EIP-AGRI Workshop Cropping for the future

4-5 June 2019 – Almere, the Netherlands

eip-agri
AGRICULTURE & INNOVATION

funded by European Commission

Programme

#EIPAgri
#croprotation
#cropdiversification

TUESDAY 4 JUNE

08:00-09:00 Registration

Introduction to the workshop

09:00-09:15 Welcome by the host and by DG AGRI

- *Martijn Weijtens, Ministry of Agriculture, Nature and Food Quality, the Netherlands*
- *Anikó Seregélyi, Unit B2 – Research and Innovation, DG AGRI, European Commission*

09:15-10:30 Getting to know each other & setting the scene

Introduction of the programme and getting to know each other (Impromptu Networking)

- *Niels Rump, EIP-AGRI Service Point*

funded by the European Commission

eip-agri
AGRICULTURE & INNOVATION

Programme

#EIPAgri
#croprotation
#cropdiversification

TUESDAY 4 JUNE

Setting the scene and preparing interaction

- ***Edoardo Costantini, EIP-AGRI Service Point***
- *Bhim B. Ghaley, ERA-NET 'FACCE SURPLUS' project 'SustainFARM'*
- *Paolo Mantovi, Operational Group 'Agroecological Cover'*
- *Roberto Garcia-Ruiz, PRIMA project 'SUSTAINOLIVE'*
- *Judith Treis, Operational Group 'Organic vegetables'*

Networking for crop rotation & crop diversification

10:30 – 11:15 **Discovering diversity** – getting familiar with projects represented at the workshop

Sharing projects with a cup of coffee – interactive session (Project Mesclun)

11:15 – 12:30 **Building common ground**

Looking for shared challenges and opportunities – interactive session (World Café)

funded by the European Commission

eip-agri
AGRICULTURE & INNOVATION

EIP-AGRI Workshop Cropping for the future

4-5 June 2019– Almere, the Netherlands

Setting the scene and preparing interaction

Edoardo Costantini
EIP-AGRI Service Point
Workshop coordinating expert

funded by European Commission

History of crop rotation

- Virgil in pre-Christian Rome: virtues of i) fallowing the land from continuous cropping and of ii) rotating small grains with legumes
- Chinese over 2.000 years BP: value of rotations with legumes
- From the Middle Ages to the 18th Century: three year rotation, including a fallow year
- 1730's, England, Norfolk rotation: a 4-year rotation of wheat (Triticum aestivum L.)-turnip (Brassica rapa L.)-barley (Hordeum vulgare L.)- and red clover (Trifolium pratense L.).

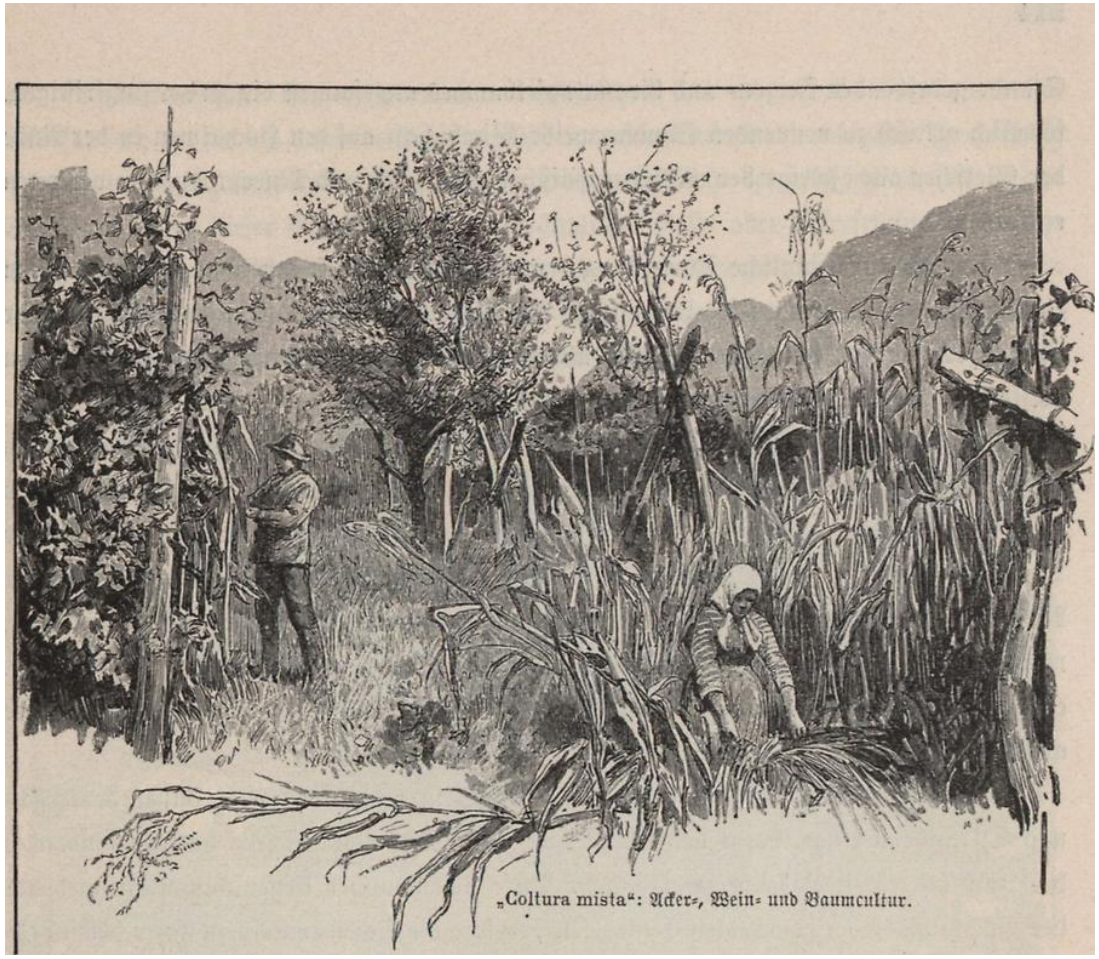
Average wheat yield at Rothamsted, England (1851-1919) (From Martin et al., 1976.)

Treatment	Yield (kg ha^{-1})
Continuous wheat unfertilized	829
Continuous wheat fertilized	1589
Wheat in a Norfolk rotation (turnip, barley, clover, wheat)	1616
Wheat in a Norfolk rotation fertilized	2183

Principles of crop rotation

- A systematic planting of different crops in a particular order over several years in the same area
- Primary or cash crop
- Grass, legumes, fallow
- Multiple crops (multiple species in the meadow)
- Distance in space and time of species of the same family

Crop diversification



Multiple cropping is the world's oldest cropping system (Brady, 1986)

Kinds of crop diversification

- Crop rotation: crops changing location in space in function of time
- Intercropping: two or more crops present in a field during a growing season (row-intercropping, mixed- intercropping, strip-intercropping, relay- intercropping)
- Agroforestry: trees or shrubs are grown around or among crops or pastureland
- Spatial arrangement: crop distribution in the watershed and in the landscape

funded by the European Commission

eip-agri
AGRICULTURE & INNOVATION

A scale dimension, enhancing the complexity of biological cycles

funded by the European Commission

eip-agri
AGRICULTURE & INNOVATION

SustainFARM

Innovative and sustainable intensification of integrated food and non-food systems to develop climate-resilient agroecosystems in Europe and beyond (SustainFARM)

Bhim B. Ghaley (project co-ordinator)
University of Copenhagen, Denmark

FACCE SURPLUS
SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

Objectives

- Assessment of productivity in Integrated Food and Non-food System (IFNS)
- Develop metrics for agronomic productivity and environmental performance assessments in IFNS
- Valorization of woody components, co-products and residual wastes
- Total budget: 1.905 K (7 countries)
- Duration: March, 2016 – August, 2019

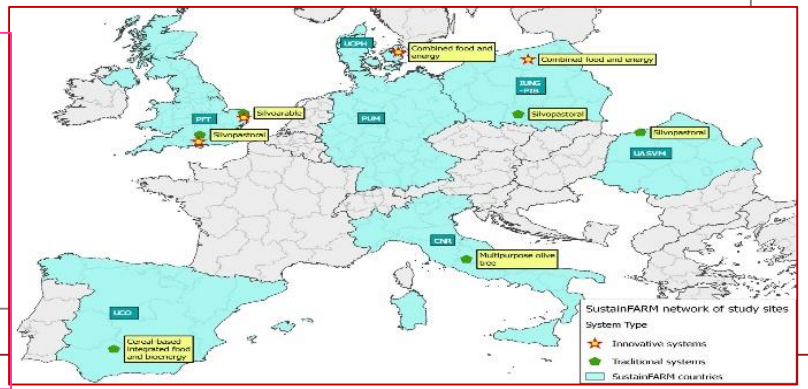
FACCEJPI

FACCE-JPI
Call for proposals

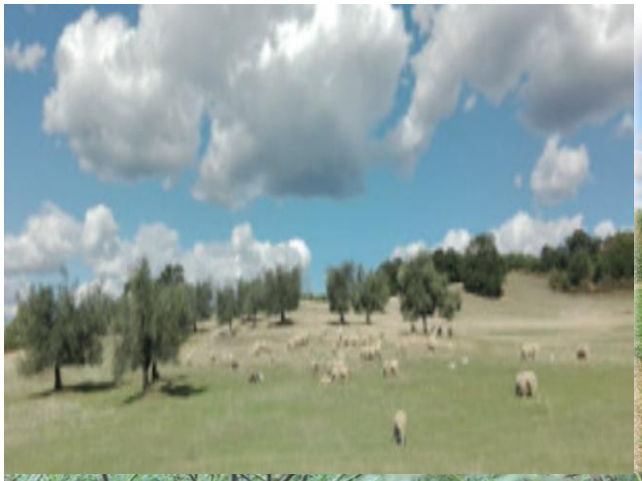
FACCE SURPLUS
Sustainable and Resilient agriculture for food and non-food systems
Call Announcement

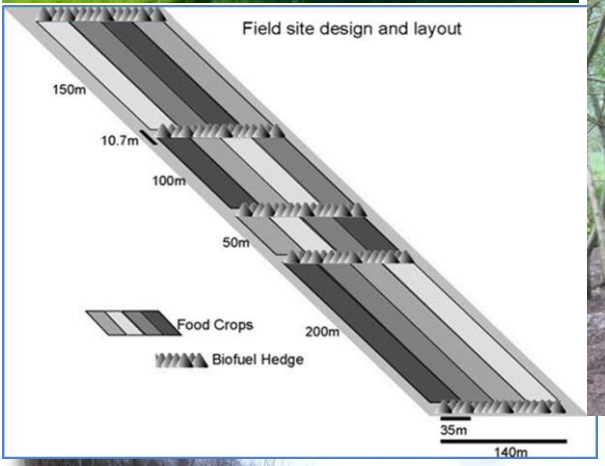
Submission of the pre-proposal on
www.submission-faccejpi.com
Deadline: 04.03.2015, 14:00 CET

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652615



Integrated food and non-food systems (IFNS)

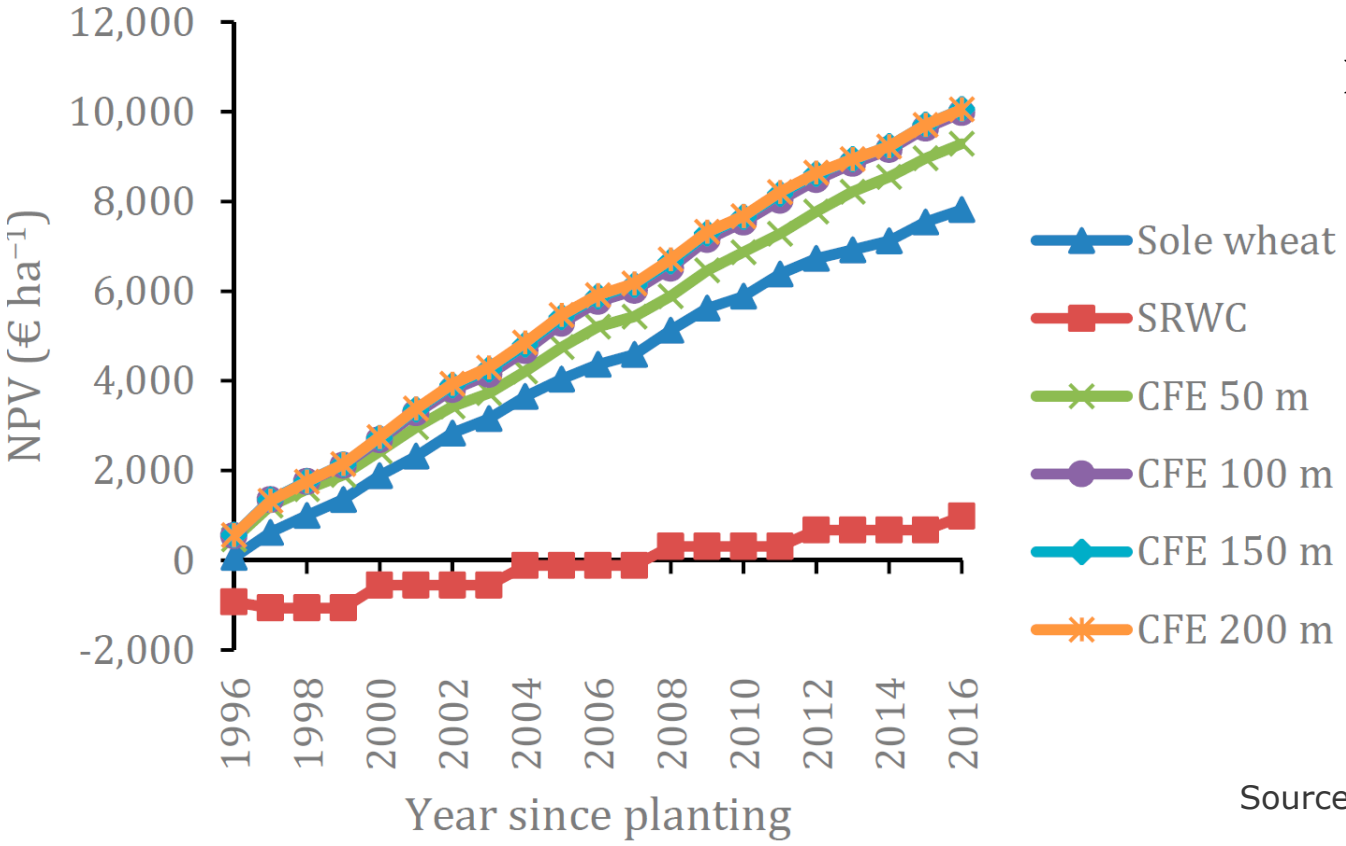




SustainFARM

FACCE SURPLUS
SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

Economic viability of agroforestry compared to sole crops in Denmark



$$NPV = \sum_{t=0}^{t=T} \frac{R_t - V_t - A_t}{(1+i)^t}$$

NPV = net present value (€ ha^{-1})
R_t = revenue in year t (€ ha^{-1})
V_t = variable costs in year t (€ ha^{-1}),
A_t = fixed costs in year t (€ ha^{-1})
T = time in years, and i = discount rate

Source: Xu et al., 2019

Figure Net present value (NPV) for sole winter wheat, sole short rotation woody crop (SRWC) and four SRWC-winter wheat combined food and energy (CFE) agroforestry scenarios over 21 years.

SustainFARM

FACCE SURPLUS
SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

Benefits of crop rotation and crop diversification

- Agroforestry systems
  - productive and economically viable compared with monocultures
  - produce stable yields compared to monocultures
  - enhances carbon sequestration, soil and water conservation, above and below-ground biodiversity for sustainable food and non-food production
  - Provision of a suite of ecosystem services (microclimate, reduced soil erosion, control of pests and diseases)
  - provides diversity of food products for balanced nutrition
  - preserve cultural heritage, traditions and landscape aesthetics

SustainFARM

FACCE SURPLUS
SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

Lessons learnt

- Balance between tree population, spatial distance and cropped area are necessary to achieve optimal complementarity between the species
- Natural unmanaged agroforestry systems can be improved for enhanced productivity with management
- Agroforestry systems are conducive for recycling and reusing the waste between different enterprises within agroforestry (e.g animal waste for manuring pasture & grassland)
- Choice of agroforestry systems need to take account of the local demand and market for the produce
- Need for on-farm demonstrations and robust field-based evidence on IFNS under diverse socio-economic contexts

SustainFARM

FACCE SURPLUS
SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

Perspectives on crop rotation and crop diversification

- ✓ Explore additional enterprises like mushroom, berries and honey production for increased income in IFNS
- ✓ Aboveground and below ground simulation of agroforestry systems for identification of productive systems
- ✓ Agroforestry systems are source for biomass to contribute to bio-energy, food, fodder and fiber production

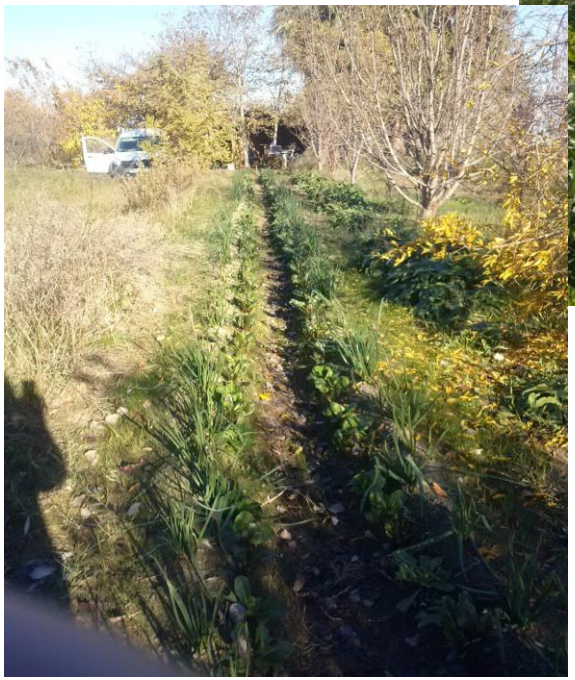

Cover-crops of grass, clover & chikori


Pea-barley intercropping

Enhancing ecosystem services, beyond crop yield

- Maximisizing C capture through multiple crops: trees+shrubs+grasses+vegetables

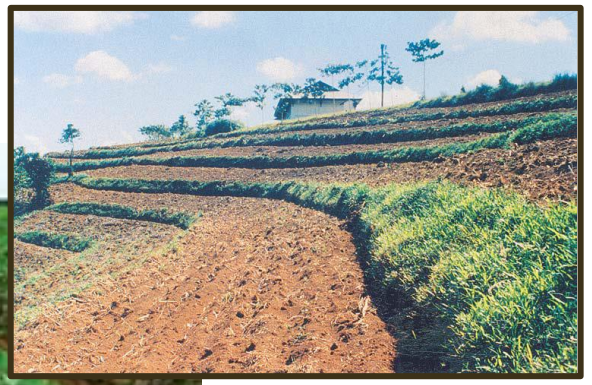
Cropping along the drains



Intercropping

Multi-storey cropping

Ecosystem infrastructures to reduce water pollution and soil water and wind erosion: buffer zones, water ways, cover crops, grass strips, and shelterbelts



Operational Group Agroecological cover

Paolo Mantovi

FCSR

Fondazione CRPA Studi Ricerche

Programma di Sviluppo Rurale dell'Emilia-Romagna 2014-2020

UNIONE EUROPEA
Fondo Europeo Agricolo per lo Sviluppo Rurale

RegioneEmilia-Romagna

L'Europa investe nelle zone rurali

PARTICIPATING IN

eip-agri

funded by

Problem and objective

Problem

- ✓ Soil organic matter decrease over time
- ✓ Weeds increasingly hard to control

Objective

To develop innovative conservation tillage systems for farms in the Po river Valley, based on the use of cover crops…

…to take advantage of agroecological functions, such as:

organic matter production, nutrient recycling, soil protection, competition with weeds, others.

What we do

Spring-summer crops (maize, soybean) have been cultivated after autumn-winter cover crops kept on the soil surface.

The proposed agronomic paths are 'pioneering' in our region.

The effects on soil quality (organic matter, structural stability, earthworms and microarthropods, nitrogen dynamics, etc.), economic sustainability and carbon footprint are evaluated.

Results so far

The new cropping system is viable but… some technical difficulties in the management of the cover crops (termination) and the crop protection (slugs).

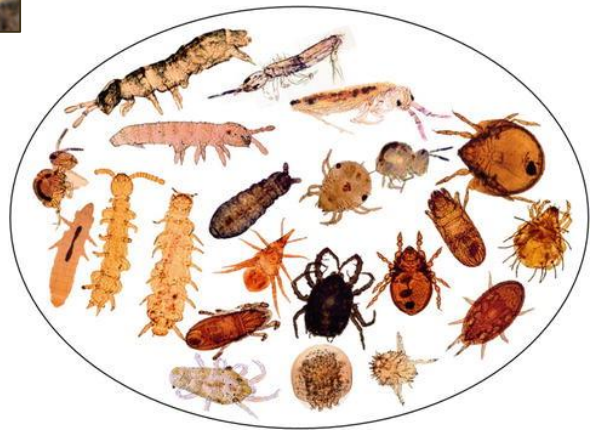
Productions obtained in the first two years:

Grain maize (2017) ~ 10 t/ha *Soybean (2018) 2-3 t/ha*

Results so far

Overall, the soil quality appears to be increasing from year to year.

Earthworms:
+28%



QBS-ar index: +4%

Water aggregate stability
+48% in 0-5 cm layer

Perspectives

To define the most suitable cover crops for use in the soil and climate conditions of the Emilia-Romagna, and the best management methods for these, such as…

rye

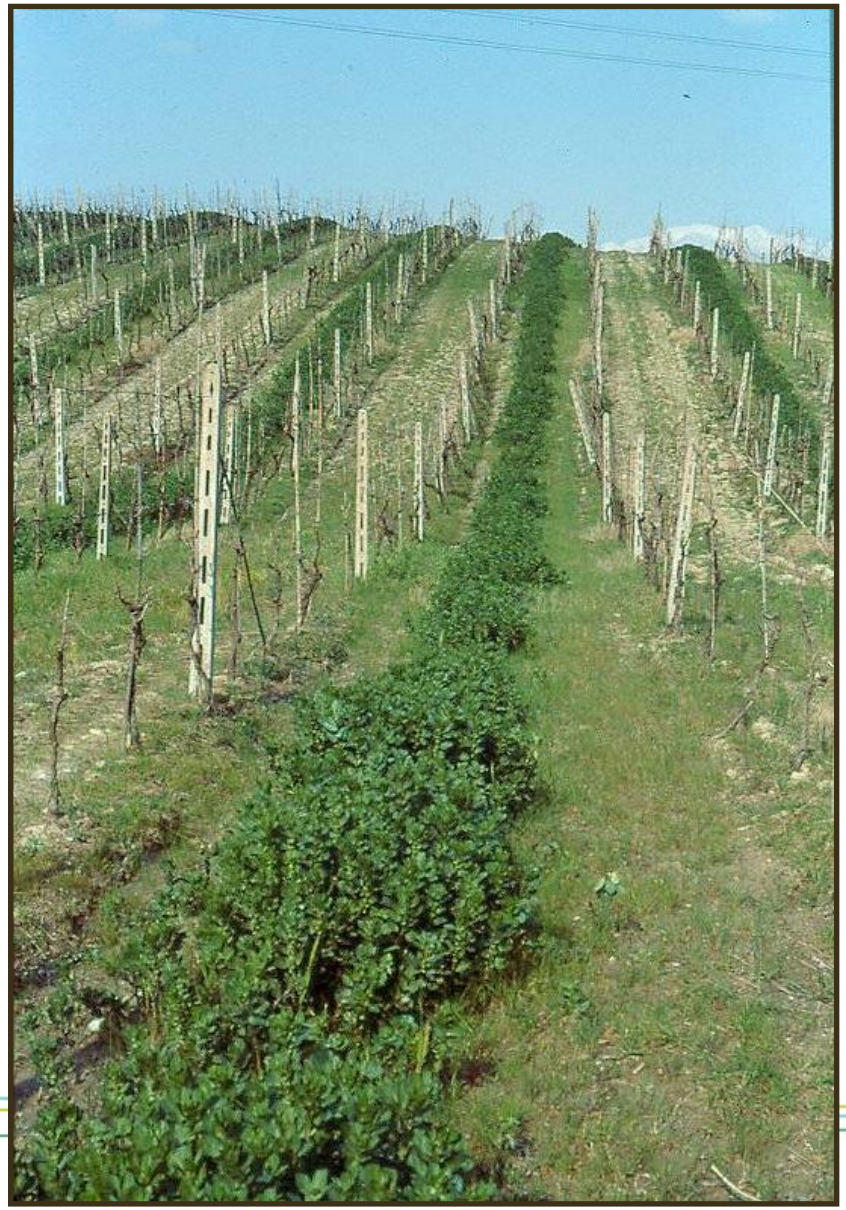
mustard

phacelia

clovers

The agronomical trial will be continued within the **H2020 Circular Agronomics**, where the conservation tillage system will partly return conventional (ploughing) to compare the two.

Tree crops and their grass cover



funded by the European Commission

eip-agri
AGRICULTURE & INNOVATION

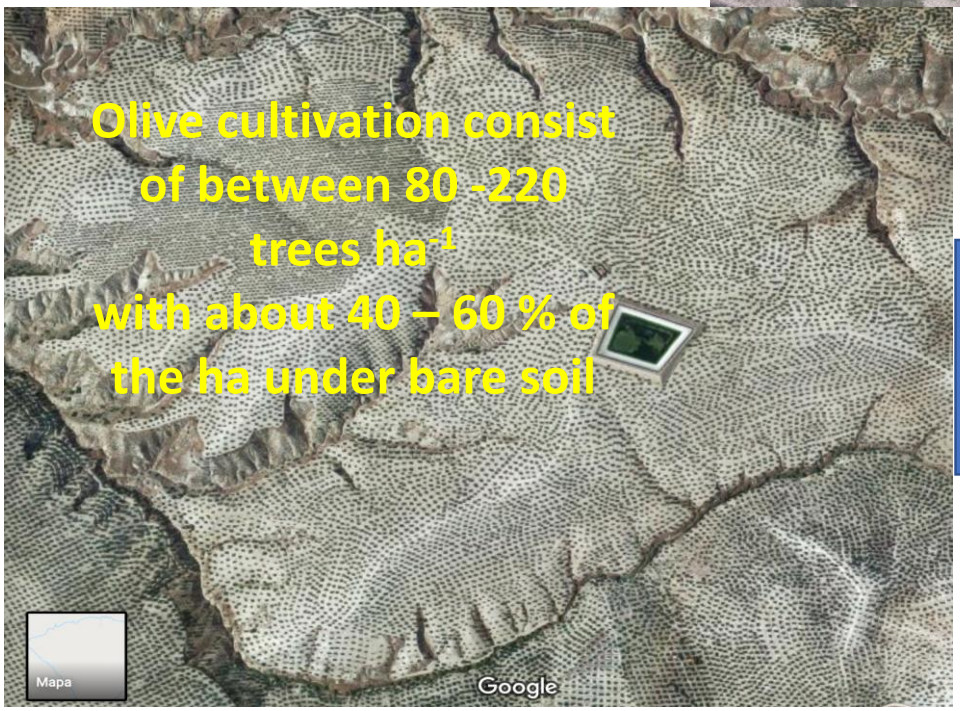
Dr. Roberto Garcia-Ruiz (Professor of Ecology, University of Jaén) and responsible of the Functional Unit of Ecology of the Center for advances studies in olive groves and olives oil)

SUSTAINOLIVE: Novel approaches to promote the SUSTAInability of OLIVE cultivation in the Mediterranean

The overall objective of SUSTAINOLIVE is to enhance the sustainability of the olive oil farming sector throughout the implementation and promotion of a set of innovative sustainable management solutions that are based on agro-ecological concepts, and on the exchange of knowledge and co-creation involving multiple actors and end-users.

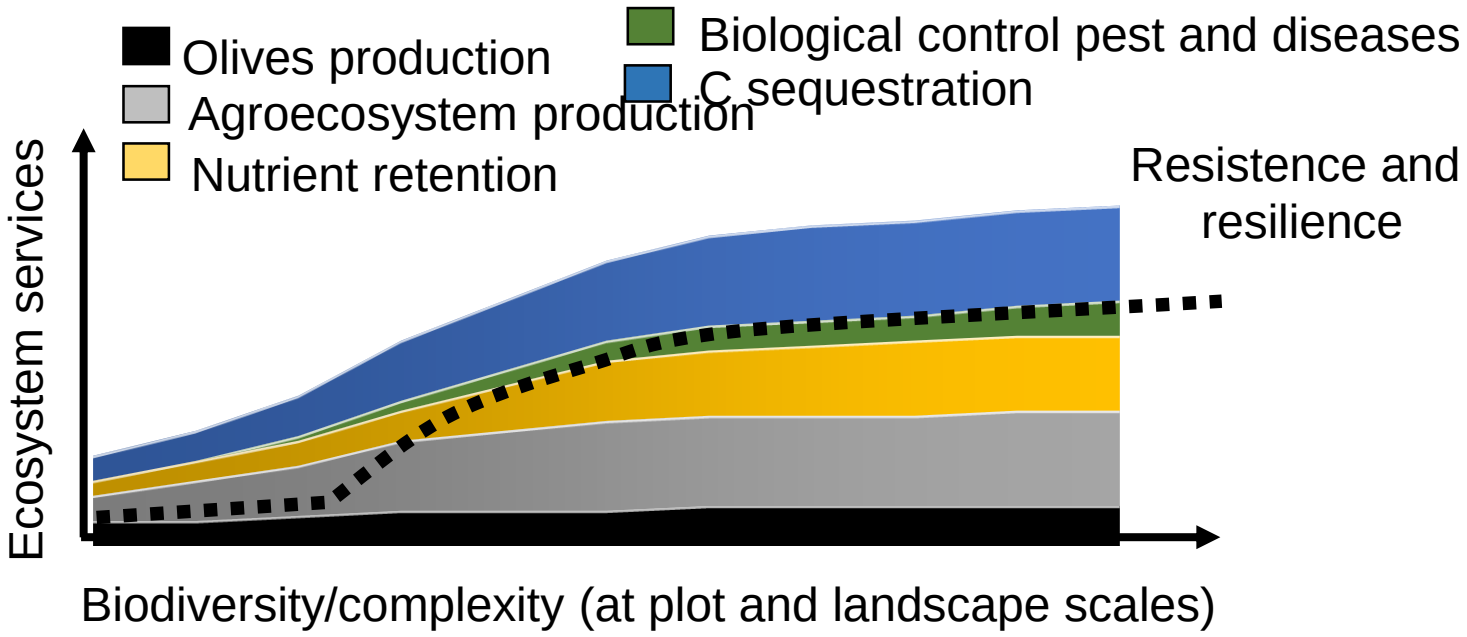
Olive crop diversification, throughout the introduction of cover crops in the inter-row of olive trees is a essential part of SUSTAINOLIVE

The context/The problem



Soil degradation. No ecosystems services

Benefits from crop rotation and/or crop diversification that SUSTAINOLIVE wants to implement



-Soil loss reduction
-Increase SOM and other soil fertility indicators
-Biological control of pest and diseases
-Nutrient retention
-C sequestration.
-Esthetical (Oleotourism)
-Increase and diversified

$AGRO_{ECOSYTEM}$ Crop diversification/rotation AGROECOSYSTEM

According to the landscape, pedoclimatic, socio-economic and technological knowledge

Enhancing a diversified production

Olive + cereals (for beer industry)
Olive + cereals (for livestock)
Olive + rotation (cereals and legume) (for livestock)

Olive + saffron (*Crocus sativus*)

SUSTAIN OLIVE

Enhancing ecosystems services

Olive + spontaneous herbaceous plants
Olive + seeded legumes
Olive + (rotation of seeded legumes and cereals)
Olive + (polyculture of seeded legumes, cereals and cruciferous)

Lessons, pros and cons

Pros

- In general, olive farmers are open to crop diversification, but they need clear “rules”
- Spontaneous plant cover crops is well implemented by olive farmers
- Between 80-95 % of soil erosion reduction
- Higher soil water availability (if cover crops is adequately controlled)
- Soil fertility indicators increase significantly at the medium term
- In most cases effective pest and disease control
- Significant C sequestration

Cons

- Spontaneous plant and seeded crops do not establish well under most of the degraded soils
- Very high inter-annual and pedoclimatic variability hinders the establishment of ”rules”
- Secondary crops or cover crops must be well adapted to low rainfall and the main management practices calendar
- Cost of the seeded crops and lack of clear markets are handicaps for the farmers

Main perspective for a smart agricultural vision for woody crops are:

1.- For most of the rainfed olive groves: mature spontaneous cover crops, controlled by alternating different techniques.



2.- In areas with livestock (mainly sheep): polycultures of legumes and cereals.

Ecosystem services of crop rotation and crop diversification

Category	Benefit
Improvement of nutrition balance and inputs	Reduction of nutrient depletion
	More nutrient input (natural and artificial)
Reduction of pesticedes, higher pollination rates	Pest and deseases control
	Weed management
Better soil and water management	Efficient use of water
	Soil physical structure and cultivation
	Soil erosion and runoff control
	Groundwater pollution

Other services of crop rotation and diversification

Category	Benefit
Increased income of the enterprise	Sharing the risk of farming among crops
	Market opportunities
Better farm organization	Complementarity of outputs for the farm needs Complementarity of workload
Non material values	Aesthetic value of the land
	Mantainance of traditional cropping systems

Experiences with vegetables in arable crop rotation

Judith Treis
Manager of OG Biogemüse, Germany
Phone: (+49) 5664/930968
Judith.treis@treis-agrarkomzept.de

EIP-AGRI WORKSHOP CROPPING FOR THE FUTURE
4-5 JUNE 2019 - ALMERE, THE NETHERLANDS

Operational Group project “Organic Vegetables”

- Enabling regional cultivation
- creating jobs for people with disabilities
- shaping processing
- developing of regional value chain

Benefits from crop rotation

- Use of experience in arable crops for vegetables
- Existing resources can be used (technology, manure, knowledge)
- Arable system for the production of larger quantities
- Better income for farmers by diversifying crop rotation with cash crops
- Regional production for regional supply to save climate-damaging logistics kilometers

Results and experiences

- Weed and pest pressures were low
- Surprisingly good water availability of the soil
- Real problems: sales structures, not cultivation
- Less advice was needed than expected
- Cooperation in the operational group for rapid growth of the required knowledge

BIO GEMÜSE

Vision of a smart agriculture

- Vegetables in the arable crop rotation as an interesting diversification
- It simplifies crop protection (less weeds, lower disease pressure)
- Crop rotations are intelligent when the farmer earns money, otherwise he has to give up

Mechanisms responsible for the beneficial effects of crop rotation and diversification

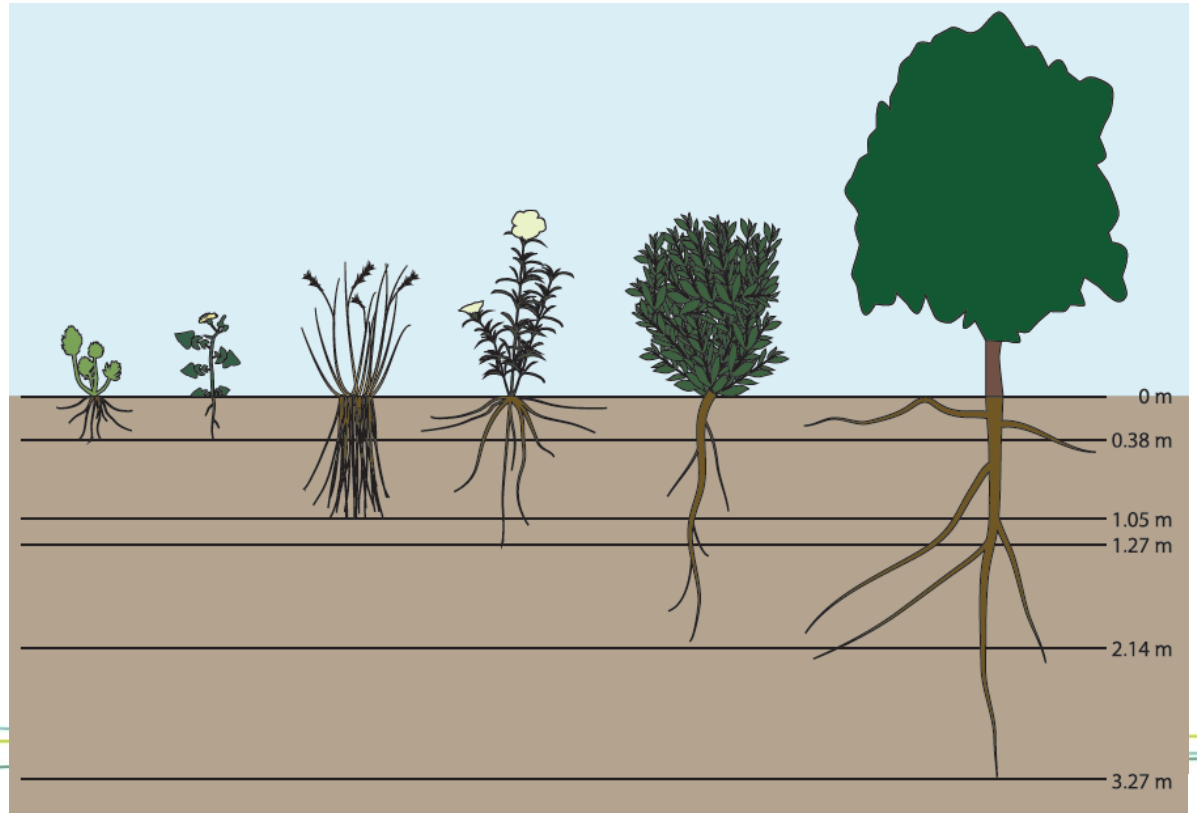
Nitrogen fixing rhizobia of legumes

funded by the European Commission

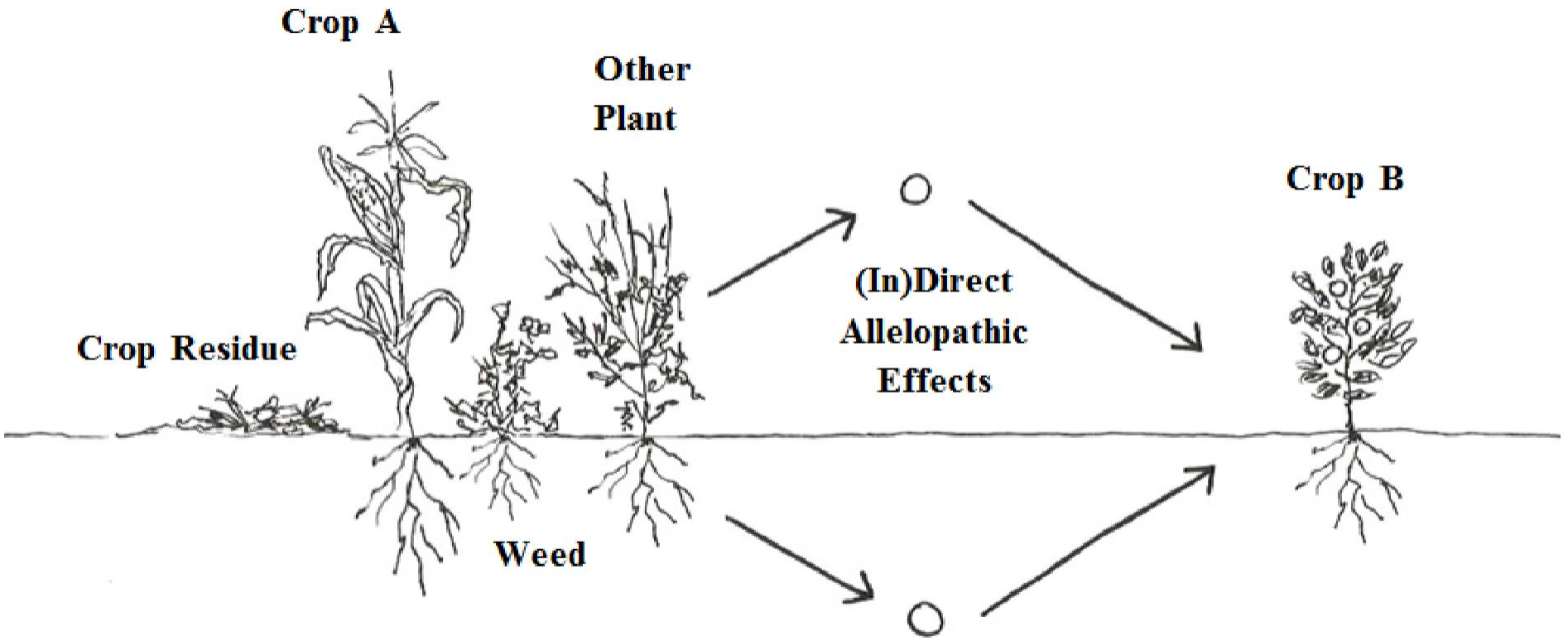
eip-agri
AGRICULTURE & INNOVATION

Complementarity of above ground and below ground architecture

- Reduced competition for resources;
- Higher efficiency in resource use;

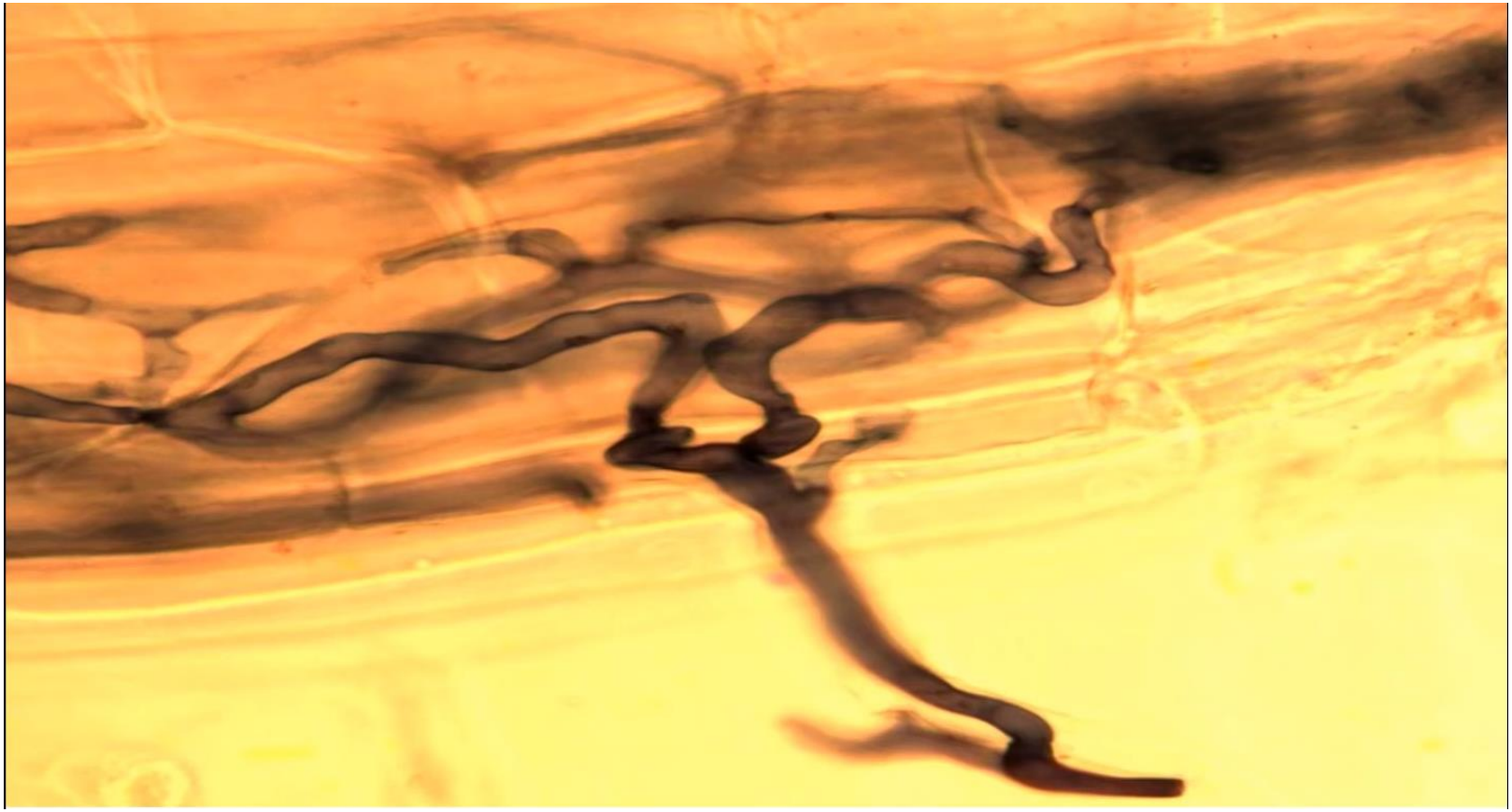


Positive and negative allelopathy



From De Liedekerke De Pailhe, 2014

Arbuscular Mycorrhizal Fungi (AMF)



Arbuscular Mycorrhizal Fungi (AMF)

► sugar from plants ◄ extension of the root system up to 15 cm from the plant's root

▲ plant ability to uptake immobile elements: P, Zn, Cu

▲ plant's resistence to drought and deaseses

▲ soil structure

funded by the European Commission

eip-agri
AGRICULTURE & INNOVATION

Relationships between AMF and crops

High dependency

Peas, beans, other legumes

Flax

Sunflower

Corn

Warm season grasses

Low dependency

Wheat

Non-hosts

Canola

Radish

Mustard

Lupin

funded by the European Commission

eip-agri
AGRICULTURE & INNOVATION

Factors that discourage Mycorrhizal Fungi

Tillage

Non host plants

Water saturated

Cover Crop Coaching

Cover Crop Innovators

Factors that Encourage Mycorrhizal Fungi

No soil disturbance

Host plants

Living roots year around

COVER CROP COACHING

COVER CROP Innovators

Challenges of crop rotation and crop diversification

- Managing complexity: infinite number of combinations of planting pattern of 2 or more crops, relative densities and dates of planting
- Enhancing ecosystem services through broad adoption of ecological infrastructures and scaling diversification
- Adoption of ICT and Decision Support Systems for the choice and integration of crop rotation and diversification schemes at different scales
- Mechanization at the most detailed spatial and time scales
- Introducing precision farming within crop rotation and diversification schemes
- Improving understanding of basic mechanisms regulating relationships between plants

Nature is complex, we can only assist it and approximate her in our creations

Jeavons (2006)

Any question?