LEGUMINOSE

the way to a green transition

Exploitable results and lessons learned

Marek Seidenglanz, Agritec Plant Research s.r.o.

Legume-cereal intercropping for sustainable agriculture across Europe

- HORIZON-CL6-2022-BIODIV-01-05 - Intercropping – understanding and using the benefits of complexity in farming and value chains
- Duration: 11/2022 – 10/2026
- Estimated budget: € 7 188 017,50 (EU contribution € 7 188 013,50)

- Consortium: 15 partners from 8 different European countries + Pakistan
- Coordinator: Università degli Studi di Firenze – prof. Giacomo Pietramellara
- Agritec Plant Research s.r.o. (APR) partner and WP5 leader

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LEGUMINOSE Goal and Objectives

Micro

Intercropping:
From Niche to
Mainstream



Meso

Identifying Obstacles and Opportunities to Intercropping Adoption

Study the benefits Beyond Nitrogen Dynamics

Provide Intercropping Decision Support system

Macro

Diverse intercrop mixtures
Technical & Practice barriers
Deploy multi-actor approach
Two-way Communication
EU Policies

Crop yield & Quality
Nutrient retention
Soil multifunctionality
Soil Microbiome
Pest & Pathogens
Soil Organic Carbon

I-Crop model
Web-based Planform
Toolbox

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LEGUMINOSE Approach



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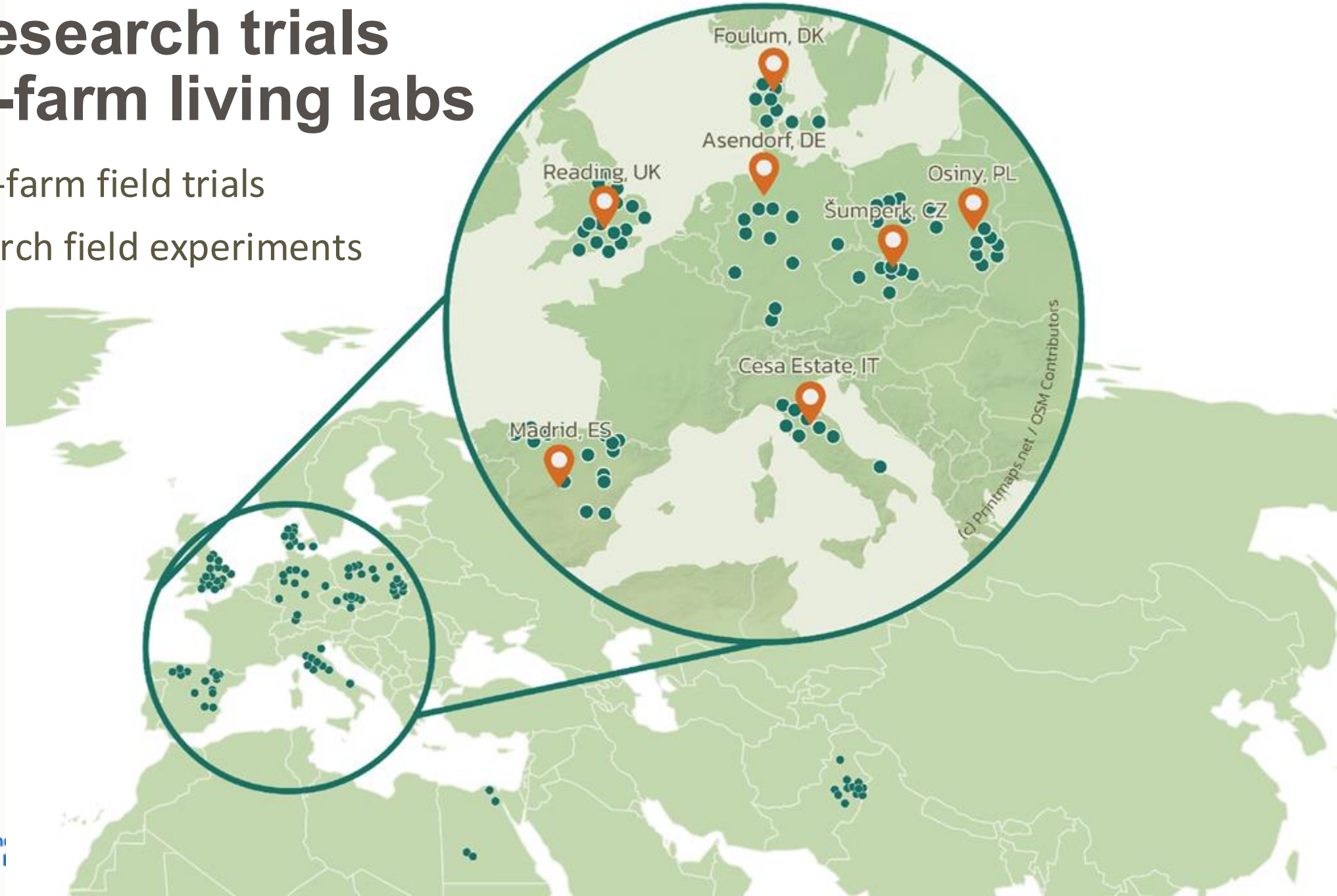
Research trials & on-farm living labs

- 189 on-farm field trials
- 7 research field experiments



Agritec Plant Research s.r.o. role

- **WP5 leader**
- Determining the efficiency of cereal/legume mixtures to as growing method leading to diminishing negative impacts induced by insect pests, diseases and weeds
- 11 contributing partners
- Harmonised protocol development → Training and support → Data analysis → Synthesis of European results

- Deliverables:
  - D5.1 – Report on identification of key mechanisms through which more diversified crops excercise a higher level of tolerance to **harmful organisms**
  - D5.2 – Report on identification of the main factors through which crop composition influences abundance/species richness of **beneficial organisms**
  - D5.3 – Report on characterization of **spatio-temporal associations between insect pests and their natural enemies**

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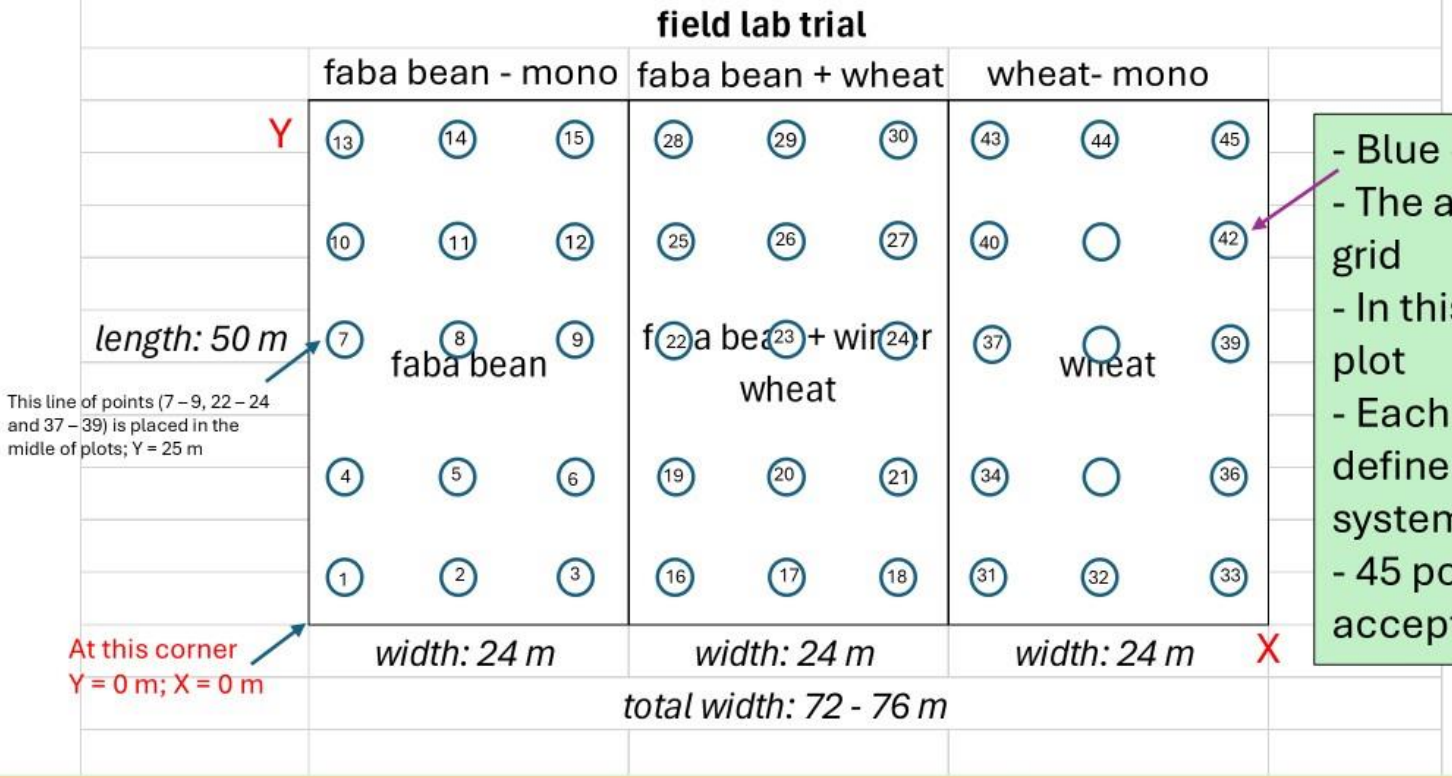
The raw data of different type (abundance of insect pests + their natural enemies, symptoms of diseases, weed density) were collected from assessment points distributed in rectangular grid placed across the plots



- Blue circles = individual assessment points
- The assessment points comprise rectangular grid
- In this case that is 45 points grid = 15 points per plot
- Each of the points is (at least approximately) defined with its coordinates in two-dimensional system (Y and X)
- 45 points grid is the grid with lowest still acceptable number of assessment points

The plots were visited repeatedly in different growth stages of crops; at different dates different organisms / traits were assessed; some of the organisms / traits were assessed two or more times (for example aphids, syrphids, leaf weevils)

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Exploitable results from WP5

- Reduced abundance of selected aphid species
  - pea/cereal aphids reduced in several intercrops
  - faster decline of aphid colonies
  - lower virus transmission risks
- Increased abundance of beneficial organisms
  - enhanced parasitoid activity
- Reduced incidence of some cereal diseases (particularly rusts)
  - strong suppressive impact of cereal rusts
- Better understanding of pest-natural enemy interactions
- Potential reduction of insecticide and fungicide applications under specific conditions

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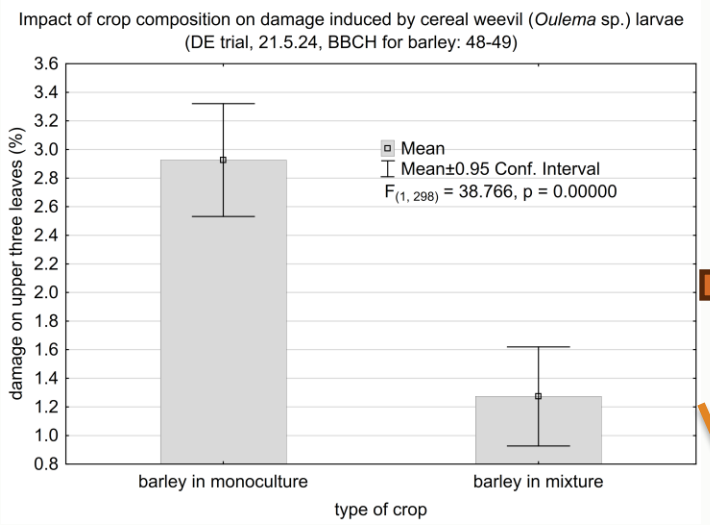
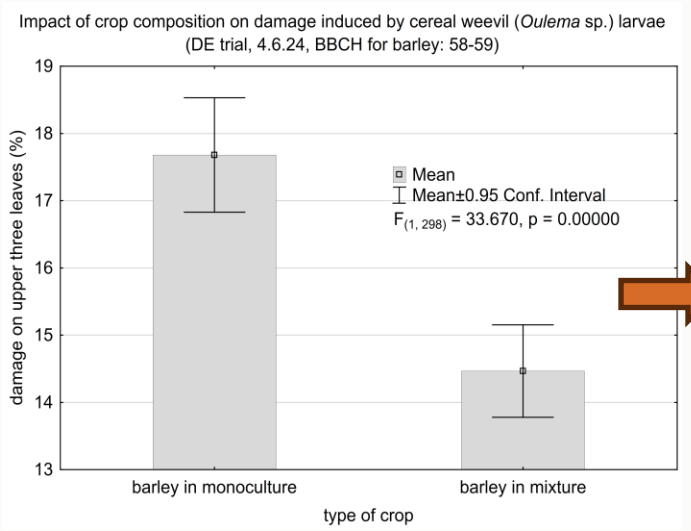
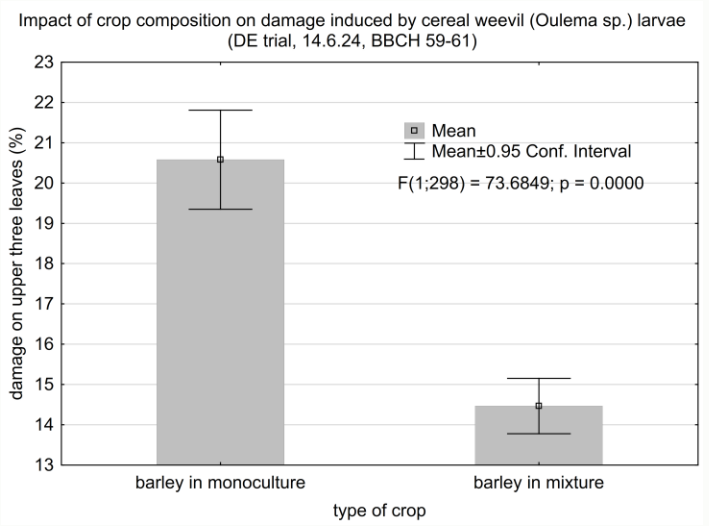
Cereals in intercrops (regardless of their composition) are usually under lower pressure from cereal leaf weevil larvae (*Oulema* sp.).











effect of:	SS	Degrees of freedom	MS	F	p
Intercept	1323.000	1	1323.000	250.1633	0.000000
Crop composition	205.013	1	205.013	38.7655	0.000000
Error	1575.987	298	5.289		

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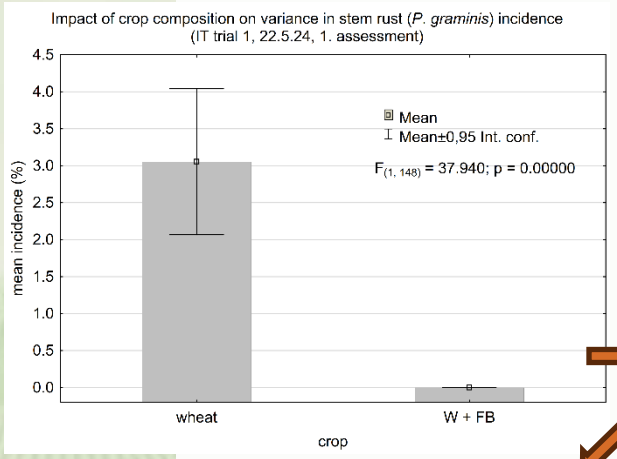
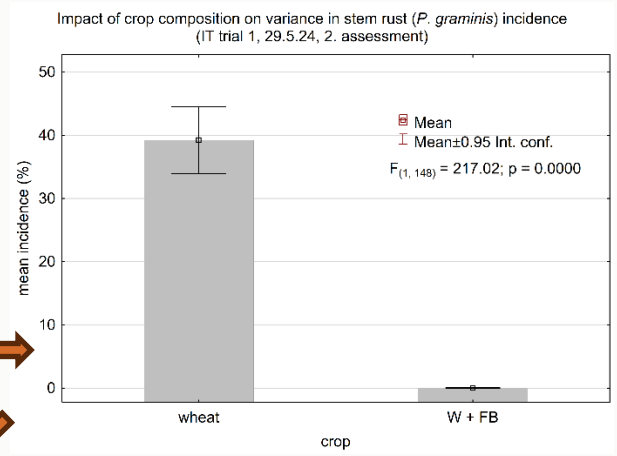
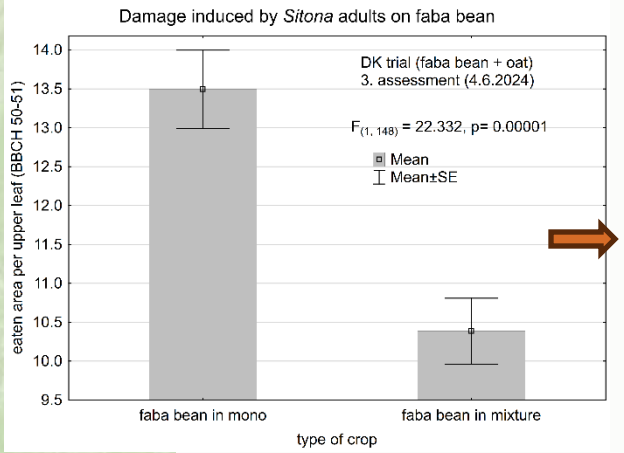
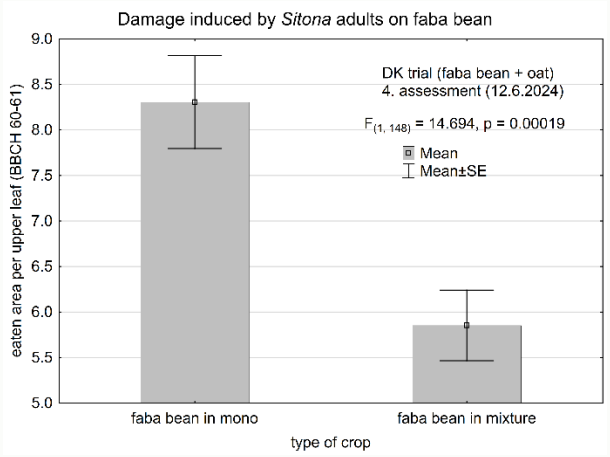
In the cases in which the levels of cereal rust severity and incidence in crops were significant, a high suppressive impact of the intercrops (regardless of their composition) on the disease (regardless of the *Puccinia* species) epidemics in cereals (regardless of the cereal s

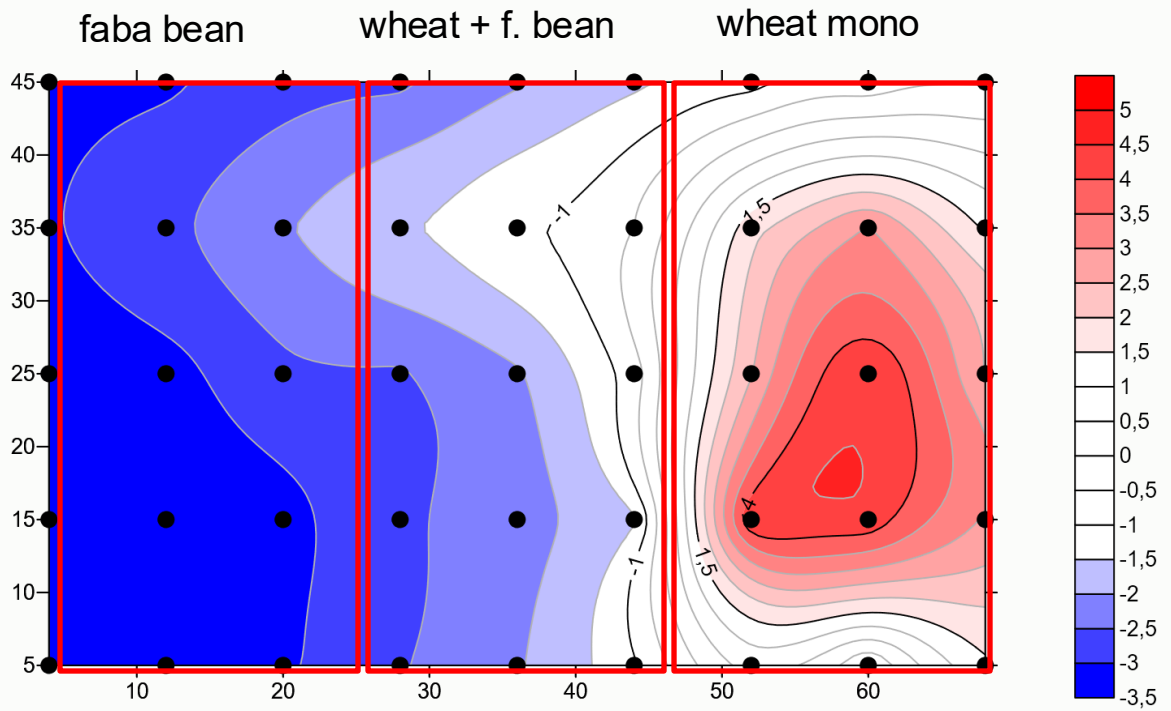












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Category (plant disease, insect pest, weeds, natural enemies)	Main effect observed in intercrop[1]
Cereal leaf weevil (*Oulema* sp.)	Lower crop damage induced by larvae; important result; potential to decrease the number of insecticide applications (from 2 - 3 per season to 1 or 0)
Sitona leaf weevil (*Sitona* sp.)	Lower crop damage - not in all cases, depends on crop composition; it was confirmed especially in DK Living Lab, this impact was not expected at all
Seed weevils (*Bruchus pisorum* and *B. rufimanus*)	low direct impact of intercropping on these insect pests; unfortunately, just bruchids are now maybe the most important insect pests of legumes in Europe (direct consequence of climate warming)
Pea aphid (*Acyrthosiphon pisum*)	lower abundance, faster decline of aphid colonies; and as a consequence significantly lower impact of hardly yield damaging viruses (PEMV, PSbMV) in pea crops – the viruses are transferred by the pea aphid (= vector of viruses); potential to decrease the number of insecticide applications (from 3 per season to 1)
black bean aphid (*Aphis fabae*)	low direct impact of intercropping on this aphid
cereal aphids (*S. avenae, R. padi, M. dirhodum*)	lower abundance, faster decline of aphid colonies
natural enemies of pea aphids	higher abundance - especially in the case of aphidophagous syrphids and hymenopteran parasitoids from subfamily *Aphidiinae* ; we can observe markedly earlier decline of pea aphid colonies and their lower population density – indirect impact – decrease in virus diseases in pea (PEMV, PSbMV); potential to decrease the number of insecticide applications (from 3 per season to 1)
natural enemies of black bean aphids	probably low impact of intercropping
natural enemies of cereal aphids	higher abundance, higher parasitision levels, earlier decline of cereal aphid colonies; especially hymenopteran parasitoids from subfamily Aphidiinae are more abundant in intercrops
natural enemies of seed weevils (*B. pisorum and B. rufimanus*)	higher levels of bruchid larvae parasitisation induced by braconid *Triaspis thoracicus*
Ascochyta blight on field pea and faba bean	not strong suppressive impact of intercropping on the causal agents of this field pea disease
cereal rusts in general	lower incidence and severity - strong suppressive impact of intercropping on the rust epidemics in crops; presence of legumes negatively influence development of secondary infections of *Puccinia* sp. rusts – such cold *uredinial* cycles; potential to decrease the number of fungicide applications (from 3 per season to 1)
leaf spots and blotches on wheat, barley, and oat	not so strong suppressive impact of intercropping on the pathogens causing these diseases (*Pyrenophora teres, P. graminea, P. avenae, P. tritici–repentis, Zymoseptoria tritici, Stagonospora nodorum, Rhynchosporium secallis, Cochliobolus sativus*); we expected (or we hope in) significant impact of intercropping on suppression of secondary infections caused by these pathogens – significant impact was confirmed only in several Living Labs; the issue would need continuing in field trials – some methodological changes would be necessary to accept; It is very important topic because just some of very important pathogens in these group (with high economic impacts on barley wheat production) developed resistance against synthetic fungicides: DMIs (= azoles) and strobilurins

[1] *more detailed information and explanation of principles why it is so are available in Deleverables 5.1 - 5.3.*

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Beyond WP5: Project-Level Exploitable Results

- Decision Support System: https://leguminose.farming.software
- Agronomic, environmental and soil-health performance of various legume-cereal intercropping combinations under different climatic conditions:
  - Soil-plant microbiome interaction in intercropping and their potential phytosanitary effects
  - Deeper understanding of soil functionality in legume-cereal intercropping
- Field-based evidence to enhance adoption of intercropping practices
- Economic analysis of intercropping at farm level
- Living Labs network
- Policy recommendations to support a wider adoption of intercropping practices in the EU

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Lessons learned from participation in the LEGUMINOSE

- **1. Expertise Is Not Enough**
  - We joined activities far beyond our original expertise.
    - farmer surveys
    - interviews
    - stakeholder workshops
    - economic analysis
    - business model development

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Lessons learned from participation in the LEGUMINOSE

- **2. Standardisation is Hard and Europe is Not One Environment**
  - Methodologies that work in Central Europe do not automatically work in Mediterranean, North African or South Asian conditions.
    - different countries
    - different crops
    - different pests and diseases
    - different experience levels

    - tailored protocols
    - crop-specific methodologies
    - individual consultations
    - continuous support

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Lessons learned from participation in the LEGUMINOSE

- **3. Communication is Essential**
  - prepare protocols
  - explain them
  - train partners
  - answer questions

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Lessons for the future Horizon Applicants

- Be prepared to work beyond your specialization.
- Invest time into communication.
- Develop protocols together, not alone.
- Expect regional differences.
- Reserve resources for training and support.

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Lessons for the future Horizon Applicants

- LEGUMINOSE demonstrated that legume-cereal intercropping can contribute to more sustainable crop protection while reducing dependence on external inputs.
- From a project management perspective, our experience as WP5 leader showed that successful European research relies as much on communication, harmonisation and collaboration as on scientific excellence itself.

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Thank you for your attention

https://www.leguminose.eu/

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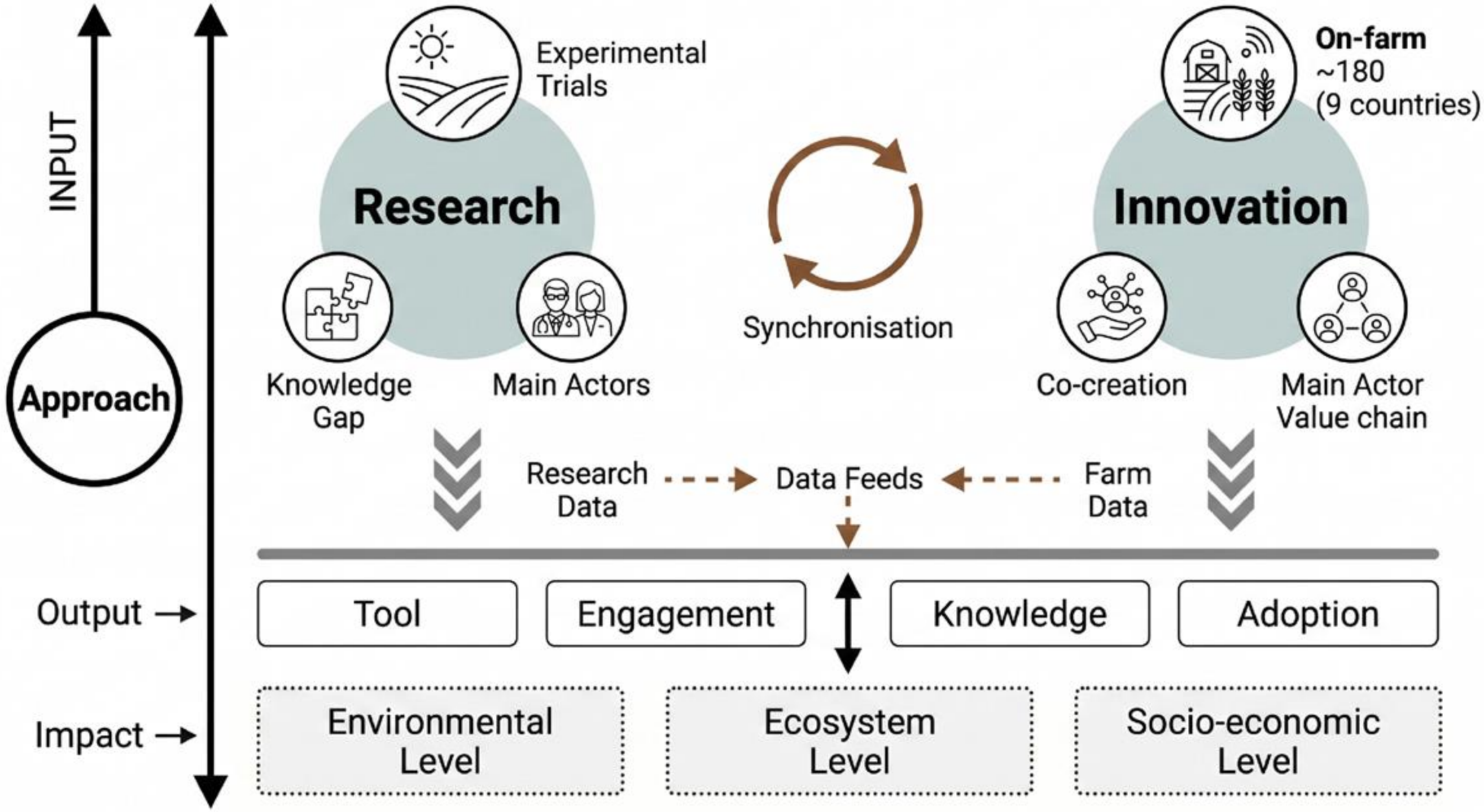

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