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

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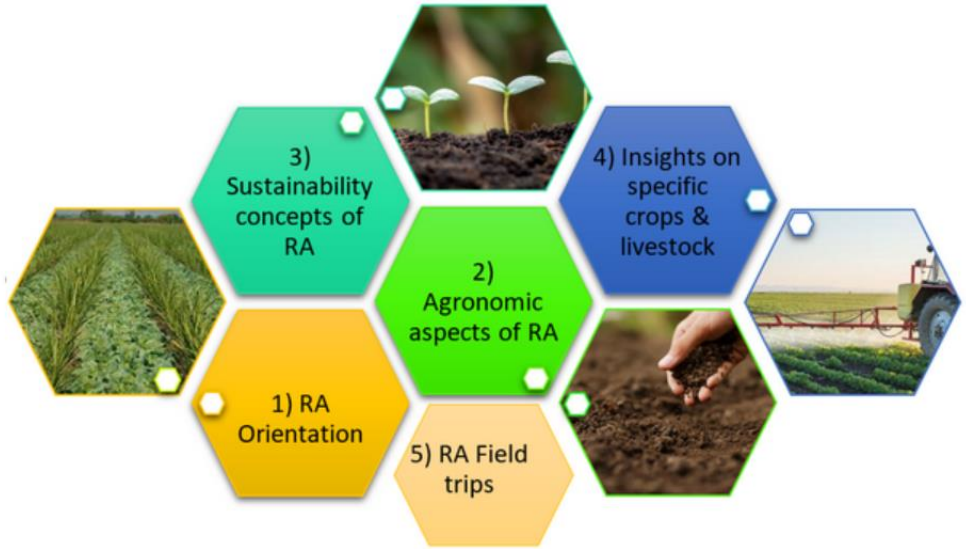
THE COURSE IN REGENERATIVE AGRICULTURE

- **RA orientation**
  - Historical context
  - Definition of RA
  - Holistic approach
- **Agronomic aspects**
  - Soil health
  - Soil management
  - Fertilization and biofertilizers
  - Crop selection and cropping systems
  - Integrated pest management
  - Integrated weed management
  - Integraterd technologies
- **Sustainability concepts**
  - Sustainable water mangement
  - Biodiversity enhanchment
  - Reduction of GHG emissions
  - Rural developme nt aspects
  - The role of genetics in RA
- **Insights on specific crops & livestock**
  - Cereal cultivation
  - Industrial crops
  - Horticultural crops
  - Grassland management
  - Agroforestry
  - Livestock management



INTRODUCTORY MODULE

RA orientation

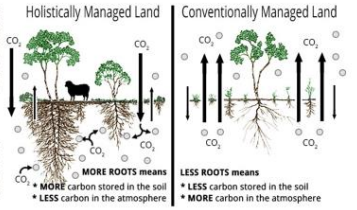
- Historical context
- Definition of RA
- Holistic approach

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

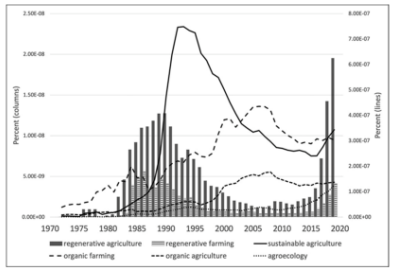


Figure 2. The frequency of key terms in books (3-year rolling averages). Source: Google NGram Viewer, Corpus 'English 2019' which includes books predominantly in the English language published in any country.

AGRONOMIC ASPECTS

Agronomic aspects

- Soil health
- Soil management
- Fertilization and biofertilizers
- Crop selection and cropping systems
- Integrated pest management
- Integrated weed management
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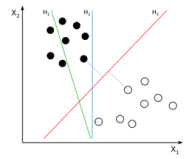
BIOFERTILIZERS: NITROGEN FIXING MICROORGANISMS

Blue Green Algae / Cyanobacteria

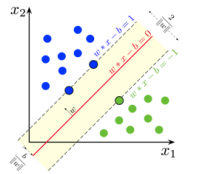
- More than 100 species of BGA can fix nitrogen in moist soils (Anabaena, Nostoc, Aulosira, Calothrix, Plectonema etc.)
- BGA are very common in rice field
  - application of 10 kg/ha of BGA one week after rice transplantation;
  - Contribute 25-30 kg/ha of N
  - Release of vitamins and hormones
  - 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.

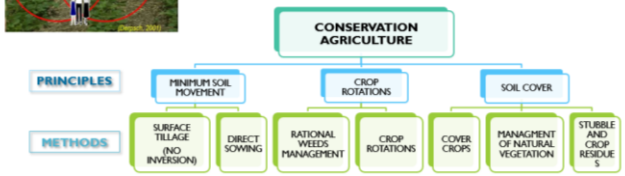
Chen, Q., Li, L., Chong, C., & Wang, X. (2022). AI-enhanced soil management and smart farming. Soil Use and Management, 38, 7–13. https://doi.org/10.1111/sum.12771

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

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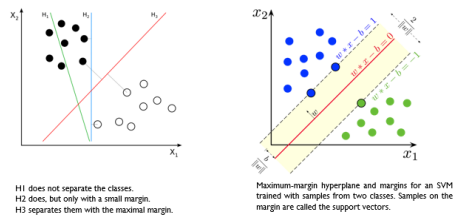

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Slide - Support Vector Machine

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.

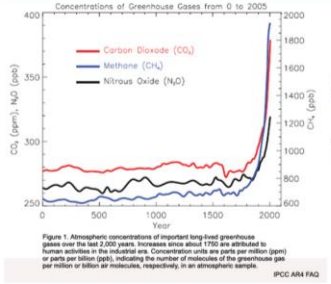
Farmers know their land better than anyone. Precision agriculture gives you the ability to understand why certain areas of your farm under produce, or are producing better, giving you the foundation to make decisions that continually improve the farm.

SUSTAINABILITY CONCEPTS

Sustainability concepts

- Sustainable water mangement
- Biodiversity enhanchment
- 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

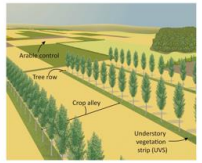
Now far exceed pre-industrial values as determined from ice cores spanning many thousands of years

Source: IPCC Fourth Assessment Report (2007)

BIODIVERSITY IN 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



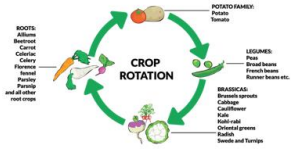
BIODIVERSITY IN AGRICULTURE

Biodiversity in space

- Intercropping
- Agroforestry

Biodiversity in time

- Crop rotation

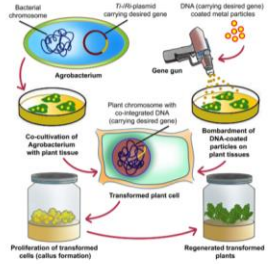


INSERTING GENES INTO A PLANT GENOME: THE GENETIC TRANSFORMATION

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



Techniques used for genetic transformation (Mukherjee & Gantait 2022)

INSIGHTS ON SPECIFIC CROPS & LIVESTOCK

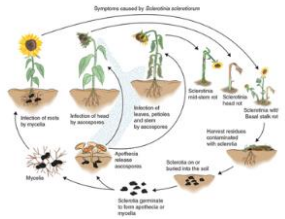
Insights on specific crops & livestock

- Cereal cultivation
- Industrial crops
- Horticultural crops
- Grassland management
- Agroforestry
- Livestock management

SUNFLOVER CULTIVATION - REGENERATIVE

Pest and disease management

- The main pathogen affecting sunflower is the Sclerotina scleritiorum.
- 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 Sclerotina
  - 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 Coniothryium minitans 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



WHAT IS AGROFORESTRY?

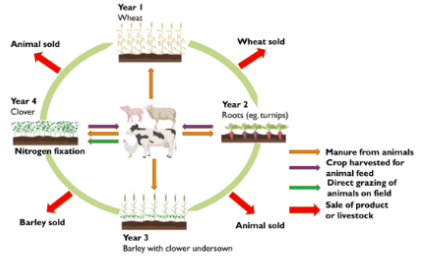
- Agroforestry is non monoculture agriculture, it is a combination of agriculture and forestry through the integration of trees on farmland by combining food crops with tree crops and/or livestock on the same land.
- Agroforestry increased social, economic and environmental benefits!

PASTURE MANAGEMENT TECHNIQUES – FREE GRAZING

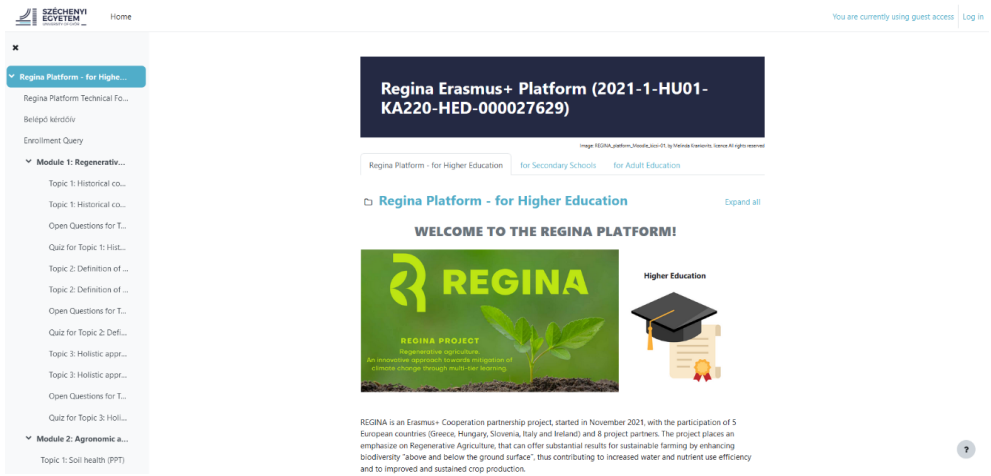
NORFOLK 4-CROP ROTATION SYSTEM

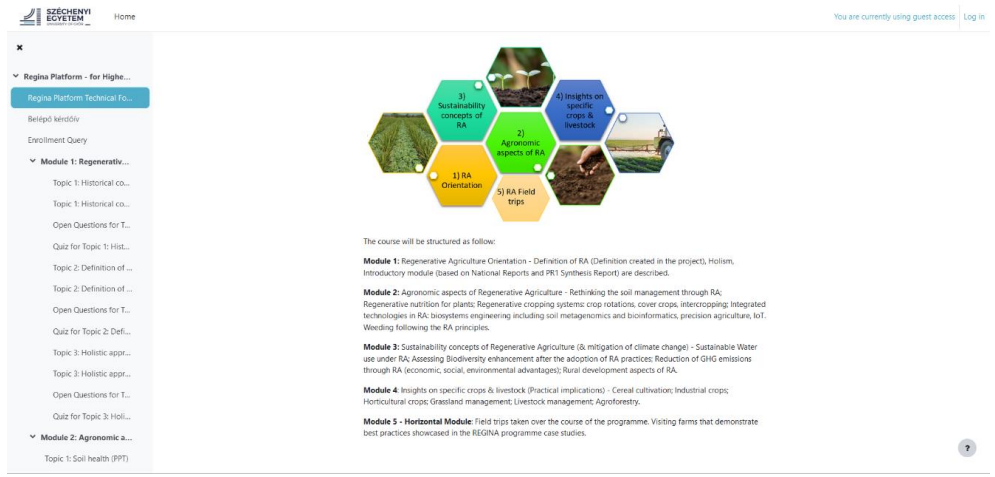
The benefits of this crop rotation system include:

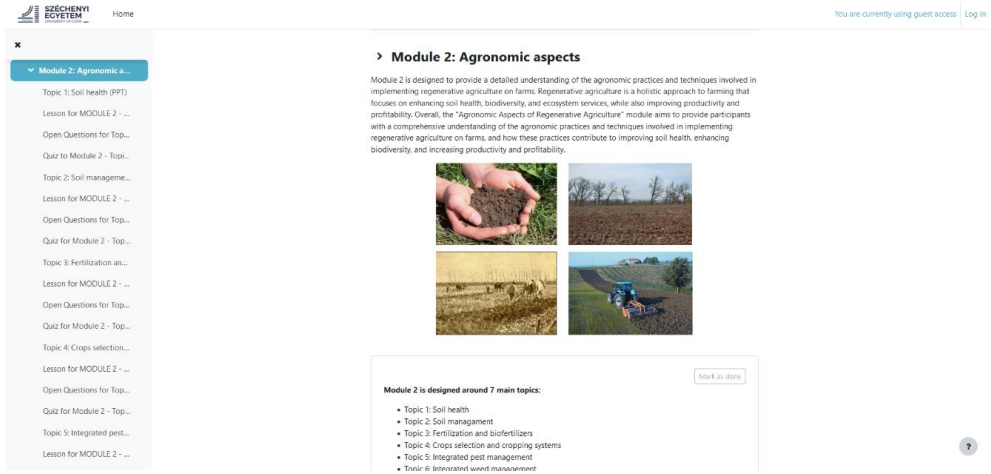
- Increases soil fertility
- increases crop yield
- increases soil nutrients
- reduces soil erosion
- limits the concentration of pests and diseases
- reduces the stress of weeds
- improves the soil structure
- reduces pollution
- diversification and reduced cost of production
- increases nutrient uptake.

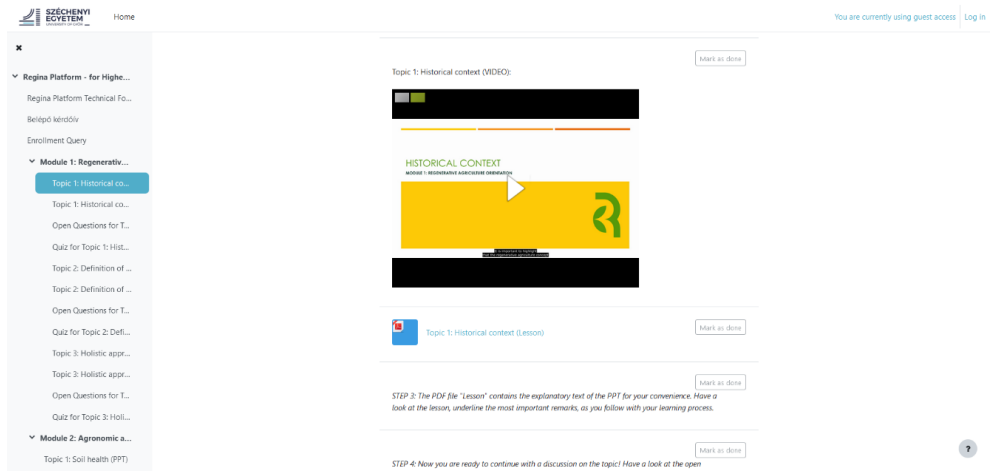


THE COURSE IN REGENERATIVE AGRICULTURE - PLATFORM









THE COURSE IN REGENERATIVE AGRICULTURE – LESSONS AND SEMINARS

FIELD VISITS














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

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