

# **LEGUMINOSE web- based platform - Training manual -**

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Authors

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1 PU = Public, fully open, e.g., web (Deliverables flagged as public will be automatically published in CORDIS project's page)

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EU-C = EU Confidential under the Commission Decision No2015/444

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## Document History

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## Summary

This training manual allows users to create and run the InterCrop model for simulating intercropping systems using the LEGUMINOSE web-based platform. It provides detailed instructions on how to identify and define the boundaries of the field, create a scenario for running a simulation based on input datasets (crop, soil, weather and management practices), and visualise the simulation outputs in graphical format.

## Summary of Deliverable

We provided a detailed demonstration of how to create and run a simulation in the LEGUMINOSE web-based platform. We presented two case studies involving a field in the Czech Republic. In the first example, users were guided through all the necessary steps that need to be completed on the platform for running a basic simulation where only the field location was known. In the second example, users had access to soil measurements and a weather dataset collected from a nearby weather station. Finally, we demonstrated how to compare intercropping with monocrop simulations.

## Disclaimer

This publication reflects only the author's view. The Agency and the European Commission are not responsible for any use that may be made of the information it contains.

## Table of Contents

1	Introduction	5
2	Preparation	6
3	Steps for running a simulation	12
3.1	Exercise 1: A basic intercropping simulation scenario	12
3.2	Exercise 2: An intercropping simulation using measured data	17
3.3	Exercise 3: Comparing the performance of monocrop versus intercrop	24

# 1 Introduction

Welcome to the training manual for the LEGUMINOSE web-based platform!

The LEGUMINOSE web-based platform is an interactive system that assists farmers, agronomists, decision-makers, and other interested stakeholders to draw strategies and make decisions about intercropping systems across Europe. Users can explore various features related to intercropping practices, such as identifying suitable mixtures of crop species/cultivars and management practices for specific sites.

They can also investigate the impact of intercropping designs on crop growth and the dynamics of water and nitrogen over time and space. This is of critical importance for the design of sustainable and resilient cropping systems, as well as for the establishment of a knowledge-sharing platform.

Users can create multiple scenarios by selecting different legume-cereal combinations, intercrop configurations, and management practices. This tutorial will introduce you to creating and running your simulations using the LEGUMINOSE web-based platform.

The objective of this tutorial is to allow all members of the LEGUMINOSE project and interested stakeholders to use the LEGUMINOSE web-based platform to create and run intercrop simulations for any agricultural field in Europe.

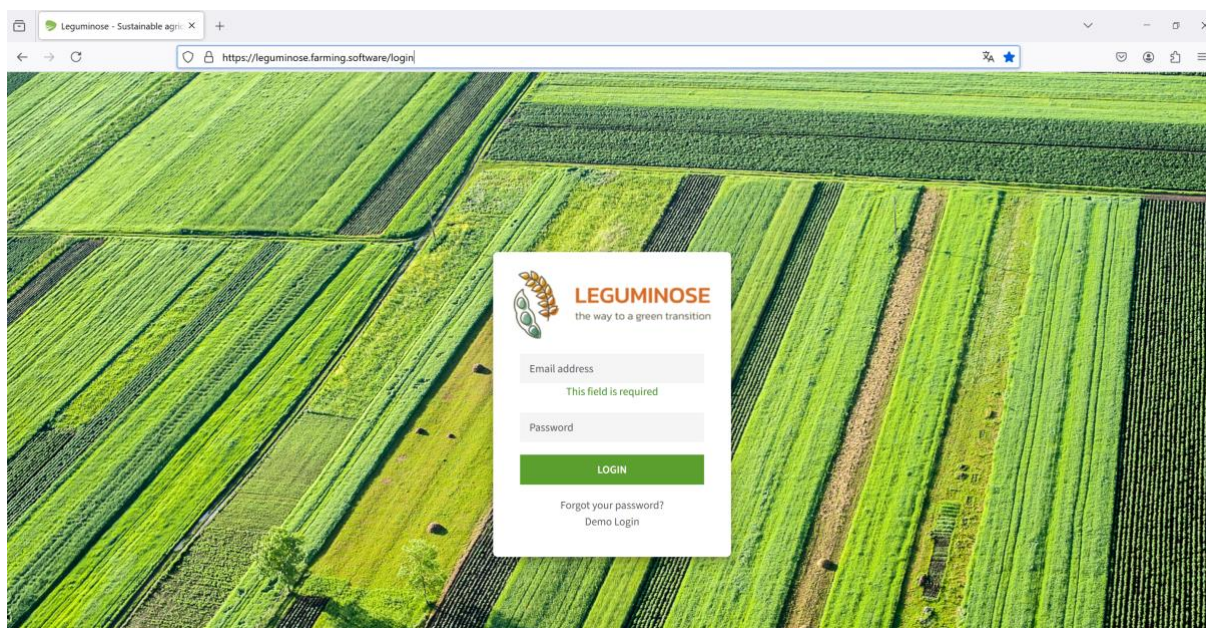
## 2 Preparation


Before running an intercropping simulation, a few preparatory steps are required. The first is logging into the system:

1. Open your preferred web browser and navigate to the following web application:

<https://leguminose.farming.software>

2. You should now see this view:



3. Enter your credentials (i.e., registered email address and password) in the boxes and click the  button.
4. You are now logged into the system.

Next, you need to create a field to define the simulation's point of interest. This field location is used to retrieve the appropriate weather dataset and derive soil data.

The screenshot shows the LEGUMINOSE dashboard. At the top, there is a navigation bar with 'Home', 'Administration', 'Inventory', 'Planning', 'Simulation', and 'Reporting'. The main content area is divided into several sections: a weather forecast for '15.1° CLEAR SKY' with hourly data, a 'My fields' section, a 'Next planned events' section, and a right-hand sidebar with various alerts and statistics. The sidebar includes 'Fields/Plots' (0/0), 'ha' (0), 'Procedures' (0), 'Crop cultivars' (0), 'Fertilizers' (0), 'Pesticides' (0), 'Machines' (0), and 'Profile incomplete'.

You will now be guided through the process of drawing a polygon to identify an agricultural field located in the Czech Republic. The geocoordinates of the field are:

- **Latitude:** 49.7906758
- **Longitude:** 16.9115911

1. Select the **Administration** top menu item.
2. On the left side menu, press **Fields and plots** (in red).

The screenshot shows the LEGUMINOSE Administration page. The left-hand navigation menu is expanded, and 'Fields and plots' is highlighted with a red box. The main content area is divided into two columns: 'Personal data' and 'Agricultural holding'. The 'Personal data' section includes fields for 'First name', 'Last name', 'Street', 'House number', 'Postal code', 'City', 'Country', and 'Telephone'. The 'Agricultural holding' section includes fields for 'Name', 'Agricultural holding number', 'Description (opt.)', 'Street', 'House number', 'Postal code', 'City', 'Country', and 'Telephone'. There are also dropdown menus for 'Latitude', 'Longitude', and 'Sea level', and a section for 'Management method', 'Farm type (production)', and 'Farm type (sideline)'.

3. You should now see a similar screen:



The screenshot shows the LEGUMINOSE web application interface. The top navigation bar includes 'Home', 'Administration', 'Inventory', 'Planning', 'Simulation', and 'Reporting'. The left sidebar lists various administration and field management options. The main area is split into two panels: 'Map view' on the left and 'Fields (0.00 ha)' on the right. The 'Map view' panel shows a satellite map with a search bar and a 'PLACE' dropdown. The 'Fields (0.00 ha)' panel features a table with columns for 'Fnr', 'Name', 'Field usage', 'Plots', and 'Area (ha)'. A green '+ Import from KML, XML file' button is highlighted with a red box in the top right corner of the fields panel. Below the table, there is a message: 'Please click on the green PLUS symbol in the top right corner to manually create fields. The button next to it allows you to import fields and plots from an IACS file.'




4. Click the  button in the top right corner and the following screen will be presented:

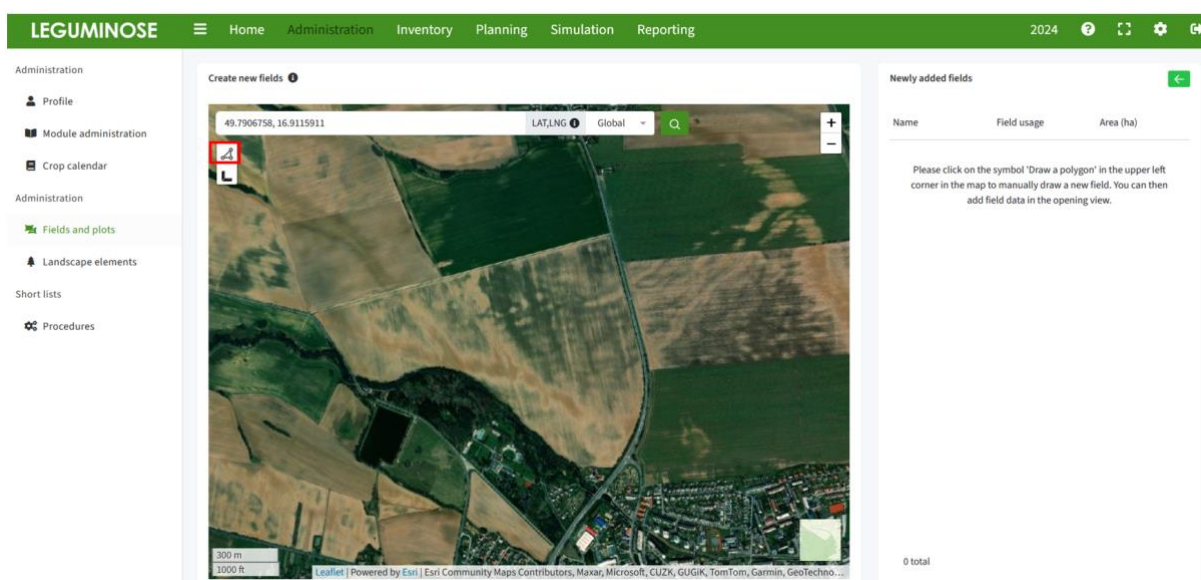
The screenshot shows the LEGUMINOSE web application interface after clicking the '+' button. The main area is split into two panels: 'Create new fields' on the left and 'Newly added fields' on the right. The 'Create new fields' panel has a search bar containing the coordinates '49.7906758, 16.9115911', which is highlighted with a red box. A green '+ -' button is also highlighted with a red box in the top right corner of the map area. The 'Newly added fields' panel shows a table with columns for 'Name', 'Field usage', and 'Area (ha)'. Below the table, there is a message: 'Please click on the symbol 'Draw a polygon' in the upper left corner in the map to manually draw a new field. You can then add field data in the opening view.'


5. Enter the following geocoordinates of the field into the search bar:

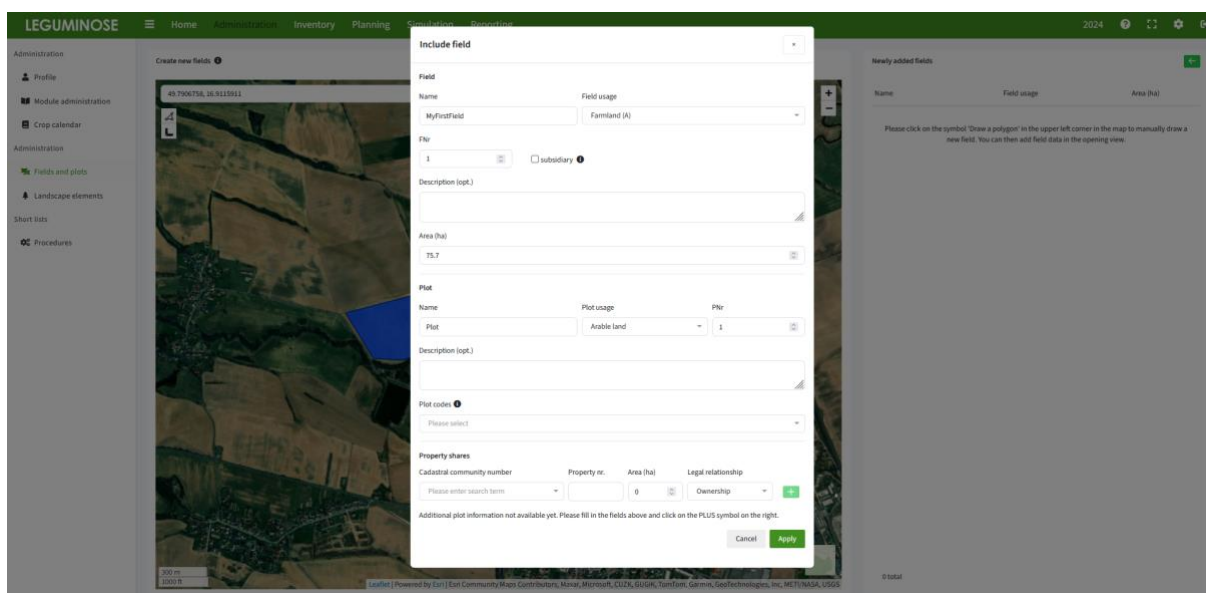
**49.7906758, 16.9115911**

and then press ENTER or click the  button. For simplicity, we use decimal degrees for the geocoordinates of the field. However, other formats of coordinates can be chosen (see the  icon next to the geocoordinates search bar).

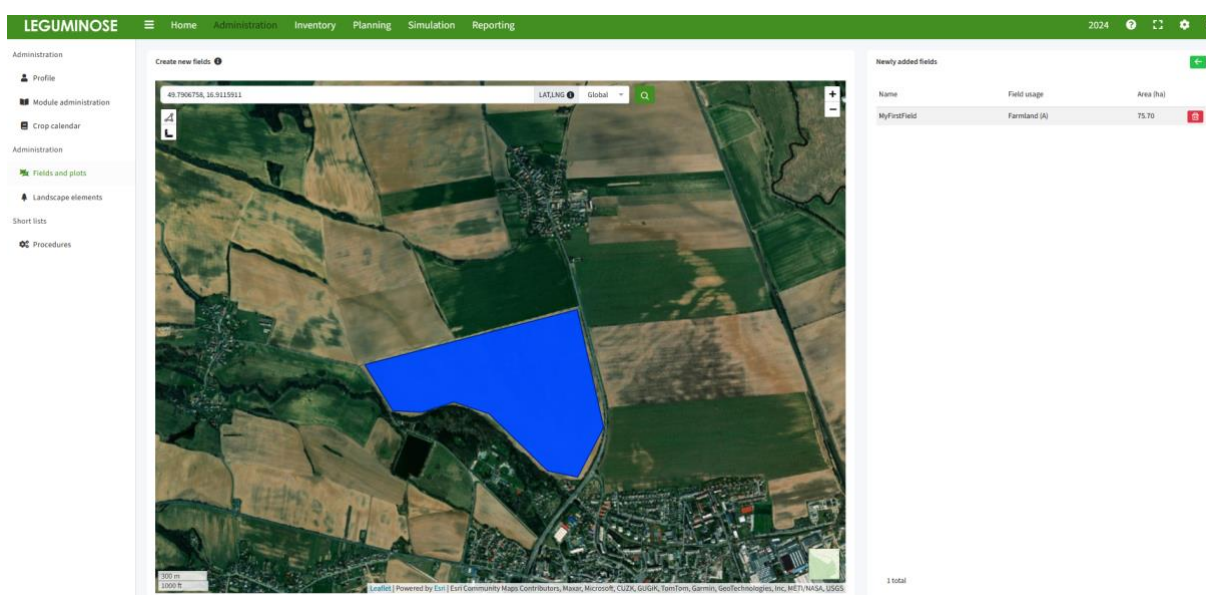
- Click on the  button to switch to the satellite background. You can adjust the zoom factor using the   buttons or with the mouse wheel:



- Click the  button, and then click on the vertices of the field. You do not need to be overly precise when setting the vertices, just make sure that the boundaries are reasonably accurate. To finish drawing the polygon, simply click on the first vertex of the polygon again.
- A form will automatically appear on your screen:

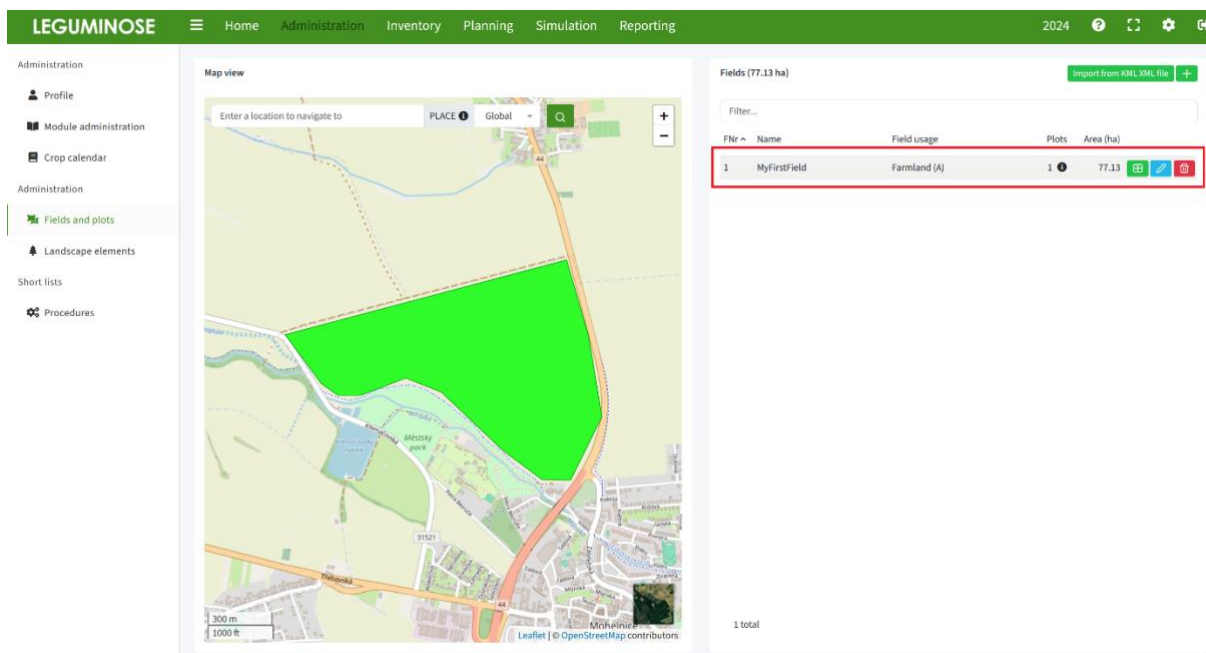


9. Enter all relevant information about your field in the respective boxes (name, field and plot numbers, field and plot usage, etc). The majority of the required fields are preset, only add an appropriate name for the field for this example (e.g. **MyFirstField**).
10. Press the Apply button and DONE! You have created the polygon that identifies the field trial in the Czech Republic:



11. Return to the previous view by clicking on the green arrowed button (**Return to existing fields**) in the top right corner. You can change the field name or any other parameters (except for the geometry) at any time later on by clicking on the blue pencil button. Since each field can be divided into several plots, a default plot with the same size is created automatically for this field. Click on the green grid button to enter the plot view of the field, if you want to change the plot details.

12. Alright! You have correctly created your field in the LEGUMINOSE web-based platform.



The screenshot displays the LEGUMINOSE web-based platform interface. The top navigation bar includes 'Home', 'Administration', 'Inventory', 'Planning', 'Simulation', and 'Reporting'. The left sidebar lists 'Administration' options: Profile, Module administration, Crop calendar, Fields and plots (highlighted), Landscape elements, Short lists, and Procedures. The main content area is split into two panels. The left panel, titled 'Map view', shows a map with a large green field highlighted. The right panel, titled 'Fields (77.13 ha)', contains a table with the following data:

FNr	Name	Field usage	Plots	Area (ha)
1	MyFirstField	Farmland (A)	1	77.13




Below the table, it indicates '1 total'. The interface also includes a search bar, a scale bar (300 m / 1000 ft), and a 'Leaflet | © OpenStreetMap contributors' attribution.

### 3 Steps for running a simulation

Once the field location is set, we can continue with the setup of the actual simulation scenarios.

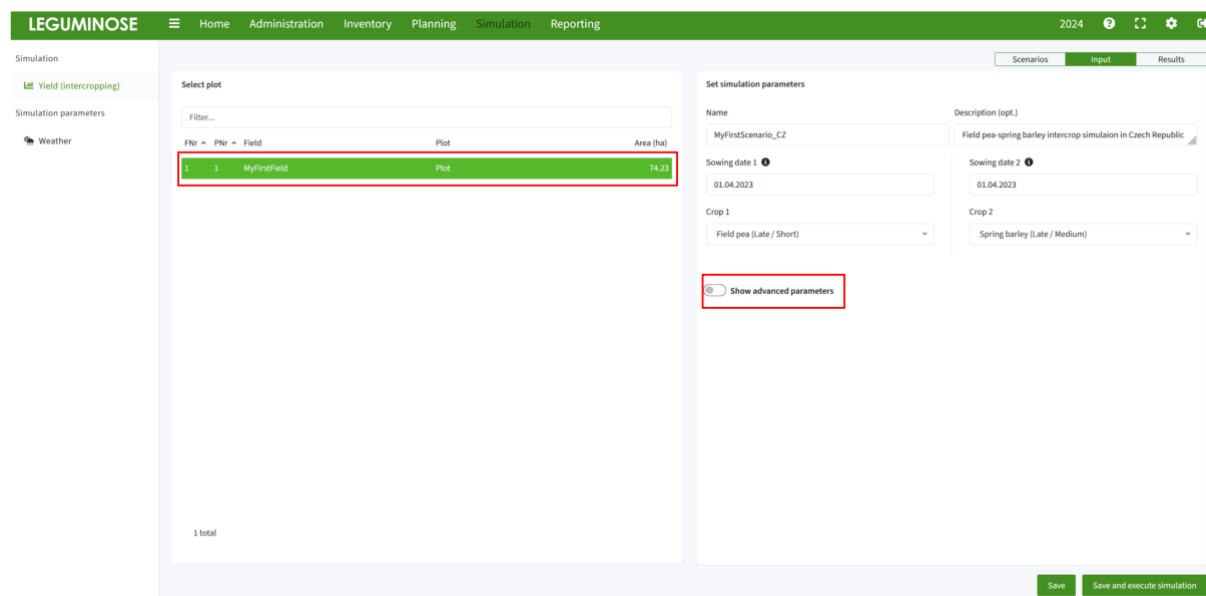
#### 3.1 Exercise 1: A basic intercropping simulation scenario

Now that you have created a polygon to identify your field (called **MyFirstField**), let's set up a scenario which will be used for running your first simulation on the LEGUMINOSE web-based platform.

1. In order to create our first scenario, select the **Simulation** view by clicking on the corresponding link in the top nav bar and then click the  button. A window will automatically pop up in your screen.
2. Enter the name **MyFirstScenario\_CZ** of the scenario. If you like, you can also add an optional description.
3. Click the  button and you are **DONE!** Your first scenario was created and selected. You can return to the list of scenarios if you click on the **Scenarios** link in the top right corner. If you want to again select the scenario, click the  button.



Let's investigate the input parameters for this newly created scenario:



1. On the left, select the plot of interest by clicking on the name of the field you have created (**MyFirstField**). The selected plot will be displayed in green.
2. In the **Set simulation parameters** menu on the right, note that the system has created the simulation scenario with the following default settings:
  - Sowing date 1: 01.04.2023
  - Sowing date 2: 01.04.2023
  - Crop 1 (maturity / max plant height): Field pea (Late / Short)
  - Crop 2 (maturity / max plant height): Spring barley (Late / Medium)

These parameters are sufficient to quickly get started with the intercropping simulation. The system provides feedback when any of these parameters are invalid, e.g. when the sowing dates' years do not match or when two legumes are selected (one legume and one non-legume crops are required). For now, let's keep the default settings.

However, the LEGUMINOSE web-based platform supports modifying more advanced parameters when required. Click on the **Show advanced parameters** switcher to display the advanced parameters. It will show the following options:


**Intercropping design:** This switcher determines the mode between stripped and fully mixed intercropping. Either mode requires its own set of parameters. Leave the switch button on the **Fully mixed** for now. You can see the default values for seeding densities which need to be set separately for each crop (in seeds/m<sup>2</sup>):

- Field pea: 40
- Spring barley: 150

**Weather data:** The simulation engine requires daily weather data (min/max temperature, precipitation, solar radiation) for the whole simulation period. The system supports either field-location-based default weather data or custom uploaded datasets. For this example, the weather dataset for running this simulation will be automatically taken from the German Weather Service (DWD) based on the field location. Earliest available weather data from DWD in the system is 2019.

**Irrigation:** For advanced simulations, the simulation model supports explicitly setting application day-based irrigations. Do not change anything for now (leave as default).

**Fertilization:** Similar to irrigation, we can also set fertilizations at a day-basis. The default scenario does not include any fertilization applications, so let's create one:

1. Make sure that the N-limited condition box is activated (  N-limited condition )
2. Click the edit button (  ), and then a window will pop up on your screen:

## Edit fertilization strategy

x

Application day	Amount (N g/m <sup>2</sup> )	Volatilization fraction (%)	Distribution	
<input type="text"/>	<input type="text" value=""/>	<input type="text" value="4"/>	<input type="text" value="1st Crop"/>	<input type="button" value="+"/>
This field is required	Invalid number			

## Saved applications

No applications to display. Please set the desired parameters above and click on the PLUS symbol.

Cancel

Adopt changes

- An N fertilization rate of 30 kg N ha<sup>-1</sup> has to be applied one day before the sowing date (i.e., **31.03.2023**).

**ATTENTION!** The system requires that the amount of N rate is defined in g N m<sup>-2</sup>. As farmers usually define their N fertilization rates in kg N ha<sup>-1</sup>, **it must be converted** (in this case, dividing by 10, i.e. **3 g N m<sup>-2</sup>**).

- Do not change the default volatilization fraction (4%).
- Set the distribution of N to **Both**, since we want to simulate a fully mixed intercropping system.
- Click the  button to save the N application just entered for the specific date, N rate, volatilization fraction and distribution settings.
- If any mistake was done here, the unwanted application can be deleted (using the  button).
- Make sure that you **ONLY** have a single application with the correct date and amount shown in the **Saved applications** area. Your N management box should be as follows:

## Edit fertilization strategy

x

Application day	Amount (N g/m <sup>2</sup> )	Volatilization fraction (%)	Distribution	
<input type="text" value="31.03.2023"/>	<input type="text" value="3"/>	<input type="text" value="4"/>	<input type="text" value="Both"/>	<input type="button" value="+"/>

## Saved applications

31.03.2023	3.00	4.00	Both	<input type="button" value="🗑️"/>
------------	------	------	------	-----------------------------------

Cancel

Adopt changes



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9. Save the changes you have made, by pressing the **Adopt changes** button.

**Soil layers:** The simulation model requires detailed soil data to correctly simulate the processes of daily and cumulated water and nitrogen uptake by the plants. Since detailed soil data is often hard to come by, the system automatically creates three soil layers based on the geographic location of the field-of-interest by relying on gridded ESDAC soil data. For this example, keep the default selections as follows:

1. The default soil profile is 90 cm deep and divided into 3 layers of 30 cm each.
2. The default value for initial soil plant available water is 2/3 of the total plant available water in the profile.
3. And the default value of initial soil mineral N is 60 kg N ha<sup>-1</sup>.

After you have inspected all the information for running an intercrop simulation, simply click the **Save and execute simulation** button. The system executes the simulation run after which the following charts will be displayed on your screen, displaying a set of key indicators for the simulation run:




Hovering over the points in the line charts or over the bars displays the exact values. Clicking the zoom button in the top-right corner enlarges the chart; clicking it again returns you to the overview view.

## 3.2 Exercise 2: An intercropping simulation using measured data

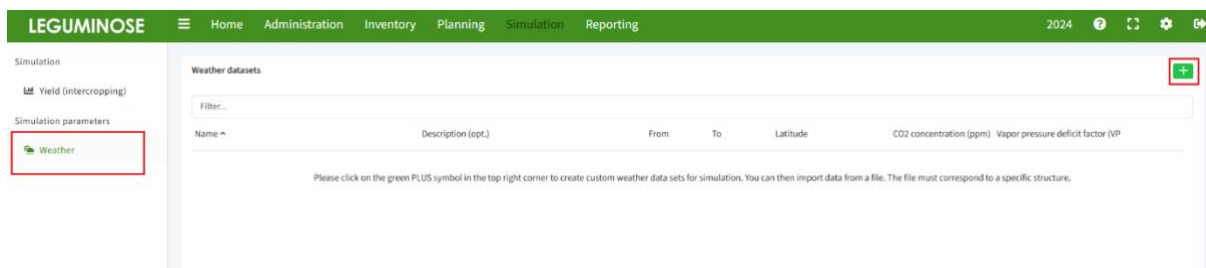
Now, you will create a simulation for the same field already created (**MyFirstField**). In addition to the field location, field measurements of soil properties and weather records from a nearby ground weather station are used.


Create a new scenario by copying the settings from the scenario created above:

1. Click on **Scenarios** to switch the view to the scenarios list or click on **Simulation** in the top nav bar if you have navigated to somewhere else in the web app.
2. Click on the button  to copy the scenario already created (**MyFirstScenario\_CZ**).
3. Name the new scenario as **MySecondScenario\_CZ**.

Now, let's upload a custom weather data set:

1. Press  **Weather** on the left to navigate to the custom weather view.



2. Click the  button. A box will pop up in your screen and you need to enter the following information:
  - Name of your weather dataset: **Weather\_CZ\_Exercise2**
  - Latitude: **49.7906758**

If you like, you can also add an optional description. Leave CO2 concentration and Vapor pressure deficit factors at their default values.

3. You should now see a screen like this:

### Create new weather dataset ✕

Name

Description (opt.)

Latitude  CO2 concentration (ppm)  Vapor pressure deficit factor (VPDF)

[Download example file](#) ⓘ

Drop file here or click here

Loaded file: No file selected

4. You have been provided with an example weather file **MyWeather\_CZ\_Exercise2.csv** for upload. The file contains the following data points per rows (day):
- Year
  - Day of Year (1 to 365 or 366, in the leap years)
  - Solar radiation ( $\text{MJ m}^{-2} \text{d}^{-1}$ )
  - Maximum air temperature ( $^{\circ}\text{C}$ )
  - Minimum air temperature ( $^{\circ}\text{C}$ )
  - Daily rainfall (mm)

```

Year;Day_of_Year;Solar_radiation_(MJ/m²/d);Maximum_temperature_(°C);Minimum_temperature_(°C);Daily_rainfall_(mm)
2023;1;3.45;9.5;1.4;0
2023;2;1.15;8.3;5;0
2023;3;3.73;8.4;-1;0
2023;4;2.93;7.1;-2.8;3.3
2023;5;3.9;10;4.4;0.1
2023;6;0.8;8;3.5;1.8
2023;7;3.65;7.1;2.2;0
2023;8;1.34;6.3;4;0.2
2023;9;1.05;7;3.5;4.6
2023;10;1.97;5.9;-0.4;1.4
2023;11;3.86;5.1;-3.4;3.4
2023;12;4.29;8.6;1.4;2.4
2023;13;0.6;7.2;4.3;5.8
2023;14;4.17;8;1.2;0.1
2023;15;0.68;5.5;2.2;10.5
2023;16;4.25;5.1;-0.6;0.1
2023;17;5.22;5.1;0.6;0.5
2023;18;1.7;3.8;-1;3.2
2023;19;3.18;1.8;-2.4;0
2023;20;4.5;1.8;-5.2;0.5
2023;21;4.17;0.7;-2;2.8
2023;22;1.7;1.4;-1.4;1.3
2023;23;2.74;3.7;-3.9;0
2023;24;2.1;3;0.9;0
2023;25;2.5;2;0.3;0.1
2023;26;2.48;-0.2;-1.6;0.3

```

The file covers the whole 2023 year. If you want to use your own custom data, make sure that:

- the file covers the whole simulation range, i.e. starts a few days before the first sowing date or the first irrigation/fertilization date (whichever is earlier) and allows for a reasonably long simulation duration (around 360 days after the simulation start date).
- the data points per line are separated by a **semicolon**.
- Either **coma** or **point** is used as decimal separator.
- No gaps in the provided daily data are existing.

You can also download an example file by clicking on **Download example file**.

5. Now, click on **Drop file here or click here** to open the file explorer, navigate to the file, and open the file. Alternatively, you can also **drag and drop** the file to the drop zone.
6. If you have successfully loaded the file, the file name should be shown as follows:

[Download example file](#) ⓘ

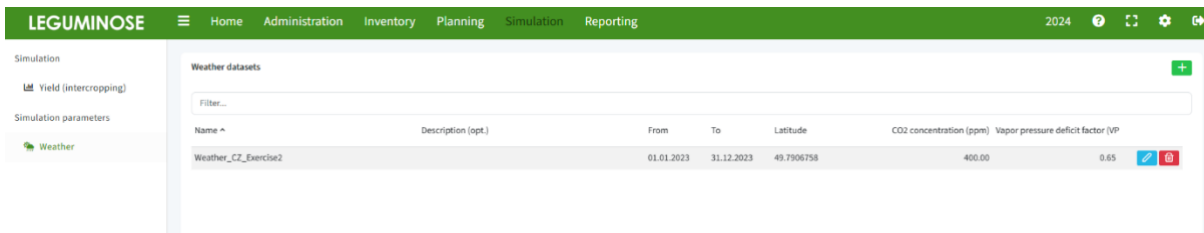
Drop file here or click here

Loaded file: MyWeather\_CZ\_Exercise2.csv

Cancel

Create


7. Click on the **Create** button and you will see your weather station in the list of weather datasets:



The screenshot shows the LEGUMINOSE software interface. The top navigation bar is green and contains the following items: Home, Administration, Inventory, Planning, Simulation, Reporting, and the year 2024. On the left, there is a sidebar with 'Simulation' and 'Weather' selected. The main content area is titled 'Weather datasets' and features a table with the following data:

Name ^	Description (opt.)	From	To	Latitude	CO2 concentration (ppm)	Vapor pressure deficit factor (VP)
Weather_CZ_Exercise2		01.01.2023	31.12.2023	49.7906758	400.00	0.65

Let's navigate back to the simulation scenario and select the weather data:

1. Select the **Yield (intercropping)** view
2. Select the scenario that you created (**MySecondScenario\_CZ**) by clicking the  button.
3. Select the plot **MyFirstField** if it is not already preselected. The sowing dates, crops and sowing depths should be the same as in the Exercise 1.
4. Activate **Show advanced parameters**.
5. Change the source of weather data by clicking on the drop-down bar of the **Weather data** source and selecting the weather dat that you've uploaded (**Weather\_CZ\_Exercise2**).

**Set simulation parameters**

Name: MySecondScenario\_CZ Description (opt.): With user-defined WEATHER and SOIL

Sowing date 1: 01.04.2023 Sowing date 2: 01.04.2023

Crop 1: Field pea (Late / Short) Crop 2: Spring barley (Late / Medium)

Show advanced parameters

Stripped  Fully mixed

*Field pea* Density (seeds/m<sup>2</sup>): 40

*Spring barley* Density (seeds/m<sup>2</sup>): 150

Weather data

- Weather\_CZ\_Exercise2 (01.01.2023 - 31.12.2023)
- DWD-ICON-EU
- NASA POWER
- Auzeville\_cochard\_2010 (01.01.2009 - 31.12.2010)
- Schöngrabern (01.01.1990 - 19.12.2023)
- Weather\_CZ\_Exercise2 (01.01.2023 - 31.12.2023)

In the next step, let's change the default soil data:

1. Click on the  button in the **Soil layers** section. Currently three soil layers are pre-defined with default settings:

**Edit soil layers** ✕


Soil texture	Bulk density (g/cm <sup>3</sup> )	Organic carbon content (%)	Fraction extractable water	Init. soil mineral nitrogen (N kg/ha)
ESDAC	ESDAC	ESDAC	2/3	60
Layer 1 (0 - 30 cm)				
Soil texture determined through ESDAC soil map	Bulk density determined through ESDAC soil map	Organic carbon content determined through ESDAC soil map	Initial soil water calculated from the proportion of extractable soil water	Initial soil mineral nitrogen calculated from the total amount of nitrogen
Layer 2 (30 - 60 cm)				
Soil texture determined through ESDAC soil map	Bulk density determined through ESDAC soil map	Organic carbon content determined through ESDAC soil map	Initial soil water calculated from the proportion of extractable soil water	Initial soil mineral nitrogen calculated from the total amount of nitrogen
Layer 3 (60 - 90 cm)				
Soil texture determined through ESDAC soil map	Bulk density determined through ESDAC soil map	Organic carbon content determined through ESDAC soil map	Initial soil water calculated from the proportion of extractable soil water	Initial soil mineral nitrogen calculated from the total amount of nitrogen

+

Cancel Adopt changes

We'll enter the following measured soil data example regarding texture (Sand, Silt and Clay), bulk density (BLD), soil organic carbon (OrgC) and initial mineral nitrogen (Nmin). Note that the system requires organic carbon, if you only have soil organic matter (SOM) available, it needs to be converted to organic carbon first:  $\text{OrgC} = \text{SOM} / 2$ .

Depth (cm)	Sand	Silt	Clay	BLD	OrgC	Nmin
	%			$\text{g cm}^{-3}$	%	$(\text{kg N ha}^{-1})$
0 - 30	68	25	7	1.25	1.5	22
30 - 60	65	25	10	1.30	1.0	15
60 - 90	65	20	15	1.43	0.7	8
90 - 120	60	30	10	1.60	0.4	5

- Click on the  button to add another soil layer.
- Click the drop-down bars (on top) for all parameters (except Fraction extractable water) and select **Manual**.
- Enter the soil information for **Soil texture**, **Bulk density**, **Organic carbon content** and **Init. soil mineral nitrogen** in their respective boxes and layers. Leave **Fraction extractable water** at their initial settings. You should now see a screen like this:

Edit soil layers
✕

---

Soil texture

Bulk density ( $\text{g/cm}^3$ )

Organic carbon content (%)

Fraction extractable water

Init. soil mineral nitrogen ( $\text{N kg/ha}$ )

Manual

Manual


Manual

2/3

Manual

---

Layer 1 (0 - 30 cm)



Sand (%)

Silt (%)

Clay (%)

Bulk density ( $\text{g/cm}^3$ )

Organic carbon content (%)

Initial soil water calculated from the proportion of extractable soil water

Init. soil mineral nitrogen ( $\text{N kg/ha}$ )

68

25

7


1.25

1.5

22

---

Layer 2 (30 - 60 cm)



Sand (%)

Silt (%)

Clay (%)

Bulk density ( $\text{g/cm}^3$ )

Organic carbon content (%)

Initial soil water calculated from the proportion of extractable soil water

Init. soil mineral nitrogen ( $\text{N kg/ha}$ )

65

25

10


1.3

1.0

15

---

Layer 3 (60 - 90 cm)



Sand (%)

Silt (%)

Clay (%)

Bulk density ( $\text{g/cm}^3$ )

Organic carbon content (%)

Initial soil water calculated from the proportion of extractable soil water

Init. soil mineral nitrogen ( $\text{N kg/ha}$ )

65

20

15


1.43

0.7

8

---

Layer 4 (90 - 120 cm)



Sand (%)

Silt (%)

Clay (%)

Bulk density ( $\text{g/cm}^3$ )

Organic carbon content (%)

Initial soil water calculated from the proportion of extractable soil water

Init. soil mineral nitrogen ( $\text{N kg/ha}$ )

60

30

10

1.6

0.4

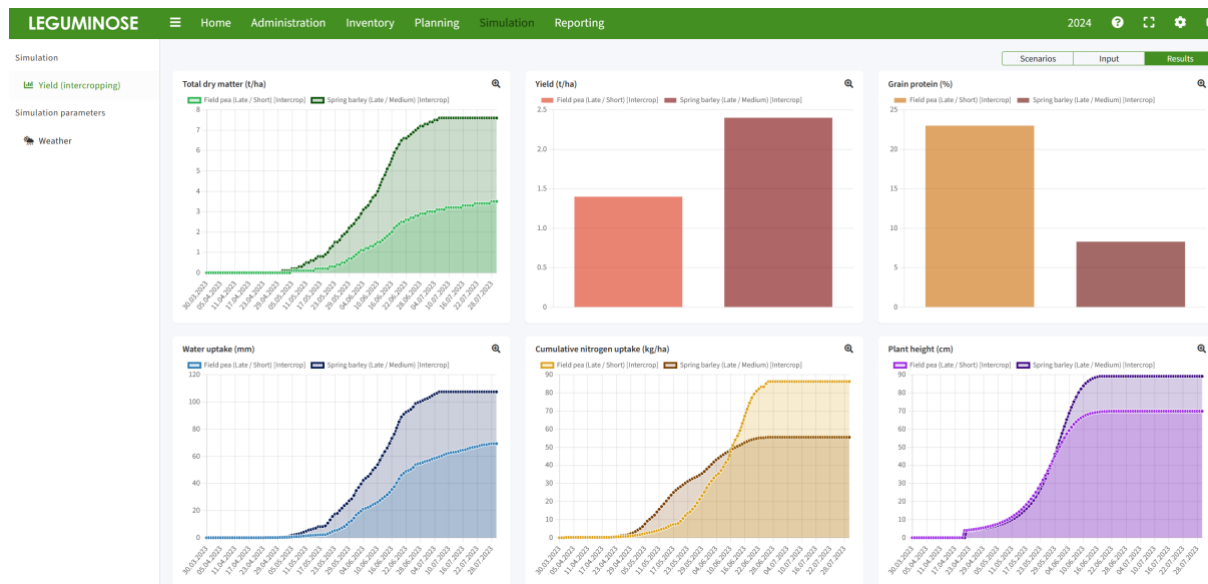
5

Cancel

Adopt changes




5. Click **Adopt changes** to save your entered soil information.
6. After you have entered all the information for running a simulation, simply click the **Save and execute simulation** button to execute the simulation with the custom weather and soil data:

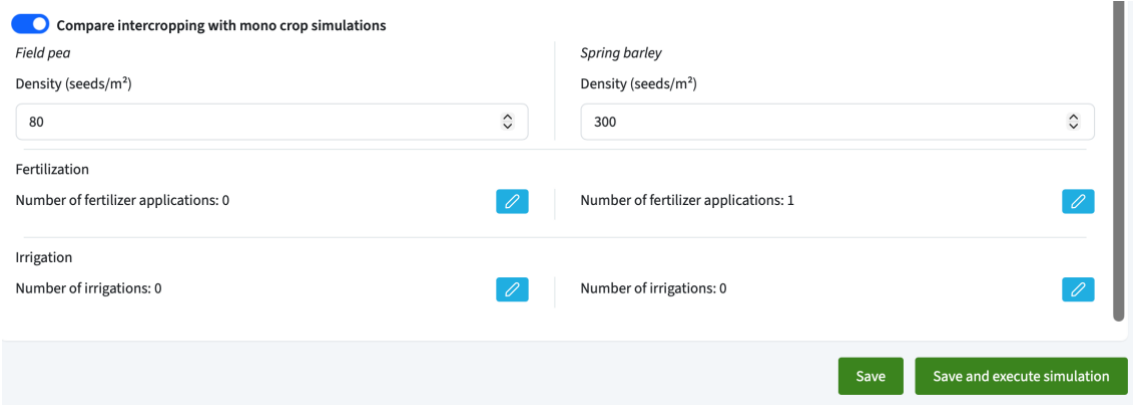


7. As in the Exercise 1, the you can examine the data of a specific chart more closely by using the zoom button (🔍).


### 3.3 Exercise 3: Comparing the performance of monocrop versus intercrop

In this exercise, you will be guided on how to compare the results of intercropping simulation with a similar monocrop simulation. The monocrop simulation is conducted with the same crop and sowing selection, but requires some additional monocrop-specific parameters. Let's use the first scenario we have created as example:

1. Switch to the **Input** view if you are in the **Results** view or select **Simulation** in the top nav bar and load the **MyFirstScenario\_CZ** scenario by clicking on the corresponding scenario-loading  button.
2. In the **Input** view, make sure on the right side that the **Show advanced parameters** switcher is active.
3. Now scroll down and you should see another switch button **Compare intercropping with mono crop simulations**. Click to display the monocrop-specific parameters:



The screenshot shows a comparison interface for two crops: Field pea and Spring barley. At the top, a toggle switch labeled "Compare intercropping with mono crop simulations" is turned on. Below this, the parameters for each crop are listed in two columns. For Field pea, the density is set to 80 seeds/m², fertilization is 0 applications, and irrigation is 0. For Spring barley, the density is set to 300 seeds/m², fertilization is 1 application, and irrigation is 0. Each parameter has a blue edit icon. At the bottom right, there are two green buttons: "Save" and "Save and execute simulation".

4. Since monocrop seed densities are usually different to intercropping densities, we can specifically set the monocrop values here. Let's leave the values at their default values.
5. In addition to monocrop-specific seed densities, we can also define separate crop-specific fertilizer applications and irrigations for monocrop. The method is the same with intercropping, click on the blue edit button, set the desired application date and amount, add to the list, and adopt the changes. Let's add a **3 g/m<sup>2</sup>** applied at **31.3.2023** **only for spring barley**, by clicking on the  button in the right section for spring barley next to **Number of fertilizer applications**:

## Edit fertilization strategy



Application day	Amount (N g/m <sup>2</sup> )	Volatilization fraction (%)
31.03.2023	3	4



## Saved applications

31.03.2023	3.00	4.00
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Cancel

Adopt changes

6. All other parameters like selected weather data and soil parameters are used for both intercropping and monocrop simulations.

7. Now click on to run the simulations for monocrop and intercropping. The system now takes both intercropping and monocrop parameters into account and executes multiple simulation runs. When the simulations are finished, the results of both intercropping and monocrop simulations are shown in the charts. You can see two additional lines and bars for the corresponding key indicators. If you want to declutter the view (e.g. if you want to specifically compare the first crop in intercropping and monocrop operation), click on the colored boxes (or the crop names) in the legend above the lines/bars to activate or deactivate individual lines/bars. Note that the yield bars for monocrops are naturally higher than the intercropping bars because the available field space is shared between the crops in the intercropping scenario and thus cannot achieve the high yields of monocrops.



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This concludes the demo of intercropping simulation using the LEGUMINOSE web-based platform. Feel free to experiment with different parameters in the **Input** view to check out their influence. Should you enter invalid parameter combinations, the system will provide you with feedback on how to fix the issues. Also, you can hover with the mouse cursor over the info symbols to display additional information if required.

In general, simulation runs are highly sensitive to available weather data and soil properties and might be inaccurate if weather and soil data is inaccurate. For example, if the expected simulation period is exceeding the available weather data, DWD weather data includes short-term forecasts (6 days). Since accurate longer-term forecasts are unavailable, the system extends the required weather data with averaged data from the past years, i.e. if the expected harvest date is far into the future, the results are expected to be quite inaccurate. When the current day reaches the expected harvest day, the results gradually will become more accurate due to the availability of historical data. The most accurate results will be achieved with a full set of custom weather data from a weather station and a complete set of soil data measurements entered into the system.