MarginUp!

Raising the Bio-based Industrial Feedstock in Marginal Lands

Regionally Adapted Biodiversity Indicator System (RABIS)

D2.1

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MarginUp! in a nutshell

MarginUp! is developing sustainable and circular value chains to produce bioproducts and biofuels in innovative business models from natural raw materials grown on marginal lands[1]. In the project, climate resilient and biodiversity-friendly non-food crops will be introduced on marginal and low-productivity lands, which do not compete with food crop production. To further improve biodiversity and environmental benefits, MarginUp! will contribute on understanding which marginal lands are suitable, with regards to the lowest impact for indirect land-use change (ILUC) biomass production. The project will identify the best practices for sustainable biomass production and bio-based products that safeguard biodiversity and local ecosystems. All this will be done in close collaboration with land managers, farmers, and stakeholders from the growing bioeconomy industry.

Hence, MarginUp! is expected to provide viable outcomes to ecosystems degraded by e.g. water-stress or desertification due to human activity and/or climate change. The project will also contribute to restoration and stimulation of ecosystems in abandoned mine lands, as well as boosting land yield and health in low productivity marginal lands. Through this innovative approach, MarginUp! will increase farming system resilience, enhance rural areas, and promote stakeholder participation.

MarginUp! is building on learnings from seven use-cases: Five implementations across Europe (Spain, Greece, Sweden, Germany, and Hungary), and two use-cases in Argentina and South Africa, together increasing the replication potential of the project's results. Each use-case considers the current use and properties of the area and proposes crops and crop rotation strategies that promote biodiversity and increase soil productivity according to local requirements of Mediterranean soils in Spain, mining lands in Greece, boreal soils in Sweden, wetlands in Germany, desert lands in Hungary, degraded pastures in Argentina, and areas with invasive bush species encroachment in South Africa. The proposed crops create a sustainable supply of resources to foster the development of the bioeconomy businesses at local and regional levels while providing ecosystem benefits and building resilience to climate change.

On this basis, the MarginUp! project will enhance European industrial sustainability, competitiveness, and resource independence, by reducing the environmental footprint, considering biodiversity aspects, enabling climate neutrality and increasing resource efficiency (particularly through upcycling and cascading use of biomass) along different value chains in seven use cases including enhanced technologies and business models for innovative bio-based products that will lessen EU reliance on fossil-based products.

To stay up to date with MarginUp! project events and reports, follow us on Twitter (@MarginUp_EU), LinkedIn (MarginUp! EU) or visit www.margin-up.eu.

Summary

MarginUp! makes sure the biomass production on each use case (UC) is having a positive impact on the ecosystem. D2.1 is an important prerequisite to assess and optimize the biomass production's impact on biodiversity. Advances in scientific knowledge in recent years have made it clear that the impact assessment of land use change on biodiversity is highly context-dependent and requires a holistic approach. This need becomes apparent when one considers the differences in the biophysical and socio-economic contexts in MarginUp!'s UCs and the diversity of the envisaged new utilisation concepts. In addition, MarginUp!'s claim to develop transferable solutions to other regions in Europe and the non-European study areas requires the development of a holistic, transferable indicator system suitable for different frame conditions and various new land use concepts on marginal lands.

The regional adapted indicator system (RABIS) developed for MarginUp! takes up different societal and methodological challenges and develops an indicator system whose basic principles can be transferred to all regional use cases and to other regions outside MarginUp!. Here, the basic elements of the indicator system are considered to be set across regions, whereas the concrete indicators for the individual contents are determined regionally. This report describes the methodological approach of the development of a general, regionally adapted, multi-faceted indicator system (RABIS), its methodological implementation in MarginUp! and the results of this process for MarginUp!´s individual UCs.

As a crucial first step, this report describes the societal requirements and scientific methodological demands that need to be taken into account when considering and accounting for biodiversity aspects in land use change and describes the framework conditions in the different UCs. The scientific innovations of RABIS include the integration of the following six elements:

- *Consideration of targets and indicators for multiple spatial scales (national, regional, local landscapes),*
- *Consideration of nature conservation objectives and sustainable agriculture objectives in parallel,*
- *Consideration of influences from the diverging landscape context,*
- *A multi-species/multi-indicator system for two dimensions: Inside single taxa and across taxa via different trophic levels,*
- *A triple reference system consisting of: i.) Adjacent semi-natural habitats, ii.) previous kind of land use/habitat and iii.) typical surrounding agriculture,*
- *And the implementation of co-design activities with stakeholders/regional experts to fill up data gaps and for the prioritization of regional biodiversity targets.*

The selection of relevant indicators for MarginUp! is oriented on the following criteria: i.) Being characteristic for agricultural land; ii.) being sensitive for the kind of cropping of the bio-based products in the UCs, and iii.) being relevant for ecosystem services (ESS) on agricultural land.

The basic structure of RABIS was developed by WP2 in MarginUP! and filled with individual contents for the particular UCs by the regional partners. The collection of the regional inputs was organized with the help of questionnaires filled by regional partners (UCs) for three particular spatial levels (national, regional, local). The final product of D2.1 are datasheets for all UCs, summarizing the following results: i.) Collection of relevant regulations and laws relevant to the topic, ii.) individual species/ESS/indicators named in the relevant regulations and strategies, iii.) list of selected indicators for MarginUp! and iv.) list of existing monitoring activities and NGOs.

Disclaimer

Table of Contents

List of Acronyms

CBD	Convention on Biological Diversity
ESS	Ecosystem Services
FFH	Flora Fauna Habitat
HNV	High Nature Value
ILUC	Indirect Land Use Change
RABIS	Regionally Adapted Biodiversity Indicator System
SPA	Special Protection Area
UC	Use Case

List of Figures

List of Tables

Keywords list

Biodiversity

Impact assessment

Regionality

Indicator System

Multi-scale

Multi-species

Co-design

Landscape

Nature conservation

Sustainable agriculture

Ecosystem services

1. Introduction

Soils lost or depleted due to degradation processes such as erosion or pollution caused by agricultural intensification or abandonment, can require hundreds or thousands of years to be regenerated. These, and other lands with low profitability, are referred to as *marginal lands*. To this effect, identifying practices that secure land use and return profitability to marginal land is crucial and an important contribution to European policies such as the European Green Deal, Circular Economy action plan, Bioeconomy and Biodiversity strategies, to name a few. In the EU-28 region, 29 percent of the agricultural land is classified as marginal land. The biophysical constraints and the low profitability of marginal land usually result in extensive, low-input-land use systems, which are considered to be very valuable for biodiversity because they provide habitats for special species e.g., stress adapted species. The abandonment of this low-input land use as well as the intensification of use (mainly due to the increase of inputs) both endanger the biodiversity at these sites.

New cropping systems on marginal land, such as industrial crops, can promote the bio-based economy and generate new value chains in Europe through high-value bio-based commodities (bioplastics, bio-lubricants, bio-chemicals, medicines, bio-composites), as well as bioenergy. Additionally, new cropping systems provide a chance to introduce land use options that allow for integration of biodiversity promotion effects into productive agriculture, following the ideas of ecological intensification. To consider biodiversity aspects, it is crucial to understand what taxa, species and ecological structures are harbouring marginal land before they are exploited, in order to not destroy these ecosystems and impair their services, but rather go in sync with them. The main objective of MarginUp! is to introduce climate-resilient and biodiversity-friendly non-food crops for sustainable industrial feedstock in marginalized and low-productivity land. This requires finding a balance between productivity and ecosystem services (ESS), and to consider biodiversity and social sustainability goals in the design of the systems.

MarginUp! is primarily going to:

- *Expand the understanding relating to most suitable feedstock options for different farming systems and pedo-climatic conditions of marginal land in the EU and their impacts on regional biodiversity,*
- *Increase farming system resilience by expanding the biodiversity and ESS knowledge base,*
- *Demonstrate sustainable strategies for optimizing biomass production on marginal lands and improve the state of the art of marginal land considering biodiversity factors.*

A central content of WP2 is the development of a multi-species biodiversity indicator system, in order to be able to carefully analyze the impact of biodiversity in the different project regions. The established protocol will follow a common model structure for the indicator system which will make it transferable to other regions.

Relationships between biodiversity and bio-based products vary considerably between regions, site conditions and organism groups. Therefore, indicators have to be adapted to specific conservation targets and landscape constraints of the single use cases. The selection of relevant indicators is oriented on the following criteria: i.) being related to agricultural land as habitat; ii.) being sensitive to the elements of the cropping system for the bio-based products and iii.) contributing to relevant ESS on agricultural land. Indicator species serve with their functional traits as proxies for regionally important ESS. Among the relevant ESS we consider pollination, pest regulation, and food web implications. Other ESS might be specified for particular UCs. The identification of the target ESS is realized together with regional stakeholders/partners within a co-design-process.

D2.1 contributes to several EU policies, such as the EU Nature Restoration Plan, the EU Biodiversity Strategy for 2030, the European Green Deal, the new EU Nature Restoration Law as well as the Farm To Fork-Strategy.

This report:

- Provides detailed information on the chosen methodological basis for the creation of RABIS,
- Records the data collection process for RABIS implemented by means of questionnaires send out to the UC partners,
- Presents the concrete results for the individual UC in their current state by means of factsheets, and
- Refers to the further use of RABIS within the MarginUp! Project.

1.1. Societal demands

There is a growing societal concern that the global biodiversity crisis, often referred to as the sixth mass extinction, is one of the most critical challenges of the 21st century, together with climate change. Consequently, society is increasingly demanding that biodiversity aspects should be taken into account, especially in agricultural production. Agriculture has a huge impact on biodiversity, e.g., due to land use/land use change, as well as through use of pesticides, fertilizers and fossil fuels, but is also highly dependent on biodiversity, resilient ecosystems and ESS that it provides (pollination, biological control, decomposition etc.). To promote biodiversity in the agricultural sector, a consistent transition to local and nature-compatible production and the implementation of appropriate measures is needed.

These societal demands are already covered by a large number of EU regulations. The Farm to Fork Strategy as the heart of the Green Deal is addressing the transition of agriculture towards a fair, healthy and environmental-friendly food system, by considering biodiversity targets in all policy sectors. The Farm to Fork Strategy consists, among others, of concrete actions aiming to reduce the use of chemical pesticides to 50% by 2030, to strengthen measures for protecting Pollinators (EU pollinator Initiative, EC 2023), to promote the use of Integrated pest Management (IPM), and to boost the share of organic farming in EU up to 25%. This also includes the demand for a significant increase of the use of agroecological practices. The EU Biodiversity Strategy for 2030 will replace the current strategy and is a long-term plan for protecting nature and reversing the degradation of ecosystems. Its scope includes several actions to protect biodiversity of food systems and to shift towards more sustainable farming. The new strategy aims to put Europe's biodiversity on the path to recovery by 2030 for the benefit of people, climate, and the planet. It aims to shift the focus from averting degradation of ecosystems towards actual restoration and stopping the drivers for biodiversity loss. The new Nature restoration plan is already one element of the new EU Biodiversity strategy. Besides a strong focus on securing and developing protected areas, the demands on agricultural land are the same as mentioned by the Farm to Fork Strategy. Additionally, the EU will enlarge existing Natura 2000 areas, with strict protection for areas of very high biodiversity and climate value, which implies that the impacts of agriculture on neighbouring protected areas will be critically observed.

Less productive or low-profitability sites, so-called marginal lands, are of great importance for many aspects of biodiversity. There are various types of marginal land, and their ecological values vary. Some are priority areas for nature conservation, such as extensive natural grasslands, which require agricultural management, often under the concept of extensification or conservation management. Many marginal lands are already located in protected areas. Through the abandonment of marginal land, extensively used agro-ecosystems e.g., extensive grazing systems on grassland, perennial cropping systems, low-input systems (fertilizer, pesticides, rainfed cropping systems) in particular are disappearing and with them the animal and plant species adapted to them. The challenge is to find forms of land use that both consider the high biodiversity potential of these sites and allow for appropriate value creation. This concept is also called "ecological intensification" (Kleijn et al. 2019). It aims to harness ecosystem services to sustain agricultural production while minimizing adverse effects on the environment. In principle, there is a certain trade-off between maintaining the high potential for biodiversity conservation and the need to use these sites for value creation. Moreover, land use in marginal areas is often adjacent to protected areas and has to fulfil additional requirements in order to minimize lateral effects on the neighbouring area or hosting temporarily animals, which have the protected area as their main habitat (see WP1).

MarginUp! has a focus on biodiversity and will strive for that biomass production on each use case is having a positive impact on biodiversity. By developing an indicator system, MarginUp! receives a tool to quantify the impact of the biomass production expected on the environment and to make the impact of different land use options comparable. Moreover, all the data gathered allows for the further optimization of particular land use options regarding their impact on different aspects of biodiversity. The RABIS indicator model will be designed to be easily transferable to other regions and to increase the

understanding of the biodiversity challenges in different regions. By applying the model to other regions, it will be possible to measure and understand the real biodiversity challenges provoked by land-use (change) better and try to mitigate them.

1.2. Methodological challenges

The impact of land-use changes (e.g., the introduction of novel land use systems on marginal lands) on biodiversity may vary between geographical location, landscape type, target setting and taxonomic focus (Davison et al. 2021, Dauber et al. 2010). Omitting these interactions with the framework conditions may hinder our understanding of how land-use change affects ecosystem feedback and results in disparate partly also contrary conclusions. The UCs of MarginUp! show a broad geographical distance and wide coverage of European problem settings for marginal land, not only regarding the biophysical and biotic frame conditions but also the novel land use options which show a great variability. In order to face these challenges, the biodiversity impact assessment has to consider the regional frame conditions based on a common structure. RABIS address the following methodological challenges (1.2.1 –1.2.6).

1.2.1. The scale shifts between interventions and impacts

Biodiversity and ESS function at different scales, with many cross-scale interactions (Gonzales et al. 2020). The initial scale for management interventions in agricultural farming is the field or plot scale. The scale for the intervention becomes regional or national only when a certain management practice becomes frequent or dominant. Independent from this, any intervention at a local scale might have impacts on larger scales, e.g., regional biodiversity or national biodiversity targets. Biodiversity assessments can be improved by considering the problem at a broader spatio-temporal scale than the one at which local natural resource management traditionally operate in (du Toit, 2010). Seppelt et al. (2013) showed that an analysis across scales is key for an in-depth analysis of land use impacts. Kleijn et al. (2011) proclaimed the need to link the local conservation efforts to national biodiversity trends and targets.

1.2.2. Diverging biodiversity targets between nature conservation versus agricultural production

Nature conservation and agricultural production pursue divergent, partly contrary concepts for biodiversity promotion, but are interacting with each other in space and time. The biggest part of the target species for nature conservation (e.g., Red List of species) are either related to undisturbed environments or linked to historical extensive agriculture (Pärtel et al. 2005). The shift, that has been going on for several decades, from small-scale and low-input agriculture to intensive, yield or value-oriented agriculture has been accompanied by an accelerating decline in the number of endemic and IUCN Red-list species (Hendershot et al. 2020). Henle et al. (2008) have identified three major processes responsible for creating biodiversity-related conflicts: (1) The intensification of agriculture, (2) the abandonment of marginally productive but High Nature Value farmland, and (3) the changing scale of agricultural operations. Synergies between biodiversity and agriculture can mostly be found, when we move the focus from protecting rare single species to enhancing groups of species with specific traits or functionalities (ESS-focused biodiversity; Roux et al. 2009). For some ESS the direct positive feedback loops to agricultural production e.g., the more pollinator species pollinate, the better the yields (Katumo et al. 2022). For other ESS without such a direct feedback loop, the ESS concept at least provides a monetary valuation for supplying these services. The conflict between species conservation and addressing functional aspects of biodiversity is maybe especially relevant for marginal land due to the fact that in marginal landscapes there might be hotspots for rare species well adapted to e.g., biophysical marginality factors.

1.2.3. Landscape context influences the results

Within the last decades there is growing evidence for the relevance of landscape context for the efficiency of biodiversity promotion measures and target achievements (Brandt and Glemnitz 2017, Bourke et al. 2014, Uhl et al. 2020). Land use change can result in contrasting outcomes (Dauber et al. 2010) or missing effects (Kleijn et al. 2011), depending on the surrounding landscape configuration. Conservation effectiveness is mostly higher in simple than in complex landscapes (Kleijn et al. 2011) or when introducing new "qualities" (e.g., structures) into the landscape (Dauber et al. 2010). The further development of this approach also leads to the realisation that agricultural use has an influence on the development of neighbouring embedded protected areas (see Uhl et al. 2020).

1.2.4. The consideration of single species/indicators may produce contradictory results

Biodiversity in nature is a result of niche differentiation, which is based on divergent ecological behaviour of single species. Thus, single species or single indicators show a distinct effect pattern on environmental impacts and even the selection of the target species may show contrasting results (Gregory et al. 2019, Dauber et al. 2010). Hence, biodiversity impact assessments focusing on a single species lead to inadequate assessments of multiple impacts that accumulate over large spatial scales for multiple species (Whithead et al. 2017). Instead, multi-species indices are recommended as valuable policy-relevant tools for describing ecological conditions and the status of biodiversity (Gregory et al. 2019). Their calculation and interpretation need to be tailored to meet the objectives of the assessments, and they must be supported by interpretative information.

1.2.5. The choice of the reference system is essential

All human activities, including any changes in agricultural management, are influencing biodiversity. The effects of these changes act in combination with the natural dynamics of climate and ever-changing habitat structures (Robinson et al. 2020). Defining the reference state against which status and change are measured is essential for better biodiversity conservation and more valid assessments (McNellie et al. 2020). Typically, reference states describe historical conditions, which are challenging to quantify, or to falsify, and may no longer be an attainable target due to external natural dynamics or developments. Reference situations can also be hypothetical natural conditions as well as re-naturalization state, or based on a desired direction/target (Vrasdonk et al. 2019). Reference conditions are the ecological context of how we assess and interpret the changes in the current state of species, ecosystems or biodiversity. Different reference systems can reflect different land use interests e.g., between nature conservation and agricultural production (see challenge #2).

1.2.6. Divergent stakeholder and scientist perceptions of agricultural biodiversity

Perceptions of biodiversity and conservation measures differ significantly between scientists and farmers (Maas et al. 2021). Maas et al. (2021) showed that while scientists valued scientific information as more important for agricultural decision-making, farmers valued government and agricultural-sector information sources. For the success of conservation measures as well as for the results of biodiversity impact assessments the acceptance of the targets by the stakeholder (farmers) is essential. Working together with farmers on tailoring conservation measures as well as assessment targets support the identification with the results and later on the implementation of tailored cropping solutions. This has been shown by various co-design projects in ecological research and practice (e.g., Hölting et al. 2022).

2. Regional Frame Conditions - Use Cases and Alternative Cropping Options

Table **Error! Reference source not found.** summarizes the regional biophysical and land use frame conditions as well as the l and use alternatives as addressed in MarginUp!. The parameters and future options presented outline the system framework for which RABIS will be applicable (here only the 5 European UCs are shown):

UC	Landscape Characteristics	Predominant Agricultural Land Use	MarginUp ! Alternative
Sweden	Västerbotten and Norrbotten counties • Continental influenced climate with large temperature differences between seasons, cold winters, low precipitation (about 500 mm/year) • Climate is limiting cropping options Threat: Farm closures or intensification of production	Only 1.2% of Västerbotten land is arable. At Norrbotten only 0.3% • Barley • Grass	Turnip Rape (*Brassica rapa ssp. oleifera*) as an alternative industrial crop Replication potential: Northern European countries, regions with comparable pedoclimatic soil attribute, such as, Estonia, Finland, Latvia, Lithuania, and Norway.
Germany	Havelland county, large fenland areas: Havelluch • Transitional area between maritime and continental climate • Large Fenland areas on peat soils, partly degraded or drained, high water level Threat: Abandonment or intensification	• Fresh meadows • Wet grasslands • Arable cropping at sandy,hilly areas (maize, rye, wheat, barley) • Large areas of Nature reserves / SPA / Natura 2000 areas	Reed, cattail and reed canary grass on the rewetted peatlands Replication potential: 80 million hectares of drained peatlands worldwide, suited crop species have to be identified for every climatic zone
Spain	Coria region of Extremadura • Mediterranean climate. • Low organic matter content, poor cation exchange capacity, acidic pH Threat: future desertification problems, risk of getting abandoned	• Annual corn • Tomato • Grassland	Hemp and kenaf cultivation on poor yielding land, rotation with corn and tomato Replication potential: Mediterranean region, areas with comparable marginality attributes and climate conditions

UC	Landscape Characteristics	Predominant Agricultural Land Use	MarginUp ! Alternative
Hungary	Sand Plateau (Kiskunsági Homokhátság), Hungarian Great Plain • Moderately continental climate at the Carparthian Basin, semi-arid • Sandy soil, low (decreasing) ground water level, low humus and nutrient content, low nutrient retention capability Threat: agriculture cannot be maintained without irrigation, ongoing alkalinization of soils; abandonment, desertification	• Fruit trees • Vineyards • Steppe • Cereals • Fodder grasses • Artificial forests, mainly of acacia and pine species, to stabilize the sands	Herbaceous (*Sida hermaphrodita*) and woody (*Salix viminalis*) ligno-cellulosic crops Replication potential: Water stressed or scarce areas with high risk of desertification (e.g., South-ern Europe),
Greece	Western Macedonia, NW of City Kozani • Climate is continental with cold and dry winters, and hot summers • Abandoned lignite mines • Degraded lands, no longer productive due to an in-tensive and unsustainable use.	• Agricultural land: 22.7% • Forest: 33.4% • Other: 43.9% (lignite mining) • Apples, peaches, legumes, potatoes, saffron, sheep and goat meat, dairy products, barley	Cultivation of perennial woody species and native herbs, herbs or nectar will be used by local bee-keeping cooperatives Replication potential: coal regions, areas with comparable marginality attributes and climate conditions

Table 1. Framework conditions to be considered for RABIS development and application

3. Methodology

The following chapter describes the methodology used for the development of the Regionally Adapted Biodiversity Indicator System (RABIS), used to assess the impact on biodiversity from introducing novel cropping systems in marginal land.

3.1. State of the art

The impacts of land use change on biodiversity are often analyzed in the frame of different scenario analyses on either a large scale (e.g., European scale) or on single cropping systems at the plot scale. At larger scale, studies usually work with diverse composite indicators, like e.g. trends in abundance and distribution, relative abundances of a selection of species (Reidsma et al. 2006; Alkemade et al. 2009), single organism groups like birds e.g. farmland bird index (Butler et al. 2010), species diversity for selected organism groups (Murphy et al. 2014), various composite indicators, like ecosystem health (Peng et al. 2017) or ecosystem quality (Oliver and Morecroft 2014). Other approaches concentrate on ESS and try to base the impact analysis of land use changes on ecosystem service outputs (e.g., TEEB Study, Brouwer et al. 2013). To overcome many of these methodological shortages in comparability between regions within the EU, the High Nature Farmland indicator (HNV) was developed. The HNV concept was defined in the early 1990s (Beaufoy et al. 1994) with the idea of promoting several types of farming systems that support high levels of biodiversity or maintain species and habitats of conservation concern. The HNV approach works on a national scale for distinct organism types (e.g., vegetation, birds) for certain land use types (grassland, arable) and is regionally adapted (included indicator species are adapted for every single country).

Regional scale land-use models often adopt a two-phase approach with an assessment of aggregate quantities of land-use for the entire region using global scale supply/demand variables from IAMS or economic models such as General Equilibrium models (van Meijl et al. 2005) or input/output approaches (Fischer and Sun, 2001) followed by downscaling or upscaling procedures to create land-use patterns. In these models the up- or downscaling approaches are very divers and a matter of contrary discussions.

Many publications present contrasting results on the impact of single new land use systems, e.g., like the introduction of biomass crops on biodiversity. Dauber et al. (2010) and Rowe et al. (2013) have shown that at regional scale, the main factors determining impacts of biomass crops on biodiversity are: Regional landscape type, land use type which is replaced (ILUC), the species groups considered as indicators, the kind of biomass crops and the crop management considered. This stresses the fact that there are many additional factors that can lead to limited usable results.

Biodiversity aspects in agriculture and in biodiversity conservation are traditionally addressed separately in impact assessments and show many differences in their conceptual basis (scale etc.). To this end, Glamann et al. (2017) stressed the need for a holistic approach that will be still broadly applicable across different systems, spatial and temporal scales.

Starting from this point, an integrated biodiversity assessment will be performed for MarginUp! considering regional frame conditions and multi-species indication. Among the relevant ESS, we consider pollination, pest regulation and food web implications. The ESS list will be adapted to the regions by the UCs. The indicator system follows the filter theory after Deák et al. (2018) and applies multispecies indices according to Vackar et al. (2012)

Relevant data and data collection

The data required for the regional biodiversity indicator system is composed of (1) publicly available data sources (e.g., soil maps, protected area outlines, lists of species worthy of protection, etc.) and (2) data and information collected through regional stakeholders (here mainly agricultural or nature conservation experts).

3.2. Elements of the indicator system

RABIS takes up the societal and methodological challenges and develops an indicator system, with basic principles that can be transferred to all regional use cases and to other regional analyses outside MarginUp!. Here, the basic elements of the indicator system are considered to be set across regions. The concrete indicators for the individual contents are determined regionally.

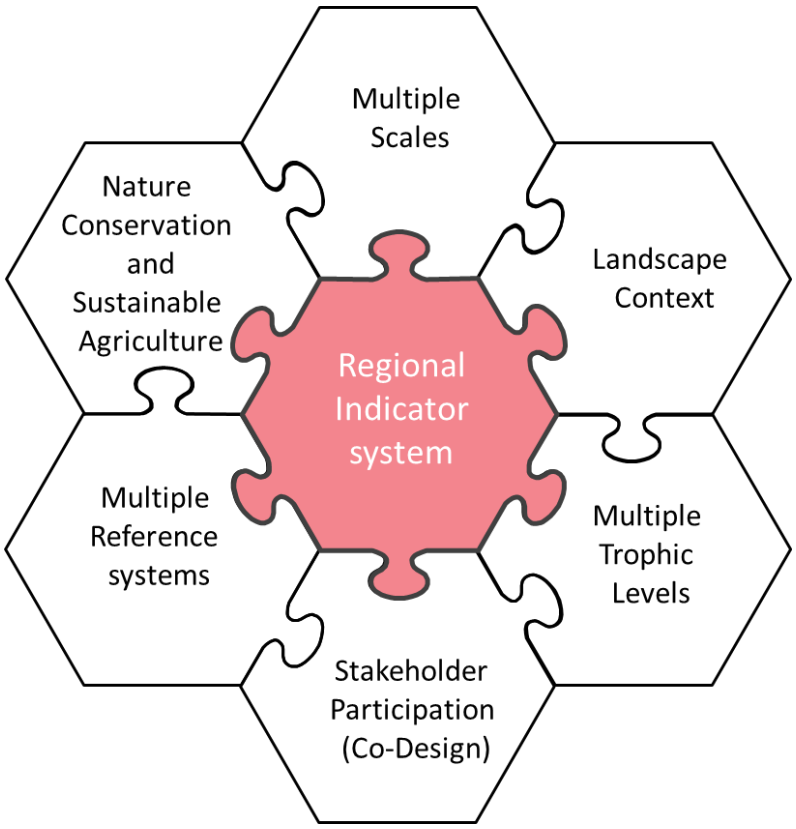


Figure 1. Main elements determining the compilation and selection of regional indicators for biodiversity assessments on new cropping options for marginal lands

RABIS is developed together with the regional partners. The derivation of the indicators follows a multi-stage concept. The principles according to which indicators are included in the individual elements are briefly explained below.

3.2.1. Multiple Scales (scale conception)

The need for a scale conception is driven by the understanding that there are plenty of interactions between scales that impact the final manifestation of land use changes at the local scale and on larger scales like e.g., national scales. RABIS takes up the ideas of community ecology from Munoz and Huneman (2016), which takes both, top-down and bottom-up processes into account.

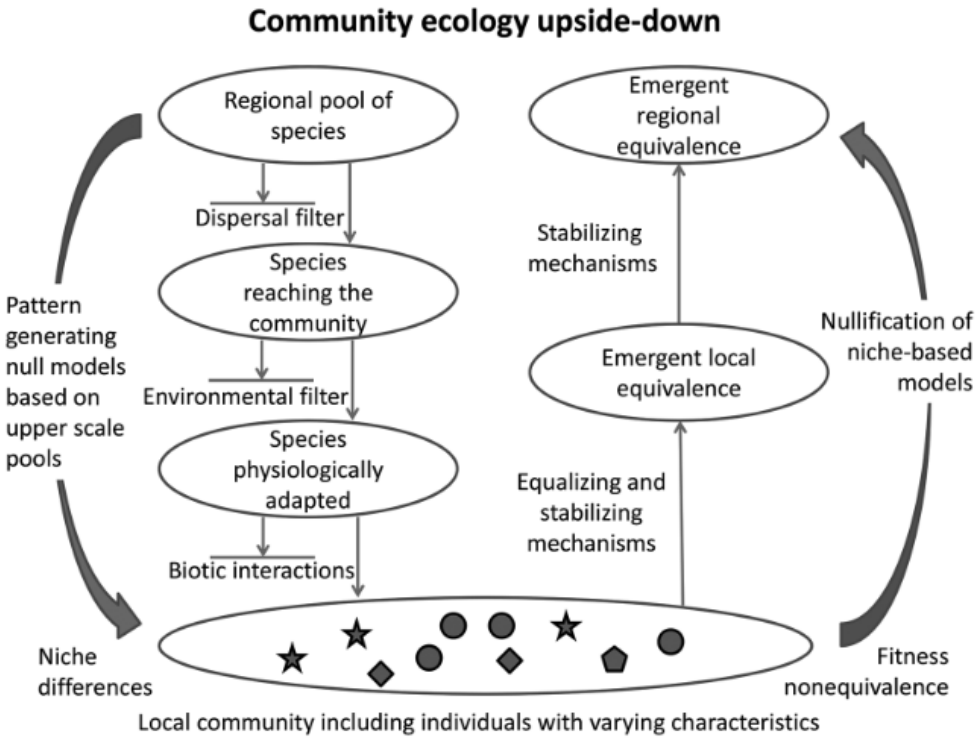
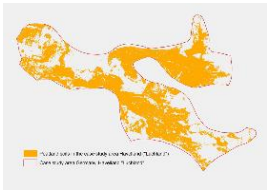


Figure 2. Biodiversity dynamics in a top-down framework of niche-based ecological filters from the regional scale (left), and in a bottom-up framework from individual dynamics to emerging patterns of ecological equivalence (right); Munoz et al. (2016)

The conception is applied by collecting existing indicators at the distinct scales (national, regional, landscape, plot), such as those being named in national regulations or strategies, obligatory reporting to EU, regional planning documents or development plans etc. The information from larger scales is checked by local experts for ensuring local relevance. The regional scale is represented by a state or region within a country and refers to administrative units below the national/federal scale. As local scale, we consider the landscape around the experimental plots of the UCs in MarginUp!. There will be clearly defined boundaries for the landscape. The boundaries will be defined together with WP1 and WP4 of MarginUp!. Besides nature reserves or other protected areas, there are normally no biodiversity targets existing for the local scale. Therefore, the compilation and selection of indicators at the local scale should be based on expert definitions. An overview on the kind of data compiled for the different spatial scales considered in MarginUp! is shown in Table **Error! Reference source not found.**. RABIS refers to the first three scales, while assessments on management implications on RABIS indicators will be feed with data from the plot scale. Data and assessments on the plot scale is an input for WP4 of MarginUp!.

Spatial Scale	National	Regional	Landscape	Plot
				
Relevance for indicator system	National biodiversity strategy HNV reports to EU Nature conservation law	Regional development plans Nature reserve development plans FFH* target species	Landscape related targets Local action plans Societal target setting	Occurrence of Red List species Representatives of habitat type Functional key species
Typical kinds of indicators	Bird indicators Distinct habitat types CBD** responsibility species	Habitats, Bird species FFH Types CBD species	Habitats Species, Ecosystem services	Weeds, wild plants Breeding animals Foraging animals Winter guests
Inputs from Monitoring	National bird monitoring Butterfly monitoring Bee monitoring NGO monitorings	FFH Monitoring Nature reserve Monitoring	Local NGOs	Local observations

*Flora Fauna Habitats, **Convention on Biological Diversity

Table 2. Overview on the kind of data compiled for RABIS from different scales (Example UC Havelland Germany)

3.2.2. Nature conservation versus sustainable agriculture

Nature conservation and agricultural production are often perceived as different land use claims for agricultural land. Their objectives are considered in RABIS in parallel and on an equal footing. To ensure that the selected indicator species are representatives of the particular UC and at the same time are sensitive to the selected land use alternatives, special selection criteria for the indicators to be considered were applied (Figure **Error! Reference source not found.**).

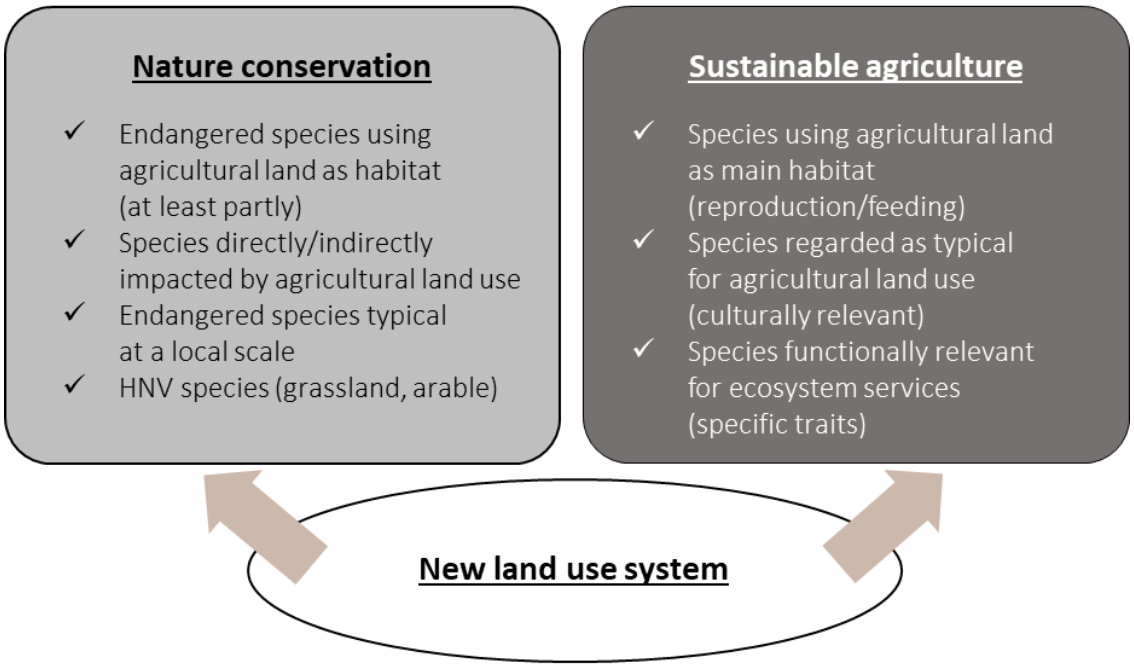


Figure 3. Overview on the two main groups of indictors and their selection criteria

3.2.3. Landscape context

The landscape context is considered in two different pathways in RABIS:

a. By integrating the filter theory approach (left side Figure 2) into the final selection of indicators. Thus, such indicators/species will be applied from national or regional scale, which are frequently or typically occurring at the local landscape scale.
b. The application of RABIS will be done within a landscape boundary of every UC. This boundary will be determined together with WP1 and WP4 in MarginUP!
c. By applying indicator species with different movement ranges. These species provide indications of the surrounding landscape by their movement. This pathway has some overlap with the multi-species-element of RABIS

Multi-species and multiple trophic levels

RABIS combines a multi-species approach with the consideration of multiple trophic levels as the following:

- At the level of the same taxa, a number of different single species (5-10) will be selected in order to cover different habitat requirements and different sensitivities to agricultural management. The selection criteria as mentioned in chapter 3.2.2 will be applied.
- The consideration of taxa from at least 3 different trophic levels per UC allows for the integration of across taxa interrelations. Moreover, habitat requirements and movement ranges show greater ranges, when taking different trophic layers into account. The choice of the trophic layers will be done by the particular UC participants, whereas interrelationships with the targeted ecosystem services at the UCs will be considered (Figure **Error! Reference source not found.**).

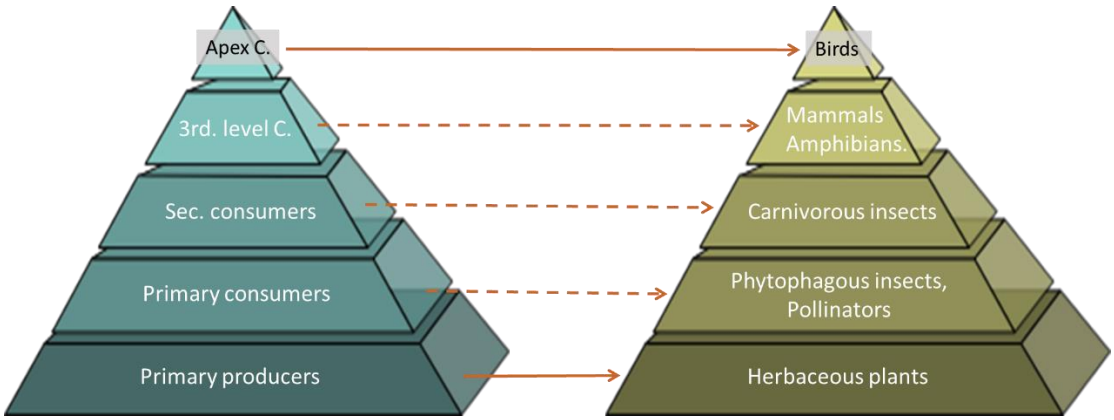


Figure 4. Assignment of the choice of taxa incorporation in RABIS according to their trophic levels

3.2.4. Multiple reference systems

As described before, biodiversity on marginal land is endangered by both, abandonment and intensification. Land use changes can result in multiple shifts in the species community. Therefore it is important to include diverse and adequate reference areas to get the broadest view of the ecological effects of (potential) changes. The inclusion of various potential development paths offers a good basis for quantitative comparisons.

MarginUp! has defined a multiple reference system, supporting the following interpretations:

1. **Semi-natural reference:** Impact of the new cropping systems compared to the abandonment of the site and development into semi-natural habitats

   Description: Depending on the kind of the MarginUp!-biomass crop, this is compared to the near-natural structures or areas (e.g., scrubland, species-rich field hedges, or sparse forests when comparing to poplar/willow agroforestry). Here, the habitat type, which the current cultivated area would reach in the medium term if the use is abandoned, can also be named.
   Interpretation: Is there an additional biodiversity value created related to the existing semi-natural landscape elements?

2. **Previous land use:** Comparing the state of biodiversity before and after impact (land use change)

   Description: How was the experimental plot previously used? (Before MarginUp!)
   Interpretation: Does the MarginUp! cropping system represent an improvement or a deterioration in habitat quality over previous land use?

3. **Typical regional agriculture:** Comparing the state of biodiversity with the one on typical agricultural areas in the surrounding area

   Description: Which crop/land use characterizes the agricultural land of the region and is proportionally strongly represented (several crops could also be considered here)
   Interpretation: Is the new cropping system on marginal land providing additional biodiversity values or habitat qualities for the given landscape context?

The approach of using the multiple reference system also allows to connect to ILUC (indirect land use change) methodology. In some cases, two of the mentioned references are the same (e.g., for Sweden, the initial state and the typical surrounding agriculture are equal, see also Table **Error! Reference source not found.**). In this case, the number of references (Figure 5) is r educed to two.

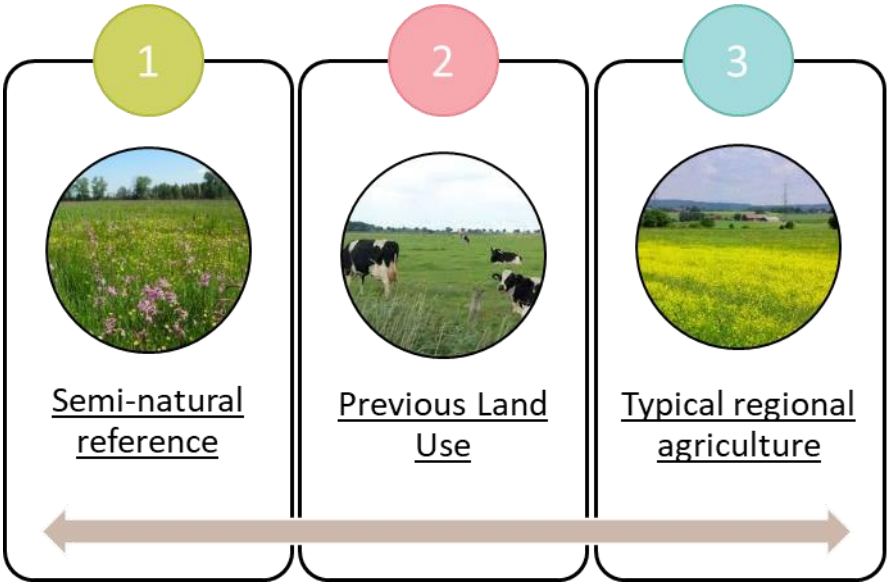


Figure 5. Set of reference systems as used in RABIS

3.2.5. Co-design

RABIS is setting the major elements for the upcoming biodiversity assessments on the land use alternatives developed and tested in MarginUp!. RABIS provides a structure that is filled together with the UC´s representatives. The regional partners are responsible for the selection and prioritizing of the final indicator and ESS sets for their respective UC. In a final step, the UC representatives have to authorize the proposed indicator list by WP2.

Another co-design step is related to the target setting at the local landscape scale. External target setting in most cases only exist for the national or regional scale, besides nature reserves or other protected areas whose targets can be at a local scale. Despite of external demands arising from laws or national strategies, in most cases there hardly exist any development targets for agriculturally used land at the local scale. For filling up this gap, UCs were asked to set up an expert panel in order to define biodiversity targets for the local agricultural sector. As guidance for this process, we asked for: i.) Ecosystem services regarded as most relevant by local stakeholders, ii.) Typical and common species determining the character of the local agricultural land (species associated with agricultural land by farmers and visitors e.g., white stork, crane, rabbit, or visually striking plants e.g., cornflower) and for iii.) ESS related species.

3.3. Process of filling up the indicator system

The process of filling up the indicator system included the following steps:

A first set of questionnaires to collect relevant data, followed by structuring the answers to have an overview over the existing data. Gaps of missing data got closed with the help of a second round of questionnaires, including questions on the pre-selection of indicator species and prioritization of relevant ESS for the different UCs. Details of the single steps of the procedure are presented in this section.

3.3.1. General structure of the process

In a first step, questionnaires and interviews carried out with the UC partners were used to obtain regional knowledge of the working groups for the individual UCs in order to gain a suitable database for the development of the indicator system. Figure **Error! Reference source not found.** illustrates the workflow on compiling RABIS for the UCs in MarginUp!.

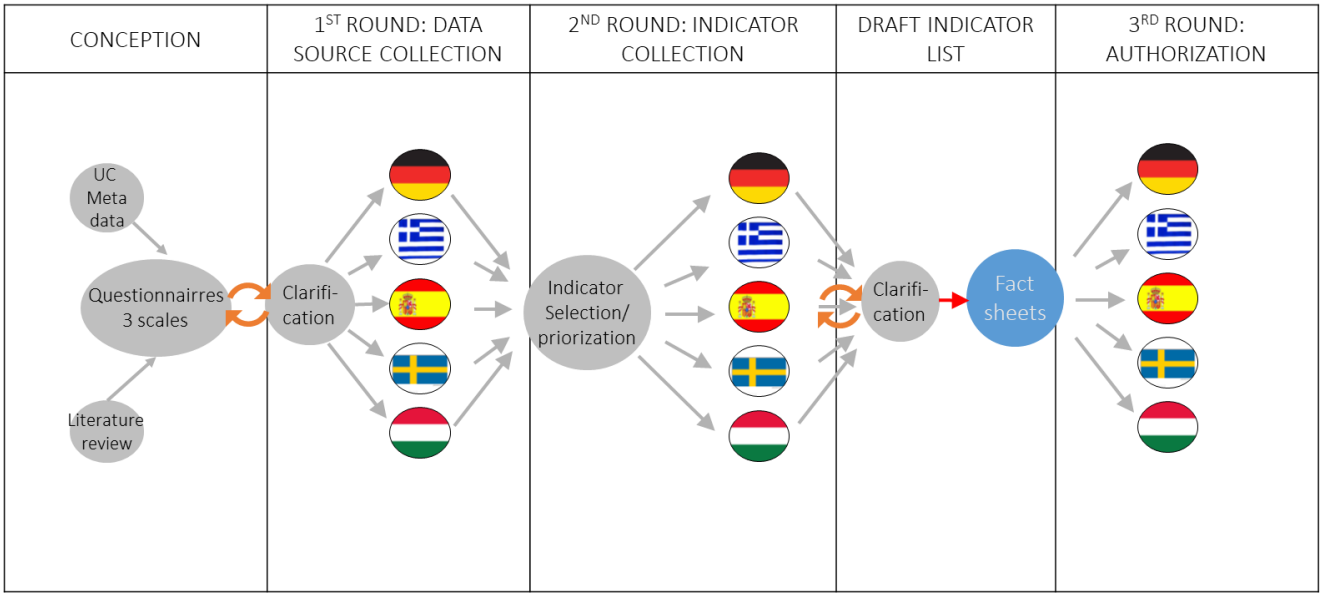


Figure 6. Workflow overview on compiling RABIS for the UCs in MarginUp!

3.3.2. First round of questionnaires: Questionnaires for use case partners

The first round of questionnaires consisted of three separate questionnaires (national, regional and local level), with the overall goal of examining each UC area according to their national, regional and local framework conditions, including regulatory conditions connected to biodiversity, endangered species and protected areas (see content of the questionnaires in **Error! R eference source not found.**; Blank questionnaires can be found in the Appendix A-C). Each partner was supposed to fill out the questionnaires for all three levels and send back their inputs. The varying degree of detail of the delivered information of the UCs was harmonized in frame of a next working step (3.3.4).

- **National questionnaire**

The questionnaire at national level contained questions related to biodiversity targets as named in national biodiversity strategies, national action plans, lists of protected species, habitats related to the Convention on Biological Diversity (CBD) and reports related to High Nature Value (HNV) for biodiversity conservation or others. It further included questions regarding the existence of Red Lists of protected species/habitats and the existence of national monitoring for any biodiversity groups. Most UCs have a national biodiversity strategy as well as a variety of other national strategies/action plans for biodiversity conservation and national monitoring programs. However, not every country has Red Lists of protected species/habitats (see Table **Error! Reference source not found.**).

- **Regional level questionnaire**

The questionnaire at regional level addressed questions related to the presence of regional plans, HNV lists of protected species, regional projects on nature conservation, as well as the availability of regional monitoring data for plants, animals or landscape structures. At regional level, information is available in every country. Questions at regional level had a focus on targets for maintenance and development as defined for regional protected areas, which commonly are neighbouring marginal land in general and the experimental plots in the particular UCs in detail.

- **Local level questionnaire**

The questionnaire at local level contained questions related to the presence of protected habitat types and species with close relationship to the chosen ESS in the UC. At local level, most information is available for all UCs, with the exception of local HNV lists of protected species, which do not exist in some UC areas.

3.3.3. Overview of existing data

The information collected from the individual UCs was structured and summarized in tables in order to get an overview of the existing database and on missing data. One detailed table per country was created as well as one table containing an overall summary of the assessed data of the first questionnaire round from all UCs (Table Overview on the kind of data compiled for RABIS from different scales (Example UC Havelland Germany).

Level	Requested Information	GE	GR	HU	ES	SE
National	National Biodiversity Strategy	Yes	Yes	Yes	Yes	Oct 2023
	National action plans/lists of protected species/habitats related to CBD*	Yes	Yes	Yes	Yes	Yes
	Specifications for agricultural lands in national action plans etc.	Yes	No	Yes	No	Yes
	Other national strategies/reports (HNV**) for biodiversity conservation (e.g., strategies for insect/pollinator conservation)	Yes	Yes	Yes	Yes	Yes
	Red Lists of protected species, habitats or landscapes related to agricultural landscape	Yes	No	Yes	No	Yes
	National/regional monitoring of protected species, habitats or biodiversity	Yes	No	Yes	Yes	Yes
Regional	Nature reserves in the use case region or near neighborhood (e.g., national parks, biosphere reserves, Natura-2000 areas, landscape protection areas)	Yes	Yes	Yes	Yes	Yes
	Biotope network/connectivity plan in the use case area	No	Yes	Yes	No	Yes
	Regional monitoring data of animals, plants or landscape structures	Yes	Yes	Yes	Yes	Yes
	Regional HNV Lists of protected species	Yes	Yes	Yes	Yes	Yes
	Projects on nature conservation/species protection in use case region or near neighborhood	Yes	No	Yes	Yes	Yes
	NGOs dealing with nature conservation, biodiversity or sustainable agriculture	Yes	Yes	Yes	Yes	Yes
Local	Experimental plots (for MarginUP!) part of protected areas in the use case region (e.g., nature reserves, national parks, biosphere reserves, Natura-2000 areas, landscape protection areas; including reserves overlapping with the plots or in the	Yes	Yes	Yes	Yes	Yes

Level	Requested Information	GE	GR	HU	ES	SE
	surroundings					
	Special/protected habitat types close to the experimental plots	Yes	Yes	Yes	Yes	Yes
	Occurrence of protected animals or plant species (e.g., Red List) at the experimental plots/surroundings	Yes	Yes	Yes	Yes	Yes
	Local HNV List of protected species specified for agricultural land	No	No	No	Yes	Yes
	Occurrence of animal/plant species related to agricultural land and of special interest for this region (typical/symbolic for region)	Yes	Yes	No	Yes	Yes

*CBD: Convention on Biological Diversity; **HNV: High Nature Value; Empty boxes: Information is requested

Table 3. Overview of availability of collected information with the help of questionnaires at national, regional and local level for each use case region

3.3.4. Second round of questionnaires/interviews and pre-selection of indicator species and ESS

Following the aforementioned questionnaires, short follow-up questionnaires and interviews were conducted with each UC partner. The goal was to verify the missing/incomplete data that emerged from the first questionnaire round as well as to start the process of selecting regional indicators. The questions were aimed at finding specific national, regional and local target species. The UC partners/experts are expected to have more extensive knowledge on national, regional and local target species/habitats. Thus, the partners were instructed to either give feedback on these aspects themselves or to contact regional/local experts (e.g., regional scientists or officials with expertise in e.g., ecology and nature conservation) to gather the required information. The partners were further asked to extract useful information related to these aspects from documents they had indicated in the initial questionnaires, i.e., select parts within the documents connected to agricultural land. Initial suggestions for potential indicator species and a prioritization of ESS were made by each UC.

3.3.5. Criteria for the selection of indicator species and pre-selection of indicators

The pre-selection of indicator species was carried out by taking into account the methodology described in chapter 3. The species were chosen due to their characteristics of covering different habitat requirements and different sensitivities to agricultural management. Further, taxa from at least three different trophic levels (Figure **Error! Reference source not found.**) w ere chosen per UC. This allows to better picture habitat requirements and movement ranges. The choice of the trophic levels was carried out by the particular UC partners, mostly with a link to the prioritized ESS (see chapter 3.3.6) thus covering the requirements of the MarginUP! alternative crops.

The selection of national and regional indicator species was made by scanning the national and regional plans and strategies and by identifying target species. These species were checked for a match with the locally selected species. A reference to agriculture was crucial on all levels for the selection of the species.

Criteria for the selection of indicator species

The selection of indicator species was made by experts in the respective UC. The following aspects were considered:

- Representation of different trophic levels (minimum:3).
  - ✓ E.g., 1. Plants (e.g., weeds, grassland herbs), 2. Pollinators (e.g., bees, butterflies or other pollinators), 3. Birds (seed and/or insectivore during breeding season), 4. Mammals (e.g., mice, bats, hedgehogs, rabbits), 5. Other groups (should be declared)
- Representation of different functional traits/ecosystem services (3 to 5) inside taxa
  - ✓ E.g., pollinators, decomposers, natural enemies of pests, erosion control plants etc.
- Species with special relevance for nature conservation
  - ✓ Rare or protected species (e.g., species on Red Lists of species lists from management plans in protected areas).
  - ✓ Endemic species
  - ✓ Umbrella species, flagship species, ecosystem engineers, keystone species
- Special habitat requirements (focus on nesting habitat or hunting/foraging areas during breeding/reproduction)
  - ✓ E.g., breeding in or on the ground, breeding in woody structures (e.g., tall trees, low (thorny) shrubs, dependence on certain woody species), breeding in or on certain herbs or grasses, use of specific nesting materials (e.g., poppy bee (*Osmia papaveris*))
- Preferences regarding certain vegetation structures (density and height of grasses, herbs or the cultivated crop),
  - ✓ Use of certain crops (e.g., preference of the Montagu's harrier (Circus pyrgagus) for winter cereals)
  - ✓ Avoidance of certain structures (e.g., avoidance of vertical structures by open land species such as the skylark (*Alauda arvensis*))
  - ✓ Use of certain structures for courtship or mate search
  - ✓ Use of certain structures for foraging during the breeding season (e.g., hunting from freshly mowed meadows (birds of prey), hunting roosts (birds of prey, songbirds))
- Temporal patterns of habitat use (e.g., temporal overlap of field management and breeding seasons)
- Susceptibility to disturbance (e.g., high risk of breeding abandonment due to intensification of land management)
- Representation of the region and relevance for tourism

3.3.6. Prioritization of ESS

The prioritization of ESS took place in parallel to the pre-selection of indicator species. The local UC partners were asked to prioritize a list of ESS with particular relevance for the local landscape and the given UC´s alternative crop.

3.3.7. Draft and authorization of selected indicator species and ESS

As an essence of the collected information and based on the selections done by the UC partners (for indicator species and ESS), WP2 created a first draft version for the list of indicators. The proposed indicator set will be sent out to the UC partners for authorization in a next stept. UC partners will either carry out the authorization on their own or will involve other experts in the process.

3.3.8. Defining reference habitats

Table **Error! Reference source not found.** shows the applied multiple reference system as introduced in chapter 3.2.4 with the r espective references of the 5 UCs. The reference areas for each UC have been defined by the respective partners. In the Swedish UC, previous land use and typical land use are congruent. In this case, the number of reference areas was reduced to two.

UC	Biomass Crop	Reference 1 Semi-natural Land	Reference 2 Previous Land Use	Reference 3 Typical Land Use
Sweden	Turnip rape	Permanent fallow, Forest	Barley, fodder grass	Arable crops: Barley, fodder grass
Germany	Paludi culture	Unused wet grassland	Meadow	Arable crops: Cereal, rape, maize
Spain	Kenaf, hemp	Pastoral used land	Annual corn	Arable crops: Annual corn, tomato, irrigated polyphyte grasslands
Hungary	Sida, willow	Steppe	Orchard	Arable crops: Wheat, rye, maize
Greece	Energy trees, herbal plants	Permanent fallow	Mining area, bare soil	Arable crops: Legumes, potatoes, fruit trees

Table 4. Reference areas

4. Usage options of the indicator system

4.1. Usage of RABIS in MarginUp!

RABIS will be used in more than one perspective (Figure **Error! Reference source not found.**):

1. *To assess the impact of the MarginUp! cropping alternatives on regional biodiversity targets of the Ucs (on the level of cropping systems at plot scale and without concrete spatial allocation)*
2. *To develop as basis for proposals for further adjustments on the cropping systems in order to improve biodiversity impacts (cropping system optimization)*
3. *To feed landscape assessments with scenarios that take into account different proportions of the new MarginUp! cultures and different spatial allocations*

As part of the impact assessments, simple expert models are built for the indicator or species groups, serving the respective ESS. These models focus on dynamic and structural parameters of the industrial crops and on what is regarded as factor pre-structuring habitat conditions for accompanying biodiversity targets. This will be done in Task 2.3 of MarginUp!. RABIS builds the core for the impact assessments on various industrial crops and/or management systems and will be used to identify biodiversity hotspot.

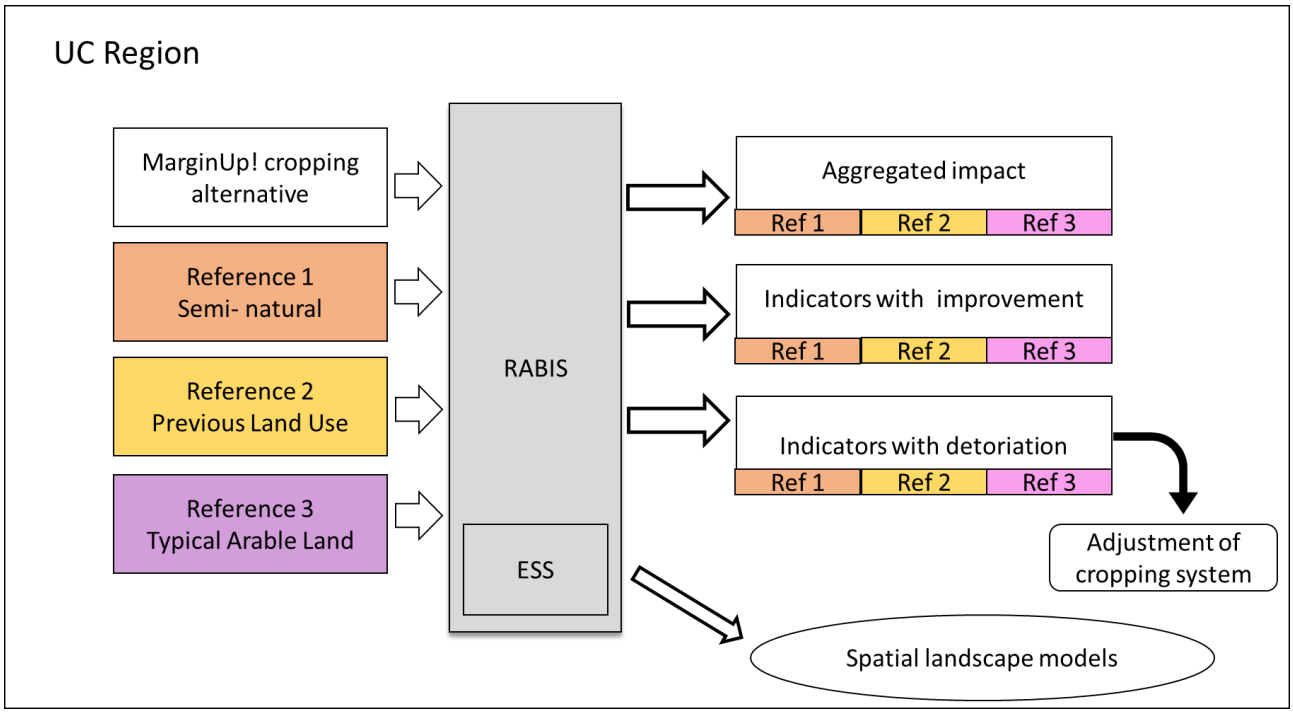


Figure 7. Overview on the application of RABIS for cropping system comparison for each particular UC.

RABIS can be applied for:

- *Ex-ante impact assessment for new cropping systems in existing crop rotations,*
- *The identification of trade-off´s and problematic effects in advance and,*
- *The identification of further needs for adapting the cultivation method in order so that potential negative effects can be reduced or even avoided.*

Due to its common model structure, RABIS will be transferable to other regions. The application for the Argentinean and South African UC will be tested, too, when the new cropping systems have been selected. The indicators have to be adapted to the extra European and any further application areas.

4.2. Links to other Deliverables in MarginUp!

RABIS is contributing to the following deliverables:

- *D 2.3 Monitoring protocol*
- *D 2.4 Recommendations for further optimization of cropping systems*
- *D 8.2 Data management plan*
- *D 6.1 Value chains for feedstock from marginal lands*
- *D 4.4 LCA framework*
- *D 4.2 Environmental Impact Assessment (ATLANTIS - T4.1)*

5. Fact sheets for the UCs

5.1. Sweden

Description UC Sweden

[2] Västerbotten and Norrbotten county, Sweden

Current state: Due to climate reason few crop options. Unused or passively used agricultural land with risk to be abandoned, or planted with forest, with negative effects on biodiversity.

Current crops: Spring cereals, fodder grasses

MarginUp! alternative: Turnip rape

Level	Part 1 Collection of relevant regulations and laws	UC Sweden
National	• EU biodiversity strategy adopted by Sweden (National biodiversity strategy will be available in October 2023) https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en • The Swedish Environmental Code https://www.government.se/legal-documents/2000/08/ds-200061/ • Environmental Objectives System https://www.naturvardsverket.se/en/environmental-work/swedish-environmental-objectives/ • Species Protection Ordinance (2007:845), including The Birds directive (79/409/EEC) and The Habitat directive (92/43/EEG) https://www.naturvardsverket.se/en/guidance/species-protection/species-protection-ordinance/	
Regional	• Regional plan for green infrastructure (Västerbotten) https://www.lansstyrelsen.se/vasterbotten/om-oss/vara-tjanster/publikationer/2020/gron-infrastruktur-i-vasterbottens-lan---regional-handlingsplan.html • Preliminary action plan for green infrastructure (Norrbotten) https://catalog.lansstyrelsen.se/store/31/resource/80	
Local		

[2] Turnip rape cultivation. Photo: Hushållningssällskapet

Level	Part 2 Target species relevant for agriculture as named in regulations and laws	UC Sweden
National	**Examples on species listed in the habitat directive:** • Butterflies: *Euphydryas aurinia Lopinga achine, Phengaris arion* • Bats*: Nyctalus noctula, Pipistrellus nathusii, Eptesicus nilssonii* • Amphibians: *Hyla arborea, Rana arvalis* • Reptiles: *Coronella austriaca* • Plants: *Arnica montana* • Insects: *Cerambyx cerdo, Osmoderma eremita* **Bird species in the agricultural landscapes:** • *Saxicola rubetra, Emberiza citronella, Motacilla flava, Linaria cannabina, Hirundo rustica, Emberiza hortu-lana, Passer montanus, Corvus frugilegus, Sturnus vulgaris, Alauda arvensis, Vanellus vanellus, Falco tin-nunculus, Lanius collurio, Curruca communis, Anthus pratensis* **Butterfly species in the agricultural landscapes:** • *Ochlodes sylvanus, Anthocharis cardamines, Lycaena phlaeas, Polyommatus icarus, Lasiommata megera, Coenonympha pamphilus, Maniola jurtina, Erynnis tages, Cupido minimus, Phengaris arion, Cyaniris sem-iargus, Euphydryas aurinia* **From Swedish Environmental Code:** • Butterflies*: Euphydryas aurinia, Lopinga achine, Phengaris arion* • Bats: *Nyctalus noctula, Pipistrellus nathusii, Eptesicus nilssonii* • Ambibians: *Hyla arborea, Rana arvalis* • Reptiles: *Coronella austriaca* • Plants: *Arnica montana* • Insects: *Cerambyx cerdo, Osmoderma eremita (Swedish Environmental Code)* • *15 Bird species, 12 butterfly species; total area of pastures and meadows, plant, butterfly and bum-blebee composition, expansive species official indicators for the Environmental objectives system)*	
Regional	**From Västra Storfjärdsgrundet: Birds** • Granbergsmyran: *Gallinago gallinago, Numenius arquata, Vanellus vanellus, Tringa nebularia and Tringa glareola.* Butterflies: *Boloria selene, Agriades optilete, Boloria aquilonaris, and Erebia embla* • Hornsmyran: *Anthus pratensis, Cuculus canorus, Muscicapa striata, Numenius arquata, Dendrocopos major, Fringilla montifringilla, Turdus iliacus Butterflies: Boloria selene, Leptidea sinapis* • Innerviksfjärdarna: *>190 species observed, Grus grus, and other*	
Local	**From local experts: typical and endangered species at the radius of 10 km to the experimental plot:** • *Lutra lutra* • *Margaritifera margaritifera* • *Lepus timidus* • *Persicaria foliosa* **Red listed species:** • *Lepus timidus* • *Eptesicus nilssonii* • *Persicaria foliosa*	

Level	Part 3 Indicator selection for MarginUp!	UC Sweden
National	**Species** **Birds:** • *Linaria cannabina* • *Vanellus vanellus* • *Emberiza hortulana* • *Hirundo rustica*	**Butterflies:** • *Anthocharis cardamines*
Regional	**Species** **Birds :** • *Gallinago gallinago* • *Vanellus vanellus* • *Anthus pratensis* **Butterflies:** • *Boloria selene* • *Leptidea sinapis*	
Local	**Ecosystem Services (ESS) :** Pollination, Biological Control **Species** **Birds:** • *Grus grus* **Pollinators:** • *Apis mellifera* • *Bombus terrestris* • *Bombus pascuorum*	**Plants:** • *Centraurea cyanus* • *Galeopsis sp.* • *Vicia cracca* **Butterflies:** • *Boloria selene*

Level	Part 4 Monitoring activities and NGOs	UC Sweden
National	• National Inventory of Landscapes in Sweden (NILS) base survey, butterfly and bumblebee survey on grasslands https://landskap.slu.se/nils/dv • National bird monitoring program, including the Swedish waterfowl count https://www.fageltaxering.lu.se/resultat/arsrapporter • Swedish butterfly monitoring program https://www.dagfjarilar.lu.se/ • Quality evaluation of grasslands / TUVA database https://etjanst.sjv.se/tuvaut/ • Swedish Species Observation System https://www.artportalen.se/ • Monitoring linked to agricultural land https://www.naturvardsverket.se/en/international/ environ-mental-monitoring/environmental-monitoring-program-areas/agricultural-land/ • Swedish Red List 2020 https://www.gbif.org/dataset/23c0a6c4-f1f4-4577-ac5c-98787c1a2d0c • 131 conservation/action programs (both terrestrial, aquatic/marine) for approximately 300 species https://www.naturvardsverket.se/om-oss/publikationer/atgardsprogram/	
Regional	• Regional environmental monitoring of small biotopes, grasslands and wetlands (Remiil) https://www.slu.se/institutioner/ekologi/foma1/jordbruk/regional-landskapsovervakning/ • Swedish coastal bird monitoring programme https://www.gbif.se/ipt/resource?r=lu_sft_kfr • Migratory bird counting and ringing at (1) Ottenby https://www.ottenby.se/; (2) Falsterbo https://www.falsterbofagelstation.se/ **NGOs** • Swedish Society for Nature Conservation (SSNC) Västerbotten https://vasterbotten.naturskyddsforeningen.se/ • BirdLife Västerbotten https://vasterbotten.birdlife.se/ • SSNC Norrbotten https://norrbotten.naturskyddsforeningen.se/ • The flora of Norrbotten https://norrbottensflora.se/ • The society for Piteå flora http://pitelappmarksflora.blogspot.com/ • Birdlife Norrbotten https://nof.nu/ • Sámi initiatives (indigenous people)	
Local		

5.2. Germany

Description UC Germany

[3] Brandenburg, Germany

Current state: Fenlands/wetlands that have been mostly drained for agricultural use, and are to be rewetted

Current crops: Willow

MarginUp! alternative: Reed, cat tail, and reed canary grass

Level	Part 1 Collection of relevant regulations and laws	UC Germany
National	• National biodiversity strategy (NBS) 2007 https://faolex.fao.org/docs/pdf/ger190467.pdf • National Biodiversity Strategy and Action Plan (NBSAP) https://www.cbd.int/doc/world/de/de-nbsap-v2-en.pdf • Strategy Arable Farming 2035. https://www.bmel.de/SharedDocs/Downloads/EN/Publications/ackerbaustrategie-en.pdf?__blob=publicationFile&v=6 • Federal Nature Conservation Act.2021 https://www.bmuv.de/fileadmin/Daten_BMU/Download_PDF/Naturschutz/bnatschg_en_bf.pdf • Federal Biological Diversity Programme (BfN) https://www.bfn.de/en/topic/federal-biological-diversity-programme • Act on the Protection of Insect Diversity in Germany and on the Amendment of Other Provisions 2021 https://plant-protection.net/fileadmin/documents/Mitwirkungen/Insektensterben/4_aktionsprogramm_insektenschutz_kabinettversion_bf.pdf • Red Lists of protected species, habitats or landscapes related to agricultural landscape https://www.rote-liste-zentrum.de/en/	
Regional	• Landscape program of the State of Brandenburg https://mluk.brandenburg.de/sixcms/media.php/9/Landschaftsprogramm-BB.pdf	
Local		

[3] Red canary grass. Photo: Charles Peterson

Level	Part 2 Target species relevant for agriculture as named in regulations and laws	UC Germany
National	**From NBS** • Birds: *Saxicola rubetra, Alauda arvensis, Emberiza citrinella, Emberiza calandra, Lullua arborea, Vanellus vanellus, Lanius collurio, Milvus milvus, Athene noctua, Limosa limosa*	
Regional	**From Landschaftsprogramm, target species for Rhin-Havelland** • Mammals: *Lutra lutra, Castor fiber, Cricetus cricetus,* • Birds: *Haliaeetus albicilla, Ciconia nigra, Pandion haliaetus, Grus grus, Otis tarda, Athene noctua, Numenius arquata, Limosa limosa, Tringa tetanus, Crex crex, Netta rufina, Porzana parva, Upupa epops, Botaurus stellaris* • Amphibians and reptiles: *Bombina bombina, Hyla arborea, Vipera berus* • Plants: *Anacamptis palustris, Gentiana pneumonanthe, Platanthera chlorantha, Angelica palustris, Iris sibirica* **Target species special protection area (SPA) Rhinluch-Havelluch** • Breeding birds: *Otis tarda, Numenius arquata, Crex crex, Gallinago gallinago, Vanellus vanellus, Circus aeruginosus, Ciconia ciconia, Milvus milvus, Milvus migrans* • Migrating birds: *Anser fabalis, Anser albifrons, Cygnus cygnus, Cyngus columbianus bewickii, Grus grus, Ciconia ciconia, Pluvialis apricaria* **Nature park Westhavelland value determining species (PEP_Westhavelland)** • 12 species for water bodies, 4 species for peatland, 36 species for wet grasslands,4 species for fresh grasslands, 13 species for dry grasslands, 10 species for forests and shrubs, 3 species for arable land **High responsibility species for CBD:** • Birds: *Milvus milvus, Milvus migrans, Vanellus vanellus, Gallinago gallinago, Calidris pugnax* • Reptiles: *Vipera berus, Lacerta agilis* • Amphibians: *Bufotes viridis, Hyla arborea, Bombina bimbina* • Butterflies: *Catephia alchymista, Cosmia diffinis, Acronicta strigosa, Chelis maculosa, Hipparchia statelinus, Dyscia fagaria , Chesias rufata* • *Odonata* **Natura 2020 area Unteres Rhinluch - Dreetzer See & Ergänzung** • Plants: 5 species • Birds: 19 breeding bird species, 11 resting bird species • Mammals: 11 species, • Amphibians: 7 species • Reptiles: 1 species • Mollusks: 3 species • Fish: 5 species	
Local		

Level	Part 3 Indicator selection for MarginUp!	UC Germany
National	**Species** **Birds:** • *Vanellus vanellus* • *Emberiza calandra* • *Lanius collurio*	
Regional	**Species** **Plants:** • *Viola persicifolia* • *Sanguisorba officinalis* • *Cardamine parviflora* • *Gentiana pneumonanthe* • *Carex limosa* • *Stratiotes aloides* • *Inula britanica* • *Hydrocharis norsus-ranae* **Invertebrates:** • *Calopteryx splendens*	**Birds:** • *Otis trada* • *Grus grus* • *Gallinago gallinago* • *Vanellus vanellus* • *Lanius collurio* • *Milvus milvus* **Mammals:** • *Nyctalus noctula* • *Myotis myotis*
Local	**Ecosystem Services (ESS) :** Carbon storage, Pollination, Emissions reduction, Water retention, Water filtration **Species** **Plants:** • *Valeriana dioica* • *Genthiana pneumonanthe* • *Inula salicina* • *Iris sibirica* • *Molina caerulea* • *Phragmites sp.* • *Typhaceae sp.* • *Carex sp.* **Mammals:** • *Microtus agrestis* • *Microtus arvalis* • *Arvicola terrestris*	**Birds :** • *Otis tarda* • *Grus grus* • *Ciconia ciconia* • *Milvus milvus* • *Anthus pratensis* **Pollinators:** • *Apis mellifera,* • *Bombus terrestris,* • *Bombus pascuorum*

Level	Part 4 Monitoring activities and NGOs	UC Germany
National	• German bee monitoring https://www.nabu.de/downloads/Bienenmonitoring_genersch.pdf • Monitoring HNV on agricultural land https://www.bfn.de/monitoring-von-landwirtschaftsflaechen-mit-hohem-naturwert • Indicator species grassland Apenndix 1 or 7 Anhang 1 bzw. Anhang 7 https://www.bfn.de/sites/default/files/2021-11/Erfassungsanleitung_HNV_bf_pac21_0.pdf • Indicator species farmland Tab 3 https://www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/Monitoring_und_Evaluation_der_Segetalflora.pdf • Indicator species birds Annex 6.5 https://www.bfn.de/sites/default/files/2021-11/Erfassungsanleitung_HNV_bf_pac21_0.pdf • Monitoring of breeding birds since 2004 https://www.dda-web.de/monitoring/mhb/programm • Monitoring in SPA https://www.monitoringzentrum.de/steckbriefe/vogelmonitoring-europaeischen-vogelschutzgebieten • FFH Monitoring https://mluk.brandenburg.de/mluk/de/umwelt/natur/natura-2000/europaeische-schutzgebiete/ • Butterfly monitoring Germany https://www.ufz.de/tagfalter-monitoring/ • Bird monitoring NGO https://www.ornitho.de/	
Regional	• Monitoring and Evaluation of the flora of Segetal https://www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/Monitoring_und_Evaluation_der_Segetalflora.pdf (p.10)	
Local		

5.3. Spain

Description UC Spain

[4] Extremadura, Spain

Current state: Low productivity cultivation of crops, poor soil quality, risk of desertification and abandonment.

Current crops: Annual corn and tomato

MarginUp! alternative: Hemp and kenaf

Level	Part 1 Collection of relevant regulations and laws	UC Spain

National

- Biodiversity and Science Strategy https://www.miteco.gob.es/es/biodiversidad/planes-y-estrategias/estrategia-de-biodiversidad-y-ciencia-2023-2027_tcm30-551619.pdf
- National Strategy for Green Infrastructure and Ecological Connectivity and Restoration https://www.miteco.gob.es/es/biodiversidad/temas/ecosistemas-y-conectividad/infraestructura-verde/Infr_verde.aspx
- National Strategy for the Conservation of Pollinators https://www.miteco.gob.es/es/biodiversidad/publicaciones/estrategiaconservacionpolinizadores_tcm30-512188.pdf
- Spanish Plant Conservation Strategy 2014-2020 https://www.miteco.gob.es/es/biodiversidad/publicaciones/estrategia_ce_vegetal_2014-2020_tcm30-197338.pdf
- Strategy for conservation and combating threats of plants protected from ruderal environments https://www.miteco.gob.es/es/biodiversidad/publicaciones/estrategia_conservacion _y_lucha_contra_ amenazas_de_plantas_protegidas_ruderales_aprobada_por_ conferencia_sectorial_tcm30-548416.pdf
- Strategic Wetlands Plan by 2030 https://www.miteco.gob.es/es/biodiversidad/planes-y-estrategias/plan_estrategico_humedales_30ene_tcm30-548431.pdf
- Atlas and Red Book of Threatened Vascular Flora (AFA) and Red Lists of the Spanish vascular flora https://www.miteco.gob.es/es/biodiversidad/temas/inventarios-nacionales/inventario-especies-terrestres/ieet_flora_vascular.aspx

[4] Kenaf plantation. Photo: CICYTEX (Carlos Campillo)

Level	Part 1 Collection of relevant regulations and laws (2)	UC Spain
Regional	• Regional Catalogue of Threatened Species published in 2001 http://doe.juntaex.es/pdfs/doe/2018/1120o/18040091.pdf • Regional Catalogue of Threatened Plant Species of Extremadura updated with the Red List of Spanish Vascular Flora 2008 http://extremambiente.juntaex.es/files/biblioteca_digital/CR_especies_ veget_amenazadas_extremadura_prot.pdf • Regional Catalogue of Threatened Species of Extremadura - Fauna I (updated with the Red Books of Fauna of Spain) http://extremambiente.juntaex.es/files/biblioteca_digital/CREA_2011_definitivo.pdf • Regional Catalogue of Threatened Species of Extremadura - Fauna II. Birds (updated with the Red Books of Fauna of Spain) http://extremambiente.juntaex.es/files/biblioteca_digital/CAT_FAUNA%20II_AVES_peq.pdf • State Strategic Plan for Natural Heritage and Biodiversity published in Real Decreto 1057/2022, December 27th, approving the State Strategic Plan for Natural Heritage and Biodiversity by 2030, in application of Law 42/2007, December 13rd, on Natural Heritage and Biodiversity (BOE number 313, 30/12/2022) https://www.boe.es/eli/es/rd/2022/12/27/1057/con	
Local		

Level	Part 2 Target species relevant for agriculture as named in regulations and laws	UC Spain
National	• List of Wild Species under a Special Protection Regime is established through the Law on Natural Heritage and Biodiversity 42/2007 and developed by Royal Decree 139/2011 • List includes species and populations that need to be protected or taken account in a particular way due to scientific, ecological or cultural values, singularity, rarity or threat degree. 889 taxons, 120 of which are categorized as vulnerable and 176 as endangered https://www.cbd.int/countries/?country=es	
Regional	**Extremadura region: Species and habitat that are related to agricultural land and are of special interest:** • Birds: *Burhinus oedicnemus, Otis tarda, Circus pygargus, Pterocles alchat, Pterocles orientalis, Tetrax tetrax, Coracias garrulus, Falco naumanni, Ciconia ciconia, Elanus caeruleus, Falco naumanni, Merops apiaster, Grus grus, Alauda avensis* • Code 91B0 Habitat type *Thermophilous Fraxinus angustifolia* woods *(Thypha sp., Callitriche sp., Fraxinus angustifolia).* **Flora:** associated with roadsides and edge of agricultural crops *Lavatera triloba L., Coincya transtagana (Cout.) Clem.-Muñoz & Hern.-Berm., Echium boissierii Steud., Galega orientalis Lam., Anchusa puechii Valdés, Echium lusitanicum L. subsp. lusitanicum, Echium salmanticum Lag., Narcissus bulbocodium L., Narcisus cavanillesii Barra & G. López*, etc. Associated with ponds or temporary watercourses in agricultural areas we could find close to agricultural areas: *Marsilea batardae Launer, Marsilea strigosa Willd. Callitriche lusitanica Schotsman, Callitriche regis-jubae Schotsman.* **Fauna (invertebrates, amphibia, reptiles, mammals):** *Triops emeritensis, Coenagrion mercuriale, Plagionotus marcorum, Vanessa virginiensis, Melitaea aetherie, Euphydryas desfontainii, Erinaceus europaeus, Talpa occidentalis, Mustela putorius, Herpetes ichneumon,* etc. amphibians and reptiles appear associated to permanent ponds or lagoons that we can find in or near agricultural landscapes *(Triturus marmoratus, Triturus pygmaeus, Discoglossus galganoi, Pelobates cultripes, Hyla arborea, Bufo bufo, Mauremys leprosa).* **Fauna (birds):** in pastures and rainfed cereal crops, olive grove, almond groves or vineyards *Circus aeruginosus, Circus cyaneus, Pterocles orientalis, Pterocles alchata, Circus pygargus, Falco naumanni, Tetrax tetrax, Otis tarda, Glareola pratincola, Elanus caeruleus, Asio otus, urhinus oedicnemus, Coracias garrulus, Cercotrichas galactotes, Falco colombarius, Athene noctua, Asio flammeus, Grus grus, Ciconia ciconia, Merops apiaster, Upupa epops, Caprimulgus ruficollis, Melanocorypha calandra, Galerida cristata, Alauda arvensis, Oenanthe hispanica, Cisticola juncidis*, etc.	

Level	Part 2 Target species relevant for agriculture as named in regulations and laws (2)	UC Spain
Local	**From local experts: species and habitats on agricultural land considered particularly typical, ecologically important or worthy of protection:** • Code 91B0 Habitat type *Thermophilous Fraxinus angustifolia* woods • Code 92D0 Habitat Southern riparian galleries and thickets *(Nerio-Tamaricetea and Securinegion tinctoriae)* • *Flueggea tinctorea* • *Callitriche sp.* • *Fraxinus angustifolia Vahl.* **Animal species regularly occurring on agricultural land and considered to be particularly typical, ecologically important or worth protecting:** • *Ciconia ciconia* • *Elanus caeruleus* • *Falco naumanni* • *Merops apiaster* • *Cobitis vettonica* **Plant species of the agricultural landscapes:** *Echium lusitanicum L.* in borders, *Narcissus bulbocodium L.* and *Narcissus triandrus L*. in marginal areas and sporadic in temporal pool *Callitriche spp.* **Potential weed species growing on the arable land of the experimental plots being interesting for pollinators:** Genera *Anacyclus, Anthemis, Chamaemelum, Cichorium, Glebionis, Scolymus, Hymenocarpus, Medicago, Trifolium and Vicia, Daucus, Torilis, Anchusa, Echium, Scrophularia.* **Near the experimental plots there is evidence of the presence of:** • *Circus aeruginosus* • *Grus grus*	

Level	Part 3 Indicator selection for MarginUp!	UC Spain
National	**Species** **Birds:** • *Otis tarda* • *Circus pygargus*	
Regional	**Species** **Plants :** • *Lavatera triloba* • *Coincya transtagna* • *Callitriche spp* • *Anchusa puechii* **Amphibians:** • *Hyla arborea* • *Bufo bufo*	**Birds :** • *Otis tarda* • *Circus pygargus* • *Coracias garrulous* • *Ciconia ciconia* • *Falco naumanni* • *Merops apiaster* • *Grus grus* • *Alauda arvensis*
Local	**Ecosystem Services (ESS) :** Carbon sequestration and storage, Prevention of erosion and conservation of soil fertility, Pollination, Habitat for species **Species** **Plants:** • *Anacyclus radiatus* • *Anchusa azurea* • *Anthyllis lotoides* • *Chamaemelum fuscatum* • *Daucus carota* • *Echium lusitanicum* • *Glebionis coronaria* • *Medicago polymorpha* • *Narcissus bulbocodium* • *Narcissus triandrus* • *Scolymus hispanicus* • *Scrophularia auriculata* • *Torilis arvensis* • *Vicia benghalensis*	**Birds :** • *Circus aeruginosus* • *Grus grus* • *Ciconia ciconia* • *Merops apiaster* **Pollinators :** • *Apis mellifera* • *Bombus terrestris* • *Polistes gallicus* • *Aricia cramera* • *Coenonympha pamphilus* • *Glaucopsyche melanops* • *Melanargia ines,* • *Zerynthia rumina*

Level	Part 4 Monitoring activities and NGOs	UC Spain
National	• Spanish Inventory of Natural Heritage and Biodiversity/Ministry for the Ecological Transition and the Demographic Challenge (in collaboration with autonomous communities and other bodies of the General State Administration), article 11 of Law 42/2007, December 13th, on Natural Heritage and Biodiversity • Annual Reports (2009-2021) https://www.miteco.gob.es/es/biodiversidad/temas/inventarios-nacionales/inventario-espanol-patrimonio-natural-biodiv/informe_anual_IEPNB.aspx • First sexennial report (2020) https://www.miteco.gob.es/es/biodiversidad/temas/inventarios-nacionales/iepnb20_sexenal_tcm30-527047.pdf	
Regional	• Herbarium of Vascular Plants Collection of the University of Extremadura (Spain) (39.029 ocurrences) https://www.gbif.org/dataset/835d30de-f762-11e1-a439-00145eb45e9a • Herbario HSS Finca La Orden-Valdesequera (CICYTEX), Junta de Extremadura (73,062 ocurrences) https://www.gbif.org/dataset/837acfc2-f762-11e1-a439-00145eb45e9a • General Directorate of Sustainability (Council of Ecological Transition and Sustainability, regional government of Extremadura) • Cartographic and Territorial Information Center of Extremadura (CICTEX), Regional Government of Extremadura (Studies, maps on landscape structures) http://sitex.gobex.es/SITEX/centrodescargas/viewsubcategoria/21 • General Directorate of Sustainability (Council of Ecological Transition and Sustainability, regional government of Extremadura) • GBIF data portal https://www.gbif.org **NGOs** • ADENEX (Asociación para la Defensa de la Naturaleza y los Recursos de Extremadura). • AMUS (Acción por el Mundo Salvaje) • ARBA Extremadura • DEMA (Defensa y Estudio del Medio Ambiente). • Ecologistas en Acción • Fundación Global Nature • SEO/BirdLife • Sociedad Zoológica de Extremadura	
Local		

5.4. Hungary

Description UC Hungary

[5] Southern Great Plain, Hungary

Current state: Abandoned land with sandy soil characterised by low and decreasing ground water level, low nutrient content and retention capability.

Current crops: Abandoned orchard

MarginUp! alternative: Herbaceous and woody crops for cascaded use in the circular oyster mushroom value chain

Level	Part 1 Collection of relevant regulations and laws	UC Hungary
National	• EU Biodiversity Strategy https://biodiversity.europa.eu/countries/hungary/eu-biodiversity-strategy • National Strategy for the Conservation of Biodiversity in 2015-2020 https://faolex.fao.org/docs/pdf/hun163398.pdf • 5th National Report to the Convention on Biological Diversity https://www.cbd.int/doc/world/hu/hu-nr-05-en.pdf • Action Plan for Implementing the Convention on Biological Diversity's Programme of Work on Protected Areas https://www.cbd.int/doc/world/hu/hu-nbsap-powpa-en.pdf • Act No. LIII. of 1996 on Nature Conservation in Hungary https://www.asser.nl/upload/eel-webroot/www/documents/HUN/hungary%20Nature%20Conservation%20law.htm • Joint Decree No. 2 of 2002 of the Ministry of Environmental Protection and the Ministry of Agriculture and Rural Development on the rules regarding sensitive natural areas https://leap.unep.org/countries/hu/national-legislation/joint-decree-no-2-2002-ministry-environmental-protection-and • Towards a National Circular Economy Strategy for Hungary https://www.oecd.org/env/waste/Highlights-Towards-a-National-Circular-Economy-Strategy-for-Hungary_EN.pdf • National Framework Strategy on Sustainable Development of Hungary https://www.parlament.hu/documents/127649/4101265/NFFT-ENG-web.pdf/f692c792-424d-4f5a-9f9d-9e6200303148?t=1580130885736 • National Red List, Hungary https://www.nationalredlist.org/country-info/HU	
Regional	• Biotope network/connectivity plan: National Ecological Network, Kiskunság National Park www.knp.hu	
Local		

[5]Sida hermaphrodita planting. Photo: PILZE

Level	Part 2 Target species relevant for agriculture as named in regulations and laws	UC Hungary
National	**Targets/indicators named for the agricultural sector on a national scale (choice by local partner)** **Birds:** • *Buteo buteo* • *Otis tarda* • *Falco vespertinus*	
Regional	**HNV Lists (High Nature Value) of protected species: Sand grassland conservation (www.knp.hu):** **Plants:** • *Colchicum arenarium* **Insects:** • *Acrotylus longipes*	
Local	**Protected animals or plant species (e.g., Red List) at the experimental plots or surroundings:** **Mammals:** • *Pipistrellus pygmaeus* • *Plecotus austriacus* • *Eptesicus serotinus* • *Nyctalus noctula* • *Barbastella barbastellus* • *Myotis bechsteinii, Myotis emarginatus, Myotis myotis, Myotis blythii* **Birds :** • *Accipiter gentilis* • *Buteo buteo* • *Falco vespertinus* • *Milvus migrans*	

Level	Part 3 Indicator selection for MarginUp!	UC Hungary
National	**Species** **Birds:** • *Buteo buteo* • *Otis tarda* • *Falco vespertinus*	
Regional	**Species** **Plants:** • *Colchicum arenarium* **Invertebrates:** • *Acrotylus longipes* **Amphibians and reptiles:** • *Rana arvalis* • *Vipera ursinii rakosiensis*	**Mammals:** • *Spermophilus citellus* **Insects:** • *Dorcadion fulvum-cervae* • *Carabus hungaricus* **Birds:** • *Falco vespertinus*
Local	**Ecosystem Services (ESS) :** Pollination, Wind erosion control, Environmental education, Self regulation **Species** **Plants:** • *Erigeron canadensis* • *Tribulus terrestris* • *Portulaca oleracea* • *Convolvulus ssp.* • *Consolida regalis* • *Papaver rhoeas* **Mammals:** • *Martes martes* • *Crocidura leucodon* • *Chiroptera*	**Birds :** • *Motacilla alba* • *Alauda arvensis* • *Linaria cannabina* • *Phoenicurus ochruros* • *Upupa epops* • *Coccothraustes coccothraustes* • *Parus major* **Pollinators :** • *Apis mellifera* • *Bombus pascuorum* • *Araschnia levana*

Level	Part 4 Monitoring activities and NGOs	UC Hungary
National	• Hungarian Biodiversity Monitoring System https://termeszetvedelem.hu/_user/downloads/biomon_eng/biodiverzitas-angolbeliv-low-res.pdf • Hungarian Biodiversity Monitoring System - 2nd edition http://mek.oszk.hu/06900/06934/06934.pdf **NGOs** • Hungarian Agroecological Network • Hungarian Ornithological and Nature Conservation Society • Hungarian Society for Environmental Education	
Regional	• Kiskunság Biosphere Reserve, Hungary – UNESCO https://en.unesco.org/biosphere/eu-na/kiskunsag • Monitoring of rare and protected: plant and bird species, endangered fish species, rare and protected amphibian and reptile species, rare mammal species www.knp.hu • Monitoring for plant species: *Adenophora liliifolia, Apium repens, Astragalus dasyanthus, Cirsium brachycephalum, Colchicum arenarium, Crocus reticulatus, Iris arenaria, Gentiana pneumonanthe* • Monitoring for animal species: Rana arvalis, Spermophilus citellus, Vipera ursinii rakosiensis, dorcadion fulvum-cervae, Carabus hungaricus LINK • Population of the red-footed falcons LINK **NGOs** • Forests of the Great-Plain Association (AEE) • Biokúltúra Association • Futóhomok Természetvédelmi Egyesület (Shifting Sand Nature Conservation Association Nature conservation, environmental protection, education) • Puszta Hangja Egyesület (Voice of the Puszta), (Folk tradition and cultural association) • Útkereső Egyesület (Finding Your Way Society), (Nature conservation, environmental protection, helping for local people) • Sporthorgász Egyesületek Bács-Kiskun Megyei Szövetsége (Association of the Anglers Associations of Bács-Kiskun County)	
Local		

5.5. Greece

Description UC Greece

[6] Western Macedonia Region, Greece

Current state: Severely degraded land that is no longer productive due to intensive and unsustainable use

Current crops: : (Abandoned former lignite mine)

MarginUp! alternative: Perennial woody species (e.g., pseudoacacia and poplar) and indigenous herbs (e.g., camomile, mountain tea, lupin and lavender)

Level	Part 1 Collection of relevant regulations and laws	UC Greece
National	• Ministerial Decision 40332/26.8.2014: Approval of the 2014-2029 National Strategy on Biodiversity and 5-year Action Plan (Government Gazette B΄2383/2014), with Paragraph 2.6.3 Agricultural ecosystem https://www.cbd.int/doc/world/gr/gr-nbsap-01-en.pdf • Convention on biological diversity, 5th national report of Greece https://www.cbd.int/doc/world/gr/gr-nr-05-en.pdf • National Forestry Strategy (Ministerial Decision 170195/758/28-11-2018, Government Gazette B' 5351/2018) https://faolex.fao.org/docs/pdf/gre187348.pdf (Strategic Forestry Development Plan 2018-2038)	
Regional	• Biotope network/connectivity plan: Management Unit of Prespa National Park and Protected Areas of Western Macedonia, based in Agios Germanos (Florina)	
Local		

[6]Pseudoacacia nectar. Photo: Pxfuel

Level	Part 2 Target species relevant for agriculture as named in regulations and laws	UC Greece
National	The Habitats Directive has a total of 2 500 species on its list, the Birds Directive has a total of 500 species of wild birds protected. **Species (examples)** *Source: https://biodiversity.europa.eu/countries/greece* **Birds:** • *Buteo buteo, Hirundo rustica, Apus apus, Streptopelia turtur, Tachymarptis melba* **Fish:** • *Alosa macedonica, Alosa vistonica, Aphanius almiriensis, Barbus euboicus* **Plants:** • *Anthemis glaberrima*	
Regional	Bird conservation in Lasser Prespa Lake: benefiting local communities and building a climate change resilient ecosystem (LIFE15 NAT/GR/000936-LIFE Prespa Waterbirds) **Birds:** • *Falco naumanni, Neophron percnopterus, Circus pygargus, Perdix perdix* **Mammals:** • *Ursus arctos* **Red List butterfly:** • *Maculinea Alcon*	
Local	**Birds:** • *Laridae, Corvus commix, Streptopelia decaocto, Parus major, Turdus merula, Pica pica* **Amphibians:** • Lizards, Turtles **Mammals:** • Mice **Plants:** • *Cynodon dactylon, Avena fatua, Avena sp, Triticum vulgarris, Artemissia sp, Mentha longifolia, Echium sp, Convolvulus arvensis, Melilotus albus, Vicia sp, Rubus sp, Alyssum campestre, Papaver rhoeas, Bassia hirsute, Atriplex tatarica, Polygonum papilum, Urtica dioica* **Habitat types close to the experimental plots:** • 6170 (not priority type) Alpine and subalpine calcareous grasslands. Distance 10.2km • 9530 (priority type) (Sub-) Mediterranean pine forests with endemic black pines. Distance 11.5km • 62A0 (not priority type) Eastern sub-mediteranean dry grasslands (*Scorzoneratalia villosae*). Distance 11.7km	

Level	Part 3 Indicator selection for MarginUp!	UC Greece
National	**Species** **Birds:** • *Buteo buteo* • *Hirundo rustica* • *Streptopelia turtur* **Plants:** • *Anthemis glaberrima*	
Regional	**Species** **Birds:** • *Falco naumannii* • *Circus pygargus* • *Perdix perdix* **Red List butterfly:** • *Maculinea alcon* **Plants:** • *Gentiana pneumonanthe*	
Local	**Ecosystem Services (ESS) :** Purification of water and air, Soil protection, Pollination, Flood protection **Species** **Birds:** • *Streptopelia decaocto* • *Parus major* • *Turdus merula* • *Pica pica* • *Falco naumanni* • *Perdix perdix* **Pollinators :** • *Bombus terrestris* • *Bombus lapidaries* • *Polygonia c- album* • *Lasiommata megera* • *Vanessa cardui* • *Protaetia (Potosia) cuprea* **Plants:** • *Melilotus albus* • *Alyssum campestre* • *Vicia sp.* • *Polygonum papilum* • *Artemissia sp* • *Mentha longifolia* • *Echium sp* • *Papaver rhoeas* • *Urtica dioica*	

Level	Part 4 Monitoring activities and NGOs	UC Greece
National	• Natural Environment and Climate Change Agency (N.E.C.C.A.) https://necca.gov.gr/en/home/	
Regional	• Natura 2000 standard data forms • Data of "Regional Strategy for the Biodiversity" **NGOs** • Arktouros • Kallisto	
Local		

6. Conclusions

The task of the developed indicator system RABIS is to create an assessment framework for the effects on biodiversity due to the introduction of new cropping systems on marginal land. This assessment framework is intended to be applicable in a very wide range of contexts, while at the same time being able to address specific regional needs and requirements. This apparent contradiction was resolved for RABIS by the fact that it consists of a universal valid basic structure of basic elements that apply equally to all UCs. The concrete indicators are defined on a UC-specific basis with the participation of regional stakeholders. The definition of the detailed indicators is not static but leaves room for dynamic adjustments over time.

In the development of RABIS, special emphasis was placed on an approach that is as holistic as possible. The approach takes accounts for the different objectives of different political levels, considers different interests of use (nature conservation and agriculture) and allows comparisons to multiple states of references. RABIS is designed in such a way that this complexity always remains transparent by making the "hidden agendas", i.e., the evaluation backgrounds, recognizable.

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8. Annex

Annex A - Questionnaire national level

Leibniz-Zentrum für Agrarlandschaftsforschung (ZALF) e.V.

Questionnaire on nature conservation at national level

Why do we need this?

In MarginUP! the ZALF team will develop a regionally adapted biodiversity indicator system for all use cases over the next few months. In order to master this task, part of our work consists of analyzing whether there are protected species or habitats in the future cultivation regions that need to be given special consideration for the indicator system. It is therefore of fundamental importance for us to know the legal and political requirements of national nature conservation.

Are there national biodiversity strategies, national action plans or lists of protected species or habitats related to CBD (Convention on Biological Diversity)? Is there any specification for agricultural lands?

Do you know of any other national strategies/ reports (HNV) for biodiversity conservation (e.g. strategies for insect/pollinator conservation)?

Are there Red Lists of protected species, habitats or landscapes related to agricultural landscape?

Was/is there any national/regional monitoring of protected species, habitats or biodiversity? (if possible please name sources and contact persons)

Thank you for your support!

Annex B Questionnaire regional level

Leibniz-Zentrum für Agrarlandschaftsforschung (ZALF) e.V.

Questionnaire on nature conservation at regional level

Why do we need this?

The ZALF team will develop a regionally adapted biodiversity indicator system for all use cases over the next few months. In order to master this task, part of our work consists of analyzing whether there are protected species or habitats in the future cultivation regions that need to be given special consideration for the indicator system. It is therefore of fundamental importance for us to know the requirements of regional nature conservation.

Are there any kinds of nature reserves in the use case region or near neighborhood (e.g. national parks, biosphere reserves, Natura- 2000 areas, landscape protection areas etc.)?

Does a biotope network/connectivity plan exist for the use case region? (if possible please name sources and contact persons)

Do you know about monitoring data of animals, plants or landscape structures available in the region? (if possible please name sources and contact persons)

Are there HNV Lists (High Nature Value) of protected species available for the region? (if possible please name sources and contact persons)

Do you know about projects on the subject of nature conservation or species protection in the use case region or in the near neighborhood? (if possible please name them)

Are there regional NGOs that deal with nature conservation, biodiversity or sustainable agriculture? (if possible please name them)

Thank you for your support!

Annex C Questionnaire local level

Leibniz-Zentrum für Agrarlandschaftsforschung (ZALF) e.V.

Questionnaire on nature conservation at local level

Why do we need this?

The ZALF team will develop a regionally adapted biodiversity indicator system for all use cases over the next few months. In order to master this task, part of our work consists of analyzing whether there are protected species or habitats in the future cultivation regions that need to be given special consideration for the indicator system. It is therefore of fundamental importance for us to know the requirements of local conditions. As local we define the fields/experimental plots for growing new biomass crops in MarginUp! and the surrounding area.

Are the experimental plots for MarginUp! part of a nature reserve in the use case region (e.g. national parks, biosphere reserves, Natura- 2000 areas, landscape protection areas etc.)? Please also consider nature reserves overlapping with the plots or in the surroundings.

Are there any special or protected habitat types close to the experimental plots?

Do you know about the occurrences of protected animals or plant species (e.g. Red List) at the experimental plots or surroundings?

Is there a HNV List (High Nature Value) of protected species related to agriculture land for this region?

Are there occurrences of animal or plant species that are related to agricultural land and of special interest for this region? (e.g. because they are a kind of symbol for the region or are important for tourism; e. g. certain bird species like Great Bustard or Montagues Harrier; mammals like rabbits or reindeers; reptiles like Greek Tortoise etc.)

Thank you for your support!