INTEGRATED PROTECTION IN VITICULTURE

Functional biodiversity in Douro vineyards

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Introduction

- **Biodiversity is threatened worldwide**

  Dramatic rates of **decline** have been reported (Sanchez-Bayo et al. 2019) that may lead to the extinction of 40% of the world's insect species over the next decades

✓ 1st **Habitat loss / intensification of agriculture**;

✓ 2nd **Pollution (use of synthetic pesticides and fertilisers)**;

✓ 3rd **Biological threats (introduced species)**;

✓ 4th **Climate change**

- **Farmers** are important **key-players** in actions to halt biodiversity loss and **must be informed about the drivers of biodiversity losses**

- **Wine sector is under social pressure to reduce the use of pesticides**

Introduction

- **Conservation biological control (CBC)** is a sustainable approach to pest management **that prevent habitat losses** and environmental disturbance, **contributing for the reduction of pesticides**

CBC strategies are based on:

Plant and **habitat** diversification

✓Reduction in cropping intensity (management practices)

✓Landscape complexity

Scientific understanding of CBC is still incomplete, particularly in **permanent crops** such as **steep sloped vineyards,** with high heterogeneous landscapes

Landscape-scale / Local-scale effects on CBC

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Landscape scale

- **Complexity of landscapes**

✓ Land use diversity

✓ Proportion of semi-natural habitats (ecological infrastructures- EI) in relation to vineyard

✓ Connectivity between patches

- The **response of natural enemy populations to the presence of EI is not consistent**, varying according to crop, management practices, landscape composition and taxonomic groups, being important to consider their dispersal capacity and intraguild competition between natural enemy groups

Local scale

- **Floral resources available** (nectar and pollen) which enhances survival, longevity and fecundity of pests´ natural enemies
- **Intercropping / hedges** (bottom-up or top-down effects)
- **Proximity of semi-natural habitats** (provision of additional food resources and favourable microclimatic conditions for pests´ natural enemies)
- **Intensity of management** (particularly tillage and pesticide use)

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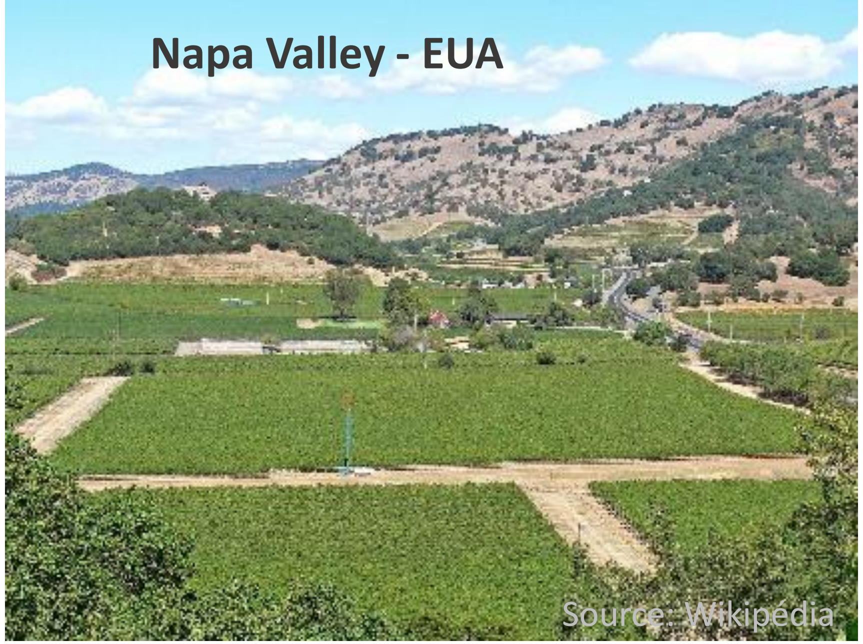
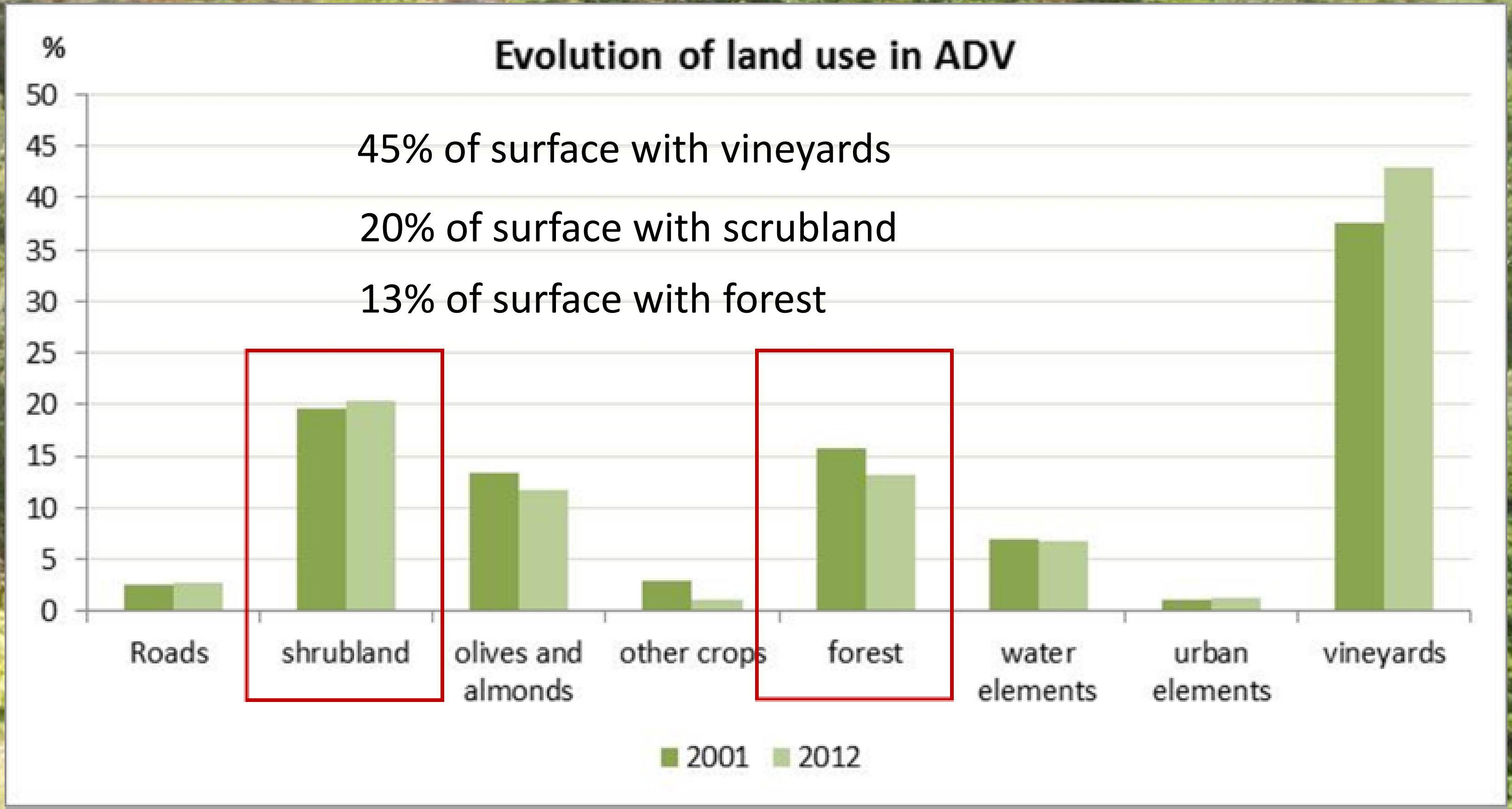
Simple / complex landscapes



Landscape of Douro Demarcated Region vineyards

Evolution of land use in Alto Douro Vinhateiro (ADV) (2001-2012)



Source: Andresen, T. e Rebelo, J.(2013). Avaliação do Estado de Conservação do Bem Alto Douro Vinhateiro - Paisagem Cultural Evolutiva Viva, Volume 1 - Relatório de Avaliação. Porto: CCDRN/EMD, CIBIO UP/UTAD.

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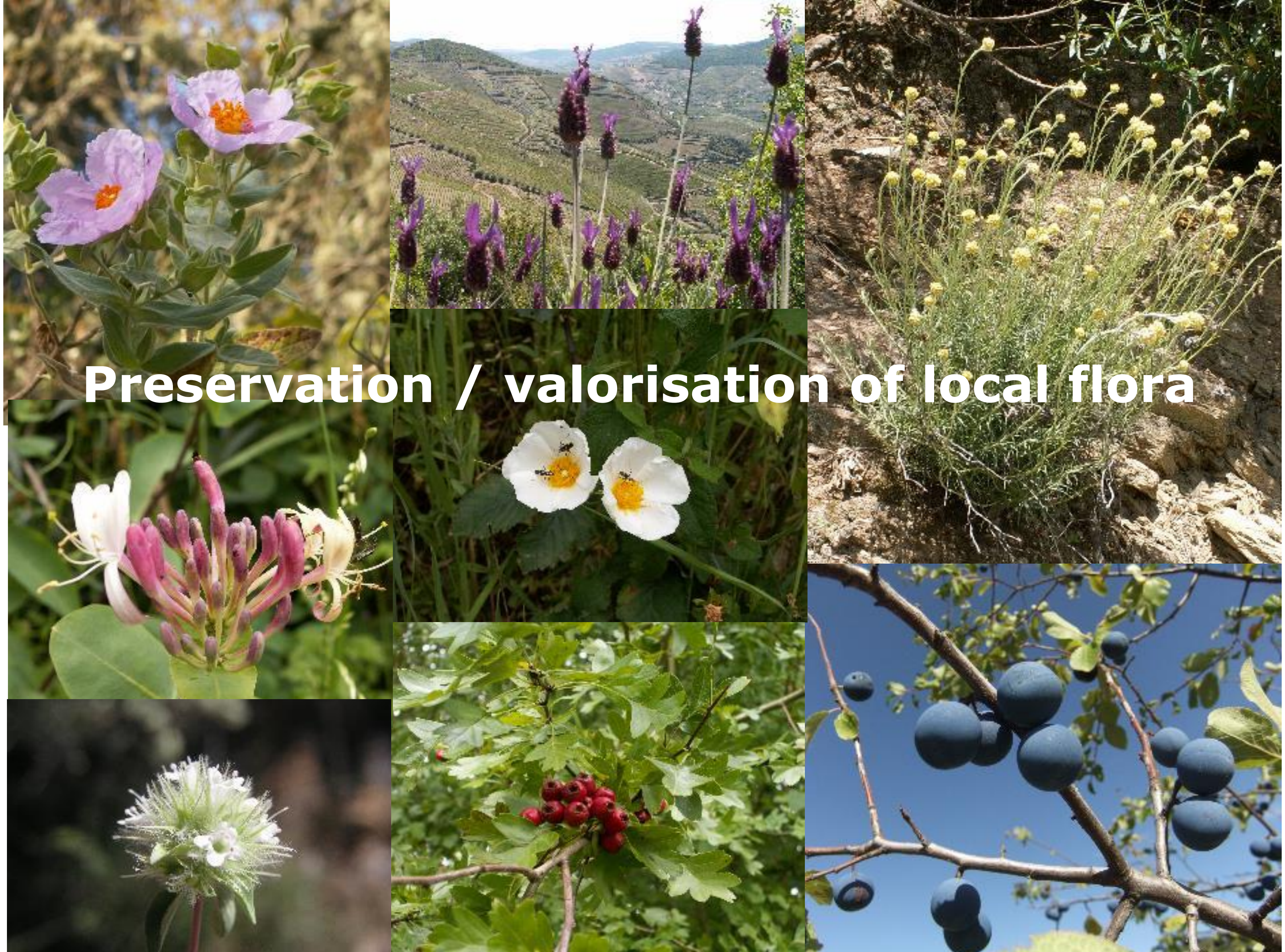
Management of vineyards in DDR

Due to the high risk of erosion, vineyards of DDR include **native vegetation**

Preservation / valorisation of local flora



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Local scale effects – Management practices

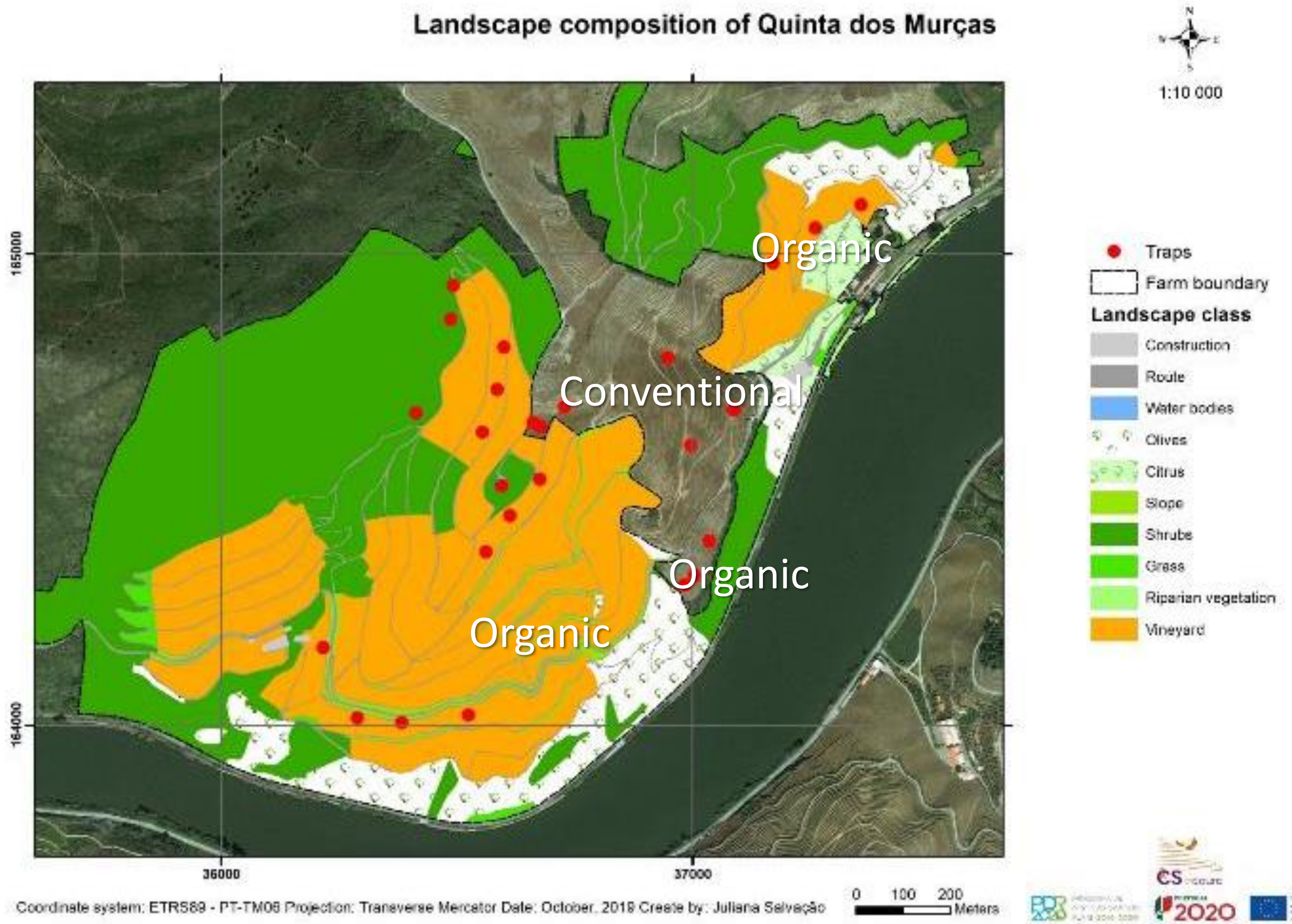
- **Each management practice** must be previously evaluated individually and according to **local conditions** (particularly climate and soil conditions, including the analysis of trade-offs between **services / disservices**

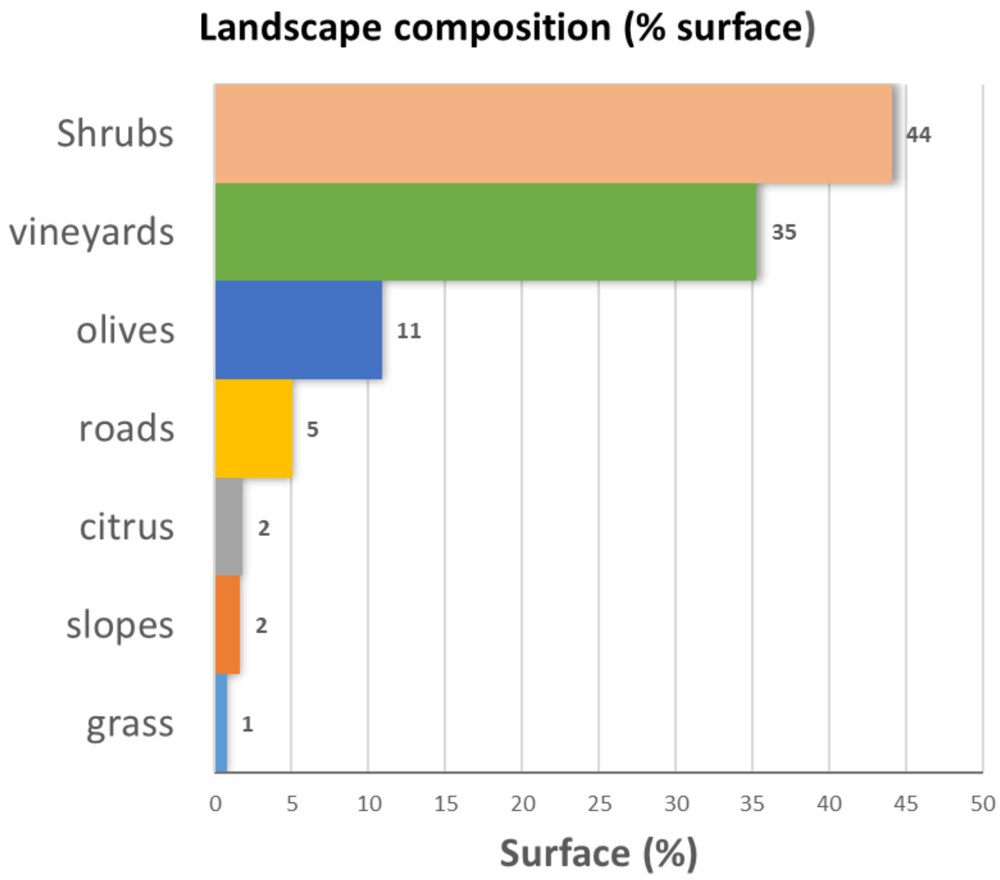
Multi-year studies must be conducted to understand these interactions but… **difficult to replicate same conditions** in regions with **highly heterogeneous patterns** of microclimate conditions / relief /systems (e.g. Douro)

Quinta de Murças case-study

Quinta de Murças case-study

Initial goal: evaluate if points assessed inside the farm (Organic conversion) have better biodiversity and bioindicators scores than those in neighborhood (Integrated Production)





Methodology

- **Combi traps**

(flying arthropods)

- **Pitfall traps**

(soil surface arthropods)

- **Berlese-tullgren funnels**

(soil living arthropods)

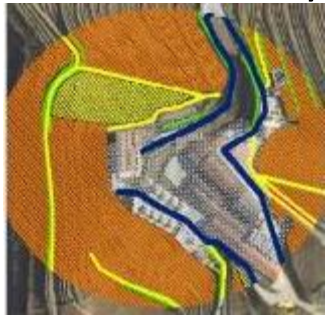
QBS = ∑ EMI individuals

- **Flora assessment**

- **Soil analysis**

- **GIS assessment**

(50 m - 250 m)



Two surveys:

May 2018 (Spring) and October 2018 (Autumn)

Characterization of plots and management practices used, including phytosanitary treatments

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Flora

Most frequent and abundant species of plants

Spring

- Most frequent

Most abundant

Andryala integrifolia
(Asteraceae)

Jasione montana
(Campanulaceae)

Autumn

- Most frequent

Most abundant

Convolvulus arvensis
(Convolvulaceae)

Cynodon dactylon
(Poaceae)

Endemic species identified

Conopodium majus
(Apiaceae)

Linaria saxatilis
(Scrophulariaceae)

Asphodelus lusitanicus
(Asphodelaceae)

Herniaria lusitanica
(Caryophyllaceae)

Erysimum linifolium
(Brassicaceae)

Centaurea paniculata
subsp. Paniculata (Asteraceae)

Ortegia hispanica subsp.
Lusitanica (Caryophyllaceae)

Lavandula stoechas
subsp. luisieri (Lamiaceae)

Results: Soil-living Arthropods

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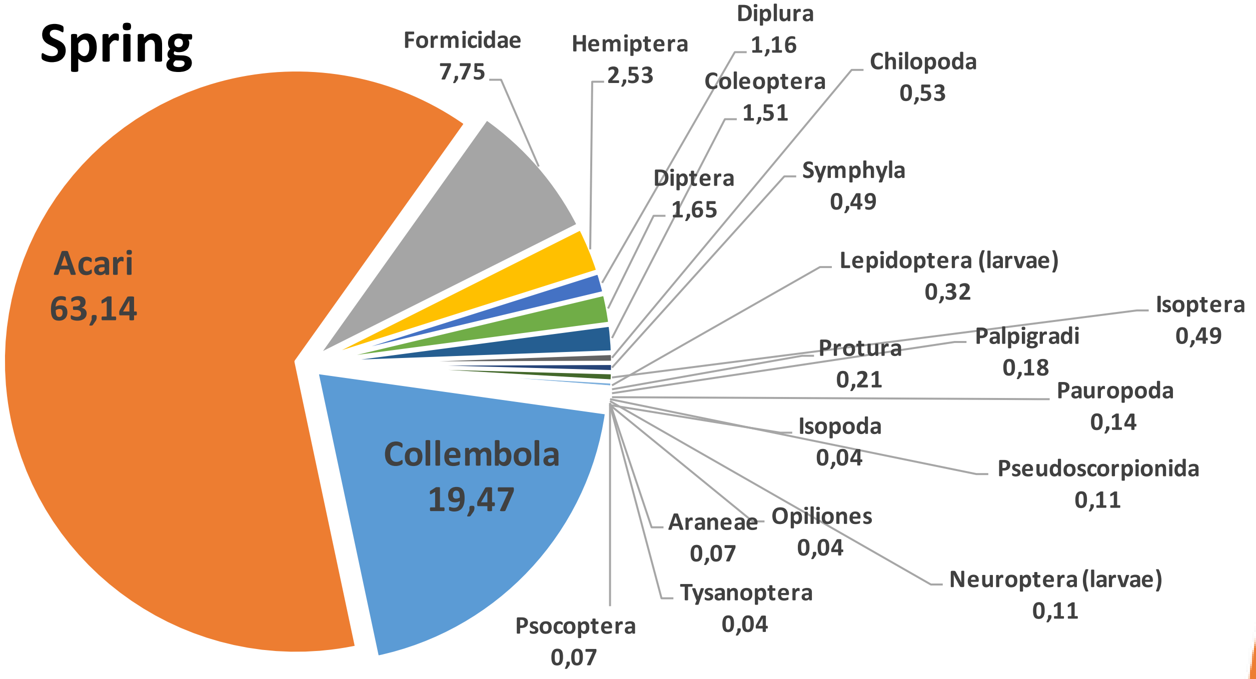
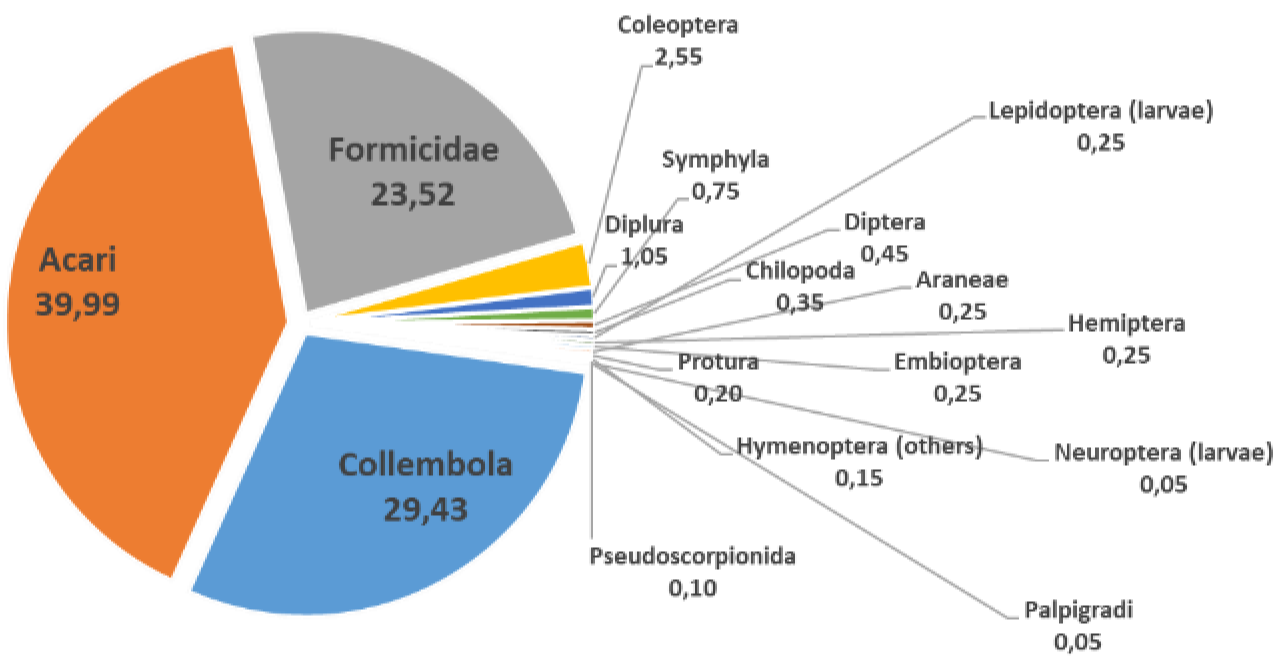
Spring



N=2,851

4,849 soil living arthropods distributed by seven classes

Autumn



N=2,037

Acari, Collembola and Formicidae in different proportions in the two sampling periods

Diversity of Soil arthropods

85 morphospecies of Acari

34 morphospecies of Collembola, useful as bioindicators

12 species of Formicidae
(useful bioindicators)

Iberoformica subrufa

Crematogaster auberti

Aphaenogaster gibbosa

Pheidole pallidula

Aphaenogaster iberica

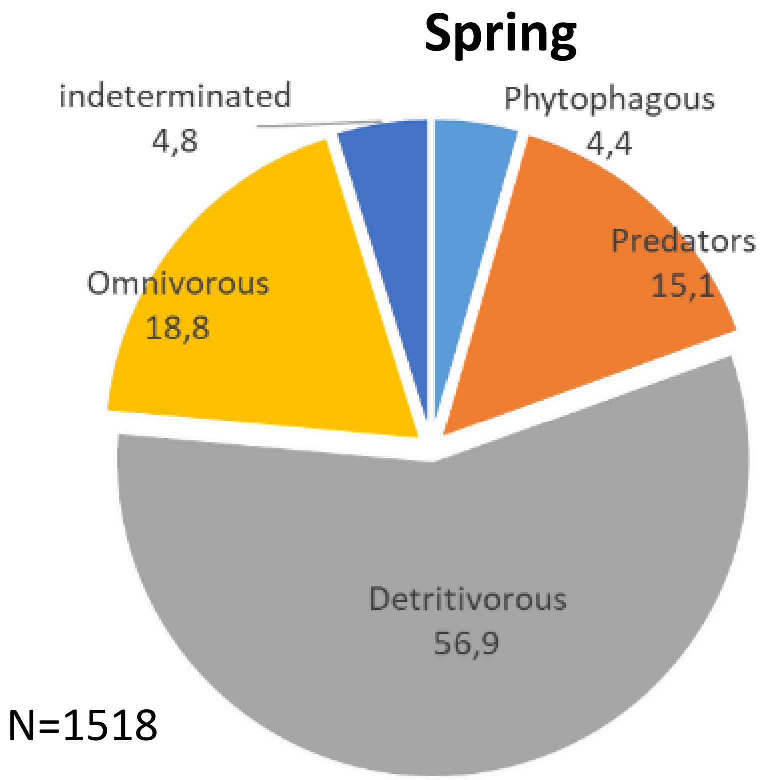
Plagiolepis pygmaea

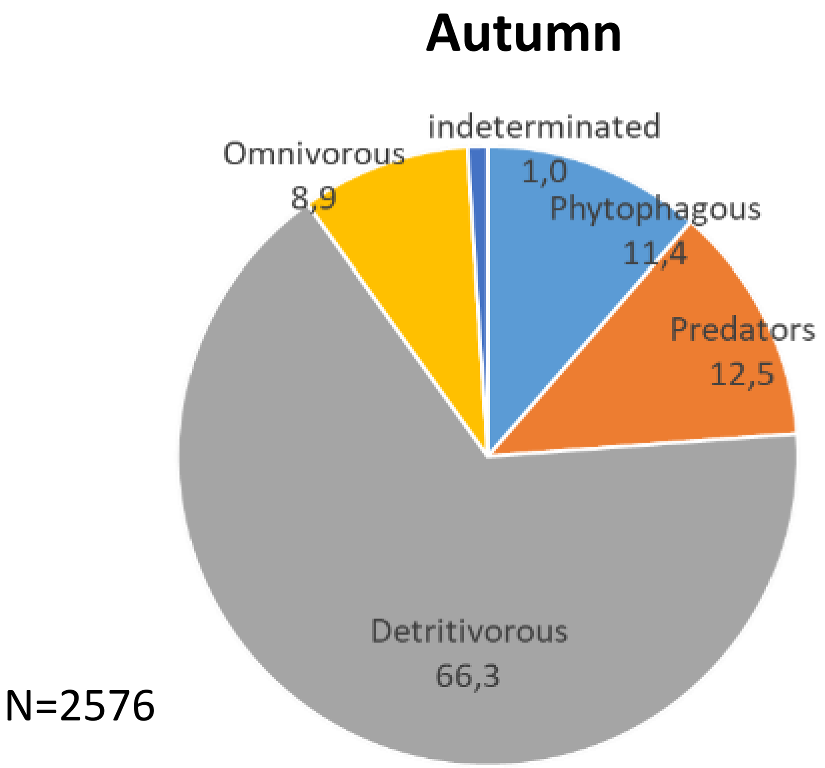
Camponotus pilicornis

Camponotus foreli

Analysis of functional groups of Soil-surface Arthropods caught

4094 soil-surface arthropods distributed by six classes



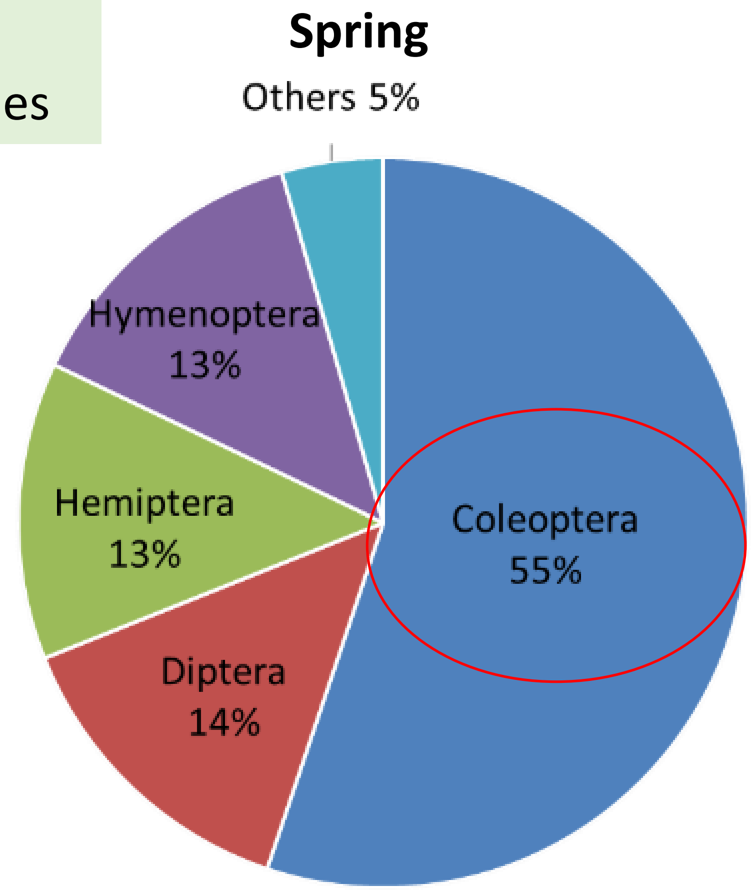


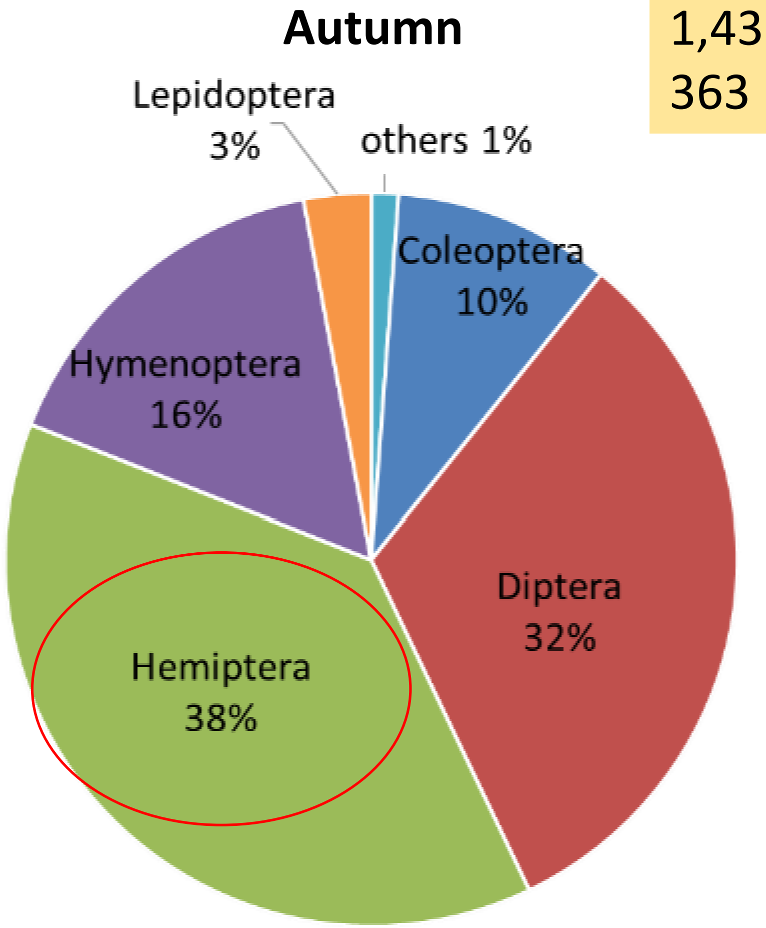
Detritivores dominated assemblage, followed by **Omnivores and Predators** in spring and by **Predators and Phytophagous**, in Autumn

Results: Flying Arthropods

4697 arthropods
365 morphospecies

1,438 arthropods
363 morphospecies

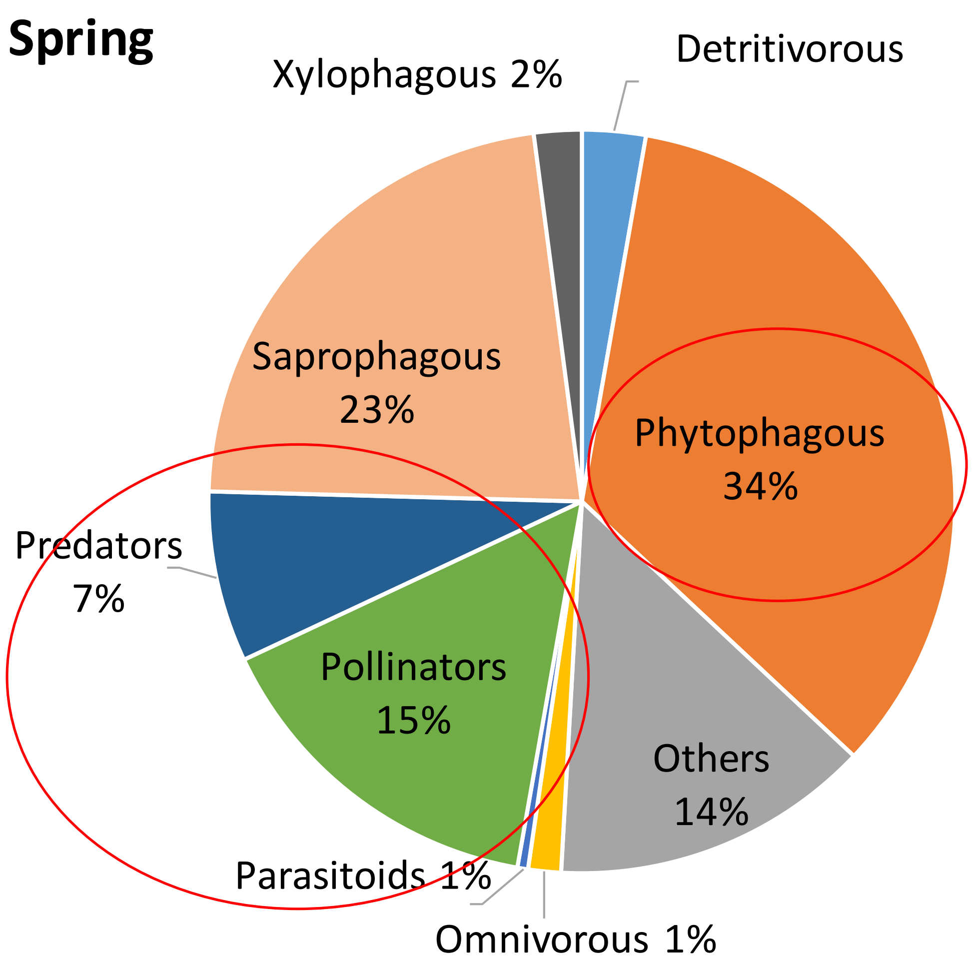


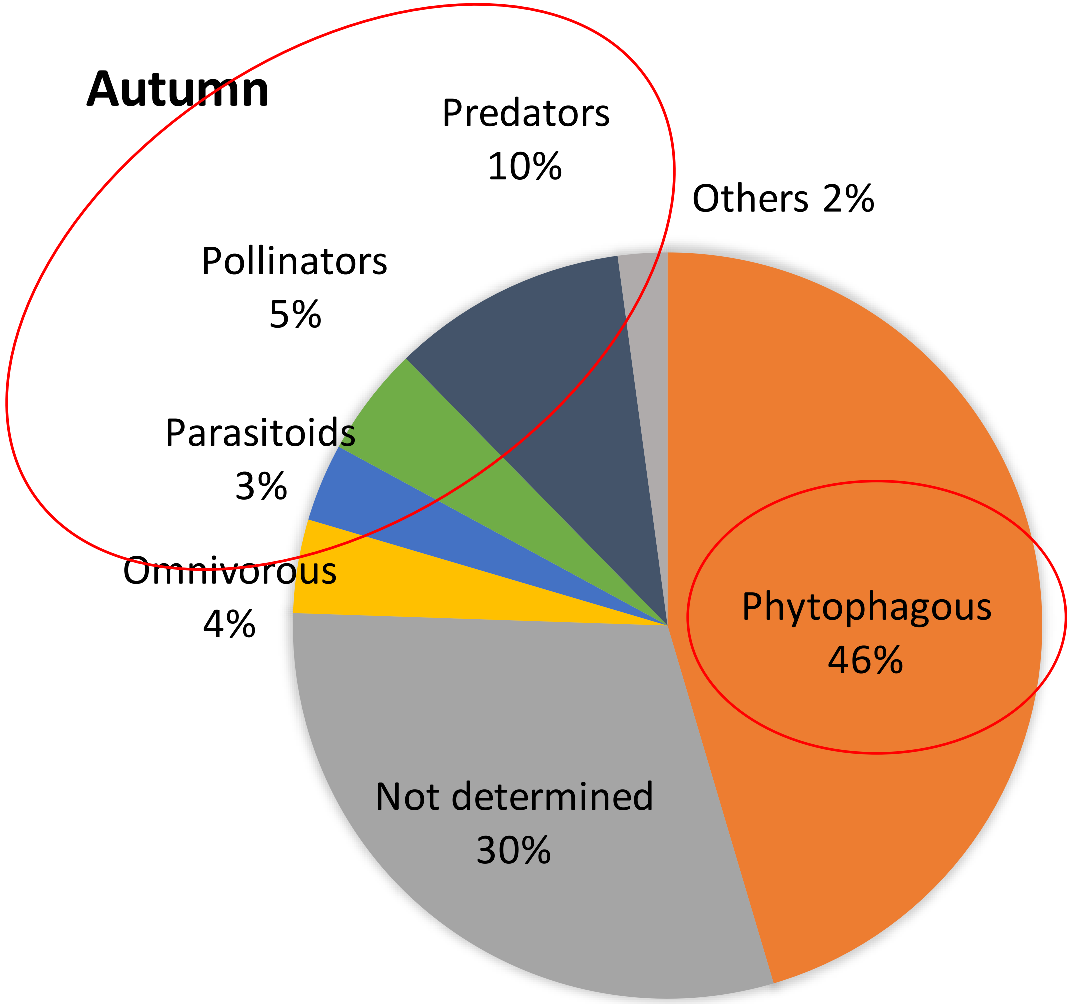


6,136 arthropods, 600 morphospecies distributed by 6 classes, 16 orders, 80 families

Assemblage was very variable between sampling periods

Analysis of functional groups of Flying Arthropods caught

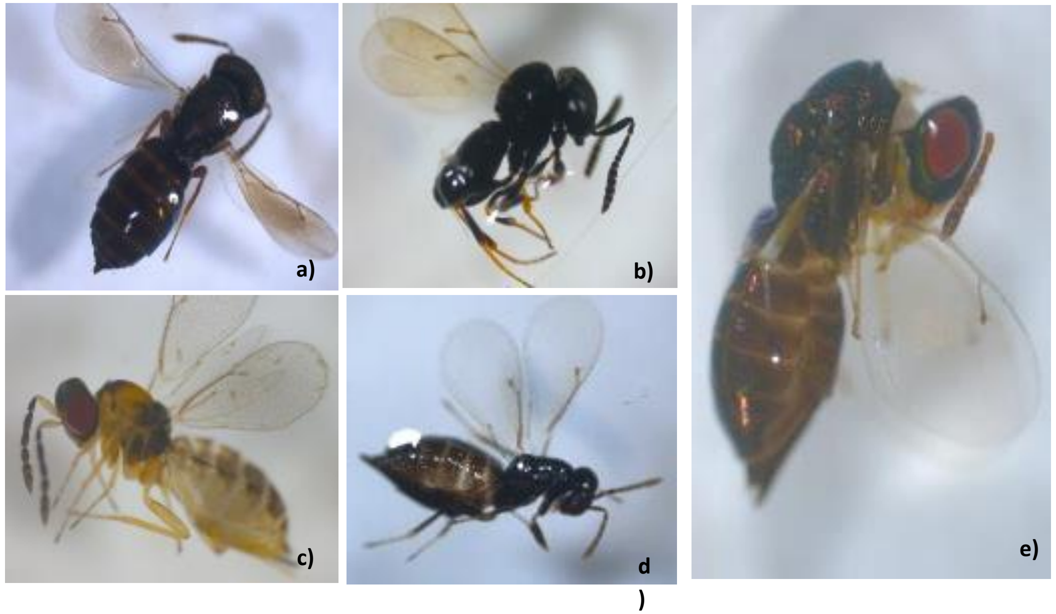




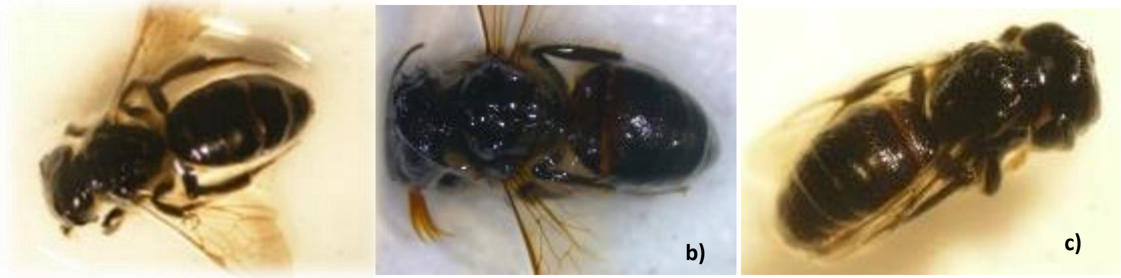
Distribution according to functional traits was also variable between sampling periods

Results: Flying Arthropods – functional groups

Parasitoids



Pollinators



Predators

Phytophagous

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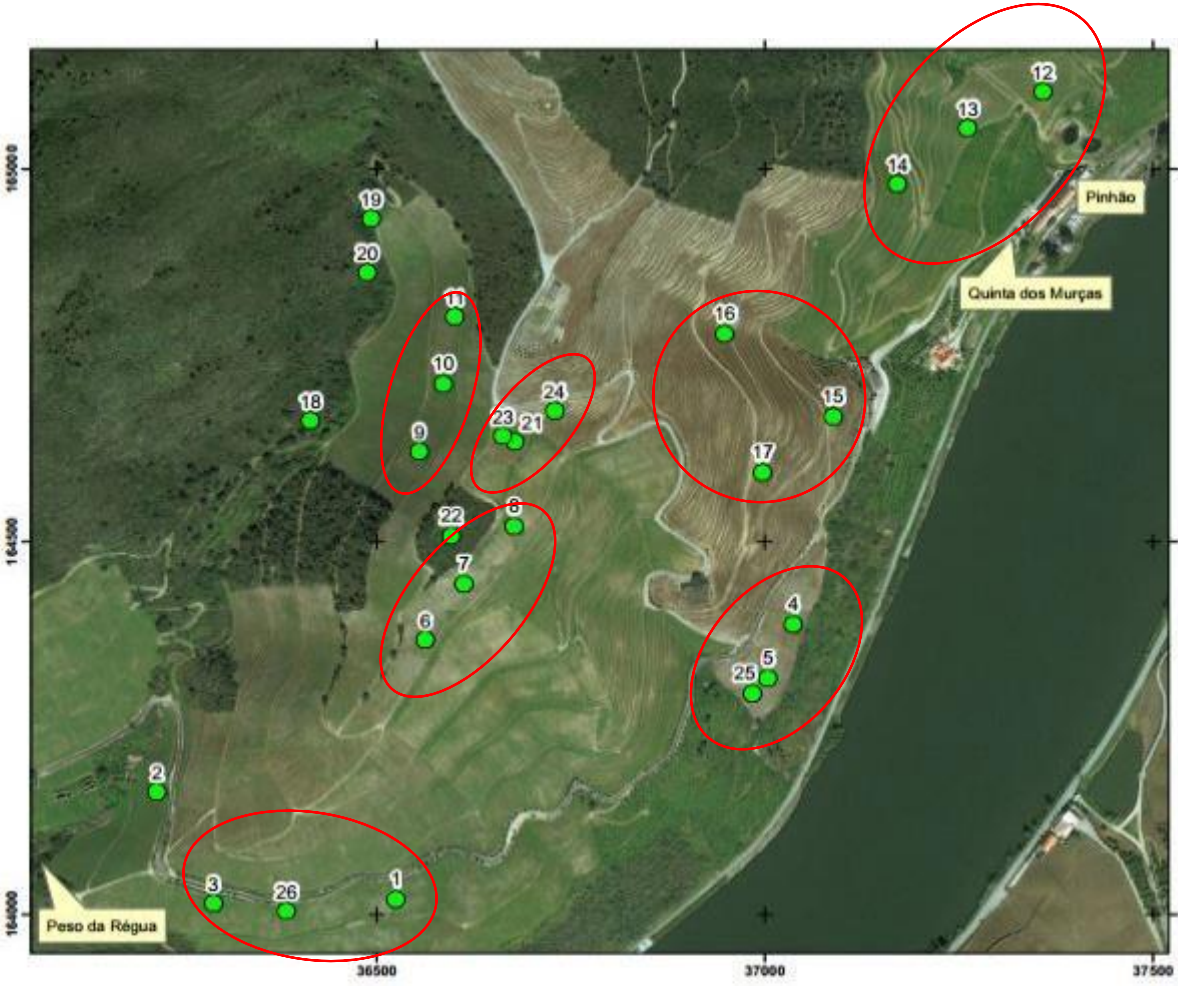
Results: Flying Arthropods

- **Great variability in abundance, richness, diversity and equitability** in **plots with similar conditions** (“homogeneous areas”) and not so many differences between plots conducted under different production system



- Preliminary results suggest that **local characteristics** (particularly **soils characteristics and flora**) may have higher impact

Preliminary results - Relations between landscape and biodiversity parameters

			Landscape Indexes								
			Richness (S) (150 m)	Diversity (H) (150 m)	Equitab (E) (150 m)	Richness (S) (200m)	Diversit (H) (200m)	Equitab (E) (200m)	Richness (S) (250 m)	Diversit (H) (250 m)	Equitab (E) (250 m)
Arthropods	Combi (Spring)	Equitability (E)	/	/	- -	/	/	/	/	/	/
Arthropods	Combi (Autumn)	Abundance (N)	/	/	/	- -	/	/	- -	/	/
		Richness (S)	- -	- -	/	- -	- -	/	- -	- -	/
		Diversity (H)	/	- -	/	/	- -	- -	- -	- -	- -

Spearman correlations: / - non sign.; +, - sig. (<0.05); ++, - - sig. (<0.01)

Diversity indexes of flying arthropods <u>were negatively</u> correlated with landscape Indexes

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Relations between land use and arthropod diversity indexes

		% surface with **vineyards**					% surface with **Ecological Infrastructures**				
		50 m	100 m	150 m	200 m	250 m	50 m	100 m	150 m	200 m	250 m
Combi (Spring)	Diversity (H)	+ +	+	/	/	/	- -	-	-	/	-
	Equitability (E)	+ +	++	+	+	+	-	- -	-	/	-
	N **pollinators**	+	+	++	+	+	-	- -	- -	/	/
	N Predators	/	/	/	/	/	/	/	/	/	+
	N **parasitoids**	/	/	+	/	/	/	/	-	/	/
	N **phytophagous**	/	/	/	/	/	/	/	+	/	/
Berlese (Autumn)	Equitability (E)	+	+	/	/	/	-	-	/	/	/

Spearman correlations: / - non sign.; +, - sig. (<0.05); ++, - - sig. (<0.01)

- Particularly in Spring, **diversity indexes of flying arthropods were <u>positively correlated with % of area with vineyard</u>** located closer and **<u>negatively correlated</u> with EI**
- For pollinators, it seems that more vineyard at 150 m have a higher positive impact

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Relations between Plant and arthropods diversity indexes

		Plant diversity indexes (Spring)				Plant diversity indexes (Autumn)	
		N	S	H	E	H	% cover
Combi (Spring)	Abundance (N)	/	/	/	/	+ +	/
	Diversity (H)	/	/	/	/	/	- -
	Equitability (E)	/	/	/	/	/	- -
Combi (Autumn)	Abundance (N)	/	/	+ +	/	/	/
	N predators	/	/	+ +	/	/	/
	Richness (S)	/	/	+ +	+ +	/	/
	Diversity (H)	/	/	/	+ +	/	/
Pitfall (Autumn)	Abundance (N)	- -	/	/	/	/	/
	Diversity (H)	/	+ +	/	/	/	/
	Equitability (E)	/	+ +	/	/	/	/

Spearman correlations: / - non sign.; +, - sig. (<0.05); ++, - - sig. (<0.01)

- The **diversity of plant cover in spring** seems to have **affected positively** the abundance and richness of **flying arthropods** (including predators) **in Autumn**
- However, **abundance of plant cover** in spring **was negatively correlated with the abundance of soil arthropods** in Autumn (reducing their mobility?)
- The **% of cover plant in the Autumn was negatively correlated with the diversity of flying arthropods** in spring

Relations between plant cover and soil parameters

		% Organic matter	Cu	Mn	% coarse elements
Plant parameters (Spring)	Abundance (N)	/	/	/	/
	Richness (S)	++	/	-	/
	Diversity (H)	++	/	- -	/
	Equitability (E)	+	/	-	/
	% coverage	+	/	-	-
Plant parameters (Autumn)	Abundance (N)	++	/	/	- -
	Richness (S)	/	-	/	- -
	Diversity (H)	/	- -	/	/
	Equitability (E)	/	-	/	/
	% coverage	+	/	/	/

Spearman correlations: / - non sign.; +, - sig. (<0.05); ++, - - sig. (<0.01)

- In spring, **diversity of plant cover** was **positively correlated** with the **% organic matter** and **negatively correlated** with **Mn soil content**
- in Autumn, **diversity of plant cover** was **negatively correlated** with **copper soil content** and **coarse elements**

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Relations between phytosanitary treatments and biodiversity parameters

		IFT	Dose sulfur	Dose Copper	Number of treatments
Combi (Spring)	N predators	/	/	-	/
	N parasitoids	- -	/	/	/
	N Pollinators	/	- -	/	-
Combi (Autumn)	N pollinators	/	/	-	/
	N predators	/	-	-	/
	N parasit	-	/	/	/
Pitfall (Spring)	N predators	/	++	+	/
	S predators	/	++	+	/

Spearman correlations: / - non sign.; +, - sig. (<0.05); ++, - - sig. (<0.01)

- **Frequency of treatments (IFT)** **<u>affected negatively</u> flying parasitoids** and **dose of sulfur affected pollinators**. **Copper seems to <u>impact negatively</u> flying predators and pollinators**
- The **dose of Copper and Sulfur** was **<u>positively correlated</u>** with the abundance and richness of **soil predators**

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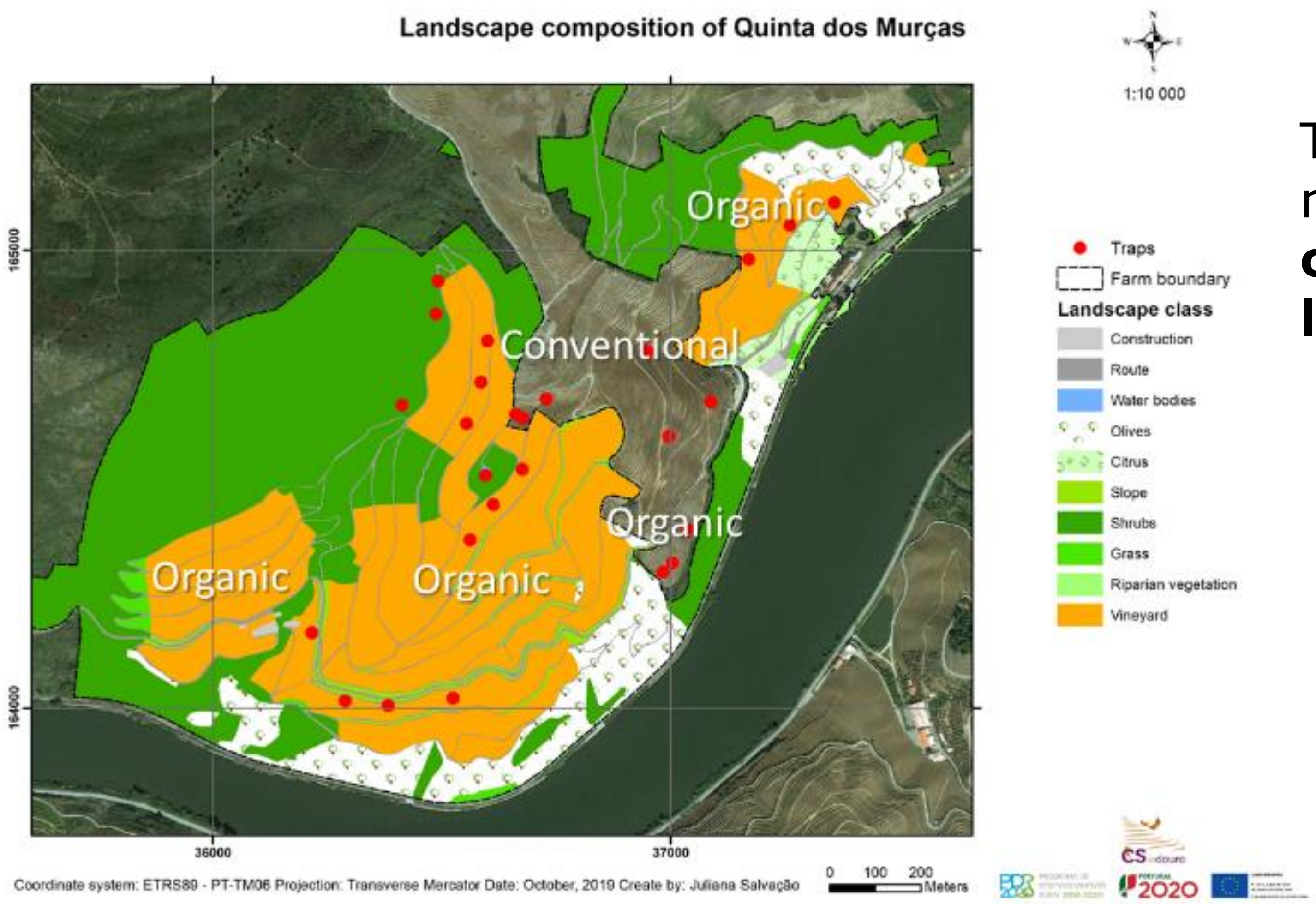
General preliminar conclusions of this study

- **Not found tendencies between indexes obtained among conventional and organic plots**
- Important to deeper this study in the same plots, for further statistical analysis



The impact of the production system must consider first the analysis of **characteristics at landscape and local level**

(Possible effect of neighbourhood)

General preliminary conclusions of this study

- **At landscape scale:** it seems that **vineyard habitat is more attractive for flying arthropods** than the IEE, which displayed a **negative impact on it**

- **Local scale:** the abundance and richness of **flying arthropods** in Autumn seems to be affected by the **diversity of plant cover** in spring

These results suggest that **native ground cover in spring** is more attractive for flying arthropods (including predators) than landscape elements (IEE)

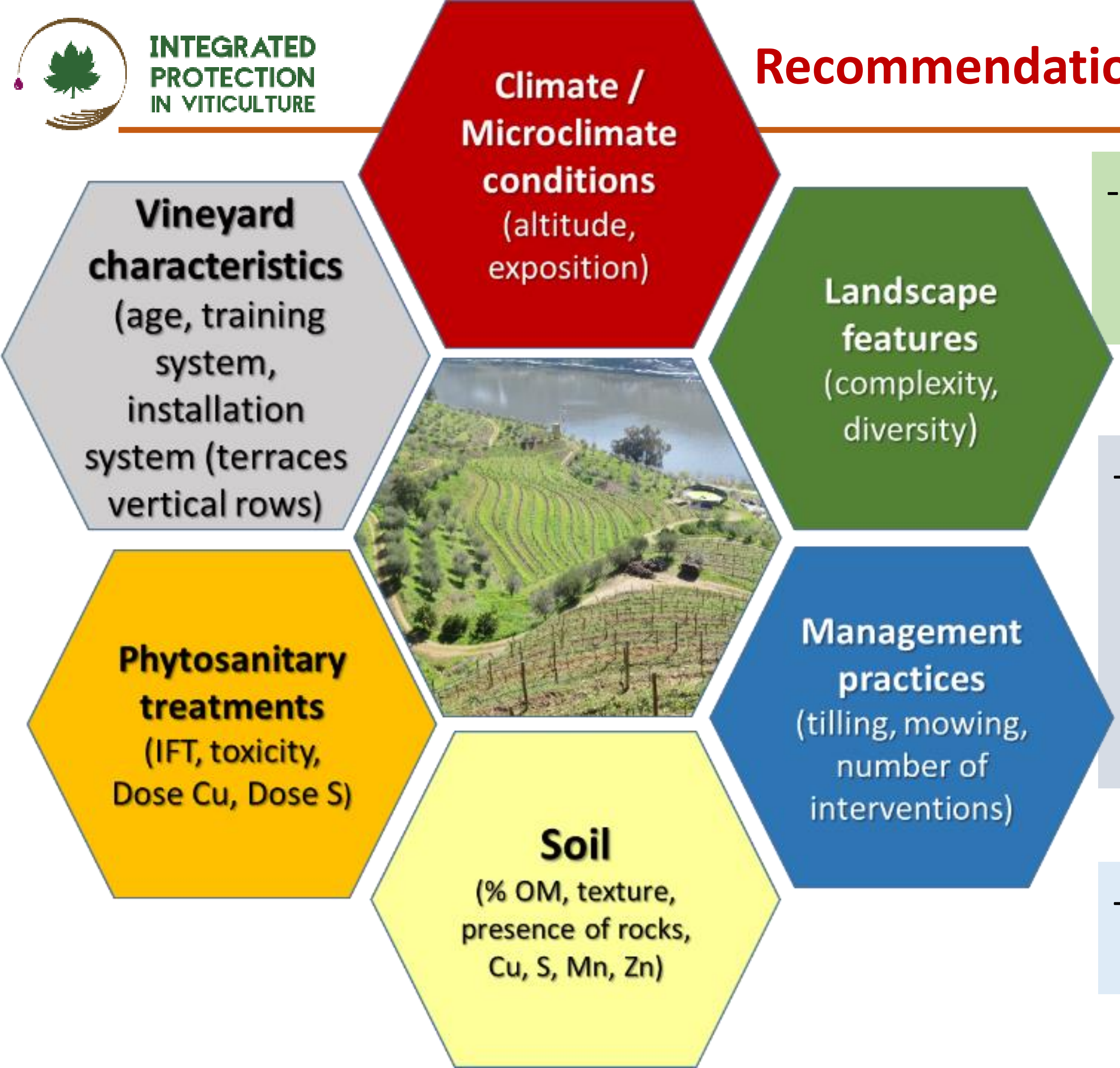
- **Diversity of plant cover** is **positively affected** by **organic matter** and **negatively affected by Copper and Mn**

  - soil fertility must be improved to support biodiversity of arthropods

- **Phytosanitary treatments negatively affected parasitoids and pollinators**

Reduction / Selection of pesticides less toxic must be done (in organic, Cu and S are difficult to avoid)

Recommendations to improve local biodiversity



- Importance of **improving fertility** of soils to **enhance cover plant** and **arthropod's biodiversity**

- **Implement "tactical cover management"** (positioning time of mowing to avoid lake of resources, performed it in alternate alleys, minimum high of cover, which will act as a mulch after dried)

- Where mechanization is difficult, promote **animals grazing**

Thanks for your attention!