Raising the Bio-based Industrial Feedstock in Marginal Lands

Implementation guidelines of various industrial crops on marginal lands regarding biodiversity impacts

Deliverable 2.2

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[1] PU = Public
PP = Restricted to other programme participants (including the Commission Services)
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4	13 September 2023	ZALF	Michael Glemnitz
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6	29 September 2023	ATB, ZAB	Philipp Grundmann, Thi Huyen Trang Dam, Rebeca Val, Mar Ainhoa Basterrechea

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. In the project, climate resilient and biodiversity-friendly non-food crops will be introduced on marginal and low-productivity lands, not competing 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 good 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 its 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, lands exposed to desertification 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! project makes sure the biomass production on each use case is having a positive impact on the ecosystem. This deliverable (D2.2) is an implementation guideline of various industrial crops on marginal lands regarding biodiversity impacts. 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 use cases and the diversity of the envisaged new utilisation concepts. In addition, MarginUp! claims 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 developed for MarginUp! (D 2.1) 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 regional outside MarginUp!. This report (D 2.2) describes the implementation guidelines of various industrial crops on marginal lands for different use cases regarding biodiversity impacts.

Impact units are elements that facilitate changes within the defined spaces or elements within a territory and contribute to its future evolution in times during which conditions are not usually determined. The cases in question are situations of direct impact on the natural and agricultural environment of a territory. Its assessment focuses on the direct consequences that are generated on a set of previously defined indicators within each of the selected environment units. The changes identified through the indicators are neutral, positive or negative. The degree of positivity or negativity are the elements that determine the degree of impact of an action on the environment and consequently on the use case areas.

In the Methodology of this report, the biodiversity impacts are described. The impact values will be projected on a matrix for each of the established elements, defining the impact lines and their direct or indirect impact on each element. The final result will facilitate the integration of all impact values on the element and conclude with a defined and comprehensive impact on the study element for each use case and situation.

Disclaimer

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List of Acronyms

ESS	Ecosystem Services
FU	Fertilization units
KFU	Potassium fertilizer units
NFU	Nitrogen fertilizer units
NPK	Nitrogen, phosphorous, potassium
PFU	Phosphorous fertilizer units
SPA	Special Protection Area
UC	Use Case

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Keywords list

Biodiversity

Landscape

Ecosystem services

Environmental impact

Bioenergetic crops

Traditional land use

1. Introduction

Agricultural areas receive continuous pressure from the development of agricultural activity, especially in the natural fraction of the area where the crop is developed. The knowledge of the elements that change, are transformed or simply must be recovered from the impacts constitute the basis for developing useful tools that allow knowing the awareness of modification that an environment supports as a result of an activity.

MarginUp! facilitates the improvement of the conditions of sustainability and exploitation in marginal areas with the implementation of measures that facilitate a brake or reduction of negative effects generated by agricultural activities on the use case areas. Additionally, improvements in environmental conditions are promoted with an exhaustive monitoring of all the processes in which agricultural activity is developed.

The measure that facilitates an objective estimate of the transformations, changes or recoveries in the environment is the evaluation of the impacts produced by agricultural activity, valuing these as positive or negative.

The changes produced in some of the elements (indicators) that make up the system, allows us to follow the evolution of environmental and productive processes and assess the sustainability of agricultural areas. The impact assessment is a basic tool that objectively applies a scalable impact weight to each of the actions that affect the surveillance system. The level of accuracy of the assessment of the level of impacts, the impact of the actions on the environment of the actions and their ultimate stability, depends on the quality of the information generated from the monitoring of the selected indicators, the coherence of the information obtained and finally the correct analysis of the information.

The impacts are globally and regionally compensated, and the overlapping actions facilitate an adequate vision of the processes in which agricultural systems are involved and especially those that are the most vulnerable. We can discriminate between the absence of impacts, the presence of impacts that strengthen the environment (positive impacts) and those that weaken it (negative impacts). The final value is a sum of limitations and strengths. Positive actions on the environment are the ones that promote the recovery of the environment against negative impacts.

All these reflections are part of the process to measure the impacts to which each of the spaces of action in MarginUp! will be subjected, because of direct actions on the environment. The methodological protocol to be followed and the search for homogeneous patterns and objectives that allow a final contrast between all systems and actions are the objectives of the methodology set out below.

2. Methodology

Impact units are elements that facilitate changes within the defined spaces or elements within a territory and contribute to its future evolution in times that are not usually determined.

The cases in question are situations of direct impact on the natural and agricultural environment of a territory. Its assessment focuses on the direct consequences that are generated on pre-defined indicators within each of the selected environment units.

The impacts on the indicators are neutral, positive or negative although the degree of positivity or negativity are the elements that determine the degree of impact of an action on the environment and consequently on the use case areas.

The impact values will be projected on a matrix for each of the established elements, defining the impact lines and their direct or indirect impact on each element. The final result will facilitate the integration of all impact values on the element and conclude with a defined and comprehensive impact on the study element for each case and situation.

An example can be seen in Table 1 for the degree of impact on soil (element) as a result of herbicide treatment for tomato cultivation under traditional agricultural conditions

Table 1. Soil impact of herbicide treatment in tomato cultivation under traditional agricultural conditions

IMPACTS/INCIDENTS	BIOTA	STABILITY	WATER	PRODUCTION	SOCIAL	ECONOMIC	GLOBAL
Systemic herbicide	-	-	-	+	0	+	5(-)
Contact herbicide	-		-	+	0	+	1(-)
Pre-emergency herbicide	-	-	-	++	0	+	5(-)

2.1. The model of development of impacts in MarginUp!

The monitoring of the development of impacts considered in each of the use case areas is necessary to delimit them based on previously established criteria with the indicators.

Origin and characterization of the environment (before development in the indicators document)

- Previous actions and their development
- Productive actions
- The impact contacts and relations
- Final valorization of impacts

In our case, we must propose a specific methodology that delimits the following assumptions:

- Interactions between impacts
- Impacts and time
- Integrated sum of impacts

The development of each of the methodological units follows:

2.1.1. Interaction between impacts

Cropping systems produce different impacts on the environment that are sometimes the result of the direct impact of the action on one element but also the subsequent consequences this can have on the rest of the elements. An example that can illustrate this trend is the change in soil water content that positively affects agricultural production. Although it has an impact on additional water consumption, a transformation in soil biota and a change in soil depth increase the ability to withstand the presence of microorganisms.

2.1.2. Impacts and time

The final assessment of an impact needs to be dimensioned temporarily. The landscape units and especially the biotic elements, with great plasticity, tend to recover over time from man-made interventions and changes *in exploitation systems.*

In addition, the consequences of these changes are not immediately observed, and it is necessary to allow time to measure and evaluate more correctly the possible impacts or the modification of the elements.

The set of situations that are organized as result of time will be assessed seasonally to determine immediate impacts, recoveries and impacts a-posteriori, within the monitoring and recovery units.

2.1.3. Integrated sum of impacts

Impacts are understood as interaction on elements, or changes to the current situation of an element and its context. Sometimes the impacts generate new impacts and their consequences are projected beyond the initial elements on which they affect.

Impacts on the richness of pollinators due to phytosanitary treatments, not only facilitate a reduction in the overall burden of pollinators on the environment, contribute to a lower efficiency in the pollination of crops and consequently facilitate a negative impact or reduction of agricultural production, but are also linked to a decrease in economic income and a lower profitability of the environment with the additional impact on the stability of human populations in rural areas.

2.1.4. Criteria for the delimitation of impacts

The indicators outlined in the previous document (Glemnitz et al., 2023) allow for a very close sequence of monitoring and will provide close and up-to-date information in the monitoring of effects that occur in the agricultural study areas in MarginUp!

The fundamentals for defining an impact on the established indicators are supported by variations at the specific or generalized level and on an immediate, medium or long term scale on the indicator(s) monitoring.

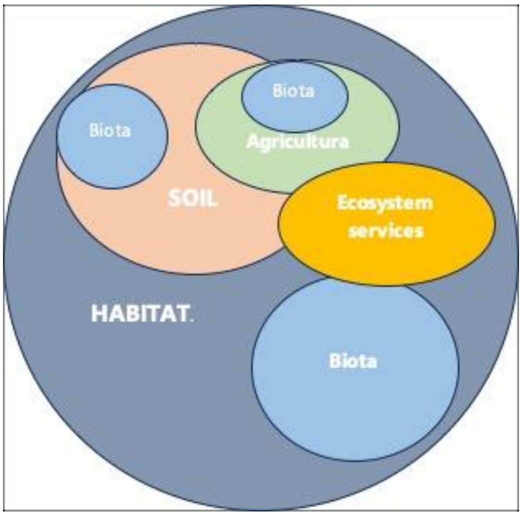

Figure 1. Interrelations between the elements origin of the indicators in the MarginUp! system and the impacts valorization

There are variations that are not immediately detected and are not observed after a period of time; Covert variations that are not noticeable until indicators are shown (e.g. seasonal flora or fauna); Variations that are only shown in a short period of time and after the passage of days are negligible (e.g. indicator recovery); Variations only noticeable after instrumental analysis (e.g.

chemical, microbiological variations); All variations or impacts that can be covered up by the lack of proper follow-up will be detailed in the assessment and processing of impacts.

The following criteria will be the basic principles in the application and definition of impacts:

1. Direct impacts on biota.
    - Changes in the composition and structure of established indicators.
    - Changes in habitat quality for the taxa established as indicators.
    - Limitations in the population development (e.g., reproduction) of taxa established as indicators.
2. Impacts on soil.
    - Changes to the indicators established to monitor the soil.
    - Variations in crop yields as result of soil modifications.
    - Changes in soil quality and composition (e.g., pH, electrical conductivity…).
3. Impacts on habitats.
    - Changes in indicators established to characterize the landscape.
    - Changes in the indicators that define the habitat quality.
    - Perception of the indicators established to characterize the habitat.
4. Impacts on ecosystem services (ESS).
    - Variations in indicators established to measure selected priority ESS.
    - Losses of values or elements that influence the indicators established to measure selected ESS.
5. Impacts on the agricultural systems.
    - Indicators for the sustainability of the agricultural system,
    - Impacts on the quality of the marketable product and the income capacity
    - Contributions or losses to the ecological environment, expressed on the basis of established environmental indicators.

2.2. Follow-up methodological development in each unit of action

Specific elements on which impacts can potentially occur in the four monitoring areas are described on the basis of the previously established indicators.

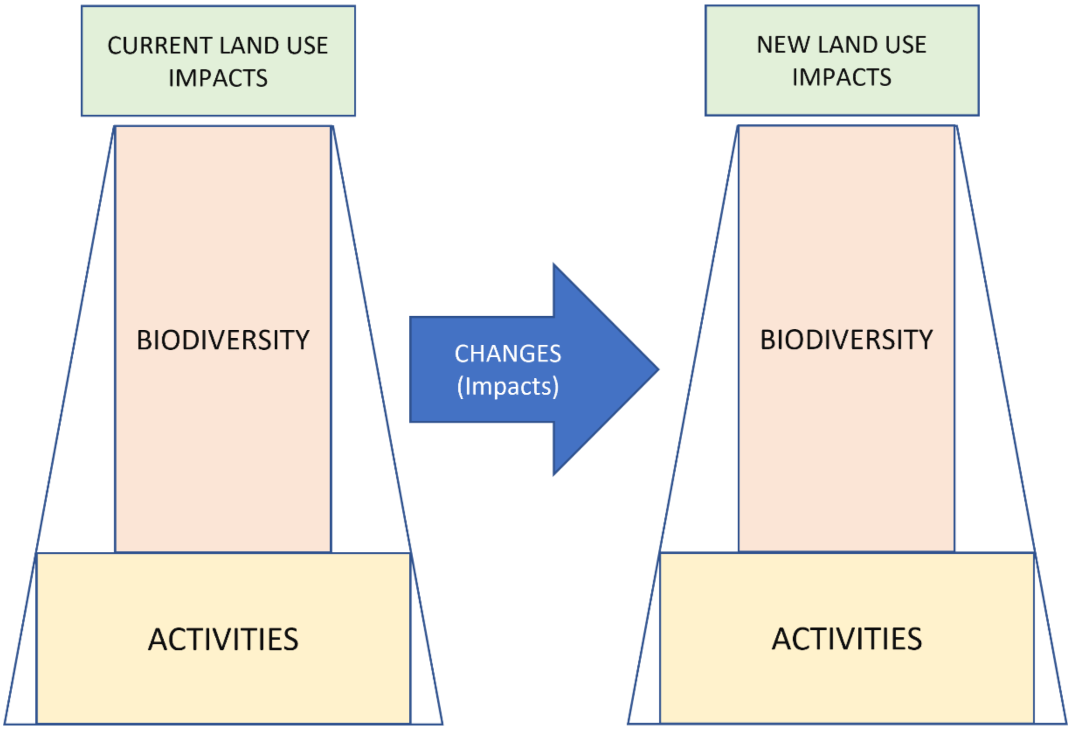

Figure 2. Changes in the traditional and new land uses valorization of impacts

2.2.1. Current or traditional land use (Part 1)

In this chapter, each use case (UC) shown in the study region will be described the starting frame conditions for the assessments on potential environmental impacts, e.g., soil, water and biodiversity.

Land use is a broad concept within so-called environmental management tools. We must delimit the use of land to a concept that includes the following aspects that can facilitate the knowledge of the impacts that are generated as a result of the applications of change of use in agricultural productions, crops and methodologies to reach new productions:

1. The landscape as a diverse crop space where it is necessary to evaluate agrarian diversity.

2. The landscape as an environmental space where it is necessary to measure the diversity of soils that compose it.

3. The landscape as a spatial unit where it is necessary to assess the diversity or homogeneity of the agrarian environment and its bordering areas.

4. The landscape as a place that inhabits a diverse or homogeneous biota where it is necessary to know its species richness.

5. The landscape as a sink of human influence where it is necessary to know the anthropic activities that develop.

6. The landscape as a space where a water system is organized that we must dimension.

7. The landscape as an economic and species richness space where tangible and intangible productions are generated annually that must be valued

8. The landscape as a space that projects leisure and intangible environmental values that it is necessary to dimension.

The knowledge of the previously established units will allow dimensioning the place where the impacts are affected, their size and resilience of the areas as consequences of crop changes and activities in the marginal areas of study.

2.2.2. New land use – industrial crops (Part 2)

In this chapter each crop (here: new industrial crops) will be described to assess possible environmental impacts, e.g., soil, water, and biodiversity.

As in the previous section and after the changes offered to the environment because of the change of use and cultivation, similar follow-up actions are established in the evaluation of impacts that allow their contrast. Follow-up lines shall be the same as set out in the previous section:

1. The landscape as a diverse crop space where it is necessary to evaluate agrarian diversity.

2. The landscape as an environmental space where it is necessary to measure the diversity of soils that compose it.

3. The landscape as a unit of the landscape where it is necessary to assess the diversity or homogeneity of the agrarian environment and its bordering areas.

4. The landscape as a place that in habits diverse or homogeneous biota where it is necessary to know its species richness.

5. The landscape as a sink of human influence where it is necessary to know the anthropic activities that develop.

6. The landscape as a space where a water system is organized that we must dimension.

7. The landscape as an economic and species richness space where tangible and intangible productions are generated annually that must be valued.

8. The landscape as a space that projects leisure and intangible environmental values with the necessity to dimension.

The contrast between the incidence and impacts initially and after the changes in the monitoring plots will make it possible to measure and evaluate the incidence of impacts associated with the MarginUp! crop alternatives.

2.2.3. Biodiversity (Part 3)

It is necessary to consider the current situation of habitats and their connectivity. This work will evaluate the existence of refuge areas for biodiversity (e.g., animals, plants, etc.) and their functionality for the selected biotic indicators (see task 2.1.)

Within this framework and linked to the general monitoring process in the study plots, it is necessary to indicate the elements of biodiversity that will be susceptible to change and their assessment within the impact section. The elements to consider will be the following supported by the previously established indicators:

- Changes in the species richness and quantity of pollinators.
- Changes in population trends of selected indicator species.
- Evaluation of animal-plant interactions in study systems.
- Assessment of habitat connectivity for selected indicator species.

2.2.4. Impacts on biodiversity (Part 4)

Finally, the main environmental impacts factors of each crop (traditional land use and industrial crops) will be described. It is important to determine the different levels of environmental impacts that land use change will cause.

It will be of interest to monitor the processes of the biota that is configured in each of the use case areas. For this purpose, the impacts that allow determining the influence of the change of agricultural activity in the monitoring units will be evaluated based on the established indicators, and based on the changes in biodiversity. Elements of attention will be:

- Impacts on soil before and after-the cropping system changes.
- Impacts on the pre and post floristic structure to changes in the cropping system.
- Impacts on species richness pre and post to changes in the cropping system.
- Impacts on the presence of pollinators' pre and post to changes in the cropping system.

The overall assessment of the impacts on each of the elements and interactions studied will allow us to define the degree of influence of changes in activity in marginal areas as result of the new cropping systems.

2.3. Basic questionnaire

During the development of the impact assessment methodology, it is necessary to know the starting situation in each of the scenarios in which the project is developed facilitating an approximation of the potential impacts before and after the changes in the use cases areas.

In order to have this information, it has been requested on the basis of the questionnaire previously agreed with all partners a document that allows establishing the starting situation in the territory and the potential lines of impacts that can be offered in the new cropping systems (see 4.1. Annex 1 Questionnaire on (potential) biodiversity impacts).

The previous questionnaire will serve as a link to the impact assessment study and will allow inferences in the elements that may potentially have a higher degree of transformation and impacts.

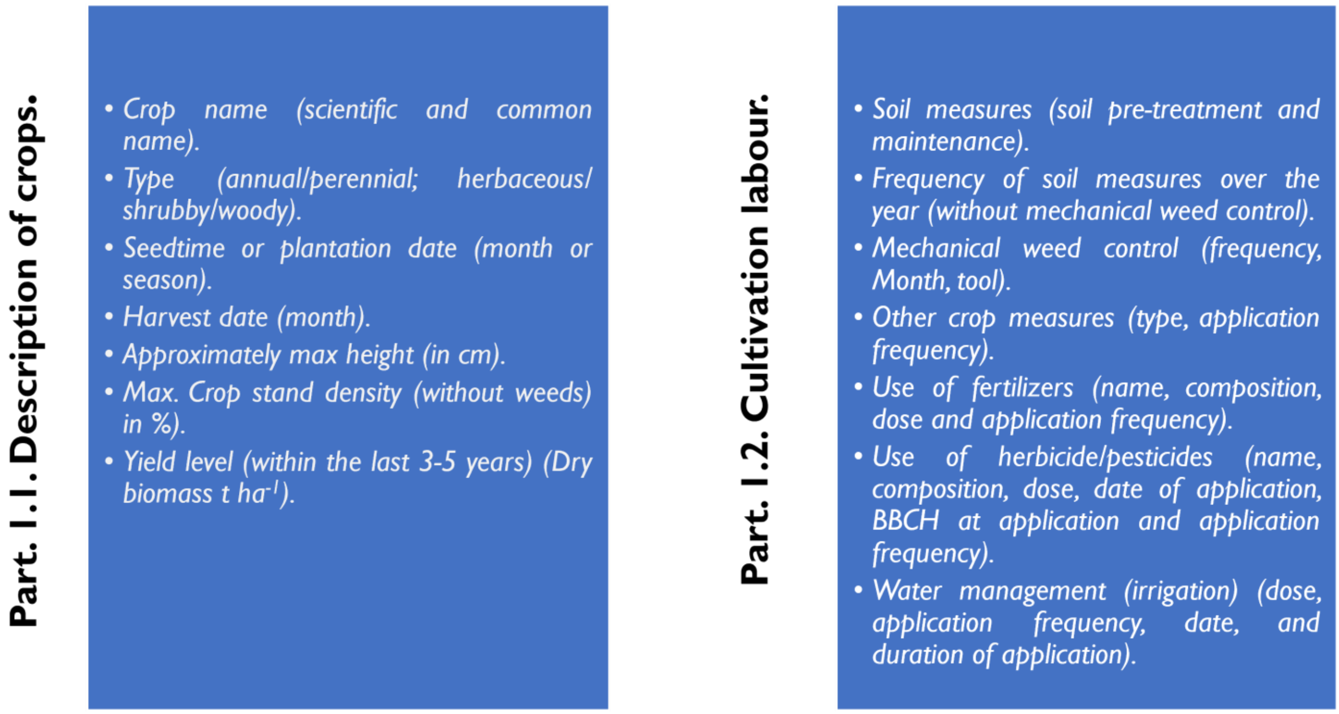

Figure 3. Part 1. Present or traditional land use.

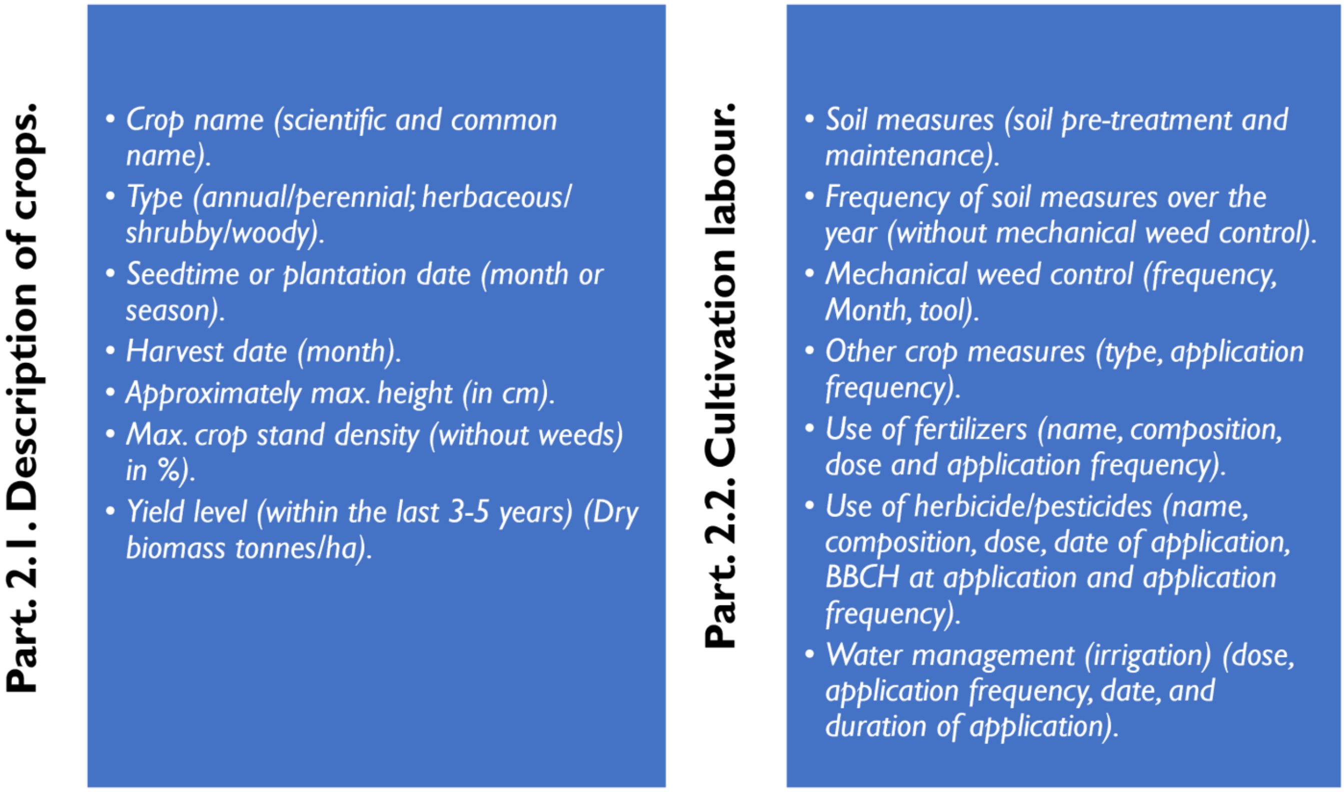

Figure 4. Part 2. New plant use-bioenergetic crops.

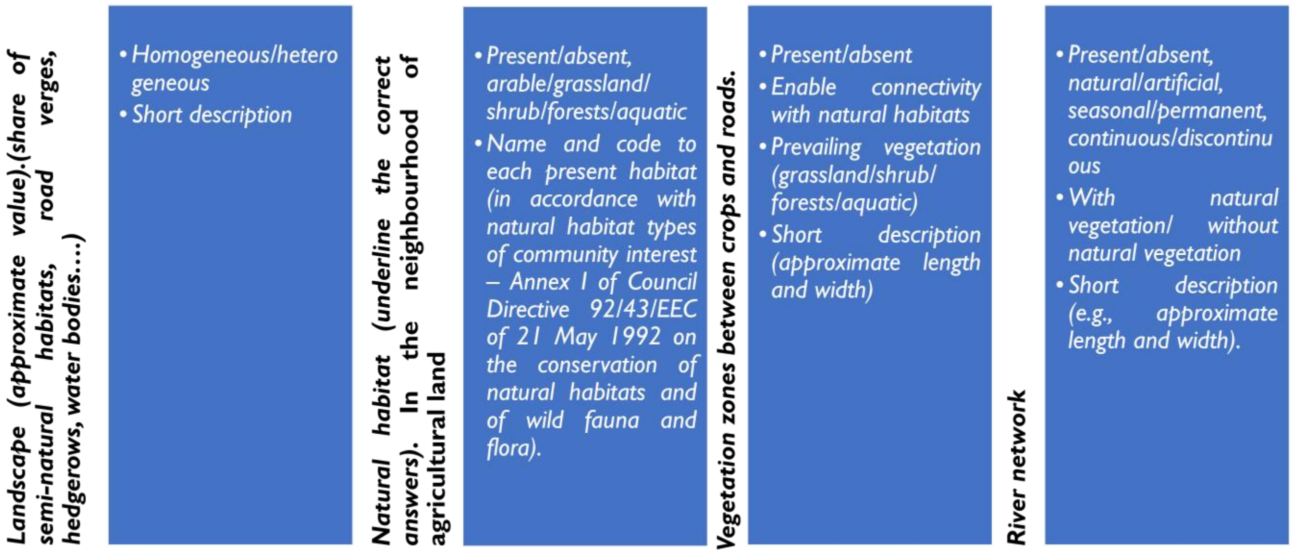

Figure 5. Part 3. Biodiversity

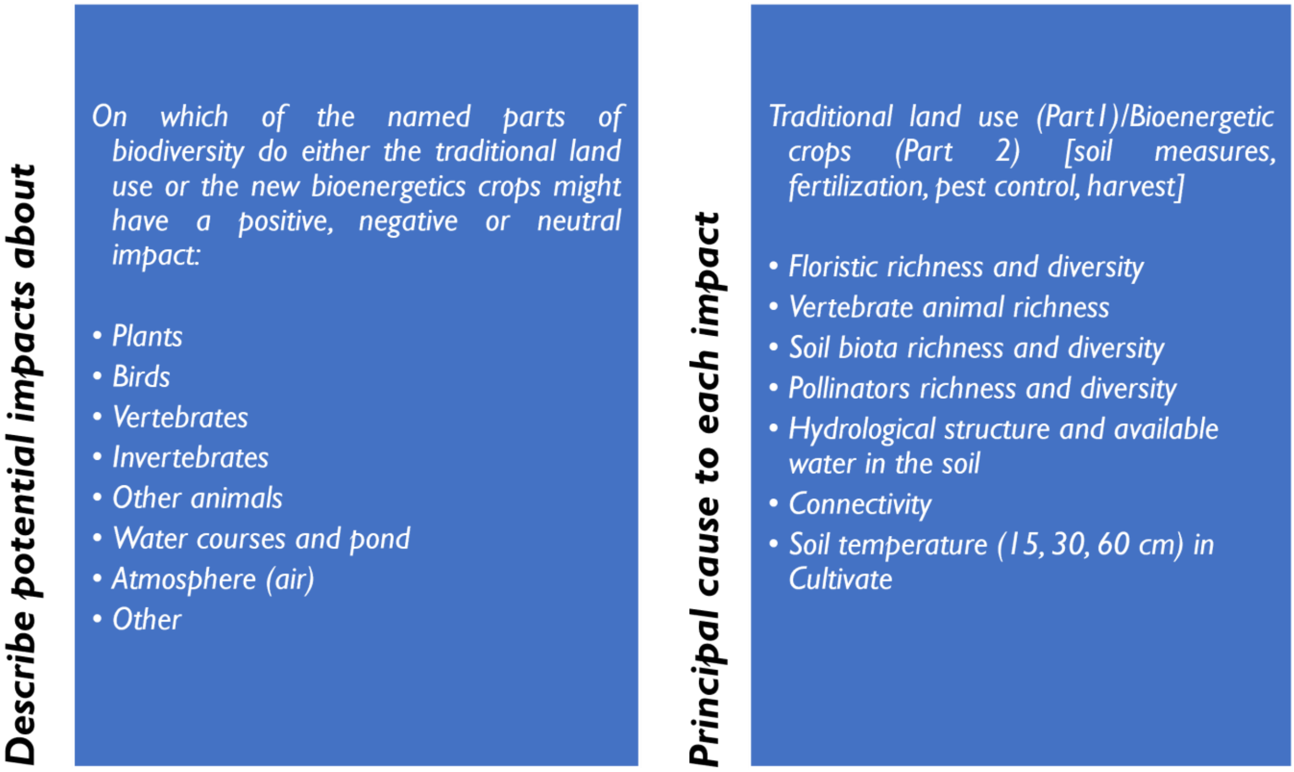

Figure 6. Part 4. Impacts on biodiversity

2.4. Data analysis

With the information provided by each use case leaders the main impacts (on plants, birds, vertebrates, invertebrates, other animals. water courses and ponds, atmosphere, and others) produced by land use change (traditional land use vs bioenergetic crops) will be synthesized indicating the sign of the impact [negative (-), neutral (0), positive (+)] (see table 2). It will also allow us to measure the main environmental impacts on the soil, flora, fauna, etc., produced by the actions derived from the preparation and maintenance of the soil, herbicide treatments, pest and disease control and harvest activities comparing the traditional land use and the bioenergetic crops (see table 3).

2.5. Projection in the agro-ecosystems and society (Final considerations)

The effects of human actions on the environment are fundamental causes in the imbalances of the environment and especially of the modifications in the biodiversity and stability of the habitats. Having tools to assess the degree of affection that has the cultivation of agricultural products with industrial interest, in marginal areas of European agricultural systems supposes immediate benefits to conserve and manage more adequately the agricultural spaces of the temperate and Mediterranean climate systems in the European continent.

The direct benefits of using tools that monitor human-crop-environment interactions and their impacts on the biodiversity of systems could be listed as below:

- Improvements in the conservation and management of biodiversity.
- Improvement in the environmental conditions and sustainability of agricultural crops.
- Generation of agricultural products with better sanitary conditions.
- Improvements in the quality of agricultural products for industrial or food use.
- Increase of ecosystem services.
- Increase of the tools aimed at improving the sustainability of agricultural systems.
- Improvement/optimization of cropping systems for new industrial crops

All these benefits represent an increase in the profitability of farms from the environmental point of view, a direct investment in the increase of global biodiversity and substantial improvements in the quality of the products generated in agricultural systems, especially those destined for food.

The ability to be a ductile tool, which can be adapted to other environmental conditions and other crops, in addition to those established in MarginUp! represents a significant advance in the potential for use in agricultural systems, especially in marginal areas.

This tool can be exported to other areas of the planet where there are similar agricultural systems or in temperate or / and Mediterranean habitat conditions.

3. Fact sheets for the UCs

3.1. Spain

Description UC Spain

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.

PART 1. PRESENT OR TRADITIONAL LAND USE

PART. 1.1. DESCRIPTION OF CROPS

Crop name (scientific and common name): Tomato for processing industry (*Solanum lycopersicum*).

Type (underline the correct answers). Annual. Herbaceous.

Seedtime / plantation date (month or season). It depends on the variety, average cycle of about 100 days. Transplant in April-May.

Harvest date (month). August-September.

Approximately max height (in cm). 200 cm.

Max. Crop stand density (without weeds!). 30,000–40,000 plants ha^{-1}.

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1}): 90–95 t ha^{-1}.

Crop name (scientific and common name). Corn (*Zea mays* L.)

Type (underline the correct answers). Annual. Herbaceous.

Seedtime / plantation date (month or season). It depends on the cycle. Average cycle 120 days. Sowing in April-May

Harvest date (month). September-October.

Approximately max height (in cm). 200–250 cm,

Max. Crop stand density (without weeds!). 60,000 – 65,000 plants ha^{-1}.

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1}): 5–6 t ha^{-1}.

PART. 1.2. CULTIVATION LABOUR

Crop name (scientific and common name): *Tomato for processing industry (Solanum lycopersicum).*

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

Preparation of the land: incorporate the harvest remains of the previous crop into the soil with a harrow. Semichisel pass in February. Harrow or cultivator work incorporating fertilizer in March. Conformation of beds in April.

Frequency of soil measures) over the year (how many times per year) (without mechanical weed control)

Mechanical weed control (indicate: yes or no; how many times, Month, tool)

Mechanical weeding of weeds as a complement to herbicides. Depends on their incidence.

Other Crop measures (indicate: type and application frequency).

Transplant and placement of drip irrigation in April.

Mechanized harvesting in August-September with a self-propelled machine yielding 5-7 hours ha^{-1}.

Use of fertilizers (indicate: name, composition, dose, and application frequency).

It is done a few days before the time of transplanting in the field in order to supplement the soil with the nutrients that the tomato will need in the first weeks in the field. The most common type of fertilizer is an NPK in the ratio 8:15:15 or 15-15-

15.

The application dose varies depending on the previous analysis of the soil, but it is usually around 600 kg ha^{-1}

Top dressing. It will be carried out by fertigation from the 3rd week after the transplant. The most common products include: N20 (NPK 20-0-0): 350 l ha^{-1}, Potassium solution (NPK 0-0-15): 200 l ha^{-1}, Calcium nitrate solution 8 (16): 300 l ha^{-1}.

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency).

Herbicides: Pendimenthalin 45.5%. 2 l ha^{-1} (before transplant) Metribuzin 70%. 0.5 kg ha^{-1} (after transplant).

Insecticide: Abamectin 1.8%. 0.15 l ha^{-1} (1-2 applications).

Depending on the incidence of pests and diseases in the campaign, other types of products such as fungicides or insecticides may additionally be used.

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

Daily water supply from transplant until 3-4 days before harvest. Drip irrigation. Flow rate of 1,324 l $hour^{-1}$ per dripper. Contribution per campaign of about 5,200 m^3 of water per hectare.

Crop name (scientific and common name). Corn (*Zea mays.* L.).

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

Land preparation: harrowing in autumn to incorporate the stubble from the previous crop.

Application of limestone amendments at a dose of 500 kg ha^{-1}.

Work with semichisel in February and pass to the harrow or cultivator incorporating the pre-sowing fertilizer.

Frequency of soil measures) over the year (how many times per year) (without mechanical weed control). -

Mechanical weed control (indicate: yes or no; how many times, Month, tool): -

Other Crop measures (indicate: type and application frequency). -

Use of fertilizers (indicate: name, composition, dose, and application frequency). -

Pre-sowing fertilization It is done a few days before planting. The most common type of fertilizer is an NPK in the ratio 10:20:30. The application dose varies depending on the previous analysis of the soil, but it is usually around 750 kg ha^{-1}.

Top dressing: 600 kg ha^{-1} nitrogen fertilizer N_2O.

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency).

Herbicide: Pre-sowing to control broad-leaf and narrow-leaf weeds, post-emergence to control narrow-leaf weeds.

Insecticide: Insecticide to control soil insects

Depending on the incidence of pests and diseases in the campaign, other types of products such as acaricides may additionally be used.

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

Water contribution on a weekly basis. Average consumption of 6,500 m^3 ha^{-1}.

Estimated average production on marginal land plots is 8,000-10,000 kg ha^{-1}.

PART 2. NEW LAND USE - BIOENERGETIC CROPS

PART. 2.1. DESCRIPTION OF CROPS

Crop name (scientific and common name). Kenaf (*Hibiscus cannabinus* L.).

Type (underline the correct answers). Annual. Herbaceous.

Seedtime / plantation date (month or season).

Planting date in Extremadura: Requires soil temperatures between 12-14 ºC.

In the Coria region, it would be sown between the last week of April and the first week of May.

1000 seeds weigh about 26 grams, with a sowing frame of 0.5m x 0.06m, for about 333,333 seeds ha^{-1}, the seed dose per hectare will be about 9 kg ha^{-1}.

Harvest date (month).

Depending on the quality of fiber that is required, two harvest dates can be. The most usual, when the crop is in the early flowering phase (which usually coincides when about ten flowers per plant have opened) in order to obtain the maximum yield and fiber quality. The harvest will take place during the month of September.

The other harvest date would be in the month of January-February, with the plant completely dry in the field.

Approximately max height (in cm). 250–300 cm.

Max. Crop stand density (without weeds!). 300,000–400,000 plants ha^{-1}

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1}): 15–20 t ha^{-1}.

Crop name (scientific and common name): Hemp (*Cannabis sativa* L.)

Type (underline the correct answers). Annual. Herbaceous.

Seedtime / plantation date (month or season).

Sowing date in Extremadura: Requires soil temperatures between 8 -10 ºC, emerging rapidly in 8-12 days.

In the Coria region, it would be sown between April 15 and May 15. The weight of 1,000 seeds is about 18 g, for a density of 250-300 plants m^{-2}, the seed dose per hectare will be between 40-60 kg ha^{-1}.

Harvest date (month).

If the production is going to be used for fiber and the sowing date has been at the beginning of May, the harvest of the crop will be at the beginning of flowering (97 and 114 days from nascence).

Approximately max height (in cm). 180–200 cm.

Max. Crop stand density (without weeds!). 500,000–700,000 plants ha^{-1}.

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1}): 6–8 t ha^{-1}

Part. 2.2. Cultivation labour

Crop name (scientific and common name). Kenaf (*Hibiscus cannabinus* L.).

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

Harrow pass (autumn) to break up the harvest remains of the previous crop and eliminate weeds.

Pass of Chisel, as deep primary work (30-40 cm) in the month of February.

Distribution of the fertilizer before sowing. (April-May).

The pre-sowing herbicide is distributed. (April-May).

Incorporation of the ground fertilizer and herbicide with a pass of Kongs-Kilder, leaving the land ready for sowing. (April-May).

Sowing with a precision pneumatic seeder, at a distance between rows of 50 cm and distance between seeds 6 cm. (May).

Installation of sprinkler or drip irrigation, according to the chosen system (end of May). Top-dressing (30 days after sowing).

Harvest, it can be done on two dates (September or January–February): Harvest date September: Mow with a forage harvester, cutting whole stems, letting it dry on the ground and later turning-rowing the kenaf plants. Packaged in round bales. The January-February harvest with the dry material, a forage chopper will be used.

Frequency of soil measures over the year (how many times per year) (without mechanical weed control)

Mechanical weed control (indicate: yes or no; frequency, Month, tool)

Other Crop measures (indicate: type and application frequency).

Parameters to study: Number of real plants per hectare and date of emergence from sowing. (2 times every 7 days), Incidence of pests and diseases in the crop (every 7 days, throughout the crop), Plant height control every 15 days until maturation, Irrigation control every week and verify the real water consumed, in the campaign for the crop, Date of beginning and end of flowering (every 7 days during the flowering period), At harvest, dry matter content and % of long and short fibers in the kenaf stalks will be determined.

Use of fertilizers (indicate: name, composition, dose, and application frequency).

For production of 15 t dry matter stalks ha^{-1}., 400 kg ha^{-1} of the complex 8-15-15 (32-60-60) will be before sowing. Top-dressing (30 days after sowing), 200 kg ha^{-1} of Urea 46% N will be provided at once (92 NFU). The total contribution of fertilizer units provided with mineral fertilizer is 124-60-60.

USE OF ORGANIC FERTILIZER + MINERAL

-Another possibility is to use an organic fertilizer as pre-sowing fertilizer, either from cattle in the area or from pig slurry (for this we have to calculate the doses to provide in order to have a balanced fertilization). The top-dressing contribution of nitrogen would be mineral. The use of organic fertilizers provides a series of advantages: - Increased soil fertility. - Saving of synthetic fertilizers. - Energy saving. - It complements perfectly with mineral fertilizers. The average fertilizing content of pig manure is 2.4 NFU m^{-3} (useful), 1.8 PFU m^{-3} and 3.6 KFU m^{-3}. If a dose of 20 m^3 ha^{-1} is used, 48-36-72 units of N-P-K are contributed. To provide approximately the same fertilizing units as with mineral fertilizer, a phosphoric fertilizer will be used, such as 18% calcium superphosphate (200 kg 18% calcium superphosphate) (36 FU PO_2O_5). The contribution of fertilized units would be: 48-72-72. In top-dressing (30 days after emergence), 165 kg ha^{-1} of 46% Urea would be applied (76 NFU). The total contribution of fertilizer units is: 124-72-72.

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency).

The objective is not to have to use herbicide in the crop, using integral practices (crop rotation, mechanical control, etc.). If the crop rotation is not well defined in the first years and it is necessary to use an herbicide, it would be a single pre-emergence treatment of the crop with the active material pendimentalin 33%, with a dose of 3 l ha^{-1}.

Water management(irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

The doses of water to be used, being a spring-summer crop in an area with no rainfall in this period, will be between 4,500 m^3 ha^{-1} and 7,000 m^3 ha^{-1}, depending on the irrigation method to be used in the plot: If surface irrigation is done (less efficient irrigation) the average would be: 2 irrigations in May, 4 in June, 4 in July and 4 in August. 14 irrigations x 400 m^3 ha^{-1} = 5,600 m^3 ha^{-1}. Sprinkler irrigation, with a 12 x 12 m sprinkler frame and a flow rate per sprinkler of 1,000 l h^{-1}. If we provide 14 irrigations in the campaign, with a flow of 272.7 m^3 ha^{-1} and irrigation = 3,818 m^3 ha^{-1}. Drip irrigation with a 1m x 0.33m frame with a flow rate of 3.4 l m^{-1}. If we irrigate for 2 hours each irrigation, we are contributing 68 m^3 ha^{-1} and irrigation x 42 irrigations (irrigation from May 15 to August 15, with a frequency of three weekly irrigations) = 2,856 m^3 ha^{-1}.

Crop name (scientific and common name). Hemp (*Cannabis sativa* L.).

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

1. Harrow pass (autumn) to break up the harvest remains of the previous crop and eliminate weeds, 2. Chisel, as deep primary work (30-40 cm) in February 3. Distribution of the fertilizer (April-May), 4. Incorporation of the fertilizer with Kongs-Kilder, leaving the land ready for sowing. (April-May), 5. Sowing with a cereal seeder, at a distance between rows of (9-17 cm) (April-May), 6. Installation of sprinkler or drip irrigation, according to the chosen system (end of May), 7. Topdressing,

with fertilizer (30 days after sowing), 8. Harvest, the first week of August. With Kemper head forage harvester. The plants are left to dry between two or four days, then a turner-rower will be used and later they will be packed in cylindrical bales, 10. Finally, they will be transported by truck to the processing industry, which will normally be within a radius of 50 km.

Frequency of soil measures over the year (how many times per year) (without mechanical weed control): --

Mechanical weed control (indicate: yes or no; frequency, Month, tool): --

Other Crop measures (indicate: type and application frequency).

Parameters to study: Number of plants per hectare and date of emergence from sowing. (14 days after sowing); incidence of pests and diseases in the crop (every 14 days, throughout the crop), plant height controls every 15 days until maturation, irrigation control every week and verify the actual water consumed in the crop campaign, date of beginning of flowering (every 7 days during the flowering period); at harvest, study of the yield of stalks per hectare, dry matter kg ha^{-1}, and the % of long and short fiber at the end of the crop cycle.

Use of fertilizers (indicate: name, composition, dose, and application frequency).

Macronutrient requirements per ton of dry matter:
18-24 kg nitrogen (N) 5-10 kg of P_2O_5. 20-40 kg of K_2O.
For a stalk production of 8 -10 t of DM ha^{-1}, total needs are 100-50-150. Mineral fertilizer 9-18-27, with a contribution of 400 kg/ha, fertilization units NPK: 36-72-108. To make a balanced contribution, we will have to incorporate 64 NFU in the form of UREA 46% (140 kg ha^{-1}) or make a fertilizer in cover with a calcium ammonium nitrate of 27% (240 kg ha^{-1}).
USE OF ORGANIC FERTILIZER+MINERAL
-Another possibility is to use an organic fertilizer, either from cattle in the area or from pig slurry (for this we have to calculate the doses to provide in order to have a balanced fertilization). The average fertilizing richness of manure in FU m^{-3}: 2.4 NFU m^{-3} (useful), 1.8 PFU $m^{-3}$and 3.6 KFU m^{-3}. If we make a contribution of 20 m^3 ha^{-1}, the contribution is 48-36-72. To provide approximately the same fertilizing units as with mineral fertilizer, a potassium fertilizer has to be added, 50% potassium sulphate, with a dose of 150 kg ha^{-1} (75 FU K_2O) and 100 kg ha^{-1} of calcium superphosphate 18% (36 FU P_2O_5). The remaining 52 NFU, it can be incorporated with a 46% Urea, on 113 kg ha^{-1}, or contributed with a 27% calcium ammonium nitrate with a dose of 193 kg ha^{-1}.

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency).

An attempt will be made not to have to use herbicide in the crop, using integral practices (crop rotation, mechanical control before sowing, increasing sowing doses, etc.

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

The doses of water to be used, being a spring-summer crop in an area with little rainfall in this period, will be between 2,500 m^3 ha^{-1} and 4,000 m^3 ha^{-1}, depending on the irrigation method that is going to be used in the plot:
If surface irrigation is used (less efficient irrigation) the average would be: 2 irrigations in May, 4 in June, 4 in July. 10 irrigations x 400 m^3 ha^{-1} and irrigation = 4,000 m^3 ha^{-1}.
Sprinkler irrigation, with a 12 x 12 m sprinkler frame and a flow rate per sprinkler of 1,000 l h^{-1}. If we provide 10 irrigations in the campaign, with a flow of 272.7 m^3 ha^{-1} and irrigation = 2,727 m^3 ha^{-1}.
Drip irrigation with a 1 m x 0.33m frame and a flow rate of 3.4 l m^{-1}. If we irrigate for 2 hours each irrigation, we are providing 68 m^3 ha^{-1} and irrigation x 36 (irrigation from May 15 to August 30, with a frequency of three weekly irrigations) = 2,448 m^3 ha^{-1}.

PART 3. BIODIVERSITY

Landscape (approximate value). (share of semi-natural habitats, road verges, hedgerows, water bodies….):

Value (homogeneus/heterogeneus): 6.

Short description:
The study area is characterized by being a highly modified space due to the abundant availability of water and the predominant use of livestock, complementary to agriculture, which conditions the management of farms favoring the presence of plant elements. In general, the state of the landscape is far from ideal and there is a wide margin for improvement. The characteristic double use, agricultural and livestock that occurs in the area conditions the configuration of the landscape, giving rise to a landscape of a certain heterogeneity with the presence of different plant formations that contribute to diversify the environment.

Natural habitat (underline the correct answers). In the neighbourhood of agricultural land

Present, grassland / shrub

Name and code to each present habitat (in accordance with natural habitat types of community interest – Annex I of Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora):
Thermic to sub-themic scrubs pre-stepe (5330): Scrubs of very different nature and physiognomy which have in common that they occur in the warmest vegetation floors of the Iberian Peninsula and the islands, with the exception of those included in other habitats; Sub-stepes of anual Grass of *TheroBrachypodietea* (*) (6220): More or less open xerophilous grasses formed by various grasses and small annual plants, developed on dry, acidic or basic substrates, in generally poorly developed soils, Mediterranean Woodlands "Dehesas perennifolias de Quercus spp." (6310) Open Woodlands with annual grasslands formations (dehesas), with oak especies such as *Quercus suber* y *Quercus rotundifolia*, Thermic ash forests of Fraxinus angustifolia (91B0): Narrow-leaved ash (*Fraxinus angustifolia*) or flowering ash (*Fraxinus ornus*) forests, distributed throughout the Mediterranean region, typical of soils with some moisture.
The categories (retamares, meadows and majadales) would be associated with the existing dryland meadow and pasture areas, and the rest (fresnedas, poplars, willows and alder groves) to the riverside galleries of the Alagón and Jerte rivers and larger streams.

Vegetation zones between crops and roads (underline the correct answers).

Present, Enable connectivity with natural habitats, Prevailing vegetation (grassland/shrub/forests)

Short description (e.g., approximate length and width):
The margins of the farms near the roads are found with a strongly anthropic vegetation where species of native origin are

mixed with other foreign ones where it is common to find invasive species of the genera *Amaranthus* spp., *Chenopodium* spp., *Sorghum halepense*, *Erigeron* spp., *Setaria* spp. Among the native species, there are formations with *Rubus ulmifolius* in the zones of permanent soil moisture, groups of *Typha latifolia* or *Typha dominguensis* in the permanently flooded places and numerous perennial species of the groups *Cyperus* spp., *Juncus* spp., *Festuca* spp., which are mixed with woody species where specimens of Fraxinus angustifolia, Salix spp., Populus spp. appear scattered in areas of higher humidity and heliophytic shrubs (*Cistus* spp., *Retama sphaerocarpa*, *Cytisus* spp., *Halimium* spp., *Genista* spp., etc.) together with tree species such as *Quercus rotundifolia* or Olea europaea var. *sylvestris*.

River network (underline the correct answers).

Present, Natural/artificial, Continuous/Discontinuous, With natural vegetation.

Short description (e.g., approximate length and width):
Plant formations associated with watercourses are abundant landscape elements throughout the study area due to several factors: - The presence of the Alagón river and all the riparian vegetation associated with it, mainly composed of species of the *Populus* spp., *Salix* spp., *Alnus lusitanica*, *Fraxinus* spp. and some bushes. Blanket irrigation in most of the study irrigable surface favors the arrival of water to the channels during periods of less rainfall, forming sections of different lengths depending on the type of channel to which it is associated, whether they are irrigation ditches irrigation, drainage or different rivers and streams tributaries to the Alagón and Jerte rivers.

PART 4. IMPACTS ON BIODIVERSITY

Describe potential impacts: (What do you believe, on which of the named parts of biodiversity do either the traditional land use or the new bioenergetics crops might have a positive, negative or neutral impact?).

	Traditional land use	Bioenergetic crops
Plants	Negative	Neutral
Birds	Neutral	Neutral
Vertebrates	Neutral	Neutral
Invertebrates	Negative	Positive
Other animals	Neutral	Neutral
Water courses and pond	Negative	Positive
Atmosphere (air)	Neutral	Neutral
Other	Neutral	Neutral

Principal cause to each impact (for each impact previously indicated, and related to the information in parts 1 and 2 of this questionnaire). (Regarding the main crops). Traditional land use (Part 1).

Environmental impacts	Traditional land use (Part 1)			
	Soil measures	Fertilization	Pest control	Harvest
Floristic richness and diversity	Negative	Negative	Negative	Neutral
Vertebrate animal richness	Negative	Negative	Negative	Negative
Soil biota richness and diversity	Negative	Negative	Negative	Neutral
Pollinators richness and diversity	Neutral	Positive	Negative	Neutral
Hydrological structure and available water in the soil	Negative	Neutral	Negative	Neutral
Connectivity	Negative	Negative	Negative	Neutral
Soil temperature (15,30,60 cm) in cultivate	Negative	Negative	Neutral	Neutral

Principal cause to each impact (for each impact previously indicated, and related to the information in parts 1 and 2 of this questionnaire). (Regarding the main crops). Bioenergetic crops (Part 2).

Environmental impacts	Bioenergetic crops (Part 2)			
	Soil measures	Fertilization	Pest control	Harvest
Floristic richness and diversity	Neutral	Neutral	Not available	Neutral
Vertebrate animal richness	Neutral	Neutral	Not available	Neutral
Soil biota richness and diversity	Positive	Neutral	Not available	Neutral
Pollinators richness and diversity	Positive	Neutral	Not available	Neutral
Hydrological structure and available water in the soil	Positive	Neutral	Not available	Neutral
Connectivity	Positive	Neutral	Not available	Neutral
Soil temperature (15,30,60 cm) in cultivate	Positive	Neutral	Not available	Neutral

3.2. Greece

Description UC Greece

Western Macedonia Region, Greece

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

Current crops: No crops (abandoned former lignite mine)

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

PART 1. PRESENT OR TRADITIONAL LAND USE

PART. 1.1. DESCRIPTION OF CROPS

Crop name (scientific and common name): There are no crops present. The land is a former lignite mine.

Type (underline the correct answers).-

Seedtime / plantation date (month or season).-

Harvest date (month).-

Approximately max height (in cm).-

Max. Crop stand density (without weeds!).-

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1}):-

PART. 1.2. CULTIVATION LABOUR

Crop name (scientific and common name): There are no crops present. The land is a former lignite mine.

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.--

Frequency of soil measures) over the year (how many times per year) (without mechanical weed control). -

Mechanical weed control (indicate: yes or no; how many times, Month, tool). -

Other Crop measures (indicate: type and application frequency). -

Use of fertilizers (indicate: name, composition, dose, and application frequency). -

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency). -

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]). -

PART 2. NEW LAND USE - BIOENERGETIC CROPS

PART. 2.1. DESCRIPTION OF CROPS

Crop name (scientific and common name). Black locust (*Robinia pseudoacacia* L.) + Lavender (*Lavandula angustifolia* Mill.)

Type (underline the correct answers). Black locust (perennial, shrubby/woody), lavender (annual, herbaceous).

Black locust has a life expectancy of 120 years, although the norm is that it does not exceed 80 years. Lavender is a perennial plant with a lifespan of 10 or more years. In the first year, the growth of the plants is small, and the production of flowering shoots is very limited. In the second and third year the plants grow more, the production of flowering shoots increases and in the fourth the lavender enters the stage of full production which lasts 8-10 or even more years. In the last 2-3 years of her life the production decreases.

Seedtime / plantation date (month or season).

Black locust: Planted when the plant is completely dormant, usually from the beginning of November to the end of April.

Lavender: Planted when the plant is completely dormant, usually at the beginning of November, depending on the temperature.

Harvest date (month).

Black locust: April to May.

Lavender: end of June and July.

Approximately max height (in cm).

Black locust: 30 meters.

Lavender: Lavender reaches a height of 20-30 cm without flowers and 50-80 cm with flowers.

Max. Crop stand density (without weeds!).

Black locust: Around 0.25% considering that we will have 1 tree per 3 to 5 meters according to the planting scheme.

Lavender: Around 10% considering that we will plant 1 root per meter.

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1}).

Black locust: 14-23 t ha^{-1}.

Lavender: A normal yield production, in dried floral stems, in the first year is 0.025 t ha^{-1}, in the second year is 1 t ha^{-1}, in the third year 1.18 t ha^{-1}, and in the fourth year 1.4 t ha^{-1}. However, in Western Macedonia region a normal yield production, in dried biomass, in the first year is 1.5-2 t ha^{-1}, in the second year is 3.5-4 t ha^{-1}, and from the third year onwards is 5-6 t ha^{-1}.

Part. 2.2. Cultivation labour

Crop name (scientific and common name). Black locust (*Robinia pseudoacacia* L.) + Lavender (*Lavandula angustifolia* Mill.)

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

Ploughing, levelling, weeding, pressing the soil around the plants so that they are firm and do not freeze in the winter season, irrigation if needed, pest management if needed. Depth at least 20cm.

Frequency of soil measures over the year (how many times per year) (without mechanical weed control)

Without mechanical weed control, weeding will be required 3-4 times per year.

Mechanical weed control (indicate: yes or no; frequency, Month, tool)

Early spring and then once a month until threshing, with a weeder.

Other Crop measures (indicate: type and application frequency).

If mechanical weed control that would be needed to be used, the rows will have a minimum distance of at least 1.20 m between the roots to accommodate the tractor wheels. If not, a good distance is 50 cm.

Use of fertilizers (indicate: name, composition, dose, and application frequency).

No fertilizers will be used.

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency).

No herbicides/pesticides will be used.

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

Irrigation is not scheduled except in the case of severe drought, in which case the duration and method of irrigation will be decided then.

Lavender is generally a dry crop. In a period of severe drought, irrigation might be needed. The worst case that any necessary irrigation should be done20 days before harvest, as the quality and quantity of the oil will be affected.

PART 3. BIODIVERSITY

Landscape (approximate value).(share of semi-natural habitats, road verges, hedgerows, water bodies….):

Value (homogeneus/heterogeneus): 6.

Short description:

The field is an old lignite mine (abandoned for over 30 years) with natural growth of grasses and trees. The habitats in the area can be described as: non-consolidated mine surfaces, heaps of extracted material piled up on storage areas, transport networks associated with the mine, lay-by areas belonging to the mine area, line vegetation belts, surface of landfills, protecting dikes, part of buffering/protective zones around the dump sites, and infrastructure of buildings and installations.

Additionally, we have to mention that there are not any water bodies in the area.

Natural habitat (underline the correct answers). In the neighbourhood of agricultural land

Present, grassland / forests

Name and code to each present habitat (in accordance with natural habitat types of community interest – Annex I of Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora):

The closer Habitat types to the experimental plot are as follow: Alpine and subalpine calcareous grasslands. [6170 (not priority type)] (Distance 10.2km); (Sub-) Mediterranean pine forests with endemic black pines [9530* (priority type)] (Distance 11.5km); Eastern sub-mediteranean dry grasslands (*Scorzoneratalia villosae*) [62A0 (not priority type)] (Distance 11.7km).

Vegetation zones between crops and roads (underline the correct answers).

Absent, No enable connectivity with natural habitats

Short description (e.g., approximate length and width): -

River network (underline the correct answers).

Absent

Short description (e.g., approximate length and width): -

PART 4. IMPACTS ON BIODIVERSITY

Describe potential impacts: (In your opinion, on which of the named parts of biodiversity do either the traditional land use or the new bioenergetics crops might have a positive, negative or neutral impact?).

	Traditional land use	Bioenergetic crops
Plants	Positive (+) & neutral (0) without human intervention in the plot area, the number and species of plants will gradually increase.	(+) By planting new species such as acacias, chestnuts, and lavender, and not applying weed removal methods, we can speed up the processes of increasing biodiversity.
Birds	(0) Taking into account the activities that take place in the study area (landfills, mines) as well as the size of our field, the continuation of the current situation cannot cause any change in the biodiversity regarding birds.	(+) Planting trees and especially fruitful trees the plot is expecting to become an interesting spot for more bird species.
Vertebrates	(+) & (0) Similar to the "plants" cell.	(+) Similar to the "plants" cell.
Invertebrates	(+) & (0) As above.	(+) As above.
Other animals	(+) & (0) As above.	(+) As above.
Water courses and pond	(0) In the area, there are no water ponds or other surface water.	(0) In the area, there are no water ponds or other surface water.
Atmosphere (air)	There will be no human intervention, so traditional land use has a positive impact (+) on the atmosphere by not introducing extra pollutants.	(+) During the preparation of the plot, there may be a small increase in pollutants. However, after the plantings, which will be done manually, we do not plan to use mechanical means in the field. In the long term, the interventions will have a positive effect on the atmosphere, as the biomass of the area will increase.
Other	(+) & (0) Similar to the "plants" cell.	(+) Similar to the "plants" cell.

Principal cause to each impact (for each impact previously indicated, and related to the information in parts 1 and 2 of this questionnaire). (Regarding the main crops). Traditional land use (Part 1).

Environmental impacts	Traditional land use (Part 1)			
	Soil measures	Fertilization	Pest control	Harvest
Number and species of plants	Not applicable	Not applicable	Not applicable	Not applicable
Number and species of animals	Not applicable	Not applicable	Not applicable	Not applicable
Biodiversity regarding birds	Not applicable	Not applicable	Not applicable	Not applicable
Soil quality	Not applicable	Not applicable	Not applicable	Not applicable
Concentration of pollutants	Not applicable	Not applicable	Not applicable	Not applicable

Principal cause to each impact (for each impact previously indicated, and related to the information in parts 1 and 2 of this questionnaire). (Regarding the main crops). Bioenergetic crops (Part 2).

Environmental impacts	Bioenergetic crops (Part 2)			
	Soil measures	Fertilization	Pest control	Harvest
Number and species of plants	Positive impact	Not available	Not available	Neutral impact
Number and species of animals	Neutral impact	Not available	Not available	Negative impact
Biodiversity regarding birds	Neutral impact	Not available	Not available	Negative impact
Soil quality	Positive impact	Not available	Not available	Positive impact
Concentration of pollutants	Positive impact	Not available	Not available	Positive impact

3.3. Sweden

Description UC Sweden

Västerbotten and Norrbotten county, Sweden

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

Current crops: Spring cereals, fodder grasses.

MarginUp! alternative: Turnip rape.

PART 1. PRESENT OR TRADITIONAL LAND USE

PART. 1.1. DESCRIPTION OF CROPS

Crop name (scientific and common name): Barley (*Hordeum vulgare* L.)

Type (underline the correct answers). Annual. Herbaceous.

Seedtime / plantation date (month or season). May-June.

Harvest date (month). September-October.

Approximately max height (in cm). 70-80 cm.

Max. Crop stand density (without weeds!). -

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1}): 2.5-3.1 t ha^{-1}.

Crop name (scientific and common name). Oat (*Zea mays* L.)

Type (underline the correct answers). Annual. Herbaceous.

Seedtime / plantation date (month or season). May-June.

Harvest date (month). September-October.

Approximately max height (in cm). 80-100 cm.

Max. Crop stand density (without weeds!). -

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1}): 2.5-3 t ha^{-1}.

Crop name (scientific and common name). Fodder grass; Timothy (*Phleum pratense*), meadow fescue (*Festuca pratensis*) and red clover (*Trifolium pratense*).

Type (underline the correct answers). Perennial. Herbaceous

3-5 years is the average period for fodder grass.

Seedtime / plantation date (month or season). May-June.

Harvest date (month). 2 times, in June and August.

Approximately max height (in cm). 50-60 cm at harvest time.

Max. Crop stand density (without weeds!). --

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1}): 4.1-4.2 t ha^{-1}.

PART. 1.2. CULTIVATION LABOUR

Crop name (scientific and common name): Barley (*Hordeum vulgare*) or *Oat (Zea mays L.)*

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

Piteå Organic

Main Activity	Field Operation	Operative Machines	Power (kW)	Fuel consumption (l h^{-1})	Input	Amount (kg ha^{-1})	Time (h)
Soil preparation	Harrowing	Tractor and harrow (7 m)	140	20	-	--	-
	Ploughing	Tractor and plough (5 cutting)	140	20	-	-	-

Soil tillage	Weed control	-	-	-	-	-	-
	Fertilization	Tractor and spreader (12m)	200	20	Cow manure	30 000	-
	Liming	-	-	-	-	-	-
	Seeding and rolling	Överum Tive Såjet (6m)	140	15	Oat	210	-
Crop Management	Harvesting	Claas Lexion 410, (18 feet)	144	20			-
Transport	-	-	-	-	-	-	-

Frequency of soil measures) over the year (how many times per year) (without mechanical weed control)

One, it is an annual crop.

Mechanical weed control (indicate: yes or no; how many times, Month, tool)

No

Other Crop measures (indicate: type and application frequency).

Use of fertilizers (indicate: name, composition, dose, and application frequency).

Yes, cow manure 30 000 kg ha^{-1}, 45 kg N

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency).

No

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

No

Crop name (scientific and common name). Fodder grass; Timothy (*Phleum pratense*), meadow fescue (*Festuca pratensis*) and red clover (Trifolium pratense)

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

Piteå, 4 ha organic

Main Activity	Field Operation	Operative Machines	Power (kW)	Fuel consumption ($l\ h^{-1}$)	Input	Amount ($kg\ ha^{-1}$)	Time (h)
Soil preparation Soil tillage	Harrowing	Tractor and harrow (7 m)	140	20	-	-	1
	Ploughing	Tractor and plough (5 cutting)	140	20	-	-	2
	Weed control	-	-	-	-	-	-
	Fertilization	Tractor and spreader (12m)	200	20	Cow manure	30 000	1
	Liming	-	-	-	-	-	-
	Seeding and rolling	Överum Tive Såjet (6m)	140	15	Mix of Clover and Thimothy, meadow fescue	20	1,5
Crop Management	Harvesting	Tractor and rear mower + round baler	144	20			4
Transport	-	-	-	-	-	-	-

Frequency of soil measures) over the year (how many times per year) (without mechanical weed control).

Once every 3-5 years.

Mechanical weed control (indicate: yes or no; how many times, Month, tool)

No.

Other Crop measures (indicate: type and application frequency). -

Use of fertilizers (indicate: name, composition, dose, and application frequency). -

Cow manure 30 000 kg ha^{-l}, 45 kg N.

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH

at application (if possible!), and application frequency).

No

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

No

PART 2. NEW LAND USE - BIOENERGETIC CROPS

PART. 2.1. DESCRIPTION OF CROPS

Crop name (scientific and common name). Turnip Rape (*Brassica rapa* ssp. *oleifera*).

Type (underline the correct answers). Annual, herbaceous.

Seedtime / plantation date (month or season).

June.

Harvest date (month).

August-September.

Approximately max height (in cm).

105 och ca 140 cm.

Max. Crop stand density (without weeds!). -

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1}). 1,200 kg oil seed ha^{-1}.

Part. 2.2. Cultivation labour

Crop name (scientific and common name). Turnip Rape (*Brassica rapa* ssp. *oleifera*).

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

Skellefteå 1.5 ha

Main Activity	Field Operation	Operative Machines	Power (kW)	Fuel consumption (l h^{-1})	Input	Amount (kg ha^{-1})	Time (h)
Soil preparation Soil tillage	Harrowing	Tractor and harrow (7 m)	64	7 (easy driving with the narrow harrow)	-	-	2
	Ploughing	-	-	-	-	-	-
	Weed control	Tractor and harrow (3m)	64	7 (easy driving with the narrow harrow)	-	-	3
	Fertilization	Tractor and centrifugal spreader (700 kg)	64	5 (easy driving)	NPK 17-5-10-SS	520	1
	Liming	Tractor and centrifugal spreader (700 kg)	64	5 (easy driving)	Lime	1500	2
	Seeding	Tractor and row drill (2.5 m)	64	5 (easy driving)	Seed Cordelia	12	2
	Rolling	Tractor and roller (3 m)	64	5 (easy driving)	-	-	1
Crop Management	Harvesting	-	-	-	-	-	-
Transport	-	-	-	-	-	-	-

Farming system of Piteå, including conventional and organic farming

Subsystem 1a: Piteå conventional farming

Main Activity	Field Operation	Operative Machines	Power (kW)	Fuel consumption (l h^{-1})	Input	Amount (kg ha^{-1})	Time (h)

Cultivation		MF 7719S + Amazone Catros 5001 (5m)	140	25	-	-	4
Soil preparation Soil tillage	Ploughing	MF 7719S + Kverneland ES 85 (3m)	140	20	-	-	5
	Harrowing	MF7719S + Väderstad (7m)	140	20	-	-	3
	Weed control	Claas Arion 410 CIS + Hardi sprayer (12m)	81	5	Galera & PG26N	0.3 L ha^{-1}	2
	Fertilization	Claas Arion 410 CIS + Rauch 935 (12m)	81	5	YaraMila NPK, 21-3-10	476	1
	Seeding	Fendt 818 + Einböck pneumatic seeding box on Jukon rolling (6m)	140	10	Seed Cordelia	9	4
Crop Management	Harvesting	Claas Lexion 410 (18 feet)	144	20	-	-	4

Subsystem 1b: Piteå organic farming

Main Activity	Field Operation	Operative Machines	Power (kW)	Fuel consumption (l h^{-1})	Input	Amount (kg ha^{-1})	Time (h)
Cultivation		MF 7719S + Amazone Catros 5001 (5m)	140	25	-	-	4
Soil preparation Soil tillage	Ploughing	MF 7719S + Kverneland ES 85 (3m)	140	20	-	-	5
	Harrowing	MF7719S + Väderstad (7m)	140	20	-	-	3
	Fertilization	Claas Arion 410 CIS + Rauch 935 (12m)	81	5	Alviksgårdens biofertilizer 7-1-3	1150	2
	Seeding and overturning	Fendt 818 + Einböck pneumatic seeding box on Jukon rolling (6m)	140	10	Seed Cordelia	9	4
Crop Management	Harvesting	Claas Lexion 410 (18 feet)	144	20	-	-	4

Frequency of soil measures over the year (how many times per year) (without mechanical weed control)

One, it is and annual crop.

Mechanical weed control (indicate: yes or no; frequency, Month, tool)

See tables above. Month: May?

Skellefteå – Tractor and harrow

Piteå, no

Well-established oil plants are competitive against many herbaceous weeds. However, there can be problems with thistle. Mechanical control can be done, initially as a blind harrowing before crop emergence.

Åkerspergel (*Spergula arvensis* L), målla (*Chenopodium*).

Other Crop measures (indicate: type and application frequency). -

Use of fertilizers (indicate: name, composition, dose, and application frequency). ** If Organic fertilizers are used (indicate: yes or no, type, dose (in kg/ha) and Nitrogen content)*

See tables above. Oil seed crops are more sensitive to lack of nutrients compared to cereal crops and plant nutrients are frequently applied before sowing and less during the growing period.

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency).

See tables above.

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

No

PART 3. BIODIVERSITY

Landscape (approximate value) (share of semi-natural habitats, road verges, hedgerows, water bodies….):

Piteå

Value (homogeneus/heterogeneus): No available

Short description:

The surrounding landscape consists primarily of forest plantations (coniferous), cropland and cultivated pastures, bogs, lakes, streams, other water bodies, islands, gravel pits, as well as residential areas including urban green spaces. Linear elements besides streams are road verges. The croplands are relatively small and creates a mosaic-like pattern. The landscape is characterized in addition by the sea (Baltic Sea/Bottenviken), and has various groups of series, islets and islands. According to monitoring programs and nature protection data, there are semi-natural/natural habitats present in the area, such as coniferous forests and (a smaller share of) grasslands.

Skellefteå

Value (homogeneus/heterogeneus): No available

Short description:

The landscape around the case study site is predominantly forest plantations (coniferous), with elements of clear-cuts. Besides forests, there are cropland and cultivated pastures, and smaller lakes and streams, bogs and fens in the surrounding landscape. Road verges are present. The croplands are relatively small and creates a mosaic-like pattern. According to monitoring programs and nature protection data, some biotopes are semi-natural/natural; primarily forests and wetlands.

***Natural habitat (underline the correct answers)*. In the neighbourhood of agricultural land**

Note: The information below is based on data provided by Swedish Environmental Protection agency, i.e., those that are mapped within monitoring programs/are covered by the Habitats Directive. There are more habitats that are present than the listed, but if they are not officially surveyed/information not available they have not been included. There are also various habitats/biotopes that are not covered in the Habitats Directive, these have not been included.

Piteå

Present, arable/grassland/shrub/forests/aquatic

Name and code to each present habitat (in accordance with natural habitat types of community interest – Annex I of Council

Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora):

Grassland [1630 Boreal baltic coastal meadows, 4030 European dry heaths, 8230 Siliceous rock with pioneer vegetation of the Sedo]; **forests** [9010 Western Taiga, 9030 Natural forests of primary succession stages of landupheavel coast, 9050 Fennoscandian herb-rich forests with Picea abies, 91D0 Bog woodland, 9080 Fennoscandian deciduous swamp woods]; **bogs, fens or similar** [7140 Transition mires and quaking bogs, 7160 Fennoscandian mineral-rich springs and springfens)]; **aquatic** [3110 Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*), 3130 Oligotrophic to mesotrophic standing waters with vegetation of the littorelletea uniflorae and/or of the Isoeto-Nanojuncetea, 3160 Natural dystrophic lakes and ponds, 3210 Fennoscandian natural rivers, 3220 Alpine rivers and the herbaceous vegetation along their banks, 3260 Water courses of plain to montane levels with the *Ranunculion fluitantis*]; **sand/stone banks, islands, reefs, dunes etc.** [1110 Sandbanks which are slightly covered by sea water all the time, 1140 Mudflats and sandflats not covered by seawater at low tide, 1170 Reefs, 1220 Perennial vegetation of stony banks, 1310 Salicornia and other annuals colonising mud and sand, 1610 Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation, 1620 Boreal Baltic islets and small island, 1640 Boreal Baltic sandy beaches with perennial vegetation].

Skellefteå

Present, arable/grassland/shrub/forests/aquatic

Name and code of each present habitat (in accordance with natural habitat types of community interest – Annex I of Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora):

Forests [9010 Western Taiga, 9050 Fennoscandian herb-rich forests with Picea abies, 91D0 Bog woodland]; **bogs, fens or similar** [7140 Transition mires and quaking bogs, 7310 Aapamires]; **aquatic** [3160 Natural dystrophic lakes and ponds]

Vegetation zones between crops and roads (underline the correct answers).

Piteå

Present, no enabled connectivity with natural habitats (All fields are located in direct connection with forest plantations and/or clearcuts.), Prevailing vegetation (forests/aquatic).

Short description (e.g., approximate length and width):

The zones between the fields and surrounding habitats consists predominantly of artificial ditches (with varying management). These are in turn linked to forests and/or clear-cuts, with edge zones in between. It is difficult to assess the length and width, as almost all fields are in direct proximity to other habitats (i.e., forests/clear-cuts).

Skellefteå

Present, no enable connectivity with natural habitats (The field is to the North located in direct connection with forest plantation(s)), Prevailing vegetation (forests), With natural vegetation

Short description (e.g., approximate length and width):

The field is surrounded by artificial ditches with natural vegetation, probably at all four sides (see (2) in the river network-question).

River network (underline the correct answers).

Piteå

Present, artificial, seasonal, discontinuous, with natural vegetation.

Short description (e.g., approximate length and width):

Almost all fields are surrounded by artificial ditches with a width of 2-4 m. As there are seven different fields at three different locations within Öjebyn Agropark, the total length of the ditches is difficult to estimate.

Skellefteå

Present, natural, permanent, continuous, with natural vegetation.

Short description (e.g., approximate length and width):

There is a meandering stream at close proximity to the field. It has a width of approximately 8 m (but varies). It is >3 km long (probably a lot longer) and is connected with a lake located South West from the case site.

PART 4. IMPACTS ON BIODIVERSITY

Describe potential impacts: (What do you believe, on which of the named parts of biodiversity do either the traditional land use or the new bioenergetics crops might have a positive, negative or neutral impact?).

	Traditional land use	Bioenergetic crops
Plants	Positive (+) & neutral (0) without human intervention in the plot area, the number and species of plants will gradually increase.	Negative: Same as traditional, but the relative impact depends on the need of input/weeding etc. in comparison to the traditional land use.
Birds	Positive: Cereal fields, attract bird species throughout the season, although some birds (e.g. Eurasian skylark) needs uncultivated plots/margins to forage. Negative: If the fields are sprayed it can have a negative impact on local bird	Positive: Oil crop fields are utilized by various bird species, and the presence of species is shifting throughout the crop season (as for barley). The fields attract numerous insects (both soil-living and airborne), and provide spilt seeds, i.e. essential forage resources for many birds.

	populations.	Negative: If the fields are sprayed it can have a negative impact on birds. There is probably slightly more spraying needed for turnip rape fields in comparison to barley.
Vertebrates	Positive/neutral/negative: Vertebrates as deer, hares and boars can utilize cereal croplands as habitats. This may have a positive effect on the local populations, and may even benefit higher-level consumers as carnivores. Whether this is has a positive impact on biodiversity depends on what species is benefitted (e.g. if there are invasive/exotic species out-competing native species) as well as the presence of predators (an "un-controlled" increase in herbivores may cause serious damage on native vegetation, affecting the rest of the food chain including pollinators).	Positive/neutral/negative: Same as traditional, but turnip rape provides even more nutrient-rich food, which could have an even stronger effect on the communities (resulting in either positive, neutral or negative effects on biodiversity).
Invertebrates	Positive/Neutral: As in other cropland, invertebrates can thrive in barley fields. Depending on the reference situation, this is positive or neutral. Negative: Further, if the fields are sprayed with chemicals, it can have a negative impact on the local populations through ecotoxicity, which could also affect higher up in the food chain (birds, mammals etc.).	Positive: Oil crop fields serve as, throughout the crop season, habitats for a lot of species of insects and spiders. Especially, during flowering season it attracts a lot of pollinating insects. Neutral: However, most threatened invertebrates are specialists and will probably not forage on turnip rape. Negative: Further, if the fields are sprayed with chemicals, it can have a negative impact on the local populations through ecotoxicity, which could also affect higher up in the food chain (birds, mammals). There is probably slightly more spraying needed for turnip rape fields in comparison to barley

Other animals	Probably no impact (comparing before and after) on other animals such as reptiles, amphibians, fish etc.	Probably no impact (comparing before and after) on other animals such as reptiles, amphibians, fish etc.
Water courses and pond	Negative: Fertilization can cause eutrophication, resulting in negative effects for the flora and fauna in water courses, ponds and other water bodies	Negative: Same as for traditional land use, but no probably no significant difference in input between the two land uses
Atmosphere (air)	Negative: Agricultural machines and ammonia contribute to air pollution	Negative: Same as for traditional land use, but no probably no significant difference in input between the two land uses
Other		

In summary, the largest differences between traditional and new land use are that (during flowering season) there will be more pollen and nectar resources (but in a rather short time, and will primarily attract generalists), barley and turnip rape will provide habitats for different species/taxa, and that there can be slightly (?) more spraying in the turnip rape field. Otherwise, the impacts will be rather the same.

Principal cause to each impact (for each impact previously indicated, and related to the information in parts 1 and 2 of this questionnaire). (Regarding the main crops). Traditional land use (Part 1).

Environmental impacts	Traditional land use (Part 1)			
	Soil measures	Fertilization	Pest control	Harvest
Impacts on native plants	Negative	Negative	Negative (herbicides)	-
Impacts on native birds	Negative	-	Negative	-
Impacts on invertebrates (ecotoxicity)	-	-	Negative	-
Eutrophication	Negative	Negative	-	-
Air pollution	Negative	Negative	Negative	Negative

Principal cause to each impact (for each impact previously indicated, and related to the information in parts 1 and 2 of this questionnaire). (Regarding the main crops). Bioenergetic crops (Part 2).

Environmental impacts	Bioenergetic crops (Part 2)			
	Soil measures	Fertilization	Pest control	Harvest
Impacts on native plants	-	Negative	Negative (herbicides)	-
Impacts on native birds	Negative	-	Negative	Negative
Impacts on invertebrates (ecotoxicity)	-	-	Negative	-
Eutrophication	Negative	Negative	-	-
Air pollution	Negative	Negative	Negative	Negative

3.4. Germany

Description UC Germany

Brandenburg, Germany

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

Current crops: Willow, grassland.

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

PART 1. PRESENT OR TRADITIONAL LAND USE

PART. 1.1. DESCRIPTION OF CROPS

Crop name (scientific and common name): Arable 1 Winter wheat (W-Wheat).

Type (underline the correct answers).

Annual, herbaceous

Seedtime / plantation date (month or season).

Depending on pre-crop: after W-Wheat: end of September; after W-Rape (Canola): Mid of September; After Maize: end of October till mid of November

Harvest date (month).

Mid of July.

Approximately max height (in cm). 100 cm.

Max. Crop stand density (without weeds!). 85-90%.

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1}): 6-8 t ha^{-1}

Crop name (scientific and common name): Arable 2 Winterrape (Canola).

Type (underline the correct answers).

Annual, herbaceous

Seedtime / plantation date (month or season).

Normally sown after WBarley or WWheat; middle till end of August.

Harvest date (month).

First half of July.

Approximately max height (in cm). 125 cm.

Max. Crop stand density (without weeds!). 80%.

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1}): 4t ha^{-1}.

Crop name (scientific and common name): Arable 3 Maize for silage.

Type (underline the correct answers).

Annual, herbaceous

Seedtime / plantation date (month or season).

End of April to first week of May.

Harvest date (month).

End of September.

Approximately max height (in cm). 250 cm.

Max. Crop stand density (without weeds!). 80-90%.

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1}): 24-28t ha^{-1}.

Crop name (scientific and common name): Grassland 1 cattle grazing.

Type (underline the correct answers).

Perennial, herbaceous. >20 years (permanent).

Seedtime / plantation date (month or season). No.

Harvest date (month).

Grazing period: End of April until end of September.

Approximately max height (in cm). 15cm.

Max. Crop stand density (without weeds!). 70%.

Crop name (scientific and common name): Grassland 2 pasture.

Type (underline the correct answers).

Perennial, herbaceous. >20 years (permanent)

Seedtime / plantation date (month or season).

Never/No

Harvest date (month).

3 cuttings (end of May, beginning of July, September).

Approximately max height (in cm). 25-30cm.

Max. Crop stand density (without weeds!). 70-80%.

PART. 1.2. CULTIVATION LABOUR

Crop name (scientific and common name): Arable 1 Winterwheat.

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

Depending on pre-crop: after WWheat: cultivator on fallow (August), ploughing 14 days before sowing; after WRape (Canola): cultivator on fallow (August), ploughing 14 days before sowing; after Maize: Cultivator (15 cm deep) middle of

October.

Frequency of soil measures) over the year (how many times per year) (without mechanical weed control). 2 times.

Mechanical weed control (indicate: yes or no; how many times, Month, tool). No

Other Crop measures (indicate: type and application frequency). -

Use of fertilizers (indicate: name, composition, dose, and application frequency).

Mineral fertilizers: 100 kg Ammonium sulphate (21% N); 200 kg urea (46%N), split into 2-3 doses: 1. March, 2. April, 3. May

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency).

Herbicide: 2 applications 1. End of October: Sumimax (Flumioxazin) 0,06 kg ha^{-1} + CIRAL (Flupyrsulfuron) 0,02kg ha^{-1}; 2. End of March: BROADWAY (Florasulam) 0,25 l ha^{-1}. 2 applications (October and March)

Insecticide: 1.application: end of May Karate zeon (lambda-Cyhalothrin) 0,075 l ha^{-1}. 1 application (End of May).

Fungicide: 2 applications: 1. Beginning of May, Capalo (Fenpropimorph) 1,6 l ha^{-1}; 2. End of June: Fandango (Fluoxastrobin) 0,75 l ha^{-1} + Aviator Xpro (Prothioconazol) 0,75 l ha^{-1}.

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

No irrigation, no additional water supply.

Crop name (scientific and common name): Arable 2 Winterrape (Canola).

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

Harrow on fallow, cultivator.

Frequency of soil measures) over the year (how many times per year) (without mechanical weed control).-

Harrow on fallow (first half of August), cultivator 7 days before sowing.

Mechanical weed control (indicate: yes or no; how many times, Month, tool). No.

Other Crop measures (indicate: type and application frequency). -

Use of fertilizers (indicate: name, composition, dose, and application frequency).

Organic Biogas Slurry (70%) 15 m^3 ha^{-1}before sowing in August.

Mineral: 3 applications: September, March and end of April Ammonium sulfate (21%N): 2, mD, 150 kg ha^{-1}; Urea (46%N): 2, mD, 150 kg ha^{-1}; Kornkali 40% (potassium) before sowing: 2, mD, 200 kg ha^{-1}.

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency).

Herbicide: 3x applications: 1. End of August [Stomp Aqua Pendimethalin (H:K1): H, 0.75 kg ha^{-1} Gamit 36 Cs Clomazone (H:F3): H, 0.25 l ha^{-1}; Fuego Metazachlor (H:K3): H, 0.9 l ha^{-1}]; 2. Middle of September [TARGA SUPER Quizalofop-P (H:A); H, 0,7 l ha^{-1}], 3. End of April [Vivendi 100 Clopyralid (H:O), H, 1 l ha^{-1}]

Insecticide: 2x applications: 1. End of September [Karate Zeon lambda-Cyhalothrin (I:3): I, ,0.75 kg ha^{-1}; 2 Beginning of May [Fastac SC Super alpha-Cypermethrin (I:3), I, 0.1 l ha^{-1}].

Fungicide: 2x applications: 1 First half of October [Folicur Tebuconazol (F:3): F, 1.2 l ha^{-1}], 2. Beginning of May [Cantus Gold Dimoxystrobin (F:11), Boscalid (F:7): F, 0.5 l ha^{-1}].

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

No irrigation, no additional water supply.

Crop name (scientific and common name): Arable 3 Maize for silage.

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

Cultivator (grubber) 7 days before sowing.

Frequency of soil measures) over the year (how many times per year) (without mechanical weed control). 1 time.

Mechanical weed control (indicate: yes or no; how many times, Month, tool). Partly 1-2times, May, harrow.

Other Crop measures (indicate: type and application frequency). -

Use of fertilizers (indicate: name, composition, dose, and application frequency).

Organic: Biogas slurry (70%) before sowing (April) 35 m^3 ha^{-1}.

Mineral: Before sowing two components: NP (18%+46%) 100 kg ha^{-1} and Kornkali (40%N) 200 kg ha^{-1}.

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency).

Herbicide: 1 application 1. End of May [Laudis Tembotrione (H:Not known): H, 1.5 l ha^{-1}, Bromotril Bromoxynil (H:C3): H, 0,3 l ha^{-1}, Aspect Flufenacet (H:K3), Terbuthylazin (H:C1): H, 1.5 l ha^{-1}. Insecticide (No), Fungicide (No).

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

No irrigation, no additional water supply.

Crop name (scientific and common name): Grassland 1 cattle grazing.

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

None

Frequency of soil measures) over the year (how many times per year) (without mechanical weed control). None.

Mechanical weed control (indicate: yes or no; how many times, Month, tool). 1 time, September.

Other Crop measures (indicate: type and application frequency). None

Use of fertilizers (indicate: name, composition, dose, and application frequency). None.

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency). None

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

No irrigation, no additional water supply.

Crop name (scientific and common name): Grassland 2 pasture.

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm. None

Frequency of soil measures) over the year (how many times per year) (without mechanical weed control).-

Mechanical weed control (indicate: yes or no; how many times, Month, tool).-

Other Crop measures (indicate: type and application frequency). None

Use of fertilizers (indicate: name, composition, dose, and application frequency). None

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency). None

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

No irrigation, no additional water supply.

PART 2. NEW LAND USE-BIOENERGETIC CROPS

PART. 2.1. DESCRIPTION OF CROPS

Crop name (scientific and common name). Paludi crops.

Type (underline the correct answers).

Perennial/herbaceous

The paludi crops of the regions Rhinluch and Havelländisches Luch are mostly very long-lived (> 20 years). The composition of the plant community may change with rewetting progression in future. The most important plants include reed (*Phragmites australis*), reed canary grass (*Phalaris arundinacea*), cat-tail (*Typha* spec.) and sedges (*Carex* spec.)

Seedtime / plantation date (month or season).

Natural vegetation without planting measures.

Harvest date (month or season).

Harvesting takes place in late summer or autumn. Reed can be harvested in winter. It is expected that later more than today the water level will determine the harvesting time.

Approximately max height (in cm). Reed: 3m, canary grass: 1.6m, Typha: 3.5m; sedges 80-90cm.

Max. Crop stand density (without weeds!). 80-100%.

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1}). -

Part. 2.2. Cultivation labour

Crop name (scientific and common name). Paludi crops.

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

No soil measures.

Frequency of soil measures over the year (how many times per year) (without mechanical weed control)

Mechanical weed control (indicate: yes or no; frequency, Month, tool). None.

Other Crop measures (indicate: type and application frequency).

No crop measures.

Use of fertilizers (indicate: name, composition, dose, and application frequency).

No fertilizer applications.

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency).

No applications of herbicides and pesticides.

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month],

and duration of application [in number of Months]).

In significant parts of the fenland, the groundwater level must be raised considerably. It is unclear up to now where the water will come from and which areas will be rewetted. The problem is that the peat layer has been decomposed as result of draining. The soil layers are sunken in different stages due to the peat degradation. The water goes to the deepest places and not necessarily to the selected areas.

PART 3. BIODIVERSITY

Landscape (approximate value).(share of semi-natural habitats, road verges, hedgerows, water bodies….):

Value (homogeneus/heterogeneus): 8.

Short description:

The German UC is characterized by high groundwater levels along a great number of rivers and channels. The predominant soil type is peat of different thicknesses. The land use follows the gradients in pet layer thickness and groundwater height. At higher altitudes (only few meters higher) arable cropping is dominant. At lower altitudes grassland use (grazing, pastures or mixed use) is the only feasible land use. At the very wet areas there are many unused areas dominated by reed stands or shallow water bodies. Forests are rare and can mainly be found on higher sandy areas. Along the rivers and channels, you can find regularly alder, poplar or willow trees. There are hardly any settlements and roads in the core areas. Within the UC there are many different kinds of nature conservation areas of different categories (SPA, Nature Park, Natura 2000 and Protected areas by law). The overwhelming part of the grassland in use is participating in different extension programmes. Value creation from grassland is very low.

***Natural habitat (underline the correct answers)*. In the neighbourhood of agricultural land**

Present, grassland/shrub.

Name and code to each present habitat (in accordance with natural habitat types of community interest – Annex I of Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora):

3150. Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* – type vegetation, 6410. Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*), 6430. Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels, 7210. Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* (Just where calcareous soils occur)

Vegetation zones between crops and roads (underline the correct answers).

Present/Enable connectivity with natural habitats, Prevailing vegetation (grassland/shrub)

Short description (e.g., approximate length and width):

Road density is very low, while most roads are just for local public. As a result, traffic density is low and roadside margin management is comparatively sparse. Road margins have typically big alley trees (*Quercus* sp., *Acer* sp., *Populus* sp.), some shrubs and a grass margin, which is not managed, thus in an abandoned grassland state.

River network (underline the correct answers).

Present, natural/artificial, Continuous, With natural vegetation

Short description (e.g., approximate length and width):

In contrast to the road network, the network of rivers and channels is very dense. On the rivers and channels there is no traffic at all. The rivers and channels are regularly cleaned up of water vegetation (1x every 3 years). Along the rivers and channels there are margins with large trees (*Alnus glutinosa*, *Salix* sp., *Populus* sp.) accompanied by shrubs. Water level in rivers and channels are regulated artificially by weirs, dams, barrages and pump stations. Water lever is managed in order to quickly drop down winter water level in spring and to retain water levels high in summer.

PART 4. IMPACTS ON BIODIVERSITY

Biodiverisity potential impacts of the spread of paludi crops: fewer monoculture of plants, more native crops, in general, paludi crops growing on rewetted fenland reduce the environmental footprint of the agriculture, and more habitat for insects, amphibians and birds.

The introduction of the paludiculture in the cultivation areas will not directly affect the structure and general landscape composition since semi-aquatic areas are already part of the current landscape. The impacts are depending on the amount of the new cropping system and the kind of previous land use. Since paludiculture goes along with the rewetting of the potential sites, biophysical conditions are changing from terrestrial to at last periodically aquatic conditions or semi-aquatic. This change in the biophysical growing conditions will change the composition of occurring coenoses first towards more specialized wetland species. Diversity of most taxa can drop as well as the total abundance of most of the taxa. Their might also occur some trade-off´s to recent grassland or open range oriented conservation targets (such as e.g. *Otis tarda*).

The paludiculture as new cropping system consists of elements that will be susceptible to impacts at the plot scale on the soil characteristics, on water resources, nutrient dynamics and matter transformation. The harvesting activities for paludicultures will have only little impact on biodiversity since they are mostly applied in winter or at least outside main activity phases for most of the taxa.

The introduction of paludicultures will at the landscape scale having impacts at the following elements [Jaccard and Sorensen indexes (Similarity measures) estimated in all cases]:

- Connectivity between the paludi crop fields and natural peatland areas.
- Connectivity between the paludi crop fields and Wild habitat.

- Floristic richness and diversity (Aquatic species).
- Pollinators richness and diversity (Aphids, Bees, Bombus, Beetles, species) in paludi crop fields and adjacent wild areas.
- Vertebrate animal richness in paludi crop fields and adjacent wild areas.
- Hydrological structure and available water in the soil, in paludi crop fields and adjacent wild areas.
- Soil temperature (15, 30, 60 cm) in paludi crop fields and adjacent wild areas.
- Anaerobic conditions in paludi crop fields.

Describe potential impacts: (What do you believe, on which of the named parts of biodiversity do either the traditional land use or the new bioenergetics crops might have a positive, negative or neutral impact?)

NOTE: Differentiated regarding kind of previous land use: arable/grassland/ unused unmanaged fallow.	Traditional land use	Bioenergetic crops
Plants	--/0/++	++/0/-
Birds	-/-/++	++/+/-
Vertebrates	+/++/++	+/+/-
Invertebrates	++/++/+	+/+/-
Other animals	--/-/+	+/+/-
Water courses and pond	--/-/-	+/+/+
Atmosphere (air)	--/0/0	++/+/0
Other	--/0/0	+/+/+

Principal cause to each impact (for each impact previously indicated, and related to the information in parts 1 and 2 of this questionnaire). (Regarding the main crops). Traditional land use (Part 1A. Arable Use).

Environmental impacts	Traditional land use (Part 1A. Arable Use)			
	Soil measures	Fertilization	Pest control	Harvest
Floristic richness and diversity	Negative	Negative	Negative	Neutral
Vertebrate animal richness	Negative	Neutral	Negative	Neutral
Soil biota richness and diversity	Negative	Neutral	Neutral	Neutral
Pollinators richness and diversity	Neutral	Neutral	Negative	Neutral
Hydrological structure and available water in the soil	Negative	Neutral	Neutral	Neutral

Connectivity	Negative	Neutral	Negative	Neutral
Soil temperature (15, 30, 60 cm) in Cultivate	Positive	Neutral	Neutral	Neutral

Principal cause to each impact (for each impact previously indicated, and related to the information in parts 1 and 2 of this questionnaire). (Regarding the main crops). Traditional land use (Part 1B. Grassland Use).

Environmental impacts	Traditional land use (Part 1B. Grassland Use)		
	Soil measures	Fertilization	Cutting
Floristic richness and diversity	Negative	Positive	Negative
Vertebrate animal richness	Negative	Positive	Negative
Soil biota richness and diversity	Negative	Neutral	Neutral
Pollinators richness and diversity	Negative	Positive	Negative
Hydrological structure and available water in the soil	Neutral	Neutral	Neutral
Connectivity	Neutral	Neutral	Neutral
Soil temperature (15, 30, 60 cm) in Cultivate	Negative	Positive	Negative

Principal cause to each impact (for each impact previously indicated, and related to the information in parts 1 and 2 of this questionnaire). (Regarding the main crops). Bioenergetic crops (Part 2. Paludiculture).

Environmental impacts	Bioenergetic crops (Part 2. Paludiculture)		
	Soil measures	Fertilization	Cutting
Floristic richness and diversity	Positive	Negative	Neutral
Vertebrate animal richness	Positive	Neutral	Neutral
Soil biota richness and diversity	Negative	Neutral	Neutral
Pollinators richness and diversity	Negative	Negative	Neutral
Hydrological structure and available water in the soil	Positive	Neutral	Neutral
Connectivity	Positive	Neutral	Neutral
Soil temperature (15, 30, 60 cm) in Cultivate	Negative	Neutral	Neutral

3.5. Hungary

Description UC Hungary

Southern Great Plain, Hungary

Current state: Abandoned land with sandy soil characterized 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.

PART 1. PRESENT OR TRADITIONAL LAND USE

PART. 1.1. DESCRIPTION OF CROPS

Crop name (scientific and common name): **Arable crops**: winter wheat (*Triticum aestivum* L.), maize (*Zea mays* L.), sunflower (*Helianthus annuus* L.), rape seed (*Brassica napus* L.); **plantations**: orchards, vineyards; grassland (data collected at county level).

Type (underline the correct answers).

Arable crops (annual, herbaceous): winter wheat (*Triticum aestivum* L.), maize (*Zea mays* L.), sunflower (*Helianthus annuus* L.), rape seed (*Brassica napus* L.); **plantations** (perennial, woody): orchards, vineyards; **grassland** (perennial).

Seedtime / plantation date (month or season).

Winter wheat (*Triticum aestivum* L.): September-October; maize (*Zea mays* L.): April-May; sunflower (*Helianthus annuus* L.): April; rapeseed (*Brassica napus* L.): September.

Harvest date (month).

Winter wheat (*Triticum aestivum* L.): July-August; maize (*Zea mays* L.): September-October; sunflower (*Helianthus annuus* L.): September-October; rapeseed (*Brassica napus* L.): June.

Approximately max height (in cm).

Winter wheat (*Triticum aestivum* L.) stalk: 80-140cm; maize (*Zea mays* L.): 160-190 cm; sunflower (*Helianthus annuus* L.): 140-170 cm; rapeseed (*Brassica napus* L.): 90-120 cm.

Max. Crop stand density (without weeds!).

Winter wheat (*Triticum aestivum* L.): 70%; maize (*Zea mays* L.): 50%; sunflower (*Helianthus annuus* L.): 50%; rapeseed (*Brassica napus* L.): 70%.

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1}):

Winter wheat (*Triticum aestivum* L.): 1-5 t ha^{-1}; maize (*Zea mays* L.): 3.5-6 t ha^{-1}; sunflower (*Helianthus annuus* L.): 0,5-1.5 t ha^{-1}; rapeseed (*Brassica napus* L.): 2-4 t ha^{-1}.

PART. 1.2. CULTIVATION LABOUR

Crop name (scientific and common name): **Arable crops**: winter wheat (*Triticum aestivum* L.), maize (*Zea mays* L.), sunflower (*Helianthus annuus* L.), rape seed (*Brassica napus* L.); **plantations**: orchards, vineyards; grassland (data collected at county level).

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

15-35 cm depends on crop cultivated and soil type, crop rotation.

Frequency of soil measures) over the year (how many times per year) (without mechanical weed control).

3-4 times depends on crop rotation and arable crop by-product residues remaining on site.

Mechanical weed control (indicate: yes or no; how many times, Month, tool).

Maize (*Zea mays* L.): 1-2 times; sunflower (*Helianthus annuus* L.): 1-2 times. For winter wheat (*Triticum aestivum* L.): and rapeseed (*Brassica napus* L.) mechanical weed control is not relevant.

Other Crop measures (indicate: type and application frequency).

Dessication, ripening process for rapeseed and sunflower are significant.

Use of fertilizers (indicate: name, composition, dose, and application frequency).

Before seeding, agricultural biogas digestate is applied at 25-45 m^3 of dosage ha^{-1}.

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency).

Preemergent herbicide active substance (flufenacet, metolachlor, terbuthylazine), **postemergent herbicide active substance** (metsulfuron-methyl, bensulfuron-methyl, rimsulfuron)

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

Small proportion of arable fields are irrigated in Bács-Kiskun County.

PART 2. NEW LAND USE - BIOENERGETIC CROPS

PART. 2.1. DESCRIPTION OF CROPS

Crop name (scientific and common name). Energy willow (*Salix viminalis* L.) + Virginia fanpetals, virginia mallow (*Ripariosida hermaphrodita* (L.) Weakley & D.b. Poind).

Type (underline the correct answers).

Salix viminalis L. (perennial, 10-15 years), *Ripariosida hermaphrodita* (L.) Weakley & D.b. Poind (perennial, 8-10 years).

Seedtime / plantation date (month or season).

Salix viminalis L. (planting unrooted cuttings: April 6, 2023); *Ripariosida hermaphrodita* (L.) Weakley & D.b. Poind (seedlings: 20 May, 2023).

Harvest date (month).

Salix viminalis L. (the first harvesting period is planned to be in 2024, it depends on plant development), *Ripariosida hermaphrodita* (L.) Weakley & D.b. Poind (it can be harvested at the end of 2023).

Approximately max height (in cm).

Salix viminalis L. (180-250 cm during the first year), *Ripariosida hermaphrodita* (L.) Weakley & D.b. Poind (140-170 cm during the first year).

Max. Crop stand density (without weeds!).

Salix viminalis L. (50%), *Ripariosida hermaphrodita* (L.) Weakley & D.b. Poind (50%).

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1}).

Salix viminalis L. (40-60 tonnes for energy willow after the second year), *Ripariosida hermaphrodita* (L.) Weakley & D.b. Poind (10-15 tonnes for Sida after the second year).

Part. 2.2. Cultivation labour

Crop name (scientific and common name). Energy willow (*Salix viminalis* L.) + Virginia fanpetals, virginia mallow (*Ripariosida hermaphrodita* (L.) Weakley & D.b. Poind).

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

Subsoiler 1 time, 45-50 cm, Tractor pulled hard disc with harrow 5 times before planting.

Frequency of soil measures over the year (how many times per year) (without mechanical weed control)

Twin rows and larger rows established on this site, only grass clipping and flail mower are applied.

Mechanical weed control (indicate: yes or no; frequency, Month, tool)

From April to September 5-10 times as we planned.

Other Crop measures (indicate: type and application frequency).

Mechanical harvesting 1 time each year.

Use of fertilizers (indicate: name, composition, dose, and application frequency).

Before planting, 45 m^3 of agricultural biogas digestates are applied as organic fertilizer for 1 ha that was provided by PILZE.

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency).

Only mechanical weed control is applied. For *Ripariosida hermaphrodita* the most relevant fungal infection is caused by *Sclerotinia* spp, however we would like to use antagonistic and effective *Trichoderma* based microbiological product.

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

Due to sandy soil cover in the Hungarian Use Case, sprinkler irrigation is applied 4-8 times for a month depending on average daily temperature, soil moisture content: from June to August in 2023. In 2024 we would like to optimize irrigation process that includes significant reduction of applied water due to the higher level of vegetation cover.

PART 3. BIODIVERSITY

Landscape (approximate value). (share of semi-natural habitats, road verges, hedgerows, water bodies….):

Value (homogeneus/heterogeneus): 8.

Short description:

There is a high level of heterogeneity due to agglomeration areas, orchards, vine yards, arable lands can be found at the surrounding of the Hungarian Use Case (10 km of radius).

***Natural habitat (underline the correct answers)*. In the neighbourhood of agricultural land**

Present, forests

Name and code to each present habitat (in accordance with natural habitat types of community interest – Annex I of Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora):

Turjánvidék (SAC) (Area code: HUDI20051, 12213.44 ha) (**Habitat codes: -)**

Nagykőrösi puszta tölgyesek (SAC) (Area code: HUDI20035, 3302.06 ha) (**Habitat codes: 3150, 6160, 5130, 6260, 6410, 6440,**

6510, 7210, 7230, 91E0, 91F0, 91I0, 91N0)

Nagynyíri-erdő (SAC) (Area code: HUKN20006, 750.08 ha) (**Habitat codes: 6260, 91I0, 91N0**)

Vegetation zones between crops and roads (underline the correct answers).

Enable connectivity with natural habitats, Prevailing vegetation (grassland, forest).

Short description (e.g., approximate length and width): --

River network (underline the correct answers).

Absent

Short description (e.g., approximate length and width): --

PART 4. IMPACTS ON BIODIVERSITY

Describe potential impacts: (What do you believe, on which of the named parts of biodiversity do either the traditional land use or the new bioenergetics crops might have a positive, negative or neutral impact?).

	Traditional land use	**Bioenergetic crops**
Plants	Neutral, negative	Neutral,
Birds	Neutral, negative	Positive
Vertebrates	Neutral, negative	Neutral, positive
Invertebrates	Neutral, negative	Neutral, positive
Other animals	Neutral, negative	Neutral, positive
Water courses and pond	Neutral	Neutral
Atmosphere (air)	Neutral, negative	Neutral, positive
Other	--	--

Principal cause to each impact (for each impact previously indicated, and related to the information in parts 1 and 2 of this questionnaire). (Regarding the main crops). Traditional land use (Part 1).

Environmental impacts	**Traditional land use (Part 1)**

	Soil measures	Fertilization	Pest control	Harvest
Soil texture	Negative	Neutral	Neutral	
Soil biological activity	Neutral, negative	Neutral, negative	Neutral, negative	
Nutrient loss in the plant-soil system	Negative	Negative	Neutral	
Carbon dioxide generation in soil	Enhances	Neutral, negative	Neutral	
Plant growth promoting rhizobacteria number in soil	Neutral, negative	Neutral, negative	Neutral, negative	
Water retention in soil	Negative	Neutral	Neutral	

Principal cause to each impact (for each impact previously indicated, and related to the information in parts 1 and 2 of this questionnaire). (Regarding the main crops). Bioenergetic crops (Part 2).

Environmental impacts	Bioenergetic crops (Part 2)			
	Soil measures	Fertilization	Pest control	Harvest
Soil texture	Positive	Neutral, positive	Neutral	--
Soil biological activity	Positive	Neutral, positive	Neutral, positive	--
Nutrient loss in the plant-soil system	It can be significantly lowered	It can be significantly lowered	Neutral	--
Carbon dioxide generation in soil	It can be significantly lowered	It can be significantly lowered	Neutral	--
Plant growth promoting rhizobacteria number in soil	Positive	Positive	Positive	--
Water retention in soil	Positive	Positive	Neutral	--

4. Results and Conclusions

The results obtained from the questionnaires completed by each use case leaders (see all the information in point 3) show that the main potential impacts that could be caused by the change of land use would be mostly positive (see Table 2) mainly due to a lower use of fertilizers, pesticides/herbicides and irrigation, etc.

		Traditional land use	Bioenergetic crops
Plants	Spain	+	0
	Greece	0/+	+
	Sweden	-	-
	Germany	-/0/+	-/0/+
	Hungary	-/0	0
Birds	Spain	0	0
	Greece	0	+
	Sweden	+	+
	Germany	-/+	+
	Hungary	-/0	+
Vertebrates	Spain	0	0
	Greece	0/+	+
	Sweden	-/0/+	-/0/+
	Germany	+	+
	Hungary	-/0	0/+
Invertebrates	Spain	-	+
	Greece	0/+	+
	Sweden	0/+	+
	Germany	+	+
	Hungary	-/0	0/+
Other animals	Spain	0	0
	Greece	0/+	+
	Sweden		
	Germany	-/+	+
	Hungary	-/0	0/+
Water courses and ponds	Spain	-	+
	Greece	0	0
	Sweden	-	-
	Germany	-	+
	Hungary	0	0
Atmosphere (air)	Spain	0	0
	Greece	+	+
	Sweden	-	-
	Germany	-/0	+
	Hungary	-/0	0/+
Other	Spain	0	0
	Greece	0/+ (soil)	+ (soil)
	Sweden		
	Germany	-/0	+
	Hungary		

Table 2. Difference in value of environmental impacts due to land use change. Note: negative (-), neutral (0), positive (+)

In addition, the greatest potential environmental impacts are generated on the soil and biodiversity (flora and fauna), and mainly during soil measures activities for cultivation and to a lesser extent using fertilizers and pesticides/herbicides (see Table 3).

	Environmental impacts	UC	Traditional land use				Bioenergetic crops			
			SM	F	PC	H	SM	F	PC	H
Soil	Soil biota richness and diversity	ES	-	-	-	0	+	0	0	0
		GE	-	-/+	0	0	+	+	+	0
	Hydrological structure and available water in the soil / Water retention in soil	ES	-	0	-	0	+	0	0	0
		GE	-	0	0	0	+	+	0	0
		HU	-	0	0		+	+	0	
	Soil temperature (15, 30, 60 cm) in Cultivate	ES	-	-	0	0	+	0		0
		GE	+	-/0	0	0	-	-	0	0
	Soil quality	GR					+			+
	Soil texture	HU	-	0	0		+	0/+	0	
	Soil biological activity	HU	-/0	-/0	-/0		+	0/+	0/+	
	Nutrient loss in the plant-soil system	HU	-	-	0		+	-	0	
	Plant growth promoting rhizobacteria number in soil	HU	-/0	-/0	-/0		+	+	+	
	Carbon dioxide generation in soil	HU	-/+	-/0/+	0		-	-	0	
Flora	Floristic richness and diversity	ES	-	-	-	0	0	0		0
		GE	-	-	-/+	-/0	+	+	+	+
		SW	-	-	-		-	-	-	
	Number and species of plants	GR					+			0
Fauna	Vertebrate animal richness	ES	-	-	-	-	0	0		0
		GE	-	0/+	-	0	+	+	+	0
	Invertebrate animal richness	SW			-				-	
	Pollinator richness and diversity	ES	0	+	-	0	+	0		0
		GE	0	-/0	-/+	-/0	-	+	+	0
	Number and species of animals	GR					0			-
	Biodiversity regarding birds	GR					0			-
		SW	-	-	-		-		-	-
Other	Concentration of pollutants	GR					+			+
		SW	-	-	-	-	-	-	-	-
	Eutrophication	SW	-	-			-	-		
	Connectivity Habitat	ES	-	-	-	0	+	0	0	0
		GE	-	0	-/0	0	+	+	+	0

Table 3. Principal environmental impacts due to land use change. Note: negative (-), neutral (0), positive (+); Use Cases (UC): Spain (ES), Greece (GR), Sweden (SW), Germany (GE), Hungary (HU); Soil measures (SM), Fertilization (F), Pest control (PC), Harvest (H)

Finally, from the data obtained we can make a guide of potential environmental impacts and the potential measures to reduce environmental impacts on bioenergetic crops.

List of potential environmental impacts:

1. **Potential soil impacts:**

   1.1. Alteration of the structure and texture of the soil. Mechanized techniques for preparing the land for planting crops involve turning the soil from time to time. This work entails the loss of the original structure and texture of the soil and indirectly affects other soil properties such as: water retention, soil microbiology, etc.

   1.2. Loss of organic matter. The nutritional requirements of the crops cause the progressive loss of organic matter because the nutritional requirements of the crops are very high, which entails the need for fertilization to maintain crop productivity.

   1.3. Alteration of the physical-chemical properties of the soil (temperature, pH, electrical conductivity, ...).

   1.4. Soil compaction. The use of heavy machinery used during crop maintenance work, originates soil compaction processes, which together with the processes of alteration of the soil texture and structure.

2. **Potential Biodiversity impacts:** The use of pesticides or herbicides causes the death of species harmful to crops and other species that live in nearby areas. This generates the loss of the natural biodiversity of the landscape and allows the appearance of adventitious species and exotic or invasive species, which present greater resistance to the effect of pesticides/herbicides.

   2.1. **Loss of species.**

   2.2. **Increase in adventitious species.**

   2.3. **Increase in exotic or invasive species.**

   2.4. **Loss of connectivity inter natural habitats.**

3. **Potential impacts of watercourses (surface and underground):** Excessive use of fertilizers causes increased nutrients (nitrogen, phosphorus, …) in waterways, which causes eutrophication processes and loss of biodiversity associated with these water courses.

List of measures to reduce the environmental impacts on bioenergetic crops:

1. **Reduce the soil measures (frequency and intensity).**

2. **Promote crop rotation.**

3. **Reduce fertilizer use.**

4. **Reduce herbicides/pesticides use.**

5. References

Bourguignon, M.; Archontoulis, S.; Moore, K. & Lenssen, A. (2017). A model for evaluating production and environmental performance of kenaf in rotation with conventional row crops. *Industrial Crops and Products* 100: 218-227. https://doi.org/10.1016/j.indcrop.2017.02.026

Burland, A. & von Cossel, M. (2023). Towards managing biodiversity of european marginal agricultural land for biodiversity-friendly biomass production. *Agronomy* 13: 1651. https://doi.org/10.3390/agronomy13061651.

Carof, M.; Godinot, O. & Le Cadre, E. (2022). Biodiversity-based cropping systems: A long-term perspective is necessary. *Science of The Total Environment* 838(1): 156022. https://doi.org/10.1016/j.scitotenv.2022.156022.

Ciria, C.S.; Sanz, M.; Carrasco, J. & Ciria, P. (2019). Identification of Arable Marginal Lands under Rainfed Conditions for Bioenergy Purposes in Spain. *Sustainability* 11(7): 1833. https://doi.org/10.3390/su11071833.

Csikós, N. & Tóth, G. (2023). Concepts of agricultural marginal lands and their utilisation: A review. *Agricultural Systems* 204: 103560. https://doi.org/10.1016/j.agsy.2022.103560.

Dauber, J.; Jones, M.B. & Stout, J.C. (2010). The impact of biomass crop cultivation on temperate biodiversity. *GCB Bioenergy* 2(6): 289-309. https://doi.org/10.1111/j.1757-1707.2010.01058.x

Englund, O.; Börjesson, P.; Berndes, G.; Scarlat, N.; Dallemand, J.F.; Grizzetti, B.; Dimitriou, I.; Mola-Yudego, B. & Fahl, F. (2020). Beneficial land use change: Strategic expansion of new biomass plantations can reduce environmental impacts from EU agricultura. *Global Environmental Change* 60: 101990. https://doi.org/10.1016/j.gloenvcha.2019.101990

European Commission. Grant Agreement number 10108208 – MarginUp!

Fernando, A.L. (2013). Environmental Aspects of Kenaf Production and Use, In: Monti, A. & Alexopoulou, E. (Eds.) Kenaf: A Multi-Purpose Crop for Several Industrial Applications. *Industrial Applications, Green Energy and Technology* pp 83-104. Springer, London. https://doi.org/10.1007/978-1-4471-5067-1_5.

Glemnitz, M.; Reger, J.; Moroder, A.; Morell, K.; Vázquez-Pardo, F.M.; Kalea, T.; Kujáni, K.; Szolnoki, T. & Kowalski. G.J. (2023). *Regionally Adapted Biodiversity Indicator System (RABIS). Delivery 2.1*. Technical Report.

Gerwin, W.; Repmann, F.; Galatsidas, S.; Vlachaki, D.; Gounaris, N.; Baumgarter, W.; Volkmann, C.; Keramitzis, F. & Freese, D. (2018). Assessment and quantification of marginal lands for biomass production in Europe using soil quality indicators. *Soil Discussions* 4: 267-290. https://doi.org/10.5194/soil-4-267-2018.

Gillingham, K.T.; Smith, S.J. & Sands, R.D. (2008). Impact of bioenergy crops in a carbon dioxide constrained world: an application of the MiniCAM energy-agriculture and land use model. *Mitig. Adapt. Strat. for Glob.Change* 13(7): 675-701. https://doi.org/10.1007/s11027-007-9122-5.

Hackett, M. & Lawrence, A. (2014). *Multifunctional Role of Field Margins in Arable Farming Report for European Crop Protection Association*. Cambridge Environmental Assessments – ADAS UK Ltd

Holland, R.A.; Eigenbrod, F.; Muggeridge, A.; Brown, G.; Clarke, D. & Taylor, G. (2015). A synthesis of the ecosystem services impact of second generation bioenergy crop production. *Renewable and Sustainable Energy Reviews* 46: 30-40. https://doi.org/10.1016/j.rser.2015.02.003.

Holland JM, Storkey J, Lutman PJM, Henderson I, Orson J. 2013. *Managing uncropped land in order to enhance biodiversity benefits of the arable farmed landscape: The Farm4bio project*. Project Report No 508 Agriculture and Horticulture Development Board.

Horrigan, L.; Lawrence, R.S. & Walker, P. (2002). How sustainable agriculture can address the environmental and human health harms of industrial agriculture. *Environ Health Perspect.* 110(5): 445–456. https://ehp.niehs.nih.gov/doi/10.1289/ehp.02110445.

Immerzeel, D.J.; Verweij, P.A.; van der Hilst, F. & Faaij, A.P. (2014). Biodiversity impacts of bioenergy crop production: a state-of-the-art review. *GCB Bioenergy* 6(3): 183-209. https://doi.org/10.1111/gcbb.12067.

Jungers, J.M.; Yang, Y.; Fernandez, C.W.; Isbell, F.; Lehman, C.; Wyse, D. & Sheaffer, C. (2021). Diversifying bioenergy crops increases yield and yield stability by reducing weed abundance. *Science Advances* 7(44): eabg8531. https://www.science.org/doi/10.1126/sciadv.abg8531.

Liu, J.; Huffman, T. & Green, M. (2018). Potential impacts of agricultural land use on soil cover in response to bioenergy production in Canada. *Land Use Policy* 75: 33-42. https://doi.org/10.1016/j.landusepol.2018.03.032.

Marshall, E.J.P. & Moonen, A.C. (2002). Field margins in northern Europe: their functions and interactions with agriculture. *Agriculture, Ecosystems and Environment* 89(1/2): 5-21. https://doi.org/10.1016/S0167-8809(01)00315-2.

Melnikova, I.; Boucher, O.; Cadule, P.; Tanaka, K.; Gasser, T.; Hajima, T.; Quilcaille, Y.; Shiogama, H.; Séférian, R.; Tachiiri, K.; Vuichard, N.; Yokohata, T. & Ciais, P. (2022). Impact of bioenergy crop expansion on climate–carbon cycle feedbacks in overshoot scenarios. *Earth System Dynamics* 13(2): 779-794. https://doi.org/10.5194/esd-13-779-2022.

Merckx T, Feber RE, Riordan P, Townsend MC, Bourn NAD, Parsons MS, Macdonald DW. (2009). Optimizing the biodiversity gain from agri-environment schemes. *Agriculture, Ecosystems and Environment* 130:177-182. https://doi.org/10.1016/j.agee.2009.01.006.

Núñez-Regueiro, M.M.; Siddiqui, S.F. & Fletcher Jr, R.J. (2019). Effects of bioenergy on biodiversity arising from land-use change and crop type. *Conservation Biology* 35(1): 77-87. https://doi.org/10.1111/cobi.13452

Robertson, B.A.; Porter, C.; Landis, D.A. & Schemske, D.W. (2012). Agroenergy Crops Influence the Diversity, Biomass, and Guild Structure of Terrestrial Arthropod Communities. *Bioenerg. Res.* 5: 179-188. https://doi.org/10.1007/s12155-011-9161-3

Rowe, R.L.; Goulson, D.; Doncaster, C.P.; Clarke, D.J.; Taylor, G. & Hanley, M.E. (2013). Evaluating ecosystem processes in willow short rotation coppice bioenergy plantations. *GCB Bioenergy* 5(3): 257-266. https://doi.org/10.1111/gcbb.12040.

Scheper J, Kleijn D. (2011). *STEP Deliverable 4.3: Analysis of the effectiveness of measures mitigating pollinator loss*. Alterra, Centre for Ecosystem Studies, Wageningen, The Netherlands.

Shinohara, N.; Uchida, K. & Yoshida, T. (2019). Contrasting effects of land-use changes on herbivory and pollination networks. *Ecology and Evolution* 9(23): 13585-13595. https://doi.org/10.1002/ece3.5814.

Smith H, Feber RE, Morecroft MD, Taylor ME, Macdonald DW. (2010). Short-term successional change does not predict long-term conservation value of managed arable field margins. *Biological Conservation* 143:813-822. https://doi.org/10.1016/j.biocon.2009.12.025.

Tudge, S.J.; Purvis, A. & De Palma, A. (2021). The impacts of biofuel crops on local biodiversity: a global synthesis. *Biodiversity and Conservation 30*: 2863-2883. https://doi.org/10.1007/s10531-021-02232-5.

Vanbeveren, S.P.P. & Ceulemans, R. (2019). Biodiversity in short-rotation coppice. *Renewable and Sustainable Energy Reviews* 111: 34-43. https://doi.org/10.1016/j.rser.2019.05.012.

Verdade, L.M.; Piña, C.I. & Rosalino, L.M. (2015). Biofuels and biodiversity: Challenges and opportunities. *Environmental Development* 15: 64-78. https://doi.org/10.1016/j.envdev.2015.05.003.

6. Annex

6.1. Annex 1. Questionnaire on (potential) biodiversity impacts

Questionnaire on (potential) biodiversity impacts

Why do we need this?

The CICYTEX team will develop a guideline of (potential) biodiversity impacts caused for the land use (task 2.2.). In this task it is necessary that each use case leader will describe and analyse its interaction with the different environmental factors (soil, animals (e.g. pollinators) and plants). This work will analyse the present or traditional land use and the new one (industrial crops) in each region.

The questionnaire is structured in four parts:

Part 1. Present or traditional land use. In this part, each land use case shows on the study region will be described to assess potential environmental impacts, e.g. soil, water, and biodiversity.

Part 2. New land use - industrial crops. In this part, each crop (industrial crops) will be described to assess potential environmental impacts, e.g. soil, water, and biodiversity.

Part 3. Biodiversity. It is necessary to study the current situation of habitats and their connectivity. This work will assess the existence of refuge zones for biodiversity (e.g. animal, plants…) and their functionality.

Part 4. Impacts on biodiversity. Finally, the main environmental impacts of each crop (traditional land use, and industrial crops) will be described. It is important for determinate the different environmental impacts level will cause for change land use.

Part 1. Present or traditional land use (complete for up to 5 main crops).

Part. 1.1. Description of crops.

Crop name (scientific and common name).

Type (underline the correct answers). * If it is a perennial crop, indicate the number of years of the crop persistence

Annual / perennial* herbaceous / shrubby / woody

Seedtime / plantation date (month or season).

Harvest date (month).

Approximately max height (in cm).

Max. Crop stand density (without weeds!) (Underline the correct answers).

10 20 30 40 50 60 70 80 90 100%

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1})

Part. 1.2. Cultivation labour.

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

Frequency of soil measures) over the year (how many times per year) (without mechanical weed control)

Mechanical weed control (indicate: yes or no; how many times, Month, tool)

Other Crop measures (indicate: type and application frequency).

Use of fertilizers (indicate: name, composition, dose, and application frequency). ** If Organic fertilizers are used (indicate: yes or no, type, dose (in kg/ha) and Nitrogen content)*

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency).

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

Part 2. New land use - bioenergetic crops (complete for each crop).

Part. 2.1. Description of crops.

Crop name (scientific and common name).

Type (underline the correct answers). * If it is a perennial crop, indicate the number of years of the crop persistence

Annual / perennial*   herbaceous / shrubby / woody

Seedtime / plantation date (month or season).

Harvest date (month).

Approximately max height (in cm).

Max. Crop stand density (without weeds!) (Underline the correct answers).

10   20   30   40   50   60   70   80   90   100%

Yield level (within the last 3-5 Years). (Dry biomass t ha^{-1})

Part. 2.2. Cultivation labour.

Soil measures (indicate: soil pre-treatment and maintenance). Depth in cm.

Frequency of soil measures over the year (how many times per year) (without mechanical weed control)

Mechanical weed control (indicate: yes or no; frequency, Month, tool)

Other Crop measures (indicate: type and application frequency).

Use of fertilizers (indicate: name, composition, dose, and application frequency). ** If Organic fertilizers are used (indicate: yes or no, type, dose (in kg/ha) and Nitrogen content)*

Use of herbicide/pesticides (indicate: name, composition, dose, date of application [in Month), BBCH at application (if possible!), and application frequency).

Water management (irrigation) (indicate: yes or no, dose, application frequency, date [in Month], and duration of application [in number of Months]).

Part 3. Biodiversity.

Landscape (approximate value).(share of semi-natural habitats, road verges, hedgerows, water bodies….)

Homogeneous Heterogeneous

1 2 3 4 5 6 7 8 9 10

Short description:

***Natural habitat (underline the correct answers)*. In the neighbourhood of agricultural land**

Present / absent arable / grassland / shrub / forests / aquatic

Name and code to each present habitat (in accordance with natural habitat types of community interest – Annex I of Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora):

Vegetation zones between crops and roads (underline the correct answers).

Present / absent

Enable connectivity with natural habitats (Yes / No)

Prevailing vegetation (grassland / shrub / forests / aquatic)

Short description (e.g. approximate length and width):

River network (underline the correct answers).

Present / absent Natural / artificial

Seasonal / permanent Continuous / Discontinuous

With natural vegetation / Without natural vegetation

Short description (e.g. approximate length and width).

Part 4. Impacts on biodiversity.

Describe potential impacts: (What do you believe, on which of the named parts of biodiversity do either the traditional land use or the new bioenergetics crops might have a positive, negative or neutral impact?).

	Traditional land use	**Bioenergetic crops**
Plants		
Birds		
Vertebrates		
Invertebrates		
Other animals		
Water courses and pond		
Atmosphere (air)		
Other		

Principal cause to each impact (for each impact previously indicated, and related to the information in parts 1 and 2 of this questionnaire). (Regarding the main crops). Traditional land use (Part 1).

Environmental impacts	**Traditional land use (Part 1)**			
	Soil measures	***Fertilization***	***Pest control***	***Harvest***
Floristic richness and diversity				
Vertebrate animal richness				
Soil biota richness and diversity				
Pollinators richness and diversity				
Hydrological structure and available water in the soil				
Connectivity				
Soil temperature (15,30,60 cm) in cultivate				

Principal cause to each impact (for each impact previously indicated, and related to the information in parts 1 and 2 of this questionnaire). (Regarding the main crops). Bioenergetic crops (Part 2).

Environmental impacts	**Bioenergetic crops (Part 2)**			
	Soil measures	***Fertilization***	***Pest control***	***Harvest***
Floristic richness and diversity				

Vertebrate animal richness				
Soil biota richness and diversity				
Pollinators richness and diversity				
Hydrological structure and available water in the soil				
Connectivity				
Soil temperature (15,30,60 cm) in cultivate				