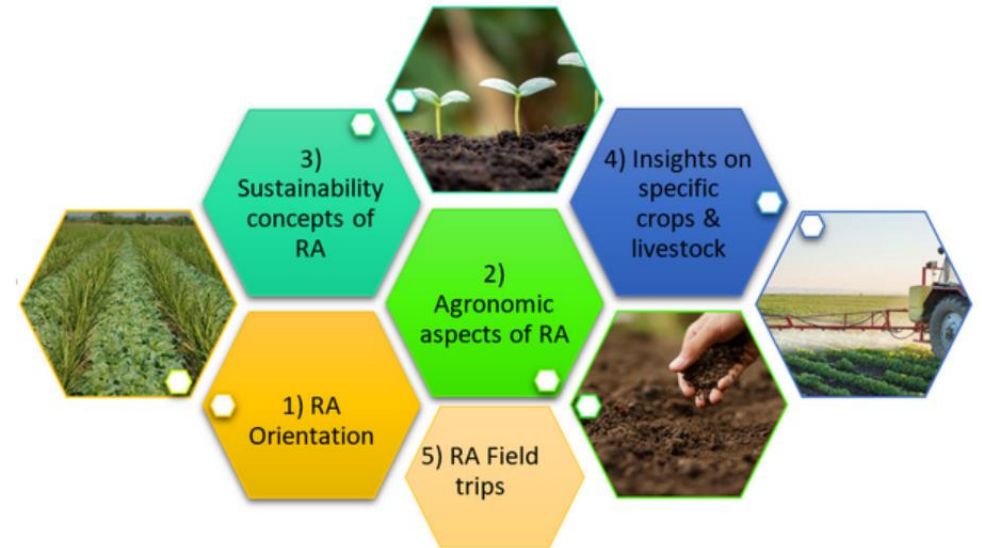
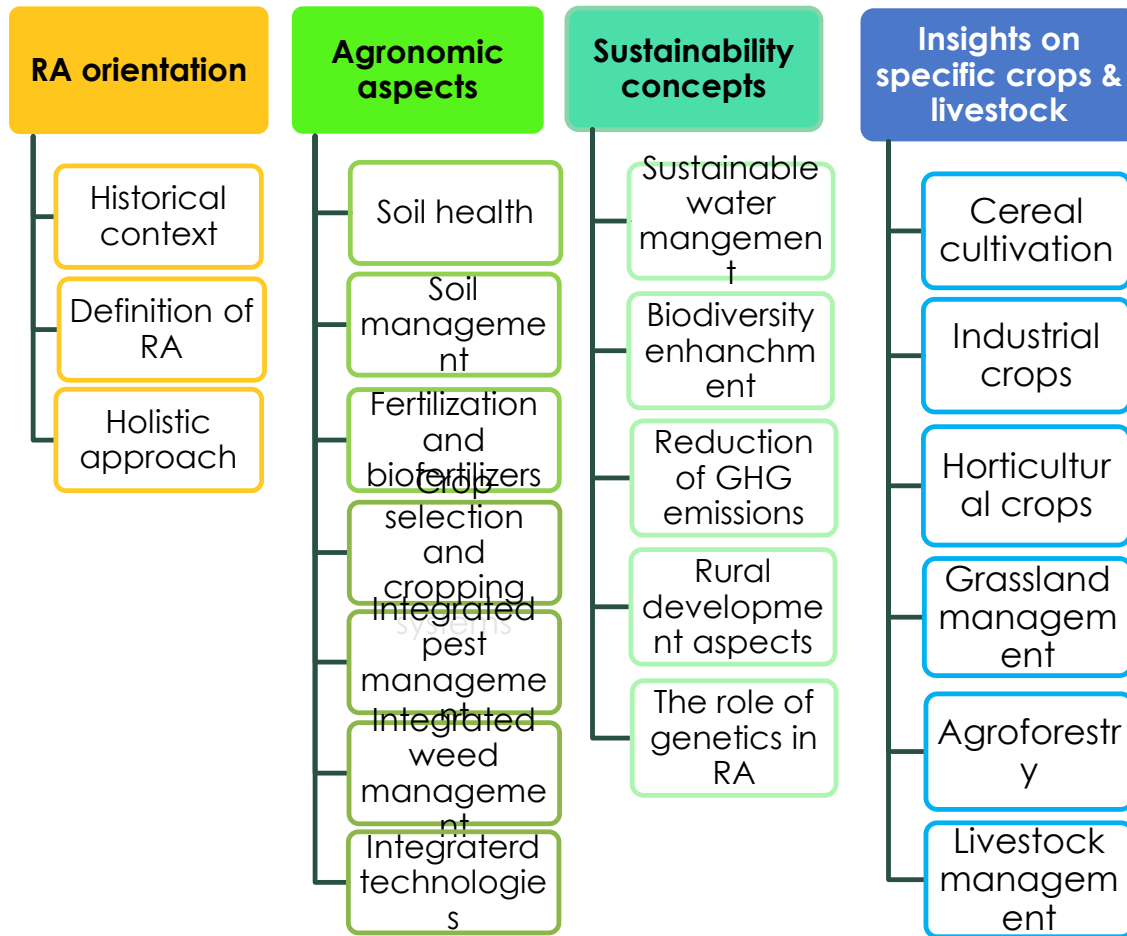

LEARNING CONTENT FOR UNIVERSITY EDUCATION, EXPERIENCES OF A PILOT TESTING UNIVERSITY OF FLORENCE

ANTONIO PESCATORE, PH.D. STUDENT
**DEPARTMENT OF AGRICULTURE, FOOD, ENVIRONMENT AND
FORESTRY (DAGRI) - UNIVERSITY OF FLORENCE, ITALY**



THE COURSE IN REGENERATIVE AGRICULTURE



INTRODUCTORY MODULE

RA orientation

Historical context

Definition of RA

Holistic approach

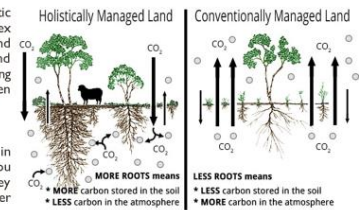
WHAT IS REGENERATIVE FARMING?

- A type of agriculture that aims to restore balance in ecological systems through a whole of farm approach.
- **Regenerative farming is characterized by a focus on:**
- Increasing biodiversity
- Maintaining groundcover
- Incorporation of farming systems into existing natural systems
- Increasing the organic matter in soils
- Monitoring the regeneration of the landscape
- Reducing reliance on inputs



WHAT IS HOLISM AND HOW ITS RELATES TO REGENERATIVE AGRICULTURE?

- The foundation of the concept of Holistic Management is the perception of nature as a complex whole, the parts of which are, without exception and at whatever level, all interconnected and interdependent. In this way, we all form part of a living community with a mutual vital relationship between people, plants, animals and the land.
- There are no individual stand-alone elements in nature: everything is intricately connected and if you remove or change the behaviour of any one of the key species it will have a wide-ranging effect on other parts of the ecosystem.



THE FREQUENCY OF RA KEY TERMS IN BOOKS

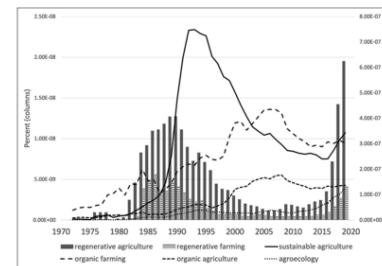


Figure 2. The frequency of key terms in books (3-year rolling average). Source: Google Ngram Viewer, Corpus 'English 2019' which includes books predominantly in the English language published in any country.

AGRONOMIC ASPECTS

Agronomic aspects

Soil health

Soil management

Fertilization and biofertilizers

crop selection and cropping

Integrated pest management

Integrated weed management

Integrated technologies

BIOFERTILIZERS: NITROGEN FIXING MICROORGANISMS

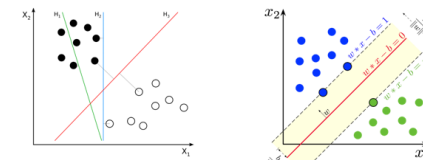
Blue Green Algae / Cyanobacteria

- More than 100 species of BGA can fix nitrogen in moist soils (Anabaena, Nostoc, Aulosira, Calothrix, Plectonema etc.)
- BGA are very common in rice field
 - application of 10 kg/ha of BGA one week after rice transplantation;
 - Contribute 25-30 kg/ha of N
 - Release of vitamins and hormones
 - Yield enhancement of 10-15%
- Some authors report that BGA are not inhibited by the presence of chemical fertilizers



ARTIFICIAL INTELLIGENCE APPLICATIONS IN SOIL MANAGEMENT AND AGRICULTURAL PRODUCTION

Support Vector Machine (SVM)



H1 does not separate the classes. H2 does, but only with a small margin. H3 separates them with the maximal margin.

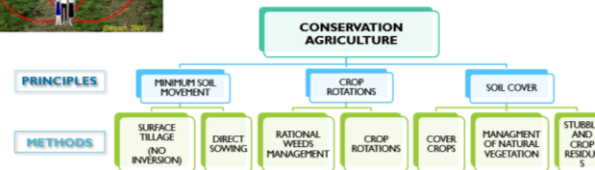
Maximum-margin hyperplane and margins for an SVM trained with samples from two classes. Samples on the margin are called the support vectors.

Chen, Q., Li, L., Chong, C., & Wang, X. (2022). AI-enhanced soil management and smart farming. *Soil Use and Management*, 38, 7–13. <https://doi.org/10.1111/sum.12771>

CONSERVATION AGRICULTURE



- Three principles**
- No or minimum soil disturbance
 - Permanent organic soil cover
 - Crop & cover-crop rotations and associations
- Maximum and sustainable benefits derived when the 3 principles overlap*



SOIL FERTILIZER ESTIMATION



Images from EIP-Agri 2015. EIP-AGRI Focus Group. Precision Farming Final Report. November 2015.

1. Reduced costs
2. Increased Profitability
3. Enhanced Sustainability
4. Better Harvestability
5. Higher Resolutions Understanding of Your Farm

• EIP-Agri 2015. EIP-AGRI Focus Group. Precision Farming Final Report. November 2015.

AGRONOMIC ASPECTS

Agronomic aspects

Soil health

Soil management

Fertilization and biofertilizers

crop selection and cropping

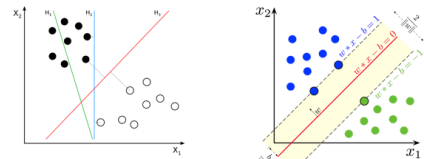
Integrated pest management

Integrated weed management

Integrated technologies

ARTIFICIAL INTELLIGENCE APPLICATIONS IN SOIL MANAGEMENT AND AGRICULTURAL PRODUCTION

Support Vector Machine (SVM)



H1 does not separate the classes.
H2 does, but only with a small margin.
H3 separates them with the maximal margin.

Maximum-margin hyperplane and margins for an SVM trained with samples from two classes. Samples on the margin are called the support vectors.

Chen, Q., Li, L., Chong, C., & Wang, X. (2022). AI-enhanced soil management and smart farming. *Soil Use and Management*, 38, 7–13. <https://doi.org/10.1111/sum.12771>

SOIL FERTILIZER ESTIMATION



Images from EIP-Agri 2015. EIP-AGRI Focus Group. Precision Farming Final Report. November 2015.

1. Reduced costs
2. Increased Profitability
3. Enhanced Sustainability
4. Better Harvestability
5. Higher Resolutions Understanding of Your Farm

• EIP-Agri 2015. EIP-AGRI Focus Group. Precision Farming Final Report. November 2015.

Slide - Support Vector Machine

Support Vector Machine is a supervised algorithm for regression and classification. Since most datasets are not linearly separable, the general SVM can allow misclassified examples, but penalties have to be paid. The objective of SVM is to construct a hyperplane to distinct positive and negative data sets. It provides binary decisions to support classification. The intuition is to attain the maximum margin, which is to maximize the distance between hyperplane and data sets.

As regard the Pros and Cons associated with Support Vector Machine

Pros:

It works really well with a clear margin of separation

It is effective in high dimensional spaces.

It is effective in cases where the number of dimensions is greater than the number of samples.

It uses a subset of training points in the decision function (called support vectors), so it is also memory efficient.

Cons:

It doesn't perform well when we have large data set because the required training time is higher

It also doesn't perform very well, when the data set has more noise i.e. target classes are overlapping

SVM doesn't directly provide probability estimates, these are calculated using an time-consuming k-fold cross-validation.

Slide - Soil fertilizer estimation

Precision fertilization represents an important component of precision agriculture technology; the basic concept is to use GPS to segment the field into grids, then check for soil nutrients and measure the required fertilizer input by using the fertilization model and fertilize based on a variable rate applicator. Practical experience shows that precise fertilization can minimize the use of fertilizers, improve crop production, balance nutrients in the soil, and minimize emissions in the atmosphere.

Being able to accurately decrease fertilizer rates in areas where it will not be economical to utilize is one of the key benefits of precision fertilization.

Increasing yields because of applying agronomic principles at a high resolution, while reducing costs increases overall profitability. Farmers Edge offers one of the lowest-priced, high-value packages in the industry through our unique application of technology.

Ensuring that crop input products applied actually get into the plant and not elsewhere affecting the environment delivers not only a superior bottom line but also supports a safer environment, and in the future, can even give you access to new markets for your crops.

One of the most significant benefits of precision agriculture is the ability to understand the farm nutrient levels and soil types across the farm. We know that fields and geographies are not created equal, and this can impact the amount of nitrogen mineralization, water holding capacity, and much more. When we understand these variances, we can ensure we do not over apply nitrogen, which can lead to lodging, or we can increase nutrients like potassium that help with standability in areas where it is low.

Farmers know their land better than anyone. Precision agriculture gives you the ability to understand why certain areas of your farm under produce, or are producing better, giving you the foundation to make decisions that continually improve the farm.

SUSTAINABILITY CONCEPTS

Sustainability concepts

Sustainable water mangemen
†

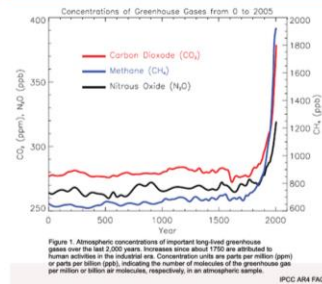
Biodiversity enhanchm
ent

Reduction of GHG
emissions

Rural developme
nt aspects

The role of
genetics in
RA

INCREASING CONCENTRATIONS OF GHGS IN THE ATMOSPHERE



Global atmospheric concentrations of CO₂, CH₄ and N₂O have increased markedly as a result of human activities since 1750

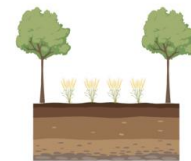
Now far exceed pre-industrial values as determined from ice cores spanning many thousands of years

Source: IPCC Fourth Assessment Report (2007)

BIODIVERSITY IN AGRICULTURE

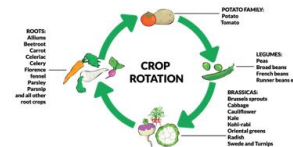
Biodiversity in space

- Intercropping
- Agroforestry



Biodiversity in time

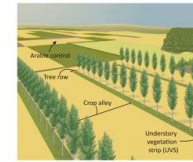
- Crop rotation



BIODIVERSITY IN SPACE

Agroforestry

- Silvoarable system:** Combination of trees and arable crops cultivation on the same land
- Silvopastoral system:** Combination of trees and livestock of the same land



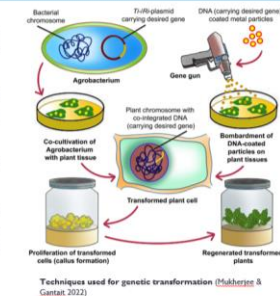
INSERTING GENES INTO A PLANT GENOME: THE GENETIC TRANSFORMATION

Since 1980s – **Plant genetic transformation:** new genetic variability was created **not randomly**, but **inserting a selected gene** from another organism in a plant genome.

The inserted gene could come from an organism of the same species (**cis-genesis**) or another species (**trans-genesis**) in a plant genome.

- PROS:** only the **desired gene** is incorporated in the host genome, so the creation of genetic variability is targeted
- CONS:** the **insertion position of the exogenous gene is random**; in addition to the gene of interest, an entire DNA construct including marker gene and other regions have to be inserted in the host genome

- CASE STUDY:** Golden rice



INSIGHTS ON SPECIFIC CROPS & LIVESTOCK

Insights on specific crops & livestock

Cereal cultivation

Industrial crops

Horticultural crops

Grassland management

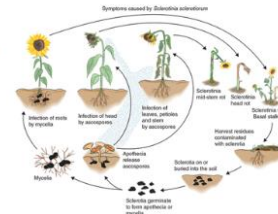
Agroforestry

Livestock management

SUNFLOWER CULTIVATION - REGENERATIVE

Pest and disease management

- The main pathogen affecting sunflower is the *Sclerotinia sclerotiorum*.
- Three diseases: *Sclerotinia* root rot, basal stalk rot; *Sclerotinia* stem rot; *Sclerotinia* head rot and midstalk rot
- Factors favoring disease: Temperatures lower than 30°C; Prolonged humid conditions (e.g., rain, fog, dew, irrigation practices); Wet soils;
- Methods to control or reduce *Sclerotinia*
 - Agronomical Management:**
 - No-tillage combined with non-host crop reduces sclerotia for subsequent seasons
 - Rotational break with non-hosts (e.g., wheat, sorghum, corn)
 - Avoid high water holding capacity soils during flowering
 - Plant minimal populations with wide rows
 - Avoid excessive nitrogen rates
 - Manage broad-leaf weeds
 - Biological Control:**
 - Mycoparasites like *Coniothyrium mitans* can directly attack sclerotia
 - Applications directly to soil or post-harvest to reduce sclerotia survival
 - Chemical Control:**
 - Fungicides applied when necessary to prevent pathogen diffusion



PASTURE MANAGEMENT TECHNIQUES – FREE GRAZING



WHAT IS AGROFORESTRY?

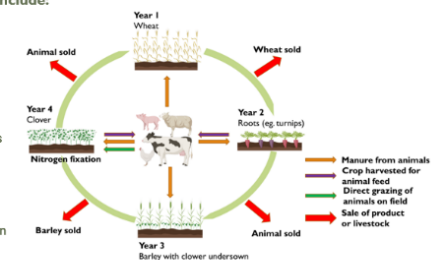
- Agroforestry is non monoculture agriculture, it is a combination of agriculture and forestry through the integration of trees on farmland by combining food crops with tree crops and/or livestock on the same land.
- Agroforestry increased social, economic and environmental benefits!



NORFOLK 4-CROP ROTATION SYSTEM

The benefits of this crop rotation system include:

- Increases soil fertility
- increases crop yield
- increases soil nutrients
- reduces soil erosion
- limits the concentration of pests and diseases
- reduces the stress of weeds
- improves the soil structure
- reduces pollution
- diversification and reduced cost of production
- increases nutrient uptake.



THE COURSE IN REGENERATIVE AGRICULTURE - PLATFORM

- Regina Platform - for Higher Education
- Regina Platform: Technical Fo...
- Bélpó kérdőív
- Enrollment Query
- Module 1: Regenerativ...
 - Topic 1: Historical co...
 - Topic 1: Historical co...
 - Open Questions for T...
 - Quiz for Topic 1: Hist...
 - Topic 2: Definition of ...
 - Topic 2: Definition of ...
 - Open Questions for T...
 - Quiz for Topic 2: Def...
 - Topic 3: Holistic appr...
 - Topic 3: Holistic appr...
 - Open Questions for T...
 - Quiz for Topic 3: Holl...
- Module 2: Agronomic a...
 - Topic 1: Soil health (PPT)



Regina Platform - for Higher Education | for Secondary Schools | for Adult Education

Regina Platform - for Higher Education



REGINA is an Erasmus+ Cooperation partnership project, started in November 2021, with the participation of 5 European countries (Greece, Hungary, Slovenia, Italy and Ireland) and 8 project partners. The project places an emphasis on Regenerative Agriculture, that can offer substantial results for sustainable farming by enhancing biodiversity "above and below the ground surface", thus contributing to increased water and nutrient use efficiency and to improved and sustained crop production.



- Regina Platform - for Higher Education
- Regina Platform: Technical Fo...
- Bélpó kérdőív
- Enrollment Query
- Module 1: Regenerativ...
 - Topic 1: Historical co...
 - Topic 1: Historical co...
 - Open Questions for T...
 - Quiz for Topic 1: Hist...
 - Topic 2: Definition of ...
 - Topic 2: Definition of ...
 - Open Questions for T...
 - Quiz for Topic 2: Def...
 - Topic 3: Holistic appr...
 - Topic 3: Holistic appr...
 - Open Questions for T...
 - Quiz for Topic 3: Holl...
- Module 2: Agronomic a...
 - Topic 1: Soil health (PPT)



The course will be structured as follows:

- Module 1:** Regenerative Agriculture Orientation - Definition of RA (Definition created in the project), Holism, Introductory module (based on National Reports and PFI Synthesis Report) are described.
- Module 2:** Agronomic aspects of Regenerative Agriculture - Refining the soil management through RA, Regenerative nutrition for plants; Regenerative cropping systems; crop rotations, cover crops, intercropping; Integrated technologies in RA; bioisystems engineering including soil metagenomics and bioinformatics, precision agriculture, IoT. Weeding following the RA principles.
- Module 3:** Sustainability concepts of Regenerative Agriculture (& mitigation of climate change) - Sustainable Water use under RA; Assessing Biodiversity enhancement after the adoption of RA practices; Reduction of GHG emissions through RA (economic, social, environmental advantages); Rural development aspects of RA.
- Module 4:** Insights on specific crops & livestock (Practical implications) - Cereal cultivation; Industrial crop; Horticultural crops; Grassland management; Livestock management; Agroforestry.
- Module 5 - Horizontal Module:** Field trips taken over the course of the programme. Visiting farms that demonstrate best practices showcased in the REGINA programme case studies.



- Module 2: Agronomic a...
 - Topic 1: Soil health (PPT)
 - Lesson for MODULE 2 - ...
 - Open Questions for Top...
 - Quiz for Module 2 - Top...
 - Topic 2: Soil managemen...
 - Lesson for MODULE 2 - ...
 - Open Questions for Top...
 - Quiz for Module 2 - Top...
 - Topic 3: Fertilization an...
 - Lesson for MODULE 2 - ...
 - Open Questions for Top...
 - Quiz for Module 2 - Top...
 - Topic 4: Crops selection...
 - Lesson for MODULE 2 - ...
 - Open Questions for Top...
 - Quiz for Module 2 - Top...
 - Topic 5: Integrated pest...
 - Lesson for MODULE 2 - ...

Module 2: Agronomic aspects

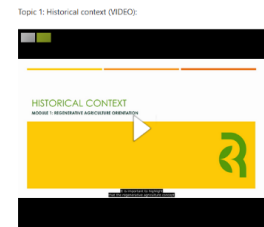
Module 2 is designed to provide a detailed understanding of the agronomic practices and techniques involved in implementing regenerative agriculture on farms. Regenerative agriculture is a holistic approach to farming that focuses on enhancing soil health, biodiversity, and ecosystem services, while also improving productivity and profitability. Overall, the "Agronomic Aspects of Regenerative Agriculture" module aims to provide participants with a comprehensive understanding of the agronomic practices and techniques involved in implementing regenerative agriculture on farms, and how these practices contribute to improving soil health, enhancing biodiversity, and increasing productivity and profitability.



- Module 2 is designed around 7 main topics:
- Topic 1: Soil health
 - Topic 2: Soil management
 - Topic 3: Fertilization and biofertilizers
 - Topic 4: Crops selection and cropping systems
 - Topic 5: Integrated pest management
 - Topic 6: Innovative weed management



- Regina Platform - for Higher Education
- Regina Platform: Technical Fo...
- Bélpó kérdőív
- Enrollment Query
- Module 1: Regenerativ...
 - Topic 1: Historical co...
 - Topic 1: Historical co...
 - Open Questions for T...
 - Quiz for Topic 1: Hist...
 - Topic 2: Definition of ...
 - Topic 2: Definition of ...
 - Open Questions for T...
 - Quiz for Topic 2: Def...
 - Topic 3: Holistic appr...
 - Topic 3: Holistic appr...
 - Open Questions for T...
 - Quiz for Topic 3: Holl...
- Module 2: Agronomic a...
 - Topic 1: Soil health (PPT)



Topic 1: Historical context (Lesson) [Mark as done]

STEP 3: The PDF file "Lesson" contains the explanatory text of the PPT for your convenience. Have a look at the lesson, underline the most important remarks, as you follow with your learning process.

STEP 4: Now you are ready to continue with a discussion on the topic! Have a look at the open



THE COURSE IN REGENERATIVE AGRICULTURE – LESSONS AND SEMINARS



FIELD VISITS





Regenerative agriculture. An innovative approach towards mitigation of climate change through multi-tier learning

The REGINA project (No. 2021-1-HU01-KA220-HED-000027629) was funded by the European Commission. The content of this publication does not necessarily reflect the views of the European Commission.

Call 2021, KA220-HED – Cooperation Partnerships in Higher Education



The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.