LEAF (Linking Environment and Farming) in collaboration with the EU H2020 IPMWORKS Project

Holistic IPM:

Case Studies from European Farmers implementing IPM

THIS PROJECT HAS RECEIVED FUNDING FROM
THE **EUROPEAN UNION' HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME**
UNDER GRANT AGREEMENT N. 101000339

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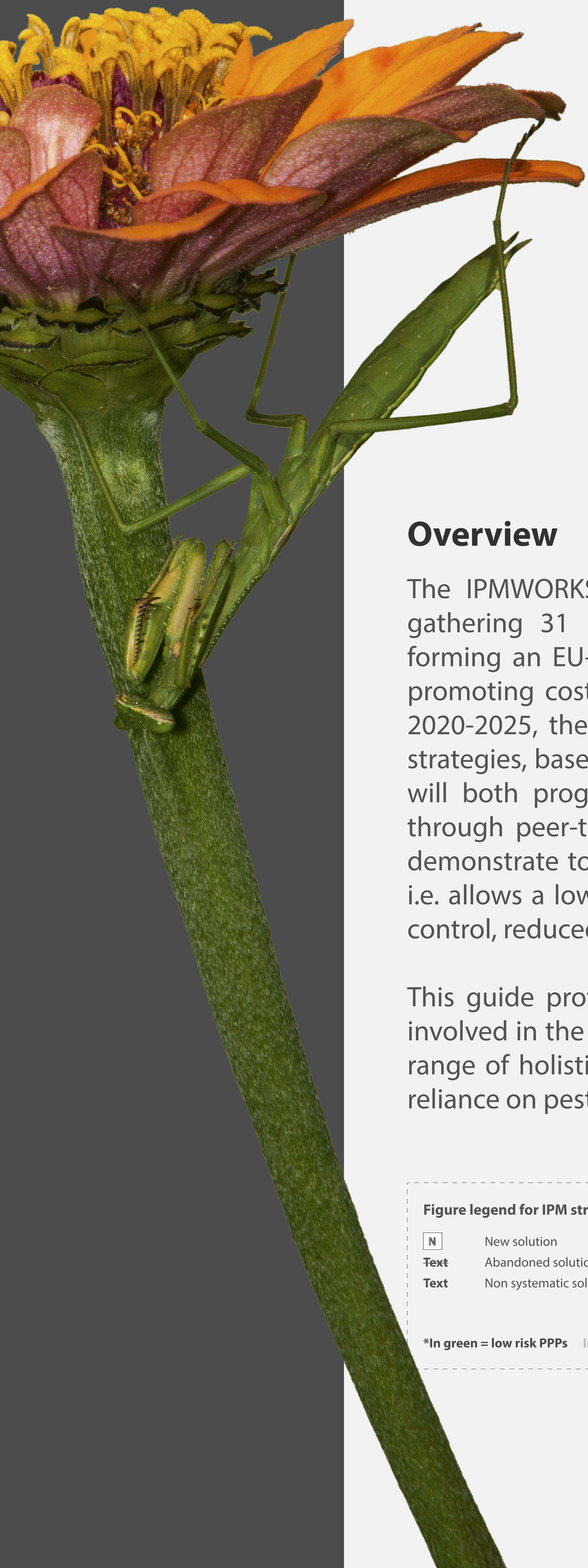

Overview

The IPMWORKS project is a H2020 financed project gathering 31 partners from 16 European countries, forming an EU-wide farm network demonstrating and promoting cost effective IPM strategies. Running from 2020-2025, the project promotes the adoption of IPM strategies, based on a EU-wide network of farmers, who will both progress further in the adoption of IPM – through peer-to-peer learning and joint efforts – and demonstrate to other farmers that holistic IPM “works”; i.e. allows a low reliance on pesticides with better pest control, reduced costs and enhanced profitability.

This guide provides an overview of how farmer hubs involved in the IPMWORKS project have implemented a range of holistic IPM practices in order to reduce their reliance on pesticides.

Figure legend for IPM strategy diagrams

N	New solution
~~**Text**~~	Abandoned solution
Text	Non systematic solution

***In green = low risk PPPs** **In blue = biocontrol agents** **In orange = synergistic effect**

1 Arable
Case Studies

Denmark **a)**
Netherlands **b)**
United Kingdom **c)**
Ireland **d)**
Poland **e)**
Germany **f)**
Spain **g)**
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Denmark

DJURSLAND LANDBOFORENING velas

Farm Location:
Agro PJ, Jutland and Fyn

Hub Coordinator:
Djursland Landboforening and Velas

Climatic & Agronomic context

- Sandy Soils
- Wet Climate

Farm Overview

- **Farm size:** 422 hectares
- **Crops grown:** winter barley, winter wheat, winter rapeseed, winter triticale, spring barley, spring barley with under sown grass

Main Pests

- **Grass weeds:** primarily Italian Ryegrass

Key IPM Measures

- More spring cropping
- Resistant varieties
- Promotion of beneficial insects, e.g., through insect hotels
- Use of decision support systems
- Adaptable crop rotation
- Hand weeding in smaller problematic areas

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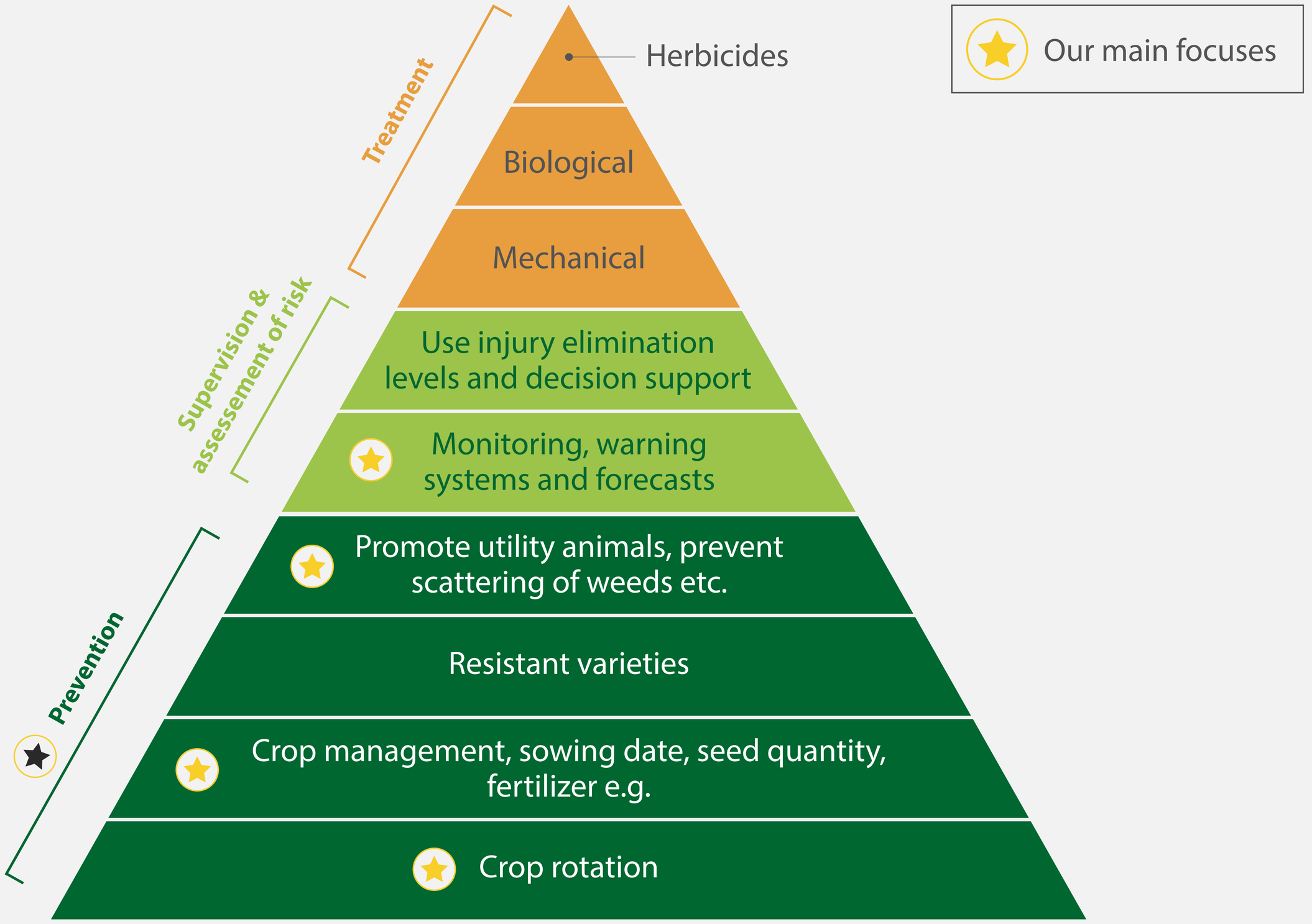
Denmark



Advice on the IPM Strategy

- Field programs, such as Farmtracking can quantify data on GPS level. We can then refer back to this data to better understand why the problem arose.
- Use of decision support systems, which produce a prognosis for when certain problems could arrive in Djursland. E.g. diseases and insects.
- Focus on optimal crop rotation was key to prevent pest build up.
- More spring cropping helped tackle Italian rye grass issues.

Feedback
from the farmer

"It is important to have other means than just pesticides, because we have seen before what will happen when only pesticides are relied upon."

"IPM has provided alternative tools to conventional pesticides, it just has to be adjusted to the practices of the farm and the effects have to be seen."

Feedback
from the hub coach

"Before it is visible in the field that traditional treatments are not working, alternative sustainable treatments have to be implemented"

"It is important to maintain the focus on sustainability and get the new methods implemented into daily practice."

Video link: https://www.youtube.com/watch?v=mAO_0P_KyMA

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Netherlands

WAGENINGEN
UNIVERSITY & RESEARCH

Hub Coordinator:
Wageningen University & Research

Climatic & Agronomic context

- Reclaimed clay soils are predominant
- Highly variable weather conditions during growing season
- Hot and dry spells with prolonged periods of precipitation
- Annual average temperature ± 10.5 °C.
- Annually ± 1700 hrs of sunshine

Farm Overview

- **Farm size:** 135 hectares
- **Crops grown:** potato, sugar beet, onion, wheat, tulips and carrots

Main Pests

- **Potato pests:** foliar and fungal pathogens, aphids, viruses, nematodes and weeds

Key IPM Measures

- **Green manures:** used to retain nutrients and manage nematodes
- Delayed sowing
- **Companion planting:** used to confuse aphids and attract natural enemies
- Resistant varieties
- False seedbeds
- Hoeing
- **Decision support tools:** for potato blight
- **Precision mapping:** of cultivars at planting allows precision spraying of only the susceptible cultivars
- **Pest monitoring:** using sticky traps to monitor carrot fly
- **Sterile insect technique:** used to control onion fly

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Netherlands

Alternative Solutions

Agronomical

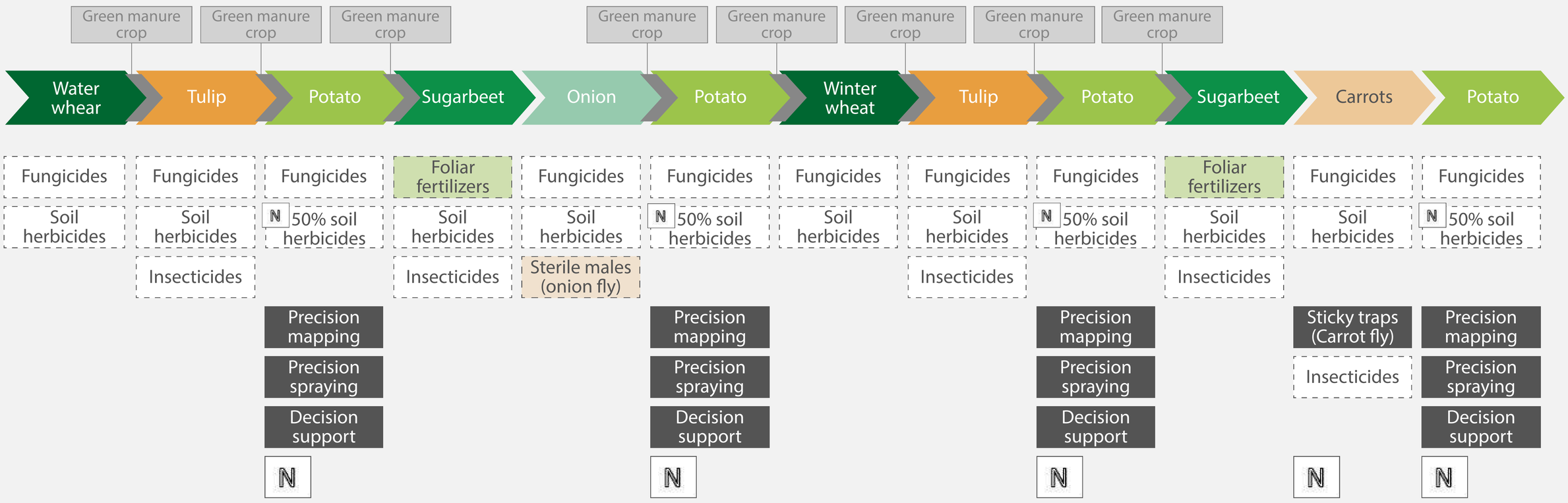
- Delayed sowing
- Companion plants (N)
- Companion plants (N)
- Delayed sowing
- Companion plants (N)
- Companion plants (N)

Genetics

- Resistant cultivar (N)
- Tolerant cultivar
- Resistant cultivar (N)
- Resistant cultivar (N)
- Tolerant cultivar
- Resistant cultivar (N)

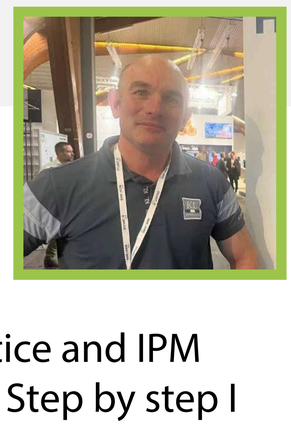
Physical Control

- False seedbed
- False seedbed
- Hoeing
- Hoeing
- False seedbed
- False seedbed
- Hoeing
- Hoeing



Advice on the IPM Strategy

- Prevention is key. Our 12-year rotation includes: Potatoes 1:3, carrots & onions 1:12, other crops 1:6.
- Operating a low input system allows a 50% reduction in soil herbicide use and using precision tools allows a reduction in spraying up to 75%.
- “The IPM approach allows me to experiment with additional preventive control measures and as a result we are gradually reducing the input of pesticides through applied agro-ecology and precision technology.”
- “Economically we continue to produce high quality arable products and seed”.



Feedback
from the farmer

“The interaction between farming practice and IPM research is inspiring and key to success. Step by step I am gaining experience and adopting more and more functional IPM measures in my control strategies for pests, diseases and weeds.
I estimate IPM currently results in average reductions of 25% (fungicides & herbicides) and 30% (insecticides) as compared to current common local practice.”

Feedback
from the hub coach

“IPM is a knowledge intensive, farm level, hands on approach to pest, disease and weed control.
A systematic, step by step approach is key to successful introduction.

Automated monitoring and evaluation techniques are urgently needed to facilitate accurate decision making and evaluation of the results.”

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United Kingdom

The James Hutton Institute
Science connecting land and people

Farm Name:
Durie Farm

Hub Coordinator:
The James Hutton Institute

Climatic & Agronomic context

- Sandy loam soils
- Maritime climate, cool and wet
- Average rainfall 800mm/y

Farm Overview

- **Farm size:** 340 hectares arable plus 200ha pasture
- **Crops grown:** winter wheat, spring barley, break crops (bean, pea, linseed), oat and cereal/legume intercrops

Main Pests

- **Weeds:** primarily brome and wild oat
- **Diseases:** yellow rust/*Septoria* in wheat and *Rhynchosporium/Ramularia* in barley

Key IPM Measures

- Cover crops
- Intercropping legumes and cereals
- Increased diversity within the crop rotation

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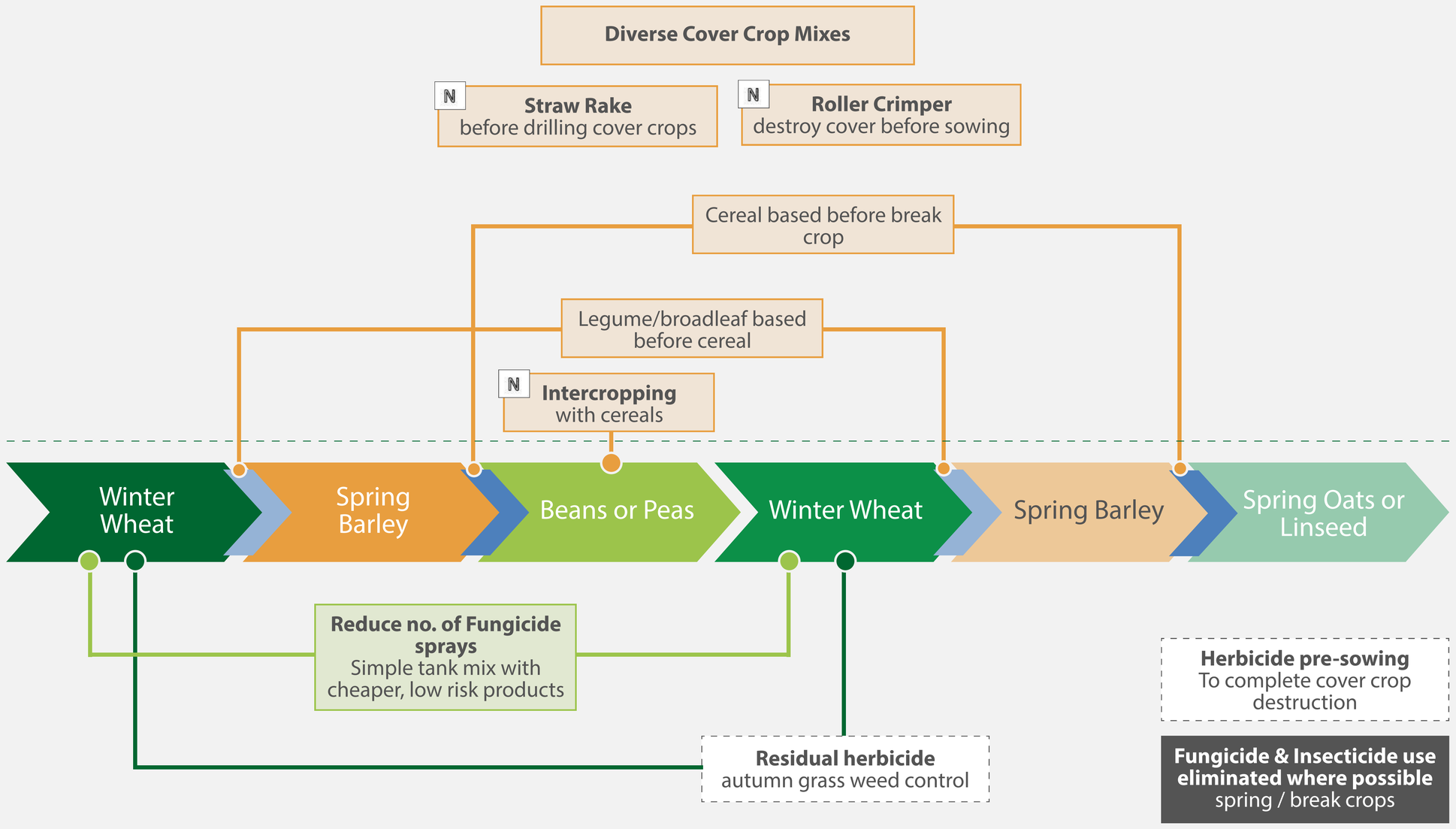
United Kingdom

Alternative Solutions

Agronomical



Advice on the IPM Strategy

- Whilst the farm is managed in a 3yr rotation, alternating break crop is flexible to provide resilience within the system and acts to extend rotation to 6yrs.
- Intercrop cereal/ legumes adds further diversity following a regenerative approach.
- Straw rake before cover crop stimulates grass weed seeds to establish within cover crop.
- Roller crimper destruction of cover crop also kills weed seeds/slugs and prepares for next crop sowing.
- Moving away from ploughing means less work and energy used for establishment but this has been replaced by other operations to make the no-till + cover cropping successful.
- Grass weed burden remains the main issue in system – double straw raking to target brome before sowing cover crop has helped but it does add complexity to the system.
- Green cover, less soil disturbance and fewer fungicides help build a healthier soil rhizosphere with higher soil organic matter leading to healthier crops.

Feedback
from the farmer

"Moving to a regenerative system is a mindset change, and once I'd made a start I realised that there was much more to it than just saving money. The soils are becoming a great deal more resilient and this means that they have the ability to procure wider environmental benefits"

Feedback
from the hub coach

"The holistic approach taken within the regenerative arable rotation is paying dividends on several levels. Whilst there are some challenges in terms of grass weeds, with the tools available, some strategic planning and a little effort, these can be overcome."

Video link: https://www.youtube.com/watch?v=LRMfMZDC9ws

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Ireland

Farm Name:
Brownstown Navan

Hub Coordinator:
Teagasc

Climatic & Agronomic context

- Heavy clay soil
- Average rainfall 850mm/y

Farm Overview

- **Crops grown:** winter wheat, winter barley, winter oilseed rape, spring beans and cover crops

Main Pests

- **Fungal diseases:** *Septoria*, *Rynchosporium*, net blotch
- **Insect pests:** *Rhopalosiphum padi* and *Myzus persicae aphids* which transit Barley Yelloe Dwarf Virus (BYDV)
- **Weeds:** Italian ryegrass, sterile brome and wild oats

Key IPM Measures

- Cover crops to improve soil structure
- Resistant varieties
- Pest monitoring for BYDV
- Crop diversification

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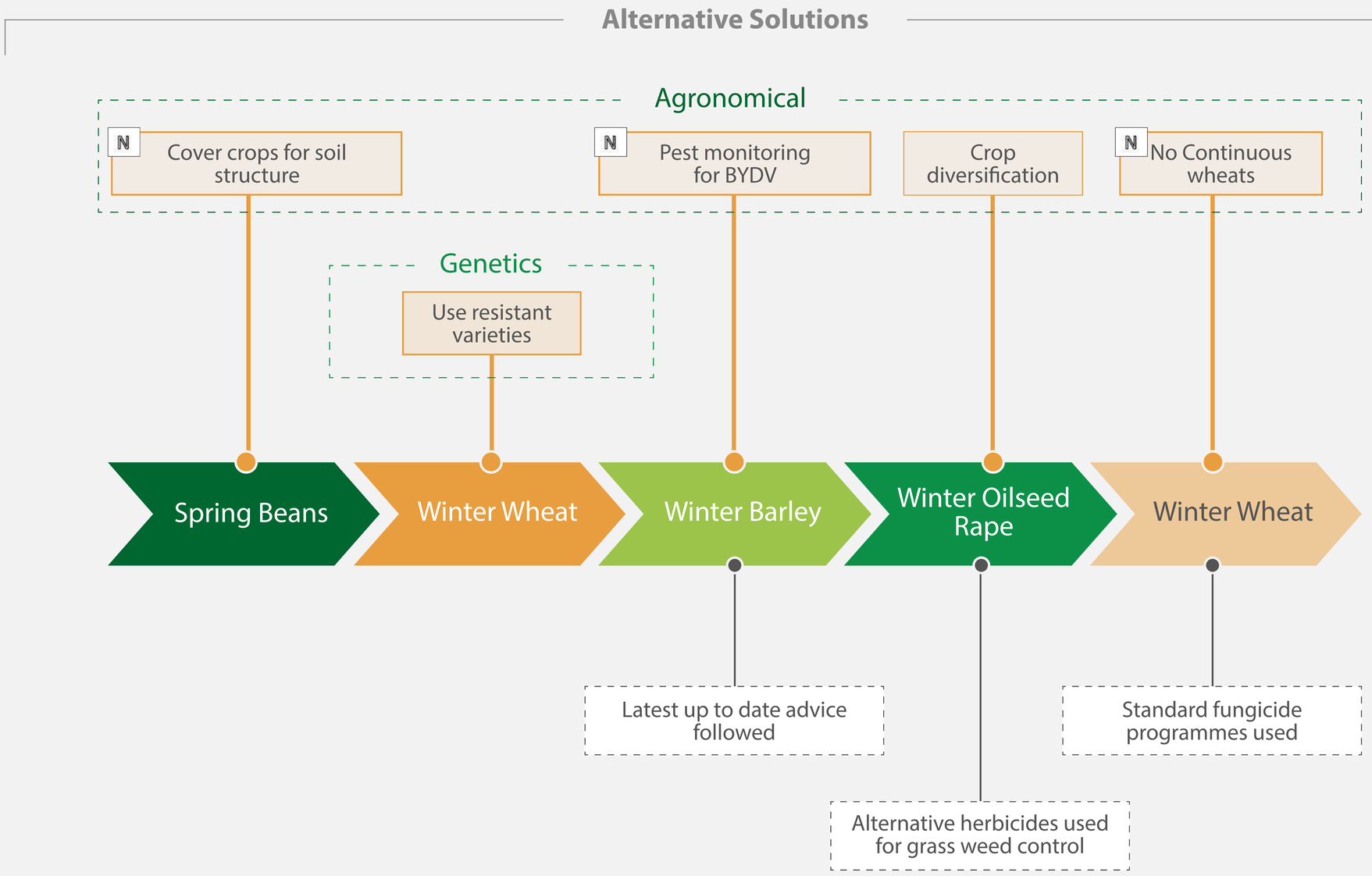
Ireland



Advice on the IPM Strategy

- Crop rotation and cover crops play an important role on the farm to improve soil health and to reduce pest issues.
- By taking the approach not to plough the soil it has made me learn more about how to take care of my soils and the impact this has on my crops.
- Monitoring the crop for pests is important and carrying out in field observations/trials provides important information for crop agronomy during the season.
- Wild oats seem to be less of an issue now than previously, however Italian ryegrass is an issue in certain fields.

Feedback
from the farmer

"We've got on well with beans and cover crops in the last few years, they are good for sustainability and seem to suit my rotation"

Feedback
from the hub coach

"IPMWORKS provides an ideal opportunity for farmers to demonstrate and discuss suitable IPM measures for their own individual farms"

Video link: https://www.youtube.com/watch?v=wTMMEfle5Qg

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Poland

KUJAWSKO-POMORSKI
AGRICULTURAL ADVISORY CENTRE
in Minikowo

Farm Location:
Tuchola County, Kuyavian-Pomeranian Voivodeship

Hub Coordinator:
Kujawsko-Pomorski Agricultural Advisory Centre

Climatic & Agronomic context

- Clay sand with clay loam below
- High levels of groundwater
- Frequent droughts in spring-summer with high intensity rainfall in growing season

Farm Overview

- **Farm size:** 100 hectares
- **Crops grown:** beetroot, winter oilseed rape, cereals (bristle, wheat, rye, triticale), peas and catch crops
- **Crop rotation:** sugar beet – wheat – winter rape – wheat – pea – wheat
- **Livestock:** 1000 heads of pigs per year

Key IPM Measures

- Promotion of beneficial insects and pollinators
- Biostimulators: chitosan
- Catch and cover crops
- Resistant varieties adapted to soil and climate
- Pest monitoring: using sticky traps and yellow water traps
- Mechanical weeding: using a harrow
- Precision application of PPPs

Main Pests

- **Fungal diseases:** *Septoria, Rynchosporium, Fusariosis*, powdery mildew
- **Insect pests:** aphids, rape beetles, turnip gall weevil, cabbage moths
- **Weeds:** common windgrass, poppy, red-root amaranth, cornflower, field chamomile, lambsquarters

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Poland

Alternative Solutions

- N Attracting beneficial insects and pollinators with molasses
- N Chitosan as a biostimulator

Agronomical

N Sowing mixtures of cereal varieties (bony + non-bony), sowing other species adapted to soil conditions, no-tillage cultivation of cereals, foliar nutrients with microelements (B, Mn, Mg, and CA) in appropriate development stages, only night PPP treatments (after 10 pm), use of own slurry, modern precise GPS equipment, soil always covered with plants.

Genetics

Selection of resistant varieties adapted to the prevailing soil and climatic conditions.

Physical Control

Yellow dishes, various types of sticky boards before the first treatment, field inspection of crops every 1-3 days depending on the conditions, mechanical weeding with a harrow weeder.

Sugar Beet	**Wheat** no till, straw, not harvested	**Winter Rape** catch crop oat, *phacelia*	**Wheat** winter catch crop, no till, unharvested straw	**Pea**	**Rye / Triticale** winter catch crop	**Wheat** winter catch crop, no till, unharvested straw

Only used after confirming the severity of the infestation and with economic justification
Rotation of active substances, dose reduction by using modern equipment, adjuvants, taking into account insect development cycles.

Does not use 1st and 2nd category PPPs

Advice on the IPM Strategy

- Selection of varieties resistant to drought stress, strong solar radiation, diseases and with potential for high yield on poorer soils.
- Determination of the nitrogen content in the soil before the first doses of N fertilizer are applied.
- Selection of PPPs so that they do not overlap (5-6 years of rotation), as few sulfonureas used as possible and adjuvants always used.
- Rethinking whether the use of PPP is necessary and economically justified.

Feedback
from the farmer

"We are moving forward all the time, testing things, counting all the costs, using catch crops, using farming 4.0.

Acceptance of certain diseases that do not affect the yield is needed. Daily monitoring, selection of better and better varieties"

Feedback
from the hub coach

"A great example of how specialist knowledge and a constant drive to improve applied practices translate into production results. The willingness to share knowledge and experience greatly facilitates the transfer of knowledge and proven solutions"

Josip Zubac

Video link: https://www.youtube.com/watch?v=eg1QO_vOSGk

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Germany

Julius Kühn-Institut
Bundesforschungsinstitut für Kulturpflanzen

Farm Location:
Pahren Agrar, Zeulenroda-Triebes

Hub Coordinator:
Federal Research Centre for Cultivated Plants

Climatic & Agronomic context

- Slate weathered soil
- Long term annual temperature mean 7.1°C; 635 mm precipitation
- Frequent pre-summer droughts in May/June

Farm Overview

- **Farm size:** 1600 hectares
- **Crops grown:** Peas, winter barley, winter oilseed rape, winter wheat, cover crops, maize
- **Minority Crops:** hemp linen, spelt, alfalfa and cup-plant *(Silphium perfoliatum)*

Main Pests

- **Fungal diseases:** minor issue
- **Insect pests:** cabbage stem flea beetle, pea moth
- **Weeds:** catchweed, cornflower, cutleaf geranium hemp-nettle

Key IPM Measures

- Avoid early sowing
- Reduced seed rates
- Increased amount of legumes in the rotation
- Under-sowing of wheat
- Cover crops
- Mechanical weeding: harrow and hoe
- Precision application of PPPs

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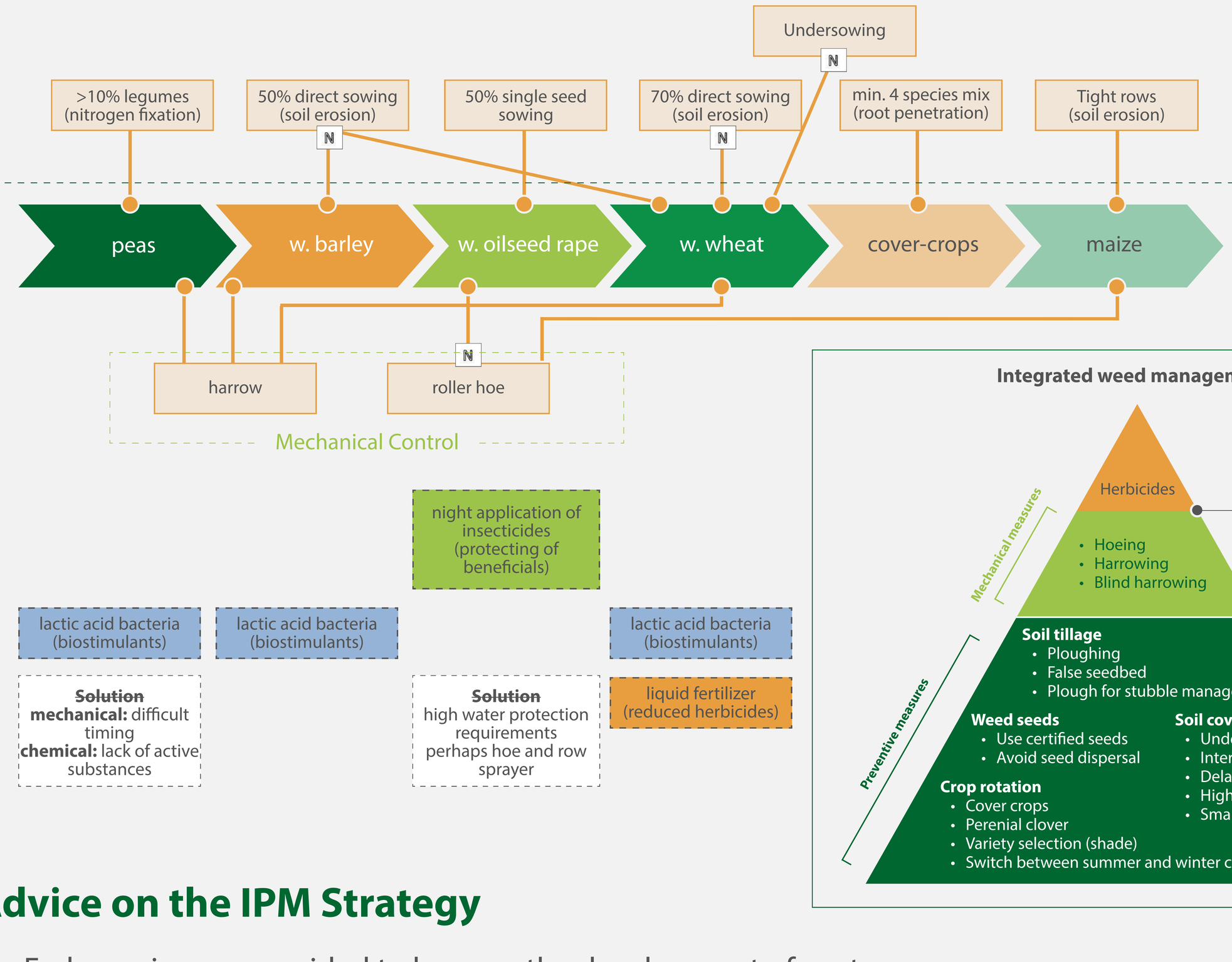
Germany

Alternative Solutions



Advice on the IPM Strategy

- Early sowing was avoided to hamper the development of pests.
- Wide spacing between seeds, high share of organic fertilisers used, mineral N applied as ammonium.
- No cereals are used in self-succession and a diverse crop rotation help spread risk.
- Mostly no-till system with permanent soil cover through cover crops and under-sowing.
- Agronomic challenges: breaking of work peaks though use of no-till instead of ploughing.
- Ecological challenges: maintaining soil-health, humus content and fertility at a high level protection of surface and groundwater.
- PPP savings of up to 50% could be achieved through using a holistic approach.

Feedback
from the farmer

"There is no recipe for farming. We can learn from nature and should think in terms of cropping systems. Crop rotation is most important and the first step in the system. If possible, with permanent soil cover. Learn to be patient."

René Kolbe

Feedback
from the hub coach

"Integrated pest management is holistically used on the arable farm presented here. By combining measures such as a diverse crop rotation, conservation tillage, permanent soil cover of fields and the use of biological plant protection products and mechanical weed control, the farmer is able to drastically reduce the use of chemical pesticides."

Dr Thomas Rottstock

Video link: https://www.youtube.com/watch?v=ZnTahhlFCiE

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Spain

INTIA

Farm Location:
Valdorba, Navarra

Hub Coordinator:
INTIA

Climatic & Agronomic context

- Loamy clay soil
- Cold winters, dry summers. Wet autumns and springs

Farm Overview

- **Farm size:** 160 hectares
- **Crops grown:** wheat, barley and alternating break crops

Main Pests

- **Fungal diseases:** Yellow rust
- **Weeds:** Ryegrass *(Lolium)*

Key IPM Measures

- Delayed sowing
- Resistant varieties
- Decision support systems
- Spraying thresholds
- No tillage

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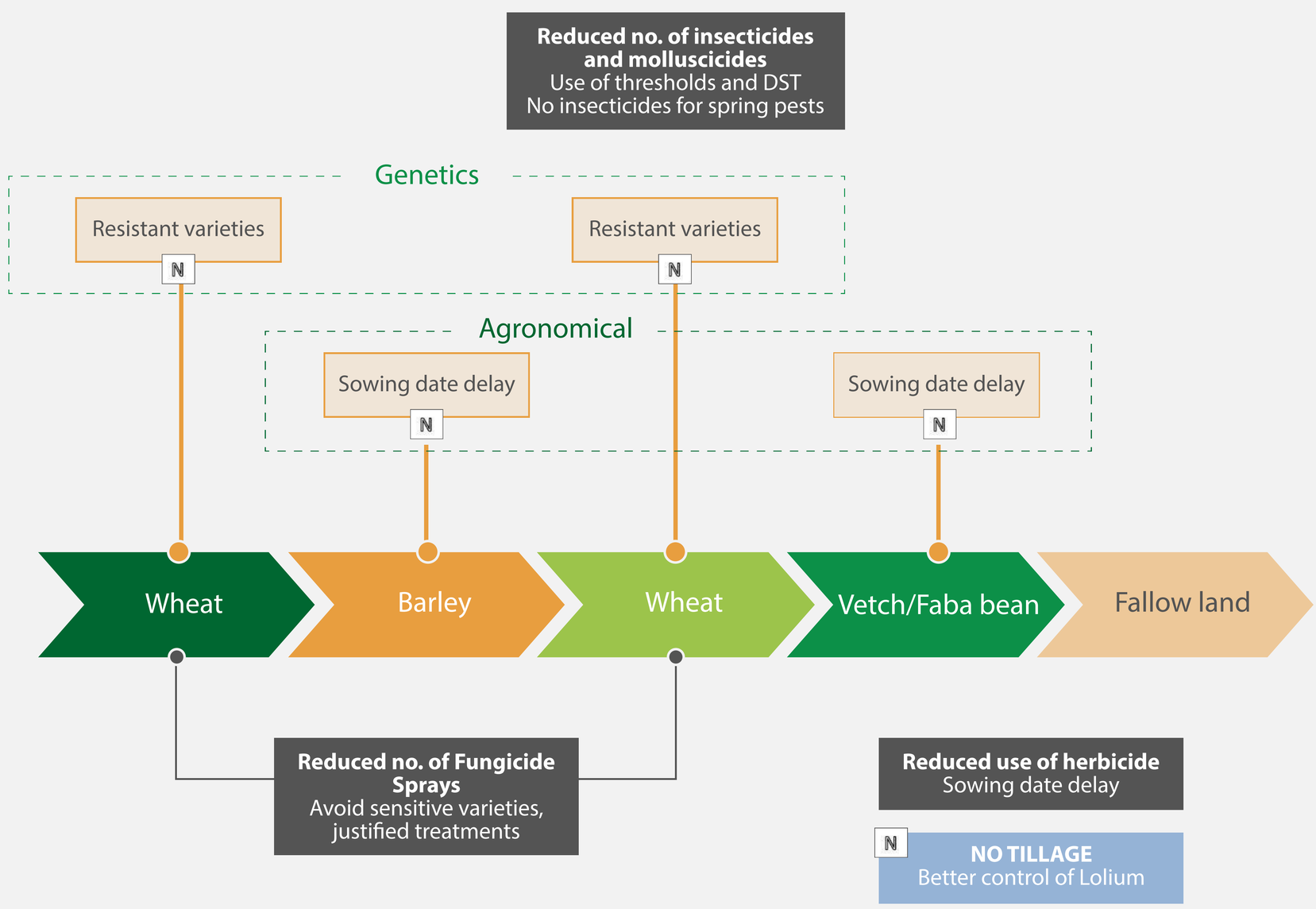
Spain



Advice on the IPM Strategy

- The usual strategy based on pesticides has been strengthened with the use of preventative solutions such as resistant varieties and sowing date delay. This has improved the control of Lolium.
- The use of fungicides is reduced through the use of resistant varieties and more carefully planned treatments.
- Considering increasing the length of the rotation and including another alternative crop in the rotation: oilseed rape.
- The most difficult pest to control is *Lolium*. The control has improved since delaying the sowing date.

Feedback
from the farmer

"I am increasing the knowledge regarding IPM and the needs that I have on my farm. That is the key to reduce problems with pests and weeds.
Farmers have realised that it is not possible to control pests using a strategy that it is only based on the use of pesticides. The management has been strengthened with the use of other alternative measures"

Victor Guillén

Feedback
from the hub coach

"Farmers are optimising the use of pesticides and improving every year in the management of their farm."

Javier Torrecilla

Video link: https://www.youtube.com/watch?v=E9y2dW5aYl0

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Italy

Sant'Anna
School of Advanced Studies – Pisa

Farm Location:
Podere il Picchio, Tuscany

Hub Coordinator:
Sant'Anna School of Advanced Studies

Climatic & Agronomic context

- Clay loam stony soils
- Mediterranean climate, hilly terrain

Farm Overview

- **Farm size:** 300 hectares
- **Crops grown:** cereals (durum wheat, emmer), forage, pulses plus 700 olive trees and 0.4ha of vineyards

Main Pests

- **Fungal diseases:** *Septoria*, rusts, take-all disease
- **Weeds:** Italian ryegrass, *Brassicacee, Phalaris spp*

Key IPM Measures

- Early sowing
- Mechanical weeding: harrow
- Green manures and cover crops
- False seedbeds
- Intercropping: wheat and lentil
- No fertilisers
- No pesticides

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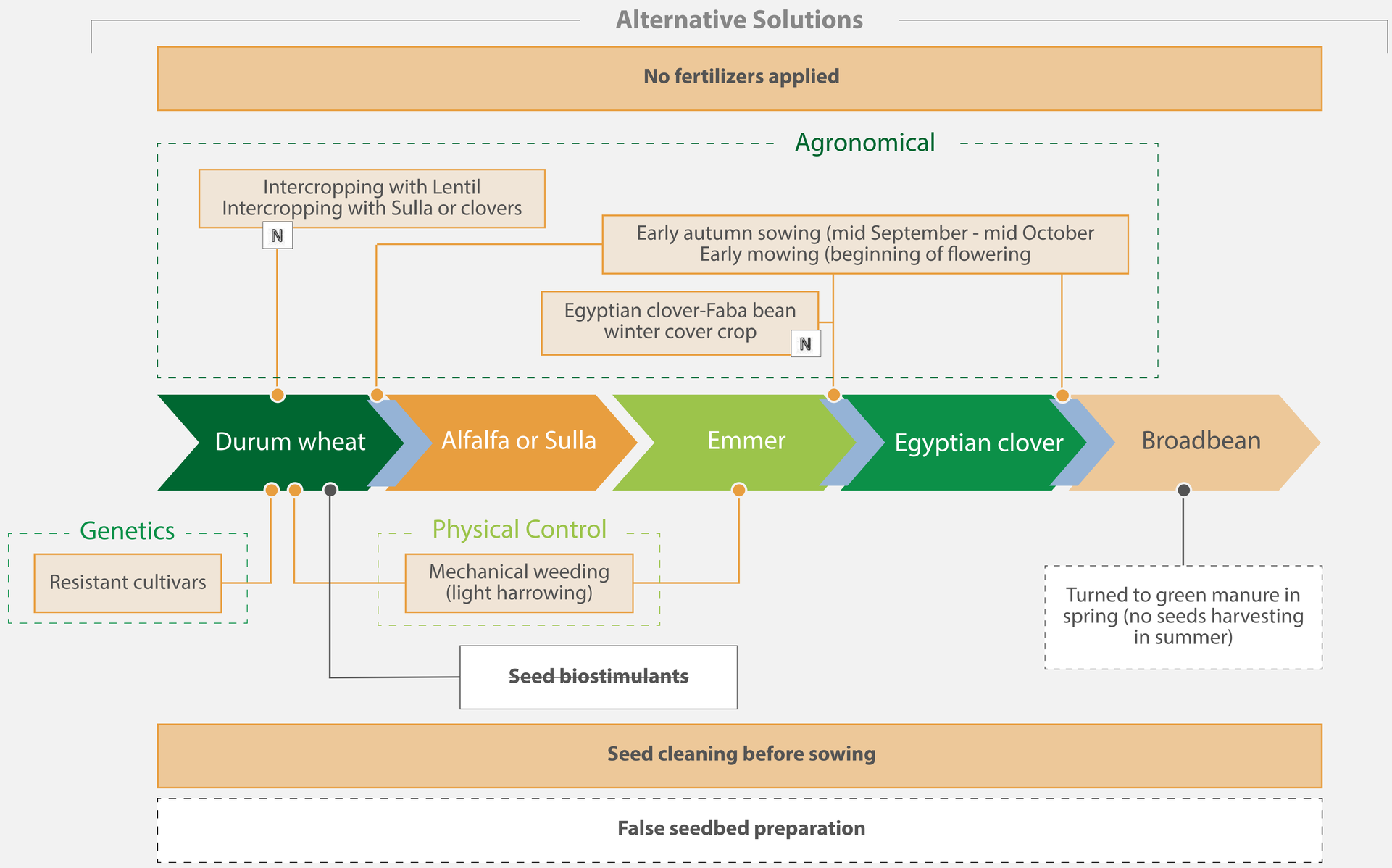
Italy



Advice on the IPM Strategy

- No pesticide used and lower yields and fungal diseases are accepted.
- Important preventative methods to reduce weeds pressure include no fertilizers being applied and seeds are cleaned before sowing. Mechanical weeding is performed on cereals and early mowing for legumes is preferred.
- Contemporary seeding (lower machinery optimization) or relay seeding in early spring (more sensitive to drought) can be used.
- Intercropping is used to produce two cash crops harvested together in the same field during a post-harvest separation (lentil) or to have a living mulch covering the soil after the winter cereal harvesting in summer with the objective of establishing a forage crop one year in advance (clovers, sulla).
- The combination of no fertilization and high soil tillage frequency and depth can deplete the soil fertility in the long term, it is important to find a good amendment or organic fertilizer.

Feedback
from the farmer

"Since I turned organic, I do not spray anymore: I feel safer, I do not notice a drop in yields, I cut many costs, I reduce the weed pressure and the cereals fungi diseases are tolerable in my opinion. I was already interested in intercropping and cover crops and I was happy to get involved with IPMWORKS to conduct field trials on my farm to improve my results.
The post harvest lentil and durum wheat separation is not easy and results in higher workload. The lentil relay seeding is more precise but it is prone to summer drought. The contemporary seeding is better for water requirements but the machineries are not optimized for seeding two crops in alternate rows."

Simone Bensi

Feedback
from the hub coach

"This farm is a very good example of commitment to new trials to improve year by year and to adapt to the changing climate. Some techniques are season-dependent and have to be carefully planned to decide if to use them or not or what to change. Residue management, cover crops, perennial legumes, soil amendments application and landscape diversification are all elements to be considered for holistic IPM and improved soil fertility."

Giovanni Pecchioni

Video link: https://www.youtube.com/watch?v=IwavA6Mzk44&t=103s

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Serbia

BioSense INSTITUTE

Farm Location:
Bački Vinogradi, Vojvodina

Hub Coordinator:
Biosense Institute

Climatic & Agronomic context

- Sandy soil – low to medium fertility with low water retention
- Semi-arid to arid climate with mild winters and hot summers

Farm Overview

- **Farm size:** 60 hectares
- **Crops grown:** potato, corn, sunflower, barley

Main Pests

- **Fungal diseases:** Potato black spot and potato blight
- **Insect pests:** Colorado potato beetle
- **Weeds:** Ambrosia, white goosefoot and scutch grass

Key IPM Measures

- Delayed sowing
- Inter-row cultivations
- Cover crops
- Intercropping
- Decision support systems
- No fertilisers

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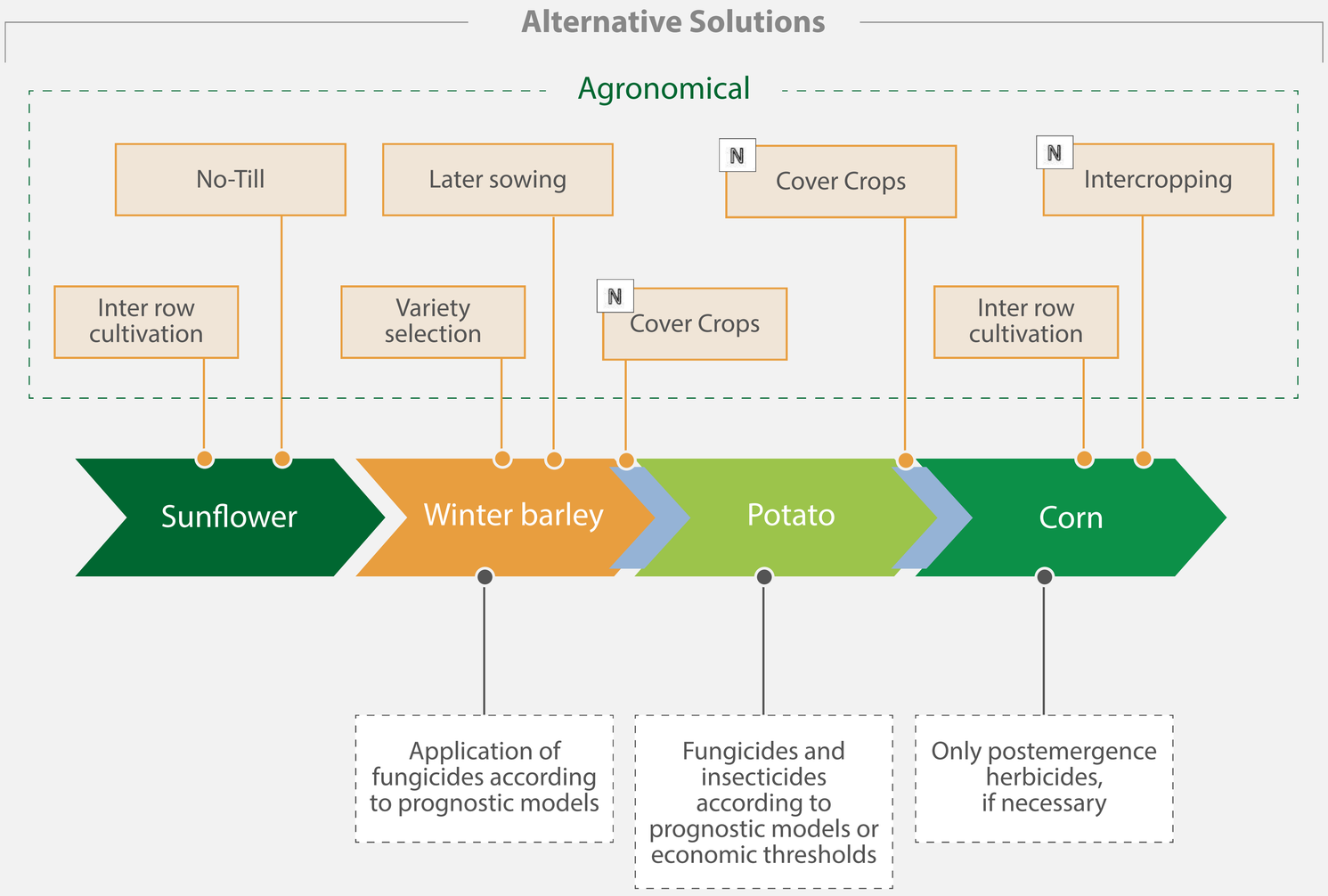
Serbia



Advice on the IPM Strategy

- Applying the principles of Regenerative Agriculture has allowed the exclusion of the use of mineral fertilizers, and reducing the use of pesticides.
- This strategy has allowed a reduction in energy use, inputs and human labour.
- A challenge has been the need for irrigation due to sandy soils.

Feedback
from the farmer

"We strive to reduce the need for labor and investment in synthetic chemistry. IPMWORKS provides an additional opportunity to learn about IPM measures and their implementation on the farm."

Turi Tibor

Feedback
from the hub coach

"IPMWORKS provides a chance for producers to become familiar with the principles and practice of Regenerative Agriculture while simultaneously implementing IPM measures on the farm."

Florian Farkaš

Video link: https://www.youtube.com/watch?v=aK__jiLYJus&t=1s

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2 Greenhouse
Case Studies

Spain **a)**
Belgium **b)**

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UNDER GRANT AGREEMENT N. 101000339

Spain

COEXPHAL
unidos exportando Futuro

Farm Location:
Níjar, Almeria

Hub Coordinator:
COEXPHAL

Climatic & Agronomic context

- Almeria-type greenhouses, unheated
- Organic amendments (manure and compost) are added to soil every 2-3 years
- Arid climate, minimal rainfall

Farm Overview

- **Farm size:** 3 hectares
- **Crops grown:** sweet pepper, tomato and watermelon
- Organic certified

Main Pests

- **Insect pests:** Aphids, white flies, *Tuta absoluta*

Key IPM Measures

- Biological control through release of natural enemies
- Interplanting flower strips to promote beneficial insects

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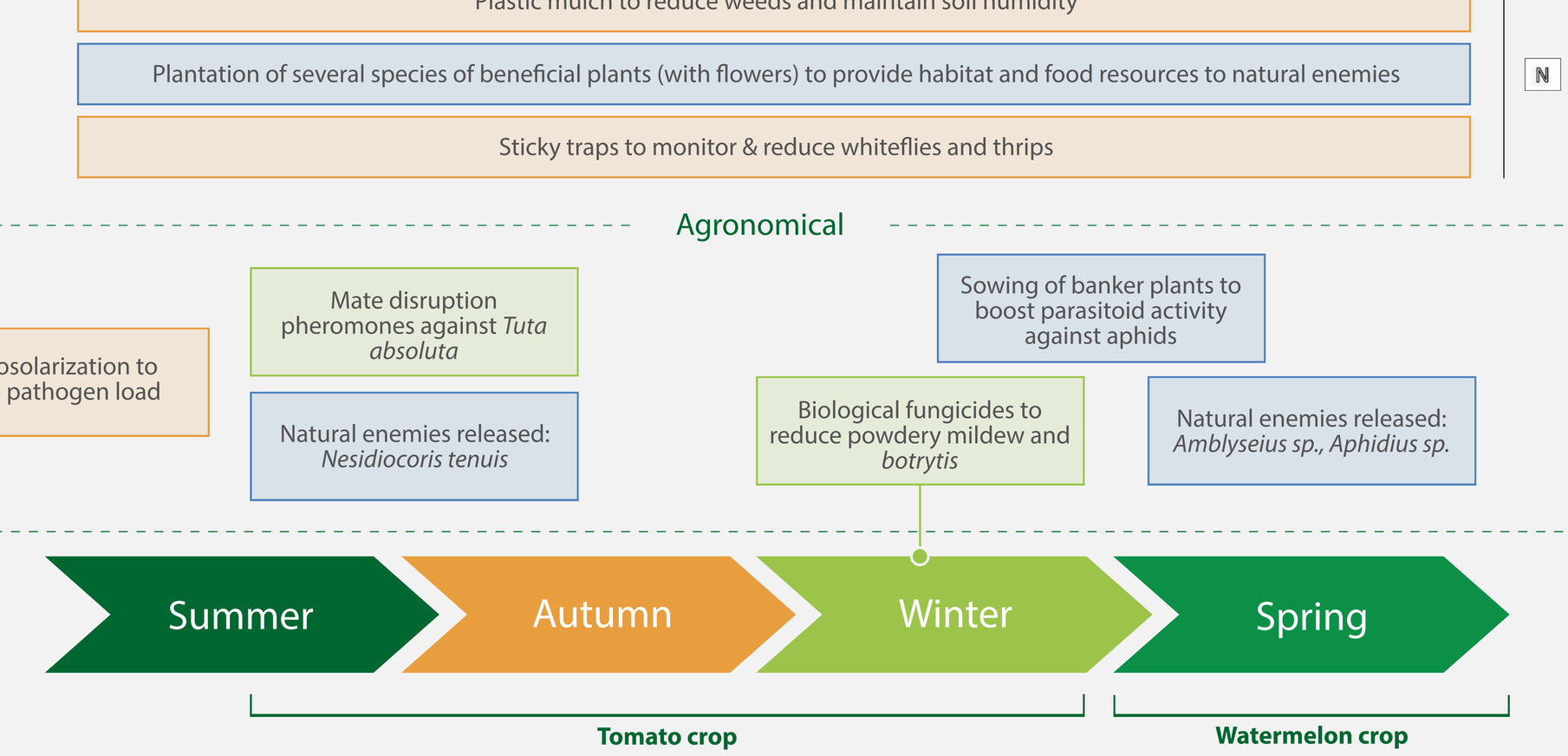
Spain



Advice on the IPM Strategy

- Tomato crops grown in summer and watermelons in winter both start with the release of natural enemies to prevent pest damage.
- Before planting the tomato crop, beneficial flowering plants are planted to boost biocontrol activity.
- Sticky traps are used in both crops to monitor and reduce pest pressure.
- In the case of tomato crops, sex pheromones are used to reduce *Tuta absoluta* abundance.
- Soil biosolarization is used to reduce pathogen load during summer.
- Weed germination is reduced using plastic mulch.
- Released species live longer, have a higher reproduction rate and a control efficacy. Several beneficial insects arrives spontaneously.
- The entire system, including the acquisition of extra plants and biocontrol agents has a cost which is the same as for control with pesticides in previous years.

Key successes	Key challenges
Very effective control of insect pests without the need for pesticides	Control of fungal diseases

Feedback
from the farmer

"This biological control system is not only profitable for organic growers, but equally for all conventional growers. Within a few years, all growers will be experts in recognizing 'bugs' and management of biodiversity."

Esther Molina

Feedback
from the hub coach

"Esther understands and recognizes the importance of the ecological interactions occurring in her greenhouse that provide her a high level of biological control and resilience against pests and diseases. She is a great example and a natural leader to other farmers in the region."

Eduardo Crisol-Martínez

Video link 1: https://www.youtube.com/watch?v=2YAIsKf-YHc | **Video link 2:** https://www.youtube.com/watch?v=u0USQf45BCI&t=126s

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Belgium

inagro
RESEARCH & ADVICE IN AGRICULTURE & HORTICULTURE

Farm Location:
Jabbeke, West Flanders

Hub Coordinator:
Inagro

Climatic & Agronomic context

- Maritime type climate
- Average annual rainfall 929mm/y
- Average temperature 11.2°C

Farm Overview

- **Farm size:** 6.7 hectares
- **Crops grown:** Strawberries (Sonsation and Elsanta)
- Hydroponic system with high levels of technology and heating

Main Pests

- **Insect pests:** Mites and aphids
- **Fungal diseases:** Powdery mildew

Key IPM Measures

- Biological control through release of natural enemies
- Resistant varieties
- Pest monitoring: using sticky traps
- Reduced fungicide use

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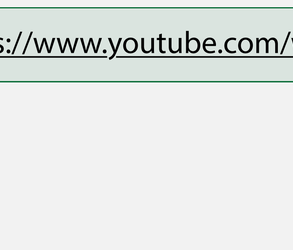
Belgium

Advice on the IPM Strategy

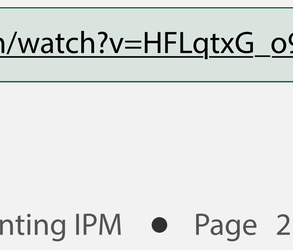
- At crop establishment natural enemies (mainly predatory mites, such as *Neoseiulus cucumeris*, *Neoseiulus californicus*) are released to prevent pest damage.
- Sticky traps are used in both crops to monitor and reduce pest pressure.
- In the early crop the cultivar 'Sonsation' is used which is tolerant against *Phytophthora cactorum*.
- Fungicide sprays are reduced to the minimum if possible. Often alternatives such as Potassium hydrogen carbonate are used.
- Between the two crops the greenhouse is empty due to the overall work planning. In meantime the disease and pest pressure can reduce.
- A good climate and growth is maintained to reduce the infection by *Botrytis*.
- Nearly all insecticides have now been eliminated by using natural enemies instead. However, this strategy is more time consuming and expensive.



Feedback
from the farmer

"Our customers have a clear demand: grow strawberries in a more environmentally friendly way. To anticipate this, we have evolved towards almost a complete biological control of insects in our crops. Thanks to good monitoring and sufficient knowledge of our partners and suppliers, we are on the right track here. This is the only way we can convince consumers to choose a healthy Belgian product."

Mathias Jonckheere



Feedback
from the hub coach

"Implementing a holistic approach of IPM that is economically viable is not easy. Mathias is a forward-thinking strawberry grower who takes every opportunity to take his IPM strategy to the next level. For instance, he demonstrated the use of natural enemies against aphids. He is a great example for the whole region."

Jolien Claerbout

Video link 1: https://www.youtube.com/watch?v=6mKNplWHlBQ | **Video link 2:** https://www.youtube.com/watch?v=HFLqtxG_o98

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3 Outdoor vegetables
Case Studies

Netherlands **a)**
Finland **b)**
Portugal **c)**
Belgium **d)**

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Netherlands

Delphy

Farm Location:
Geervlirt, South Holland

Hub Coordinator:
Delphy

Climatic & Agronomic context

- Clay soil
- Maritime climate
- Changing climatic conditions: more dry periods and more heavy rainfall periods

Farm Overview

- **Farm size:** 50 hectares
- **Crops grown:** Wheat, potatoes, sugar beet, onion, pumpkins

Main Pests

- **Insect pests:** Weeds, diseases and insect pests not specified

Key IPM Measures

- Cover crops
- Resistant varieties
- Mechanical weed control
- Decision support systems
- Reduced tillage

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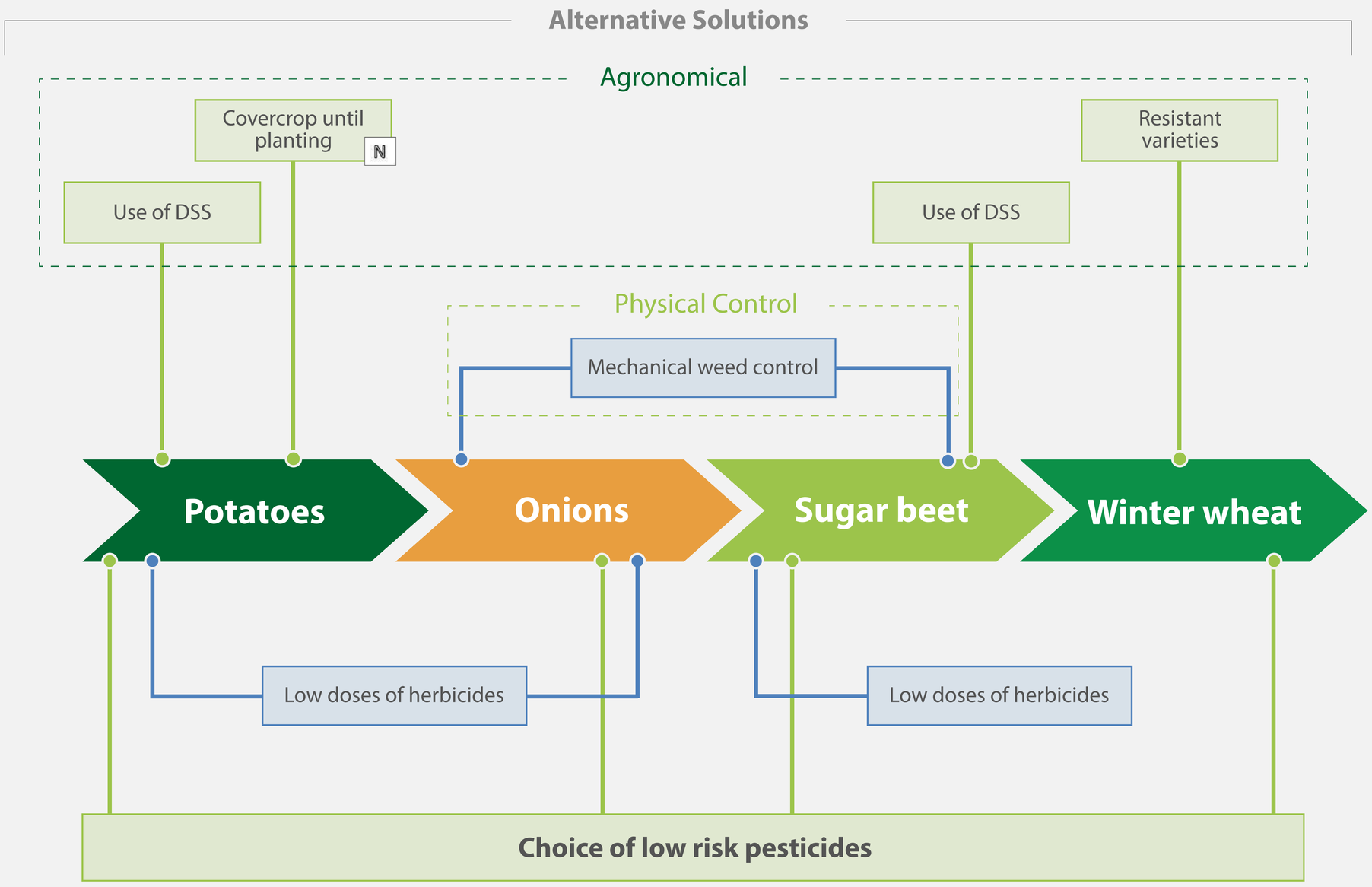
Netherlands



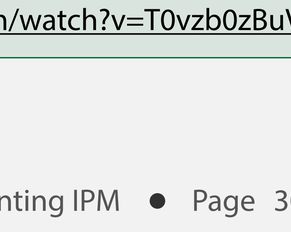
Advice on the IPM Strategy

- Mechanical weed control in sugar beet and onions to reduce herbicides and improve crop growing.
- If possible, no tillage before potatoes and sugar beet or limited tillage to create better soil conditions.
- Use of Decision Support Systems for late blight, and lice in beets and wheat.
- Use of repeated low doses of herbicides in potatoes and sugar beet to reduce costs and have a better result in combination with mechanical weeding. However, low doses are only possible with very small weeds (max. the first 2 leaves).
- For successful hoeing and harrowing weed in beets and onions, the quality of preparing the soil and the precision of sowing are very important.
- Be careful with using no-tillage on seed-crops like onions and beets. The risks of losing plants are higher.

Feedback
from the farmer

"Reducing pesticides on my farm is possible, but requires more investments, more risk and more flexibility of myself. By using a harrow for the last two years I managed to increase crop emergence and reduce pesticide use in onions and beets."

W Lugtenburg



Feedback
from the hub coach

"No tillage can help to improve the soil and help to grow a more robust crop. It requires more organization during the year and a larger variety of machines to be successful."

J Willemse

Video link: https://www.youtube.com/watch?v=T0vzb0zBuVM

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Finland

ProAgria

Farm Location:
Nikkarin Maatila, Hämeenkoski

Hub Coordinator:
ProAgria

Climatic & Agronomic context

- Loamy and sand-clay soils
- Boreal climatic zone
- Snow over winter – plant hardiness zone 3

Farm Overview

- **Farm size:** 55 hectares
- **Crops grown:** asparagus and strawberry primarily, but also grass, oilseed rape, cereals, faba beans and hemp
- **Organic certified**

Main Pests

- **Fungal diseases:** *Botrytis*
- **Insect pests:** Cyclamen mites *(Phytonemus pallidus)*
- **Weeds:** Sonchus (sow thistles) and common couch grass

Key IPM Measures

- Biological control using beneficial insects
- Bio-fungicides (Prestop)
- Plastic mulch
- Cover crops
- Diverse grass mixes

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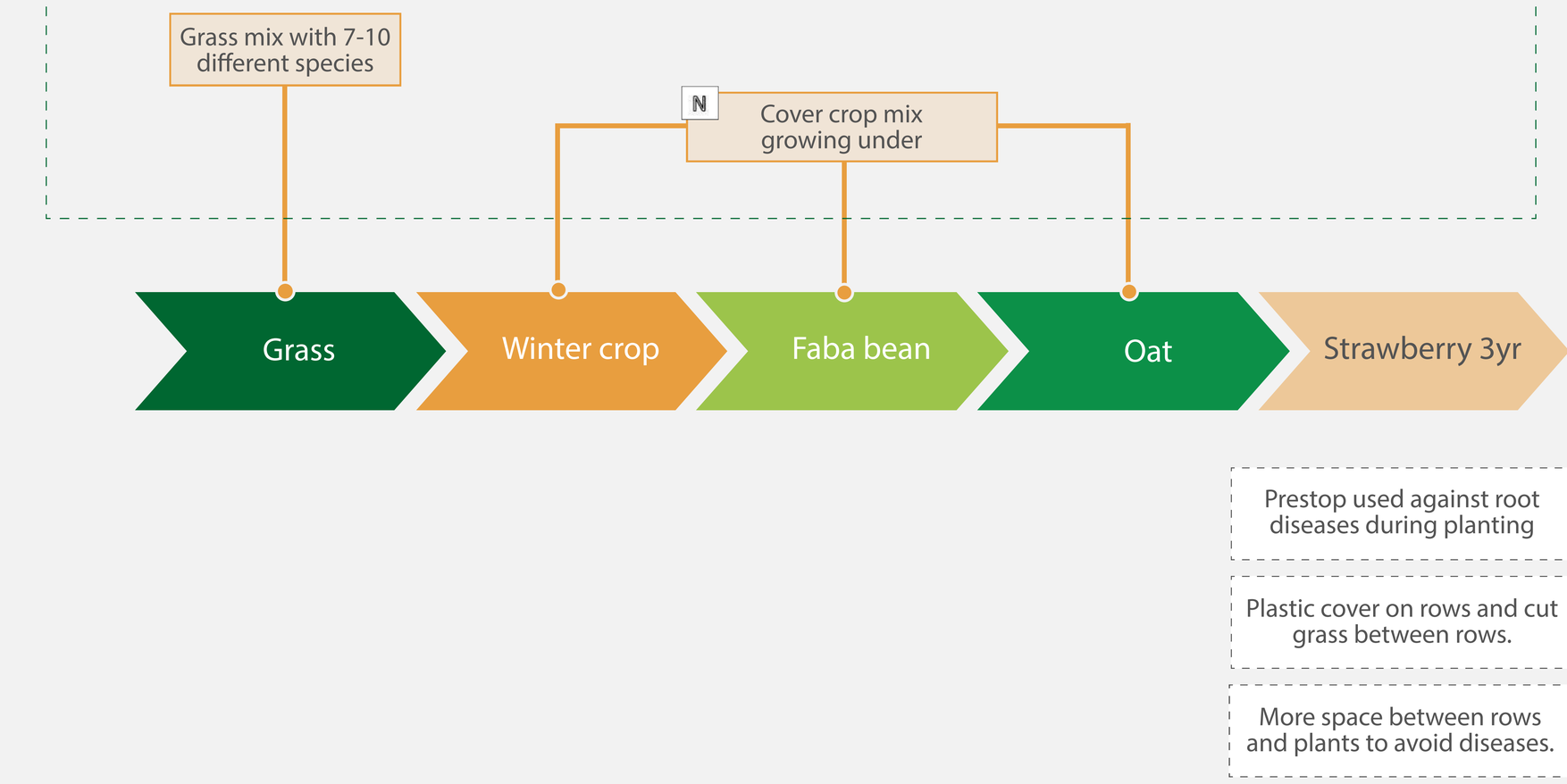
Finland

Alternative Solutions



Advice on the IPM Strategy

Strawberries:

- At least 5 years between 2 strawberry years in the same field.
- Using Prestop bio-fungicide for plants, preventing *Phytium* and *Fusarium* infection.
- Plants grow in black plastic cover and there is grass between the rows.
- Using Prestop Mix with the help of bees for preventing *Botrytis*.
- Using *Cucumeris mites* against *Phytonemus pallidus* during flowering period.

Other crops:

- Keeping the field green year-round so no room for weeds.
- Increasing the diversity in the field with cover crop mixes.
- Cover crops also help shadow weeds, reducing competition.
- Most important thing for pest management is that the soil is in good growing condition and there are lots of good microbes.

Feedback
from the farmer

"Using only biological methods in farming demands lots of planning and scanning of the results. You also have to know the ecosystem cause and effects."

Saara Kukkonen

Feedback
from the hub coach

"More than 85 % of Finnish farmers have adopted IPM methods because IPM has been a requirement of their environmental commitment for 7 years. Organic farming practices have been introduced more and more in traditional farming as well."
"In Finland, there is only one chemical product available against plant pest for several crops in the open field, which can only be used every other year for the same plants. Traditional farmers have to adopt more organic farming methods due to the lack of chemical options"

Marja Kallela

Video link: https://www.youtube.com/watch?v=uUTmEbeHCoc

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Portugal

consulai

Farm Location:
Carlos Neves Lda

Hub Coordinator:
Consulai

Climatic & Agronomic context

- Clay soils – medium to high fertility
- Mediterranean climate – dry mild summers
- Average annual precipitation: 873mm/y
- Organic matter added every year and manure added every 2-3 years

Farm Overview

- **Farm size:** 5 hectares
- **Crops grown:** lettuce and Portuguese cabbage

Main Pests

- **Fungal diseases:** *Botrytis*, Downy mildew and *Fusarium* (lettuce)
- **Insect pests:** Caterpillars and thrips on lettuce, caterpillars and aphids on cabbage

Key IPM Measures

- Biological control through release of natural enemies
- Flower strips to boost natural enemies
- Resistant varieties
- Bio-fungicides (e.g. *Basillus subtilis*)
- Cover crops
- Mechanical weed control
- Plastic mulch

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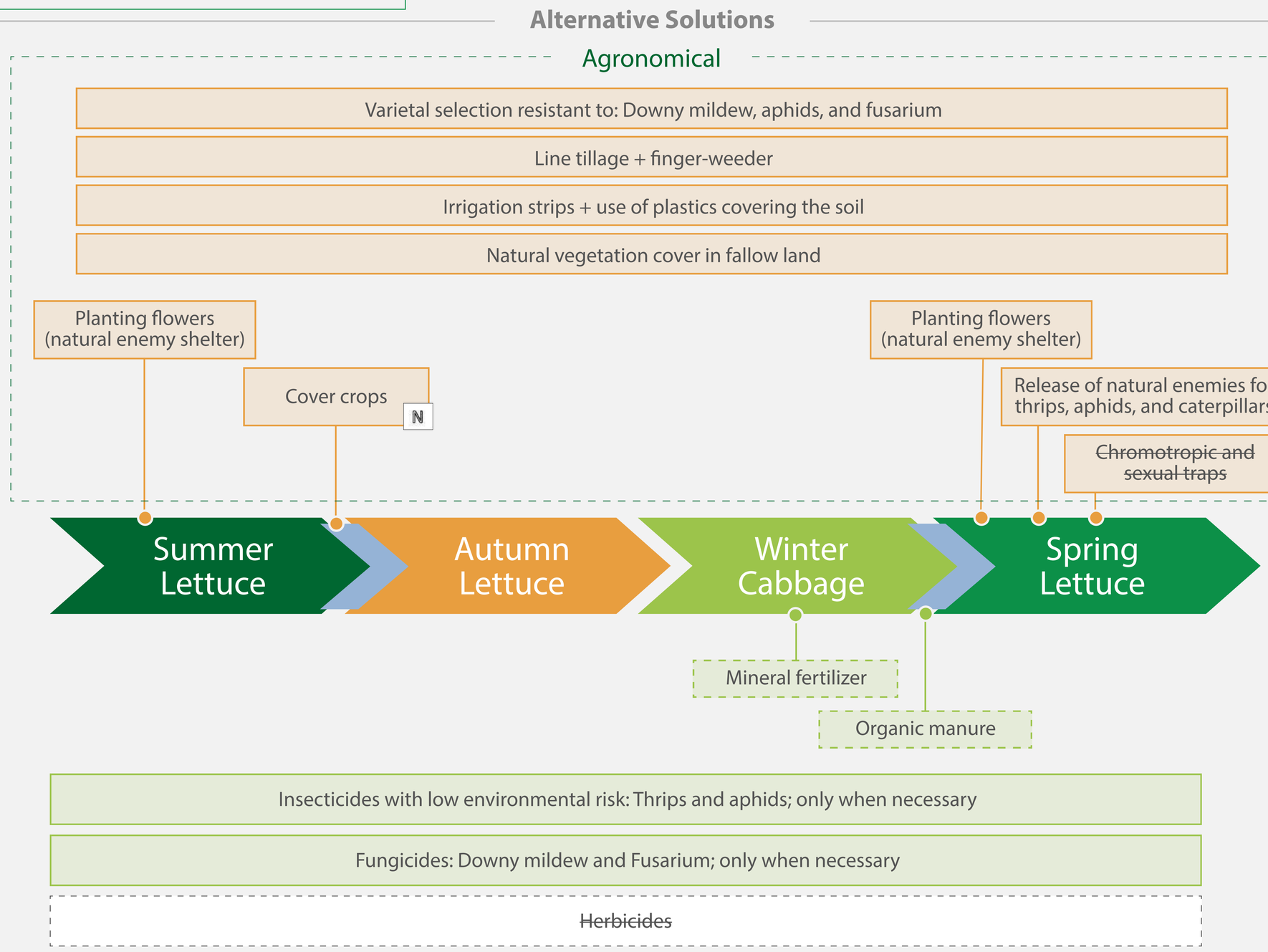
Portugal



Advice on the IPM Strategy

- Cabbage is only produced in winter, so there are no major pest and disease problems.
- Beneficial insect release has the limitation that it only works in spring/summer.
- Use of irrigation strips and use of plastics has allowed the elimination of herbicides.
- The high degree of mechanisation on the farm requires fossil fuels and high energy costs, but they are trying to improve with some ideas to reduce the use of machines. He intends in the future, to replant in each season without soil disturbance.

Key successes	Key challenges
• Herbicide use has now been eliminated • Working towards reaching zero-residue levels in crops • Reduced machinery use requires less energy	• The cultivation system has become more technical over time, which has added complexity • Work load is higher in summer and requires more skilled labour

Feedback
from the farmer

"My greatest success has been in pest control. The difficulties are related with the lack of solutions for the execution of work and for innovating and being more and more sustainable. There are no resources and solutions available, as there are in other sectors, to reduce the workload. The few that exist are very expensive and sometimes it is not worth because it is not profitable for the farmer. IPMWORKS is pivotal for sharing this knowledge and information among farmers."

Bruno Neves

Feedback
from the hub coach

"In a world where it is increasingly important to change production methods to minimise negative effects on crops, environment and human health, one of the main objectives of Bruno is to achieve a zero-residue production. He has this guideline integrated into his production method, increasingly trying to apply practices that promote regenerative agriculture, giving special emphasis to food safety over high productivity. Faced with difficulties, Bruno is always looking for innovative and sustainable solutions to overcome them. He is a great example that should be followed by other producers in the region."

Bárbara Castro

Video link: https://www.youtube.com/watch?v=M6CIK8yZkt8

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Belgium

inagro
RESEARCH & ADVICE IN AGRICULTURE & HORTICULTURE

Farm Location:
Hooglede, West Flanders

Hub Coordinator:
Inagro

Climatic & Agronomic context

- Substrate cultivation
- Temperate maritime climate
- Average annual precipitation: 929mm/y
  Average temperature: 11.2°C

Farm Overview

- **Farm size:** 3 hectares
- **Crops grown:** courgetti (zucchini)
- Polytunnel system, grown under plastic

Main Pests

- **Insect pests:** Aphids, whitefly
- **Fungal diseases:** Powdery mildew and *Pythium*

Key IPM Measures

- Substrate cultivation
- Plastic mulch
- Biocontrol through release of natural enemies
- Resistant varieties
- Climate control

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Belgium

Agronomical

- N — Substrate cultivation in pots
- N — A/B fertigation system with recirculation strategy and close follow-up (sampling)
- Climate steering in powdery mildew control (finding balance in ventilation and RH)

Genetics

- Virus resistant cultivar (IR Golden Glory)

- N — Plastic mulching against weeds

First round zucchini → **Second round zucchini**

- Biocontrol of aphids with *(Aphidius, Aphidoletes, Micromus)*
- Resistance management in powdery mildew control

Advice on the IPM Strategy

- We start with good planting material through well established plants in 10 cm blocks.
- We try to steer the climate into non favorable conditions for powdery mildew, thus limiting the need for chemical interventions.
- By moving away from using soil as a substrate, soilborne diseases like fusarium are evaded.
- Recirculation of the fertigation water optimizes the irrigation and nutrients in the cropping system
- Complementary to the organic farming practices in the other crops on the farm, biocontrol is used to control aphid populations.

Key successes	Key challenges
• Herbicide use has now been eliminated through using plastic mulch	• *Pythium* control is still a challenge • Fruit setting issues not fully resolved

Feedback
from the farmer

"I completely switched to biodegradable mulch in my zucchini crop. Last years comparison with regular foil did not show any difference. If it was permitted for organic produce to be grown in substrate rather than soil, like in the United States, we would happily switch to organic zucchini growing."

Pieter and Heidi Vandooren

Feedback
from the hub coach

"Farmers without prejudices and an open mind like Pieter are a leading example for others in the hub"

Jonathan De May

Video link: https://www.youtube.com/watch?v=rAAK6iBUsE4

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4 Vineyards
Case Studies

Portugal **a)**
Slovenia **b)**
Spain **c)**
Greece **d)**

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Portugal

consulai

Farm Location:
Herdade de Grous

Hub Coordinator:
Consulai

Climatic & Agronomic context

- Loamy clay and clay-sand soil with low fertility
- CSA type climate – temperate mediterranean
- Average annual precipitation: 530mm/y
- Organic matter added rotationally on annual basis to ~20% of land area

Farm Overview

- **Farm size:** 133 hectares vineyards
- **Crops grown:** Grapes, plus olives, grassland and livestock
- **Grape varieties:** Touriga Nacional, Alicante, Syrah, Aragonez, Trincadeira, Tinta Miúda, Arinto, Alvarinho, Sousão, Touriga Franca, Viosinho, Alfrocheiro, Roupeiro, Antão Vaz, Encruzado

Main Pests

- **Fungal diseases:** Downy mildew, powdery mildew, scale, scoria-wood
- **Insect pests:** Green leafhopper and aphids
- **Weeds:** Conyzas, malvas and grass

Key IPM Measures

- Cover crops
- Integration of livestock
- Biological control through natural enemies
- Pheromone trapping
- Bio-insecticides and bio-fungicides

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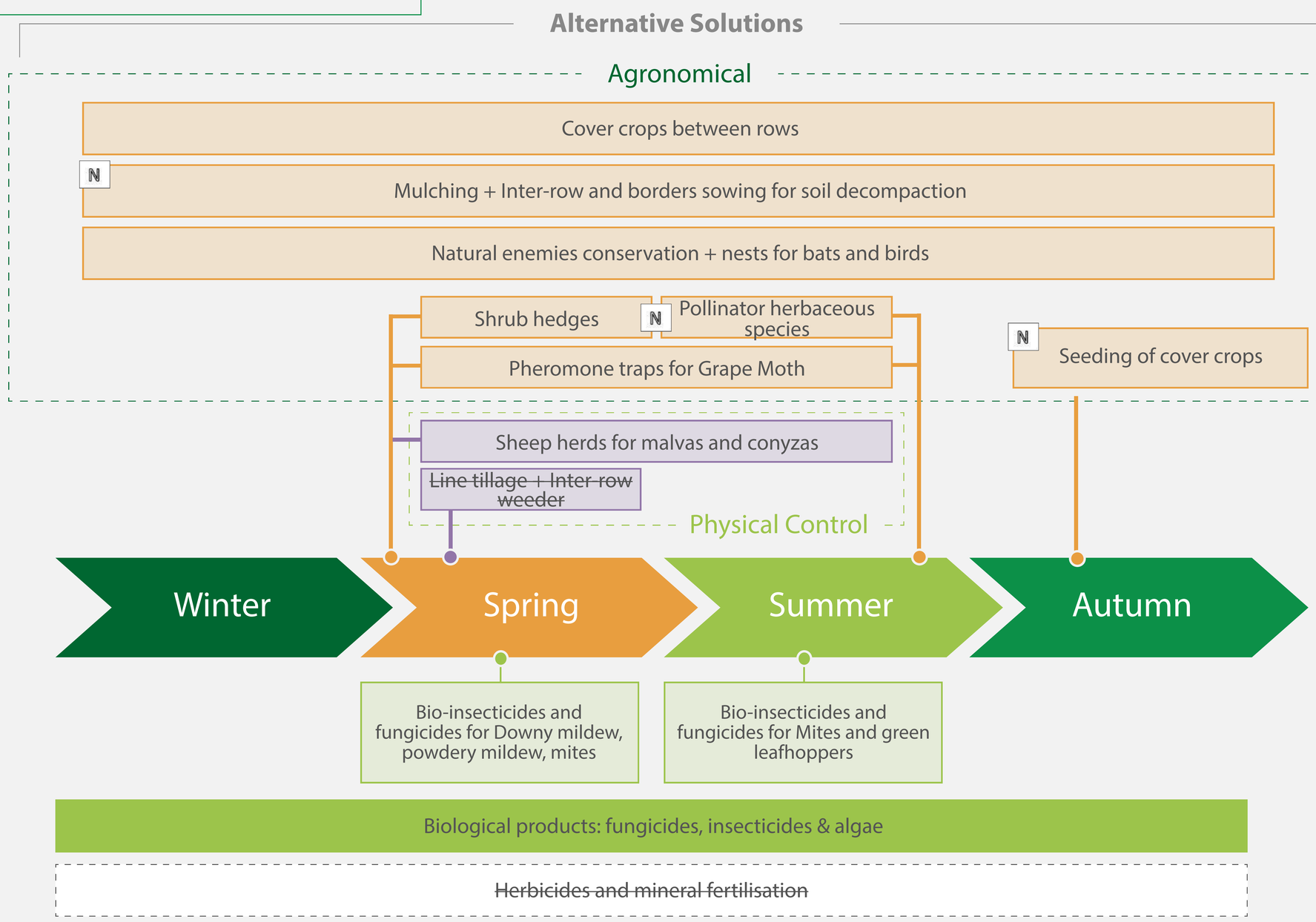
Portugal



Advice on the IPM Strategy

- Over the years there has been a reduction in the use of shredders and inter-row weeders. Use of sheep herds instead, with great results for *Conyza spp* and *Malva spp*.
- Cultivation of borders and between lines with subsoiler passes (key line) to de-compact the soil.
- There is permanent cover crops between rows and in the borders of the fields (natural and sown) with multiple goals: soil structure and water retention, shelter for beneficials etc.
- Planting of shrub hedges, pollinator mixtures, installation of nests for bats and birds and perches for birds of prey.

Key successes	Key challenges
• Reduced dependence on artificial inputs and herbicides no longer required • Improved local biodiversity and access to environmental certifications	• Increased complexity of the system requires more skilled labour • Increased production costs associated with some practices

Feedback
from the farmer

"The biggest difficulties are the immediate production losses and the adaptation of crops to new cultural practices, but the medium-term improvements are noteable, such as the increase of biodiversity and the reduction of weeds, as can be observed after the entry of sheep in vine. More initiatives like IPMWORKS should be boosted in order to promote knowledge sharing among producers"

Filipa Almeida

Feedback
from the hub coach

"Nowadays there is a huge need to search for solutions to minimize the use of PPP and control the expected higher incidence of pests and diseases, resulting from climate change. This need is shared by Herdade dos Grous, who has successfully been finding alternative solutions to not only make the farm more resilient, but also more sustainable, by integrating it into an agro-forestry mosaic increasingly less dependent on external inputs"

Bárbara Castro

Video link: https://www.youtube.com/watch?v=dx0xb9mnVUk

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Slovenia

Kmetijsko gozdarska zbornica Slovenije
KMETIJSKO GOZDARSKI ZAVOD MARIBOR

Farm Location:
Puklavec & Family wines, Podravje

Hub Coordinator:
Agricultural and Forestry Institute Maribor

Climatic & Agronomic context

- Loamy / hypoglea soil
- Temperate continental climate
- Annual average temperature: 10.9 °C
- >2000 hours of sunshine per year

Farm Overview

- **Farm size:** 500 hectares vineyards
- **Crops grown:** Grapes

Main Pests

- **Fungal diseases:** Grapevine powdery mildew, Downy mildew, Grey mould *(Botrytis)*, Grapevine trunk diseases - ESCA
- **Insect pests:** European grapevine moth *(Lobesia botrana)*, European grape berry moth *(Eupoecilia ambiguela)*, American grapevine leafhopper *(Scaphoideus titanus)* Ball

Key IPM Measures

- Mating disruption method

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Slovenia

IPM biotechnical method to suppress both the European grapevine moth and the European grape berry with mating disruption method

N

Spring

- The non-chemical method has successfully replaced chemical treatment.
- The percentage of damaged bunches in vineyard was below or close to the threshold of 5% for the second generation of both types of grape moth.
- Mating disruption method is plant protection products residue free method and slows down the development of resistance to insecticides due to a reduction in the number of insecticide treatments in the vineyards.

Advice on the IPM Strategy

- The number of applications of insecticides in vineyard has increased from one to three in recent years. Therefore, non-chemical method of mating disruption method to suppress the grape moth populations have been used to reduce the number of insecticide applications.
- The high concentration of synthetic sexual pheromone in vineyard in the various form of dispensers confuses the males and consequently reduces the possibility of successful mating.
- Dispensers were used and the farmer monitored the number of male moths on pheromone traps weekly. Before harvesting, the farmer learned to recognize damaged bunches and evaluate their percentage.

Key successes	Key challenges
• Effectiveness of moth populations comparable to chemical control	• Increased cost due to installing dispensers and labour associated with monitoring traps

Feedback
from the farmer

"Good results! The IPM method is comparable to chemical and in some cases even more effective!"

Puklavec & Family

Feedback
from the hub coach

"The % of damaged bunches was below or close to the threshold of 5% for the second generation of both types of grape moth, showing how successful this non-chemical method can be"

Jože Miklavc

Video link: https://www.youtube.com/watch?v=4RXQWaAxk_c

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Spain

fundación empresa universidad gallega

Farm Location:
Rías Baixas, Galicia

Hub Coordinator:
Feuga

Climatic & Agronomic context

- Sandy soil
- Atlantic climate: rainy and mild temperatures
- High humidity

Farm Overview

- **Farm size:** 3 hectares vineyards
- **Crops grown:** Grapes
- **Varities:** Alvariño grape: native Galician variety

Main Pests

- **Fungal diseases:** Downy mildew, Powdery mildew, Botrytis
- **Insect Pests:** European grapevine moth (Lobesia botrana) and green mosquito

Key IPM Measures

- Mating disruption techniques
- Mechanical weeding between rows
- Pruning
- Promotion of natural enemies (bats)
- Decision Support Systems

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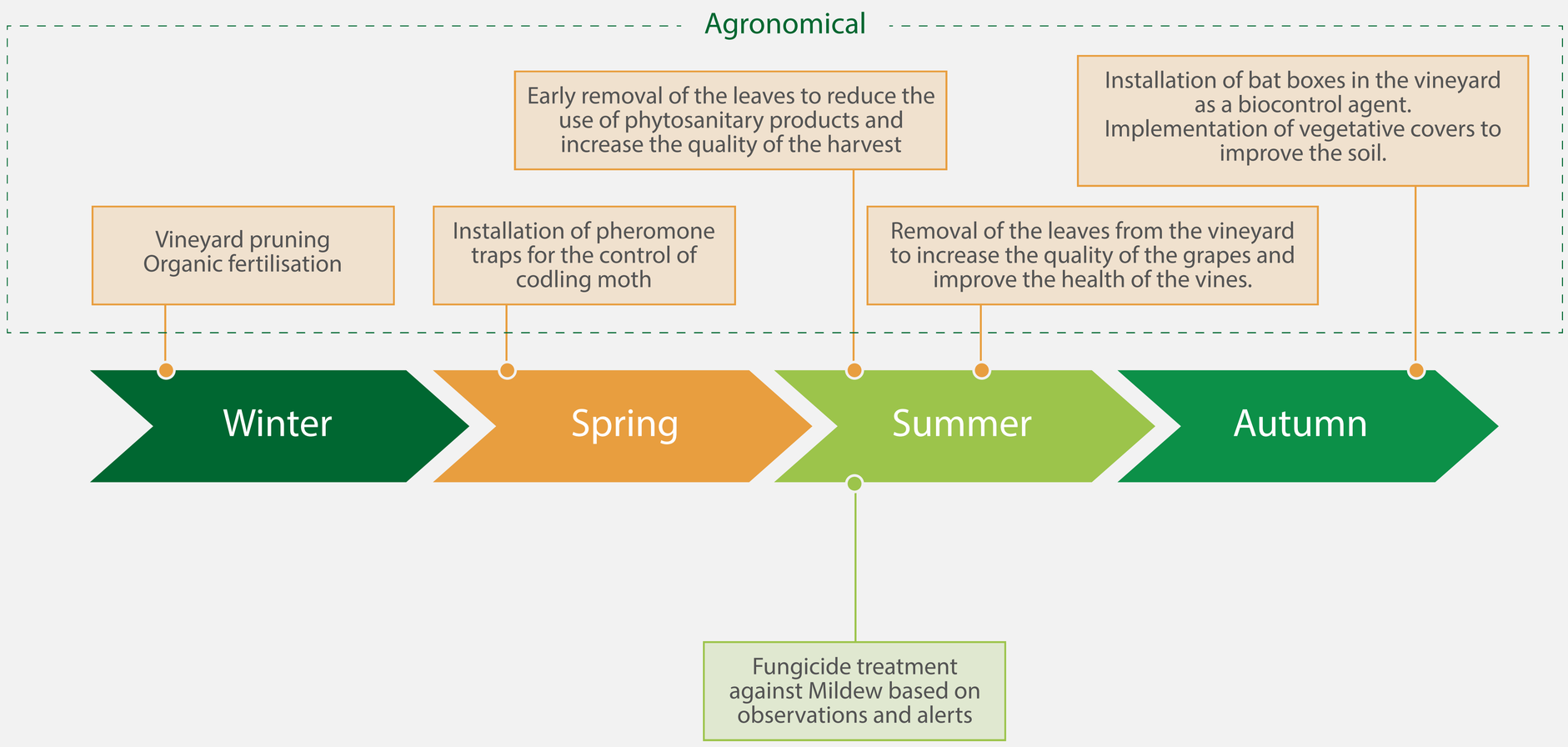
Spain

Alternative Solutions



Advice on the IPM Strategy

- Drift of phytosanitary products has been reduced through investments in sprayer upgrades such as correct calibration and the use of anti-drift nozzles, and through the implementation of 'green screens' to block drift into environmentally sensitive areas.
- Monitoring of diseases such as downy mildew and powdery mildew by using decision support systems allows for a more precise control and reduced use of aggressive or more persistent phytosanitary products.
- Dependence on inorganic fertilisers has been reduced through the use of organic amendments and cover crops. The use of composts and increased green cover have also helped improve soil stability and structure.

Key successes	Key challenges
• Lower environmental impact and reduced health risks to workers • Cost savings from reduced agrochemical use	• Climatic limitations remain due to high humidity and rainfall favouring fungal diseases • Increased complexity of the system

Feedback
from the farmer

"A change of mentality is needed, adopting a global approach that allows us to discover and adopt new measures to protect the vineyard and its environment while maintaining economic profitability."

Joaquín Martínez Rodiño

Feedback
from the hub coach

"Galician viticulture is highly influenced by climatic conditions: high humidity and mild temperatures that favour the appearance of fungal diseases such as mildew, which also requires a great effort in terms of sanitary control. Despite this, winegrowers such as those who make up the IPMWORKS group are committed to alternative methods."

Ángela Muñiz Varela

Video link: https://www.youtube.com/watch?v=IX2Tkpmn-Yo&t=34s

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Greece

ΓΕΩΠΟΝΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ
AGRICULTURAL UNIVERSITY OF ATHENS

Farm Location:
Korinthos, Peloponese

Hub Coordinator:
Agricultural University of Athens

Climatic & Agronomic context

- Well-draining soil, pH 6.8
- Arid climate
- Mean annual precipitation 750 mm and mean annual temperature 20.6ºC

Key IPM Measures

- Resistant varieties
- Pruning
- Inter-row tillage

Farm Overview

- **Farm size:** 5.5 hectares vineyards
- **Crops grown:** Grapes
- **Varities:** Crimson and Thompson

Main Pests

- **Fungal diseases:** Powdery mildew, Botrytis
- **Insect Pests:** Grape moth *(Lobesia botrana)*, Mealybugs *(Pseudococcus)*, thrips

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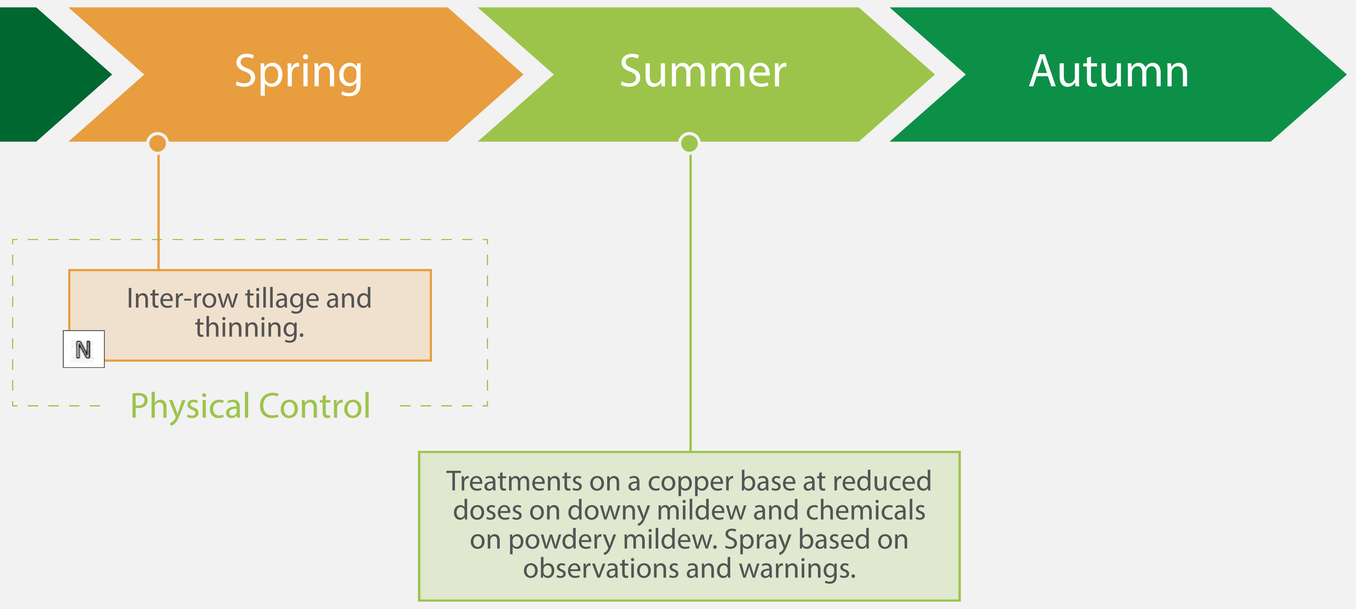
Greece



Advice on the IPM Strategy

- Pruning and thinning provides good airflow and aeration between rows and increases light levels for the crop.
- Resistant varieties of Crimson help to control *Botrytis*, in combination with optimal irrigation schedules to control humidity.

Feedback
from the farmer

"My dedication to continuous learning and my commitment to integrating IPM principles, particularly for cover crops, exemplify my motivation for sustainable agriculture"

Spiridon Karahalios

Feedback
from the hub coach

"The collaborative approach of IPMWORKS ensures that the needs and interests of all participants are met"

Kalliopi Kounani

Video link: https://www.youtube.com/watch?v=F55fzXZipeA

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5 Orchards
Case Studies

Italy **a)**

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Italy

Sant'Anna
School of Advanced Studies – Pisa

Farm Location:
Vicopisano, Tuscany

Hub Coordinator:
Sant'Anna School of Advanced Studies

Climatic & Agronomic context

- Clay calcareous soils
- Hilly mountainous terrain
- Mediterrranean climate, humid with arid summers

Farm Overview

- **Crops grown:** Olives
- **Variety:** frantoio, moraiolo, leccino, local varieties
- Terraced olive groves on high slopes, non-irrigated

Main Pests

- **Fungal diseases:** Olive caries *(Phellinus fresianus)* and Olive mange *(Pseudomonas savastanoi)*
- **Insect pests:** Olive fly *(Bactrocera oleae)* and Asian bed bugs *(Halyomorpha halys)*
- **Weeds:** Black locust trees *(Robinia pseudoacacia)*

Key IPM Measures

- Pest monitoring using chromotropic traps
- Biopesticides (Spinosad)
- Cultivation of aromatic and melliferous plants
- Free range laying hens to control fly larvae

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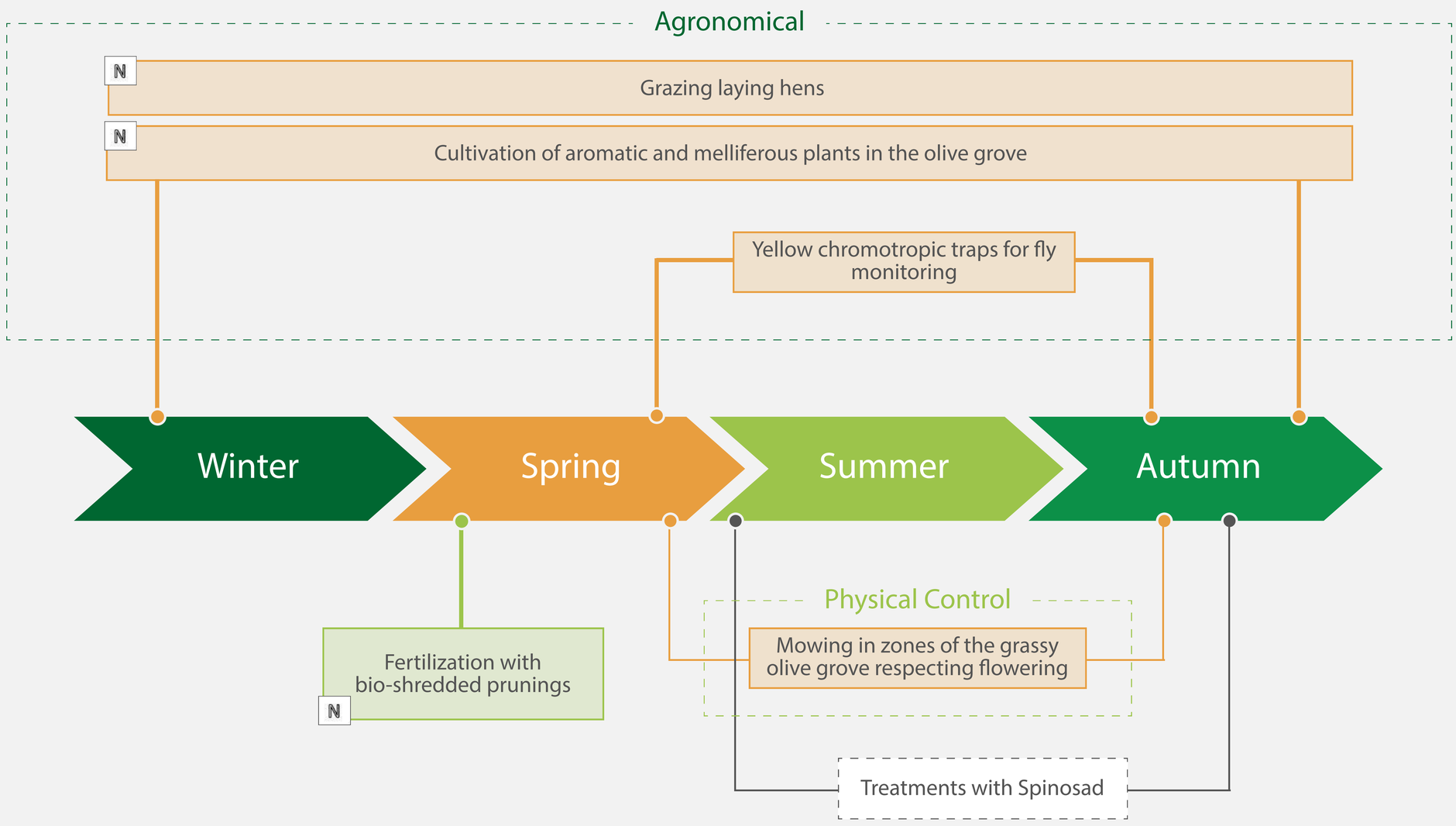
Italy



Advice on the IPM Strategy

- The key insect control takes place through monitoring with chromotropic traps. Based on pest monitoring through traps and the weekly bulletin prepared by Agroambiente.info, treatments are carried out with small doses of Spinosad (extract of artificial culture of *Saccharopolyspora spinosa*).
- Free grazing of hens under the olive trees contributes to soil fertilization and helps control the fly larvae wintering in the fallen olives.
- The presence of aromatic and melliferous plants, even perennial ones, helps to increase pollinators and to maintain a balanced olive grove ecosystem.

Key successes	Key challenges
• Improved agroecosystem health • Compliance with environmental regulations and local traditions	• Complex terrain makes mechanisation difficult • Economic cost of mass trapping

Feedback
from the farmer

"The IPMWORKS project has created relationships between the olive growers in the area and has given me the opportunity to meet people who have willingly shared their experience and their ideas. Additionally, the researchers and the facilitator I interacted with were knowledgeable and interested in my farm and ideas."

Davide Milazzo

Feedback
from the hub coach

"Davide's approach is truly holistic; he bases his work on searching for innovative and interconnected solutions and independent thinking. He, however, recognizes the need for technical support and continuous exchange between peers. His passion and his interest in a rebirth of olive growing in this area follows the spirit of all the hub farmers and represents an example and an urge for the whole group."

Virginia Bagnoni

Video link 1 (rock powder to control olive fly) : https://www.youtube.com/watch?v=22f0Oi2CZm8
Video link 2 (how to monitor olive fly): https://www.youtube.com/watch?v=lDebt9z2KrQ
Video link 3 (how to use mass trapping): https://www.youtube.com/watch?v=wOdjl1t4s1k

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