2009). Standardized methods for the assessment of indicator species are presented by Dennis et al. (2010).

3.2.1. Flowering plants

There are many arguments for using flowering plants (angiosperms) as indicators. These primary producers dominate most terrestrial ecosystems, shaping our physical environment and forming the basis of food chains. They constitute an important part of agricultural landscape biodiversity and provide food, shelter, breeding sites, refuges, etc. for a wide range of other organisms. Most mammals, birds, invertebrates and insects are directly or indirectly dependent on one or more species of flowering plants

[1] Further information and downloads of the reports can be found on the BIOBIO homepage: www.biobio-indicator.org

and diversity of flowering plants may therefore indicate diversity of other organisms. Flowering plants are mapped according to the method proposed by Bunce et al. (2010).

3.2.2. Wild, domestic and bumble bees

Bees (Apidae, Sphecidae, Eumenidae, Pompilidae) are recognized as promising indicators for ecological change of habitat quality. They are characterized by complex life histories and have specific requirements for nesting sites, such as dead wood, bare soil, plant stems or small rock cavities which should be close to feeding sites. Wild bee communities are first influenced by the land use intensity in a region, then by the landscape structure. Ricketts *et al.* (2008) emphasized the importance of conserving and managing sufficient resources for wild pollinators within the agricultural landscape to maintain the pollination services. A decline in bee diversity will affect the pollination of many insect-pollinated crops and wild plant species. While pollination by bees significantly increases the crop yield, wasps can be considered as indicators of beneficial interactions because they may be effective predators of other insects. With respect to farming systems, Holzschuh *et al.* (2007) demonstrated that organic farming increases bee diversity by enhancing flower availability. In addition, bee diversity was influenced by the landscape context and the interaction of both, organic farming being more effective in homogeneous landscapes.

3.2.3. Spiders

Spiders are abundant and form species-rich taxon occurring in (nearly) all terrestrial ecosystems including agro-ecosystems. In agricultural fields, responses of farmland spiders to agricultural practices and management intensity are well known and documented. Spiders occur in all agro-ecosystems at all levels (soil, grass/crop, trees) and can therefore be compared across them as well as among farming systems, farms, and case study regions in Europe and beyond. They are sensitive to agricultural practices and are important predators of invertebrate pests (biological control). However, while collection in fields can be done without particular expertise (e.g. by technicians), they need to be identified in the lab by taxonomists.

3.2.4. Earthworms

Earthworms (Anellidae, Oligocheta) are key soil detritivores, essential for composting and recycling soil nutrients whilst contributing to the maintenance of soil structure anecic species which are large, vertically burrowing earthworms building up stable burrows play an important role in conservation and improvement of soil structure. The activity performed by earthworms allows the soil to reach a condition that hosts many other sorts of organisms, hence enhancing the overall soil biodiversity. Rich soil biodiversity and biomass, means a supply of higher amounts of resources for greater above ground trophic levels, so contributing directly to enhance the overall biodiversity of agro-ecosystems.

3.3. Genetic diversity indicators

A comprehensive set of indicators for the detection of biodiversity in organic and low input farming systems must include measures of genetic diversity within crop species and within husbandry animals. 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 not possible. The indicators will rely mostly on information gathered through farmer interviews.

3.4. Farm management indicators

The Farm Management Questionnaire is the basis for data collection to assess farming intensity on BIOBIO case study (CS) farms. Management indicators address e.g. economical aspects, nitrogen, energy and pesticide inputs, livestock management, yield, etc..

4. ICPC CASE STUDIES (UKRAINE, TUNISIA, UGANDA)

4.1. Introduction and content of WP5

In WP5 the wider applicability of the biodiversity indicators, which are developed in BIOBIO for Europe, will be tested in other agro-ecological zones and in a different policy context. BIOBIO wants to identify:

- which indicators are generally applicable for low input and organic farming systems, even beyond Europe,
- which indicators can easily be replaced by similar indicators and
- which indicators would need to be developed in order to match the conditions of low input and organic farming in other agro-ecological zones and institutional settings.

The implementation of this work package will be based on the relationships between the following institutes:

- Bila Tserkva National Agrarian University in the Ukraine and the Technical University of München, Germany.
- Institut National de Recherche en Génie Rural, Eaux et Forêts in Tunisia and the University of Extremadura, Spain.
- Makarere University in Uganda and the University of Padua, Italy.

The ICPC case study areas comprise different farming systems, which are more or less similar to the systems that were studied in the European case studies. In total four different farming systems will be investigated:

- Organic mixed, low-input and intensive arable farming systems in Ukraine
- Cork oak agro-forests in Tunisia
- Low input and organic olive groves in Tunisia
- Organic subsistence and commercial farming in Uganda

Tab. 1 summarizes which farming systems will be investigated and how many farms will be assessed.

Tab. 1: NUMBER AND TYPE OF FARMS TO BE INVESTIGATED IN INDIVIDUAL ICPC CASE STUDY REGIONS

ICPC case Study country	Farming system	No. of farms
Tunisia	olive grove	8-10 organic & 8-10 conventional
Tunisia	dehesa	10 dehesas
Ukraine	arable	5 organic & 5 conventional
Uganda	small holders' arable farming	8-10 organic & 8-10 conventional

4.2. Description of ICPC case study regions

4.2.1. Kiev region (Ukraine)

General description of case study region – Ukraine

Ukraine with its area of 600.000 sq km, is the second largest country in Eastern Europe. It is bordered by the Russian Federation to the east and northeast, Belarus to the northwest, Poland, Slovakia and Hungary to the west, Romania and Moldova to the southwest, and the Black Sea and Sea of Azov to the south and southeast respectively. Ukraine is subdivided into twenty-four provinces and one autonomous republic, Crimea. The Ukrainian landscape consists mostly of fertile plains (or steppes) and plateaus, crossed by rivers such as the Dnieper, Seversky Donets, Dniester and the Southern Buh as they flow south into the Black Sea and the smaller Sea of Azov. To the southwest, the delta of the Danube forms the border with Romania. The country's only mountains are the Carpathian Mountains in the west. Ukraine has a mostly temperate continental climate, although a more Mediterranean climate is found on the southern Crimean coast. Average annual precipitation in Ukraine is approximately 600 mm. Amounts are typically higher in western and central Ukraine and lower in the south and east. Ukraine's steppe region in the south is one of the most fertile regions in the world. Ukraine's humus-rich black soil accounts for one-third of the world's black soil and holds great potential for agricultural production. However, the soil is rapidly losing its fertility due to improper land and crop management. Ukraine typically produced over half of the sugar beets and one-fifth of all grains grown for the former USSR. Agricultural land use has shifted significantly since Ukraine declared independence from the Soviet Union in 1991 with decreased forage-crop area and decreased area in almost every category of crop except for technical crops (specifically sunflowers). Nevertheless, agro-industry accounts for one-third of agricultural employment. In 2007 there were about 90 organic farms in Ukraine with a total area of 255,000 ha, which is 0,7% of the total agricultural land.

Fig. 2: Location of Ukrainian case study regions (Source: Google Maps 2010)

Arable farming

Location and climate

The study area is located in the Kiev province in the central part of Ukraine. The area, where the investigated farms will be located, is in the south of Kiev city near the city of Bila Tserkva. The case study region lies within the Forest-Steppe zone. The climate is temperate-continental. The annual precipitation is 550−580 mm and the average temperature is 7.7 °C.

Environmental and agronomic characteristics

The main type of soil in Kiev region is the low humus chernozem. 84% of agriculture lands in case study region have a chernozem soil. The humus content in it is 2,7-4,2%. Although Ukrainian natural soils are among the best in the world, much of its arable land now suffers from degradation, causing a decrease in soil productivity. Large parts of ecosystems in case study region are maintained predominantly by extensive agriculture. Agriculture occupies around 64% of the land, and consists mainly of cereals (wheat, barley, maize), sunflowers and sugar beets production. Most of the farms are with stockbreeding (cattle, pigs). Woodland comprises about 20% and nature protection areas about 3% of the total area.

4.2.2. Jendouba and Béja region (Tunisia)

General description of case study region - Tunisia

Tunisia is the northernmost country of the African Continent, midway between the Atlantic Ocean and the Nile Valley. It is the smallest of the nations situated along the Atlas mountain range, which traverses Tunisia in a north-easterly direction from the Algerian border in the west to the Cape Bon peninsula. The size of the Tunisian territory is 162.155 sq km with an estimated population of just over 10.3 million. Limited on the west by Algeria (1.050 km), in the southeast by Libya (480 km), to the north and in the east by the Mediterranean Sea (1.300 km of coastline), the Tunisian territory presents a landscape differentiated from north to south. The south of the country is composed of the Sahara desert, with much of the remainder consisting of particularly fertile soil. Tunisia enjoys a Mediterranean climate with mild rainy winters and hot, dry summers in the North and along its coast. The regions of the centre and the south of Tunisia are subjected to an extremely hot even dry semi-arid climate. In summer, the temperatures sometimes exceed 40°C under the warm and dry breath of the Sirocco, a wind of Saharan origin. Rains appear in November in the form of big showers. It is especially raining on the regions of the North and the peninsula of the Cap Bon. On average, precipitation is between 1000 mm and 1500 mm in the north, and only between 100 mm and 200 mm in the south.

Tunisia is the most important olive-growing country of the south of the Mediterranean. More than 30% of its arable lands are devoted to oleiculture (1.68 million ha). The culture of the olive-tree dates back to the. Phéniciens, who were the first to introduce this culture in North Africa; other Mediterranean civilizations continued its expansion.

The agriculture represents 14% of the GDP in 2005. Approximately 22% of the working population are engaged in the agricultural sector. The main farm produces are: olives and olive oil, citrus fruits, cereals and dates. Farmlands represent 4.9 million ha among which 1.6 Mio. ha are dedicated to the culture of cereals (mainly some hard wheat in the valley of Medjerda), 1.6 Mio. ha are dedicated to the culture of the olive trees (mainly in Tunisian Sahel and governorate of Sfax) and 400,000 ha are dedicated to the irrigated cultures. Organic agriculture is relatively new in Tunisia. It started in the eighties (80's) with private initiatives and has grown significantly in the last years.

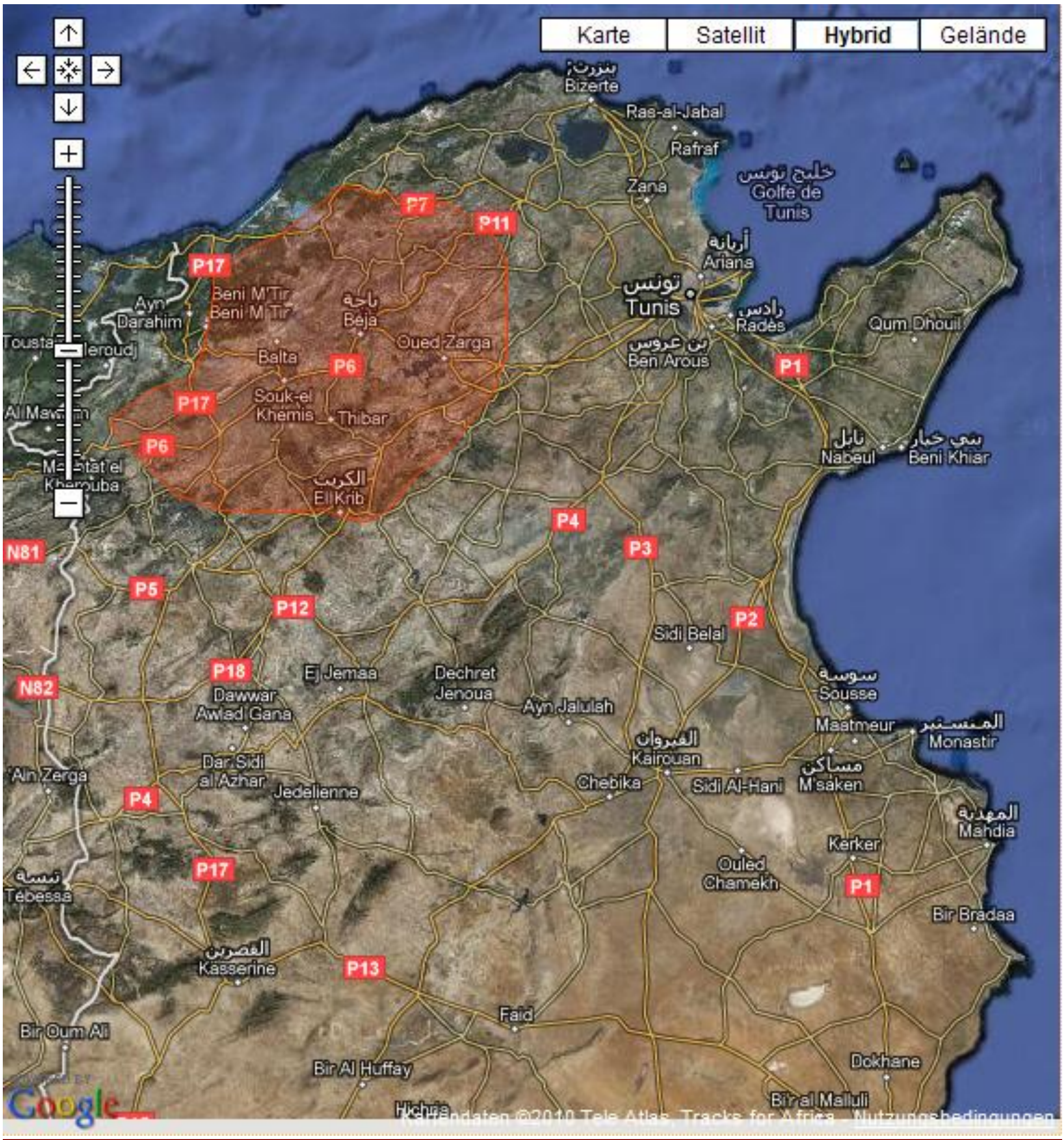

Fig. 3: Location of Tunisian case study regions (Source: Google Maps 2010)

Cork oak agro-forests

Location and climate

The region of study is located in the northwest of Tunisia along the coast. Between the north coast and the rich valley of Medjerda the Atlas Mountains or Mountains of Medjerda stretch until they reach the oriental coast between the White cape and Ghar El Melh. The area has a Mediterranean climate. Winter and spring are the rainy period. There is a long and dry estival season in the summer and an autumnal windy season with showers and stormy rains. A hydrous deficit of more than 4 months characterizes this region of the Mediterranean south. Because of its geographical situation, the western north of Tunisia's climate is influenced by the marine and Saharan winds. The north coast is exposed to winds blowing from the South of Europe, provoking a significant decline of the temperatures and an increase of the precipitation in particular in winter. The spring and the summer are characterised by the sirocco, which can easily make climb the temperature over 40°C.

Environmental and agronomic characteristics

The area is the forest region of Tunisia. It is characterized by a hilly relief with strong slopes on which more or less humus-bearing, acid grounds have developed, which were colonized by vegetation on base of cork oak and zeen oak in the not degraded zones. The strong precipitation frequently causes erosion on the hill slopes. It is also a very populated region the economy of which is based on the forest, the clearings and the small plains to develop an extensive breeding of cattle and goats. In Tunisia, the cork oak, which is the first forest resource of the country, represent 13% of the Tunisian forests. It has been under strong human and animal pressure since the Roman period which resulted in an alarming regression until present. The livestock domesticated in the whole of three governorates of the cork oak area is an important business sector in agriculture. The human pressure translated by a strong animal load is the origin of the degradation of the forest and the erosion of grounds. In the last years there was a change and the rate of afforestation is supposed to be 39% for Jendouba, 28% for Bizerte and 24% for Béja now. The cork oak stocks of the region of the Tunisian northwest are characterized by an annual average increase in volume of 1136 m^3/ha/year and an averages annual production of cork of 5000 t, of which 92% are produced in Jendouba.

Olive groves

Location and climate

The study area is located in the North of Tunisia, which is crossed by wooded mountains like the mountains of Kroumirie peaking at 1000 metres and the mountains of Nefza peaking at 600 metres. In the South the case study region comprises the valley of Medjerda, which is fed by numerous streams (Oueds Mellègue, Tessa, Béja and Zarga) and a zone of irregular hills, the mountains of Téboursouk, between the city of Kef and the gulf of Tunis. The area is still in the part of Tuinesia with moderate Mediterranean climate with about 700 mm precipitation per year.

Environmental and agronomic characteristics

The Tunisian olive groves are estimated to comprise more than 65 million trees which cover a surface of 1.680.000 hectares. The average density of the plantations varies between 100 and 150 olive-trees/ha in the oil olive groves. The average density in groves for table olives is 200 olive-trees/ha in irrigated production and 100 olive-trees/ha in rain-fed production.
The distribution of the national stock of olive groves by age is estimated as follows:

- Young plantations: 17%
- Plantations in production: 58%
- Old plantations: 25%

The Tunisian varietal inheritance consists of a large number of cultivars. Among the varieties with oil are: Chemlali, Chetoui, Oueslati, Zalmati, Zarazi, Barouni. The varieties with olives for table fruit are: Meski, Besbesi, Octobri, Limli and Limouni. The olive groves are primarily made up of two principal varieties:

- Chemlali: It occupies 60% of olive-growing surface Tunisian, located in the North-East, the littoral Center, the South and the extreme South.
- Chetoui: This is a variety with double use, which occupies 35% of the olive-growing surface of the country. It extends especially along the North coast of Tunisia. The populations of olive-trees are present in all the areas of the country, of North in the South. They are often intercropped with cereals in north, with citrus fruits and vineyards on the peninsula of Good Cape and in strict monoculture in the southernmost zones (Sousse, Mahalia).

Tunisia’s olive oil exports peaked in 2006/07 with about 200,000 t of exported oil. Organic farming is an important part of the Tunisian olive oil production. Tunisia currently has around 285,000 ha of organically certified land. Already over 40 % of organic land is planted with olive trees and around 115,000 ha of olive plantations (in 2008) are no longer treated with chemical fertilisers and pesticides. In 2009 25,000 t of organic olive oil were produced, of which 10,000 t were exported.

4.2.3. Kayunga region (Uganda)

General description of case study region – Uganda

The Republic of Uganda is a landlocked country in East Africa. Uganda is roughly the size of England, covering a total area of 236,040 sq km, with a population of about 27 million people. It is bordered on the east by Kenya, on the north by Sudan, on the west by the Democratic Republic of the Congo, on the southwest by Rwanda, and on the south by Tanzania. The southern part of the country includes a substantial portion of Lake Victoria, which is also bordered by Kenya and Tanzania. The country is located on the East African plateau, averaging about 1100 metres above sea level, and sloping steadily downwards to the Sudanese Plain to the north. Much of the south is poorly drained, while the centre is dominated by Lake Kyoga, which is also surrounded by extensive marshy areas. Uganda lies almost completely within the Nile basin. The Victoria Nile drains from the lake into Lake Kyoga and then into Lake Albert on the Congolese border. Although generally equatorial, the climate is not uniform as the altitude modifies the climate. Southern Uganda is wetter with rain generally spread throughout the year. Further to the north, a dry season gradually emerges. The north-eastern Karamoja region has the driest climate and is prone to droughts in some years. Rwenzori in the southwest on the border with Congo (DRC) receives heavy rain all year round. One of the world's biggest lakes, Lake Victoria, heavily influences the south of the country. It prevents temperatures from varying significantly and increases cloudiness and rainfall. In Uganda 50,000 certified smallholders practicing organic farming covering over 122,000 ha of land. Organic export companies increased from 5 in 2001 to 22 by the end of 2005.

Small holders' farming

Location and climate

The case study region is located in the central region of Uganda in the Kayunga, which lies approximately 74 kilometres northeast of Kampala. The district is bordered by Mukono District in the south, Jinja District in the east, Kamuli District in the northeast, Apac District in the north, Nakasongola District in the northwest and Luweero District in the west. The area, where the investigated farms will be located, lies to the southeast of Kayunga town. The area has a modified equatorial climate, which means humid to sub humid conditions. There are two rainy periods separated by two short dry periods. Rainfall is received between March and June and between September and November. The amount is about 1228 mm. The average temperature lies between 22 and 25 °C.

Environmental and agronomic characteristics

Kayunga District is characterised by gently rolling hills with wide valleys. The uplands are dissected by drainage ways. The elevation is between 1300 in the north and 950 m in the south of the area. Soils are sandy clay loams of Luvisols and some silty loams of Fluvisols. Farmers rely on soil organic matter for nutrients and good soil structure. Kayunga is one of districts that have many active farmers producing organic products. The district is the leading producer of pineapple in Uganda. Agriculture is the main economic activity in Kayunga district and represents 90% of the total employment. Kayunga practices two types of agriculture: (a) animal husbandry or livestock farming and (b) crop husbandry of subsistence agriculture. Some of the crops raised in the district include vanilla, cassava, matooke, maize, millet, watermelon and passion fruit.

Fig. 4: Location of Ugandan case study region (Source: Google Maps 2010)

5. POTENTIAL APPLICABILITY OF INDICATORS IN THE ICPC CASE STUDY REGIONS

5.1. General assessment

The purpose of this report is to appreciate whether the European candidate indicators, which are fixed in D2.2 (Dennis *et al.* 2010), are considered to be applicable in the ICPC case studies.
WP5 ICPC partners have been associated with WP2 in the process of conceptualising the criteria for indicator selection. Requirements for applicability of indicators in ICPC case study did, however, not override the selection of the best candidate indicators for the European WP3 case studies because the overall objective of BIOBIO is proposing an indicator set for Europe. However, issues and problems of indicator selection and implementation were discussed with ICPC team members during the BIOBIO meetings in Brussels, Vienna and Placencia. To advance the cooperation Tiziano Gomiero from University of Padova visited the Ugandan BIOBIO team from Makerere University in Kampala in November 2009 and Gerardo Moreno from the University of Extremadura visited the Tunisian ICPC

partners in Tunis. Additionally Tetyana N. Dyman from Bila Tserkva National Agrarian University (BTNAU) came to Switzerland for three month during the 2010 field season to join the indicator assessment conducted by the BIOBIO team from the Research Station ART in Zurich.
The members of the ICPC teams assessed the indicators currently tested in the European case studies. The following criteria were important for the ICPC partners when evaluating the indicators:

- the indicators are generally applicable to the farming systems under investigation
- the indicators are user-driven
- the indicators are policy relevant
- the indicators are scientifically credible under the specific climatic and biogeographic conditions
- the indicators are easily understood by the target audience
- data can be obtained at a reasonable cost
- the expertise and infrastructure for species identification and habitat mapping is available

The final assessment is summarised in Tab. 2.

Tab. 2: EVALUATION OF APPLICABILITY OF THE CANDIDATE BIODIVERSITY INDICATORS IN THE ICPC COUNTRIES

	Indicators	**Sign/label**	**Uganda**	**Ukraine**	**Tunisia**
	Animals/ Livestock				
A	**Genetic diversity indicators Animal husbandry**				
A1	Number and amount of different breeds per species	Breeds	X	+	+
A2	Information on breeding practices ("on-farm" bull, artificial insemination	Liveprac	X	+	+
A3	Where available, pedigree of the herd	LivePedi	X	+	+
	Arable crops, legumes and trees				
A4 + A5	Number, amount and origin of different cultivars / landraces / accessions per species	CultDiv	+	+	+
A6	Information on seed propagation practices (on farm multiplication, sharing with neighbors, etc)	seedmultis	+	+	+
A7	Where possible, description of the cultivars based on IPGRI descriptors (through the farmer)	CropCu Phe Div	(+)	+	(+)
A8	Where available, pedigree information on the cultivars grown	CropPed Div	(+)	+	(+)
	Grassland species				
A9	Where available, number and amount of different cultivars	GrassGenDiv	X	+	+
A10	Information on seed propagation practices and amount of re-seeding	ReSeed	X	+	+
B.	**Species diversity indicators**				
B2	Flowering plants of farmland habitats		+	+	+
B4	Earthworms		+!	+	+!
B6	Bird species richness (candidate without field validation)		+	+	+!
B8	Araneae –spiders		+!	+	+!
B9	Hymenoptera, bees and wasps		+!	+	+!

C.	**Habitat diversity indicators**				
C1	Habitat Patch density	HabDensity	+	+	+
C2	Habitat richness				
C3	Habitat diversity	HabDiv	+	+	+
C4	Number of crops in rotation	CropRot	+	+	+
C5	Percentage area of arable land	Arable Area	+	+	+
C6	Percentage area of permanent grassland	GrassArea	+	+	+
C7	Percent of tree cover	Tree	+	+	+
C8	Cover of shrub layer	Shrub	+	+	+
C9	Availability of nitrogen, pH, moisture as Ellenberg values	Ellenberg	X	+	(+)
C10	Weeds in crops	Weed	+	+	+
C12	Vegetation composition: share of valuable habitats	ValueHab	+	+	+
C13	Linear elements: hedgerows, grassy strips between fields, streams, rivers and lakes, stone walls and terrace walls	Linear	+	+	+
C14	Multispecies grassland swards	Multigrass	X	+	+
C15	Grassland quality	GrassQ	X	+	+
D	**Farm management indicators**				
D1	Diversity of enterprises at the farm	DivEnt	+	+	(+)
D2	Average stocking rates (grazing livestock units ha^{-1}) on farm	AvStock	X	+	+
D3	Area of land without use of mineral-based fertilizers	Minfert	+	+	+
D4	N input (meat)	NitroIn	+	+	(+)
D5	Input or Direct and Indirect Energy for crop production	Enerln	((+))	+	((+))
D6	Certified as Organic	CertOrg	+	+	+
D7	IRENA Indicator 1: area under agri-environment support	AgrEnv	+	+	+
D8	IRENA Indicator 15: intensification/extensification	IntExt	+	+	+
D9	Pesticide Use – Treatment Frequency Indicator	PestUse-TFI	+	+	+
D10	Area of land without or with reduced use of chemical pesticides	PestUse-Area	+	+	+
D11	Frequency and timing of field operations	FieldOp	+	+	+
D12	Frequency and intensity of livestock grazing	GrazInt	X	+	((+))
D13	Productivity (yields eg fruits)		+	+	+
D14	Irrigation (practiced or not?)		X	+	+

\+ = appropriate;
(+) = appropriate but hard to assess;
((+)) = appropriate but very difficult to assess;
+! = appropriate, a specialist is needed for identifying the species;
X = not appropriate;

The main challenges are expected with the following indicators:

- A7, A8 — data cannot be obtained from the farmers with a questionnaire
- B4-B9: — species have to be identified by specialists; which may not be available
- C9: — Ellenberg values have been assigned for mostly for plant species of temperate Europe. Their applicability for Tunisia and the Ukraine needs to be evaluated, for Uganda such values are not existing
- D4: — N-input is not easily available in Tunisia
- D5: — energy input is not or not easily available
- D12: — frequency and intensity of grazing may be not available in Tunisia due to the unclear property rights

All other indicators seem to be applicable for the ICPC members in their case studies. Detailed implementation plans will be put together in order to organise the case study work.

5.1. Major challenges for the implementation of BIOBIO indicators

5.1.1. Ukraine

Within the three ICPC partners in BioBio the Ukraine is the most similar one to the middle European agricultural systems. Thus, there seems to be no major problem in implementing the indicators that were fitted to the European conditions. However, the following points may be problematic and should be considered for the 2011 assessment:

- Species composition may be slightly different from the one found in middle European countries requiring local taxonomic expertise.
- Farms with several thousand ha of land are much bigger than the ones found in middle European countries requiring adapted sampling schemes and plot numbers to be sampled.
- There are comparatively few organic farms in the Ukraine. This restricts the choice of participating farms.
- The stakeholder process has yet to be initiated.

5.1.2. Tunisia

The two case study areas in Tunisia are most similar to the case study areas in Spain. For that reason, in general all indicators that proofed to be suitable for Spain should be applicable to Tunisia, too. However because Tunisia is not a part of the European community and thus is e. g. not subject to European legislation or institutions, there may arise some issues that need to be considered when implementing the BioBio indicator set:

- Grazing is seen as one of the major pressures on biodiversity of agricultural used land in Tunisia. However data on intensity and extent of grazing is difficult to obtain (e. g. illegal grazing, unclear property rights) if not unavailable (e. g. grazing by feral animals).
- Activities on the farms are much less documented (amount and quality) in Tunisia than in Europe, thus making it difficult to assess some of the management data (N-input, energy-input, etc.) needed for BIOBIO indicators.
- Information on genetic resources will be hard to assess due to missing traceability (e. g. pedigree information) of breeding activities.
- Species composition may be slightly different from the one found in middle European countries, requiring local taxonomic expertise.
- Cork oaks dehesas are not actually organised as farms but – in contrast to Spain – are regarded as forest. There are administrative / forestry management units which can be the base for selection. Pasture activities under the cork oaks are illegal but tolerated to some extent by the forest authorities. This will make it very difficult to obtain management data (on e.g. herding pressure).
- The stakeholder process has yet to be initiated. Whereas for the olive case study the selection of stakeholders can be similar as in the European case studies, for the cork oak case study stakeholders have to be chosen very carefully.

5.1.3. Uganda

Uganda is the case study that is most different from the European systems. Almost all relevant components of the agricultural system in Uganda (climate, soils, crops, management, socio-economic and legal framework etc.) differ largely from the European characteristics. Due to this differences a one to one implementation of the BioBio indicators, fitted to the European conditions, seems to be problematic. Main issues arising will be:

- Species composition in all three groups used as BioBio indicators will be different from the one found in European countries requiring adoption of sampling and local taxonomic expertise. However, the latter will be hard to find if not unavailable due to missing taxonomic recording.
- Activities on the farms are documented in much less amount and quality or even not at all in Uganda, thus making it difficult to assess some of the data (e. g. energy-input) needed for BIOBIO indicators. In most cases no farm records are kept on paper.
- Information on genetic resources will be hard to assess due to missing traceability (e. g. pedigree information) of breeding activities.
- Logistics (e. g. transport of equipment) and infrastructure (e. g. communication) is a major problem. This is on the one hand a problem for effective preparation and management of the sampling scheme and on the other hand, it could be challenging for actual implementation, especially if e. g. special material is not available on the plots or species can't be identified on-site or would need to be sent abroad.
- Another problem is financing the activities in Uganda. This is on the one hand due to the difficulties in implementing the BIOBIO sampling schema, causing high expenditures and on the other hand due to general institutional problems.
- The stakeholder process has yet to be initiated.

Livestock indicators are not relevant for the Ugandan case study region because the investigated farms do not keep animals and thus the indicators will not be assessed.

6. RECOMMENDATIONS

6.1. General recommendations

To accomplish the indicator testing in 2011 and organize the final implementation of the BIOBIO indicators by the ICPC partners a straightforward and concise course of action in WP5 is recommended. For yielding the intended results, the following actions should be implemented:

- The designated partners (TUM/BTNAU; UEX/INGREF; UP/MAKARERE) start another round of intensive bilateral cooperation (visits or personal communication) to implement the recommended actions.
- EU and ICPC partners discuss the selection, possible adaption and implementation strategy of the BIOBIO indicators
- EU and ICPC partners discuss the experiences and constraints (capacity, Know-how of the field workers, long travelling distances, weather constraints, "difficult" farmers, ...) of the field work done in European case studies in 2010.
- The ICPC partners fix a realistic time and travel schedule and a budget-plan for the field season 2011 until end of September 2010.
- ICPC case study regions and farms are finally fixed in early autumn 2010.
- Core indicators to be tested in ICPC case studies are selected and adapted in early autumn 2010
- The methodology to be used in the fieldwork is fixed and implemented by setting up a preliminary test in autumn 2010.
- Coaching visits of the European to ICPC partners or vice versa in 2011 are organized and fixed.

In addition to these general recommendations on the practical implementation process, the main issue will be the necessity to adapt the BIOBIO indicator set to lower levels of available resources (funding, knowledge, infrastructure and institutions) if it shall be used in countries less developed than the European Union or differing in environmental conditions (Ukraine » Tunisia » Uganda). One solution for this problem could be the adaption or even the reconstruction of biodiversity indicators considering these deficiencies and putting more weight on e. g. simplicity of methods, low cost approach, etc. when it comes to the evaluation of suitable indicators and sampling schemes (see e. g. Coddington J. A. *et al.* 1991; Danielsen *et al.* 2000). Another way to cope with deficiencies in human resources and institutions could be to adapt biodiversity indicators to these conditions by using more participatory monitoring methods (see Danielsen *et al.* 2005; Danielsen *et al.* 2006). The relation of scientific background of biodiversity indicators for monitoring and the potential of participatory approaches for developing countries was discussed by Yoccoz et al. (2001; 2003), Rodríguez (2003) and Danielsen et al. (2003a; 2003b).

6.2. ICPC partner specific recommendations

6.2.1. Ukraine

The implementation of the BIOBIO indicators in the Ukrainian case study region seems largely to be unproblematic if the general recommendations are met. For improving cooperation and maybe exchange further expertise, a coaching visit of one of the BIOBIO team members is suggested.

6.2.2. Tunisia

The implementation of the BIOBIO indicators in Tunisia seems to be unproblematic for the Olive case study if the general recommendations are met and slight adaptations to local conditions (e. g. adjustment or modification of livestock indicators) are made. The Cork oak case study requires some conceptual considerations and a member of ART will support those considerations by means of a site visit in late 2010. For further improving cooperation and exchange expertise, a coaching visit of one of the BIOBIO team members or vice versa is suggested.

6.2.3. Uganda

Besides the need for a detailed planning of activities and budget for the Ugandan case study it seems especially important to adapt the selected indicators and the sampling methods to the local conditions. The integration of participatory approaches should be considered. For reaching the goals of BIOBIO it is also recommended to guarantee the quality of assessment and data by training the local team intensively either by sending a member of one of the European BIOBIO teams for coaching to Uganda or inviting the Ugandan team members to a workshop. To ease the financial problems the EU partners should support the Ugandan team as far as possible (e. g. by transfer of knowledge, providing equipment or aerial photographs). A site visit of a member of ART is planned in late 2010 to support the planning process.

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