40-year changes in weed communities induced by management and climate change in Mediterranean vineyards

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Elena KAZAKOU, Aurélie METAY, Guillaume FRIED

1980s

2020s

La Région Occitanie Pyrénées · Méditerranée

Liberté · Égalité · Fraternité
RÉPUBLIQUE FRANÇAISE
MINISTÈRE DE LA TRANSITION ÉCOLOGIQUE ET SOLIDAIRE
MINISTÈRE DE L'AGRICULTURE ET DE L'ALIMENTATION

ÉCOPHYTO
RÉDUIRE ET AMÉLIORER L'UTILISATION DES PHYTOS
AGENCE FRANÇAISE POUR LA BIODIVERSITÉ
ÉTABLISSEMENT PUBLIC DE L'ÉTAT

anses

Centre d'Ecologie Fonctionnelle & Evolutive

L'INSTITUT agro Montpellier

Funding

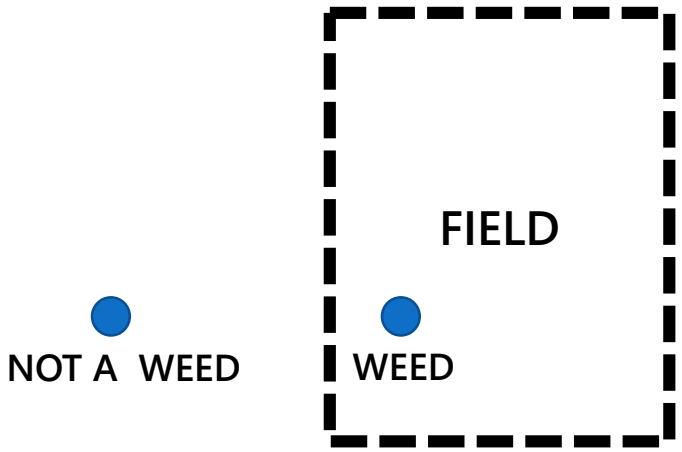
Project SAVING : Spatio-temporal dynamics of weed species communities in response to soil management practices in vineyards and consequences for grapevines: transition to zero glyphosate management

Weeds in vineyards

Weeds as ruderal species

AGRICULTURAL SCIENCES BASED DEFINITION

Any spontaneous plant species located within fields



Buchholtz (1967)

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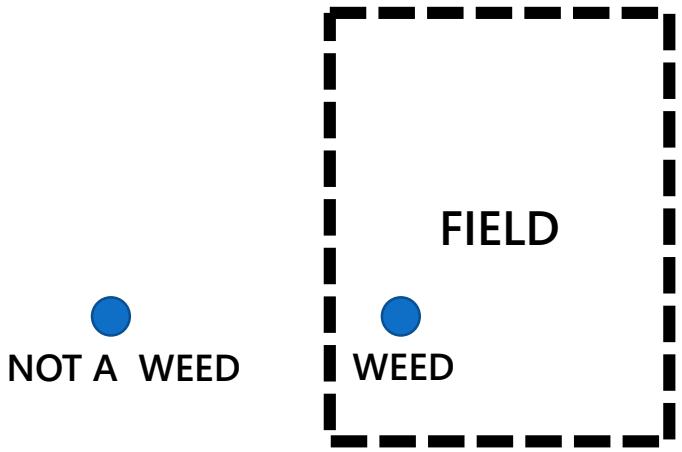

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FUNCTIONAL ECOLOGY BASED DEFINITION

Any spontaneous plant species with trait values that make them tolerate disturbance = ruderal

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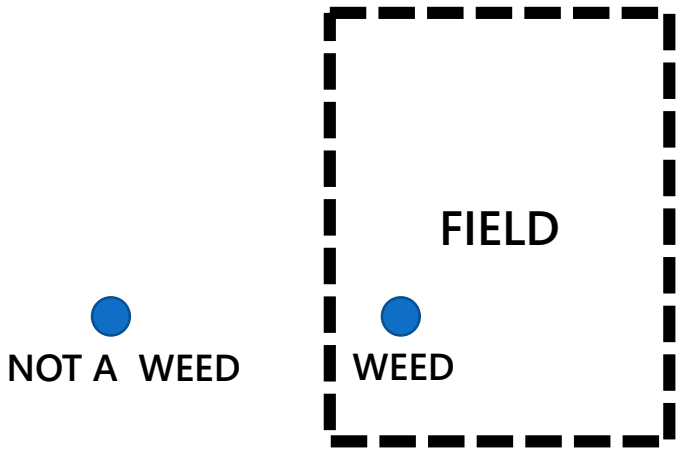

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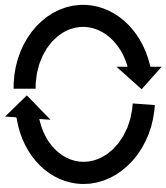
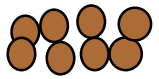


Short life cycle



Low seed mass

High photosynthesis efficiency per dry mass

Baker (1965)

Grime’s strategies

Grime (1974)

Two main constraints to which species must adapt: (i) the availability of resources

Ressources

☀️N P K💧

Two main constraints to which species must adapt: (2) the disturbance regime

Ressources

☀️N P K💧

Disturbance

3 strategies to survive

Ressources
☀️N P K💧

Competitive

Ruderal

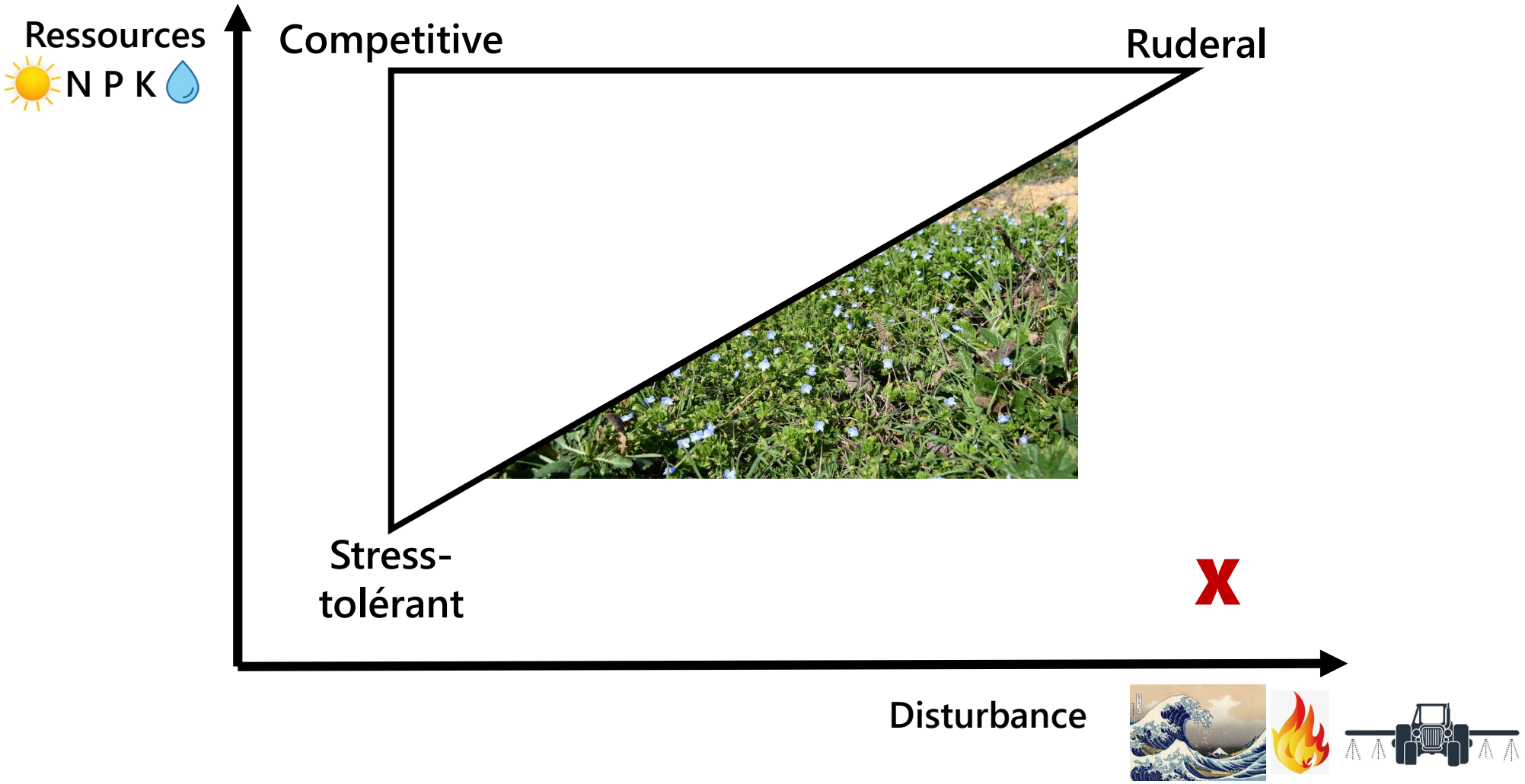
Stress-
tolérant

X

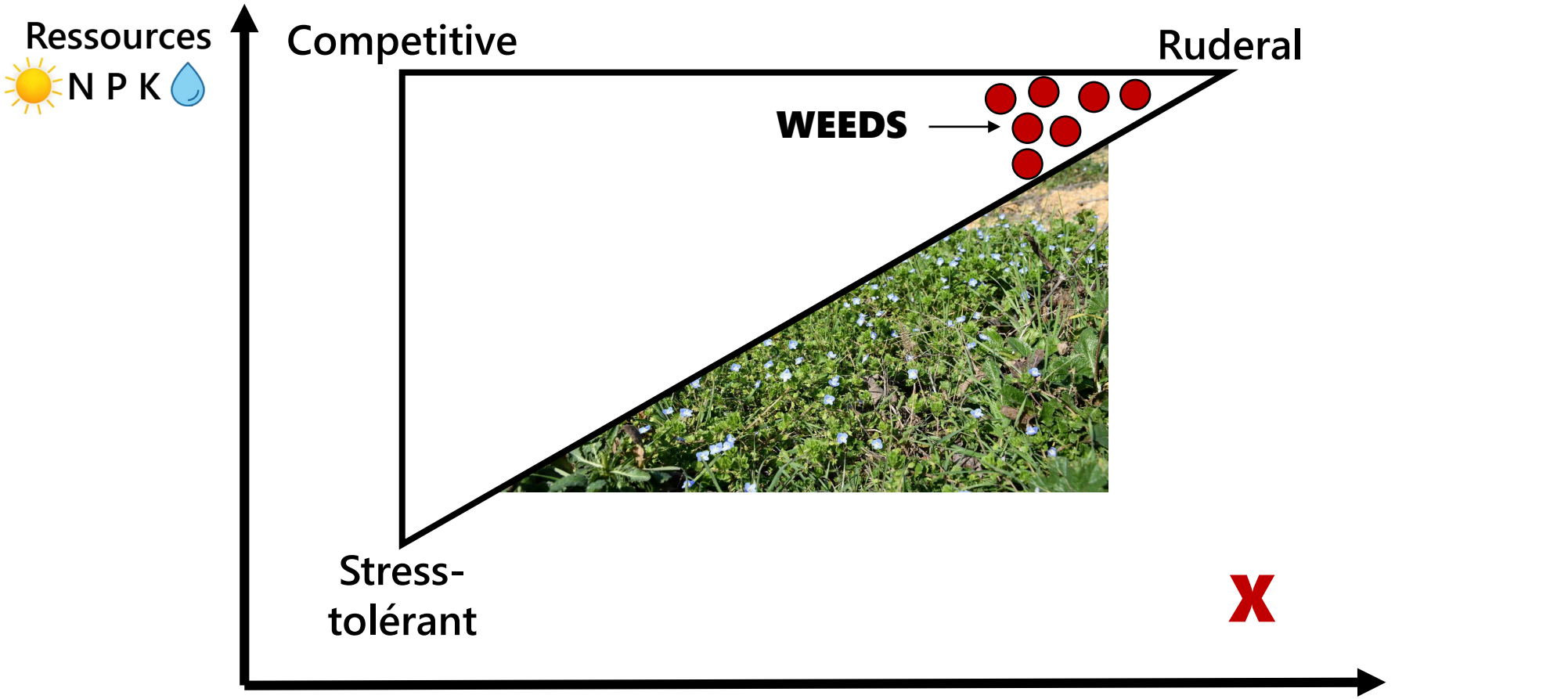
Disturbance



3 strategies to survive

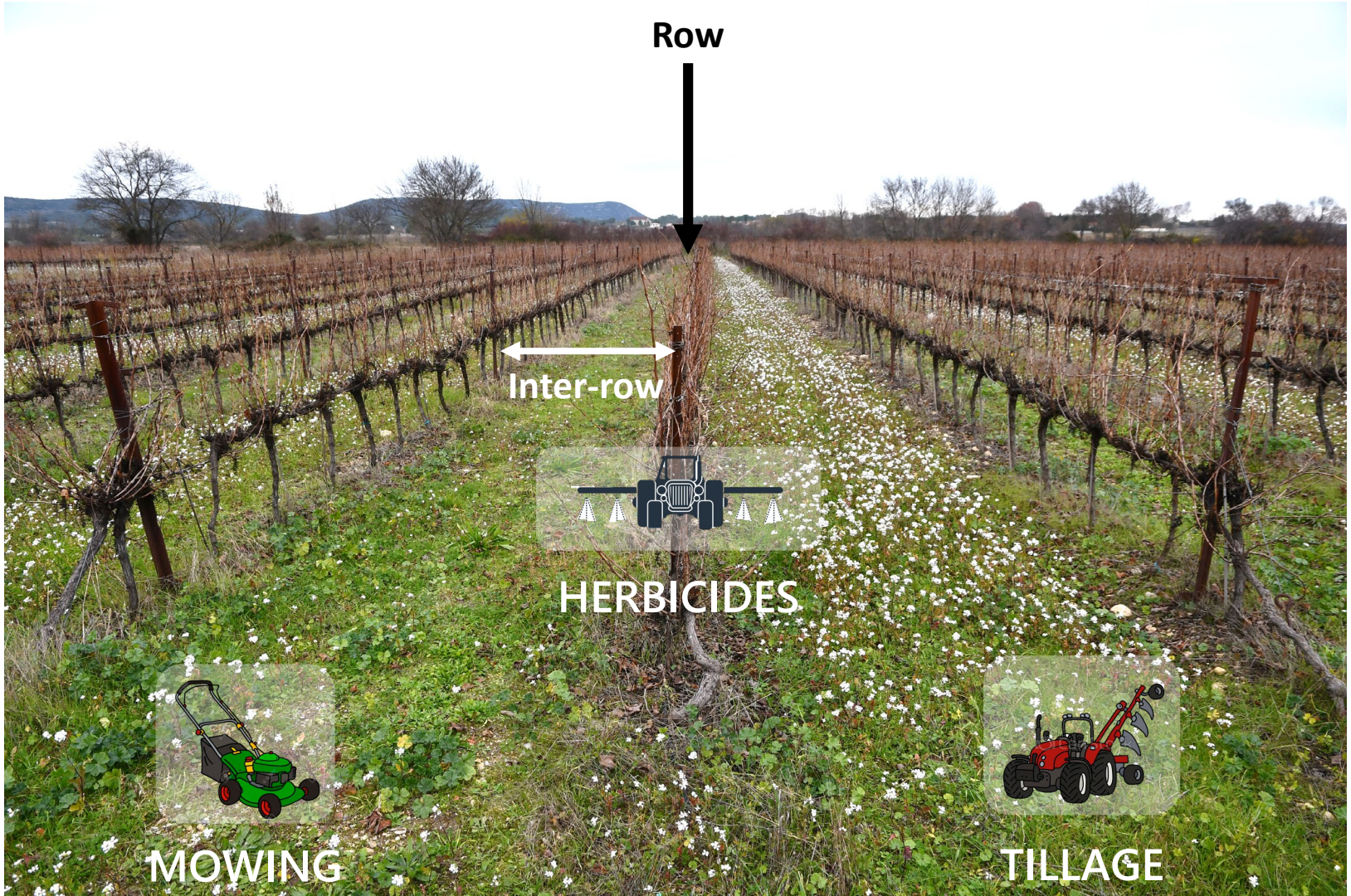


3 strategies to survive



Baker 1965
Bourgeois
et al. (2019)

Three main type of disturbance in vineyards : weeds are managed to limit competition for resources with vines



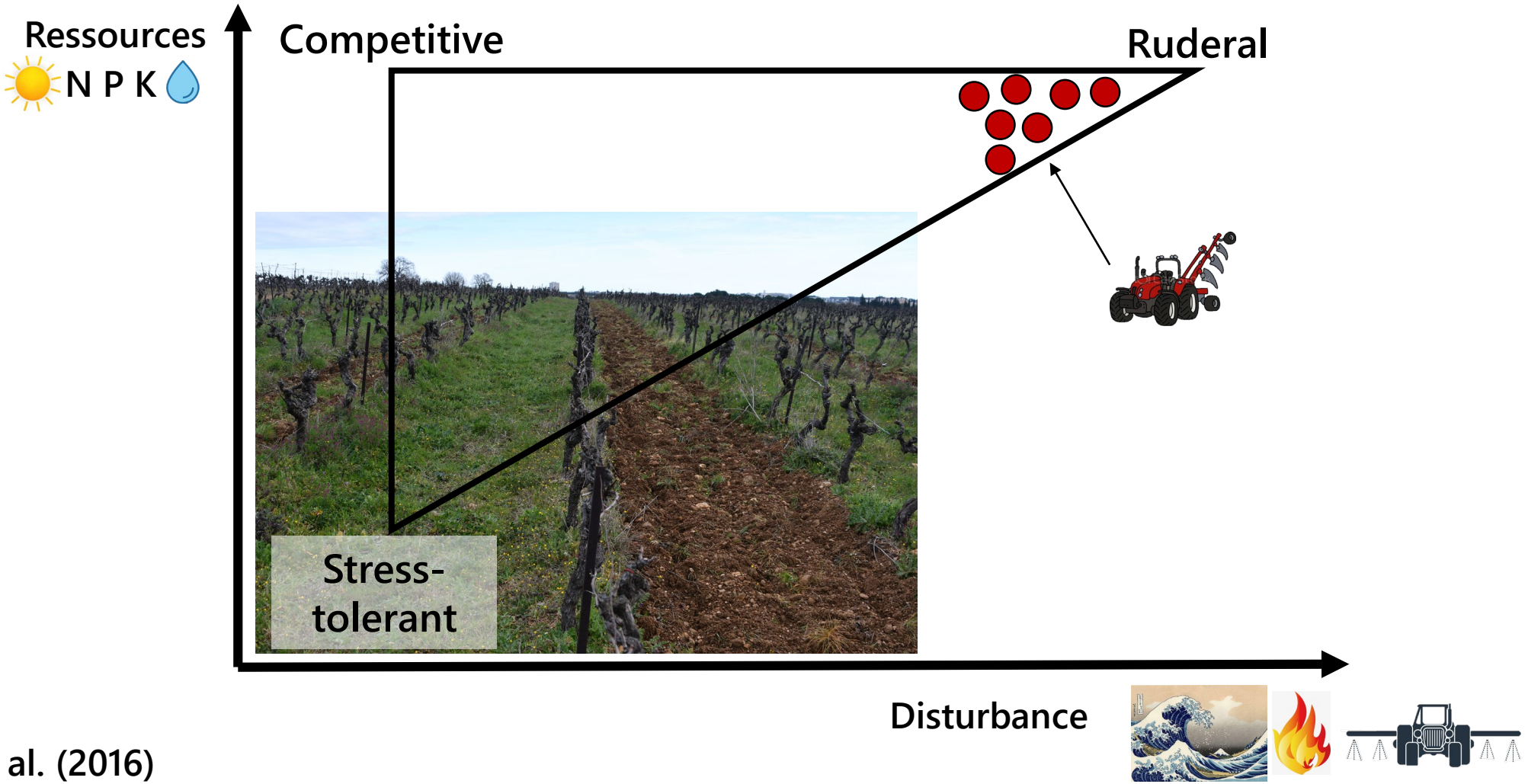
Fernandez-Mena et al. (2021)

Weed management modifies the composition of communities

Weed management modifies the composition of communities

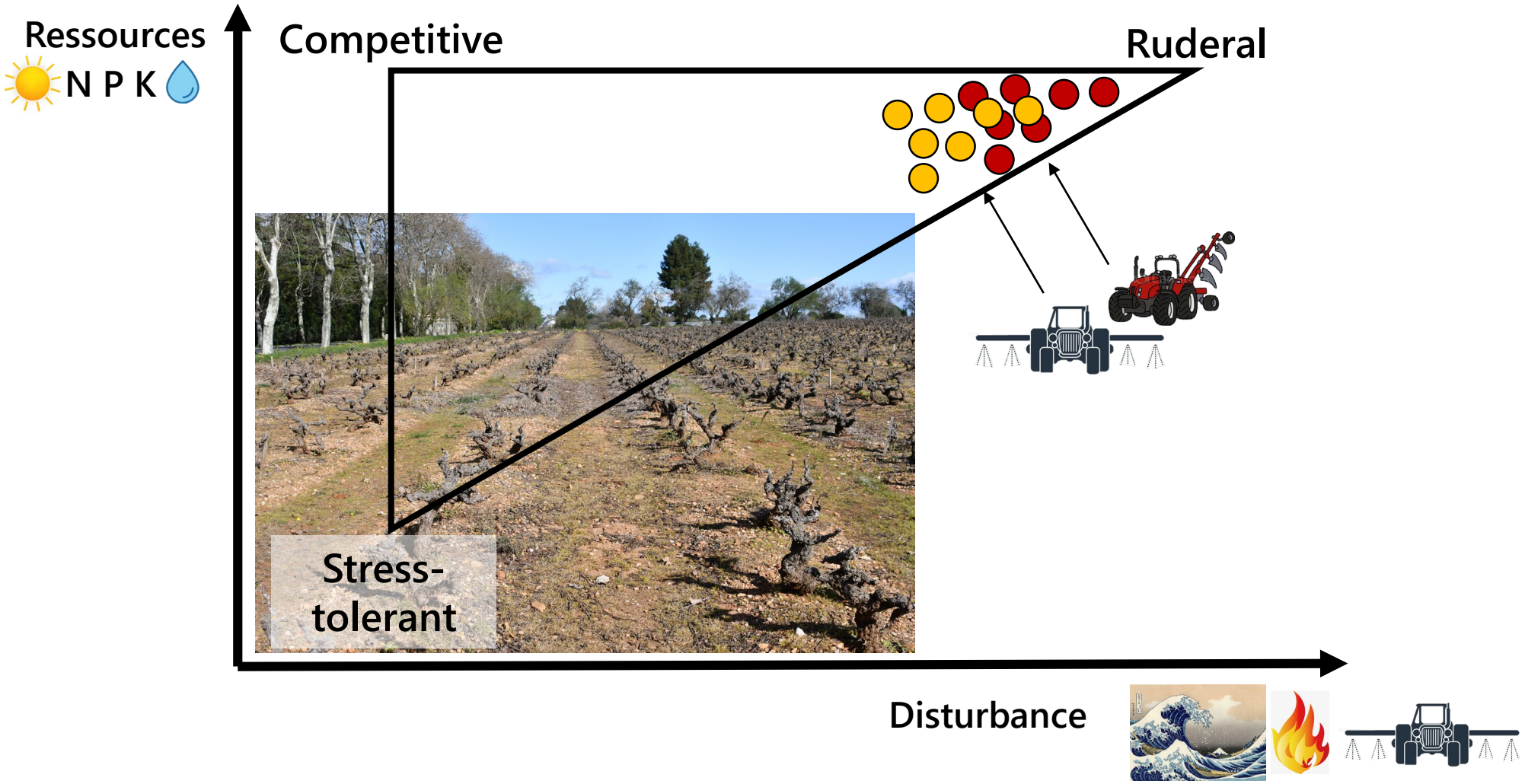
Diplotaxis erucoides

Three main type of disturbance in vineyards

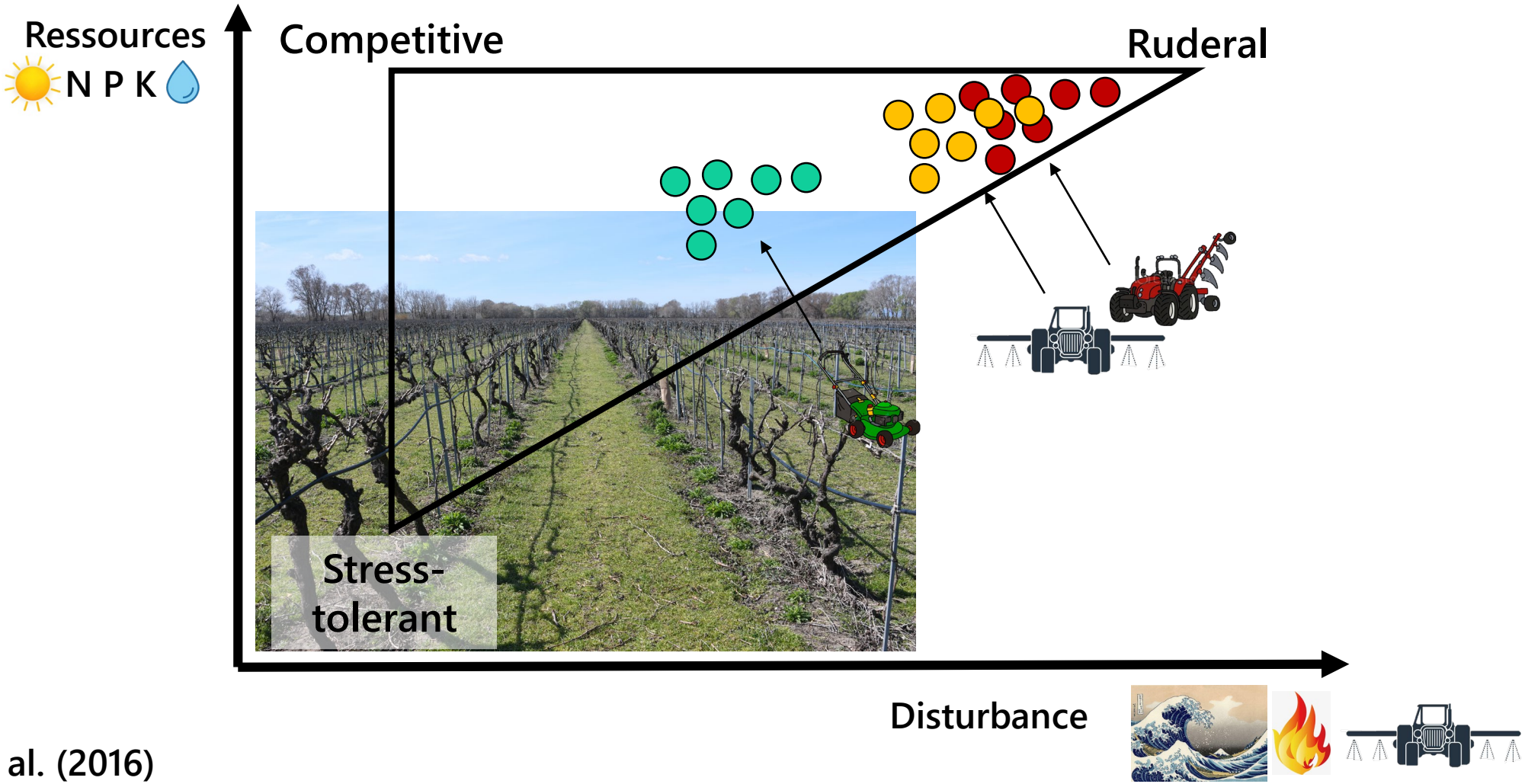


Kazakou et al. (2016)

Three main type of disturbance in vineyards

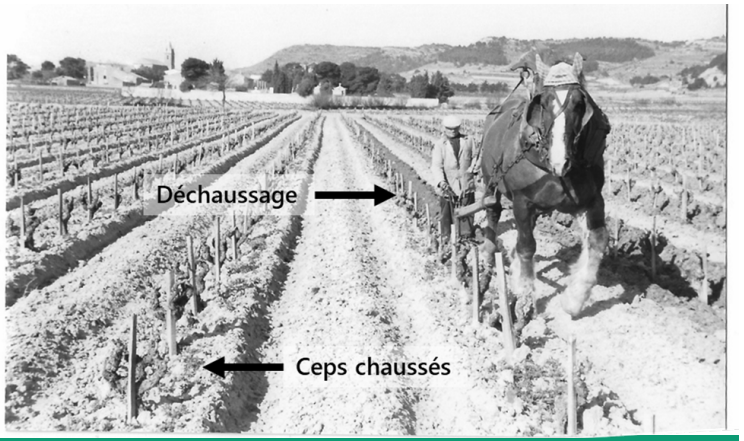


Three main type of disturbance in vineyards



Kazakou et al. (2016)

The historical evolution of management practices…



Tillage

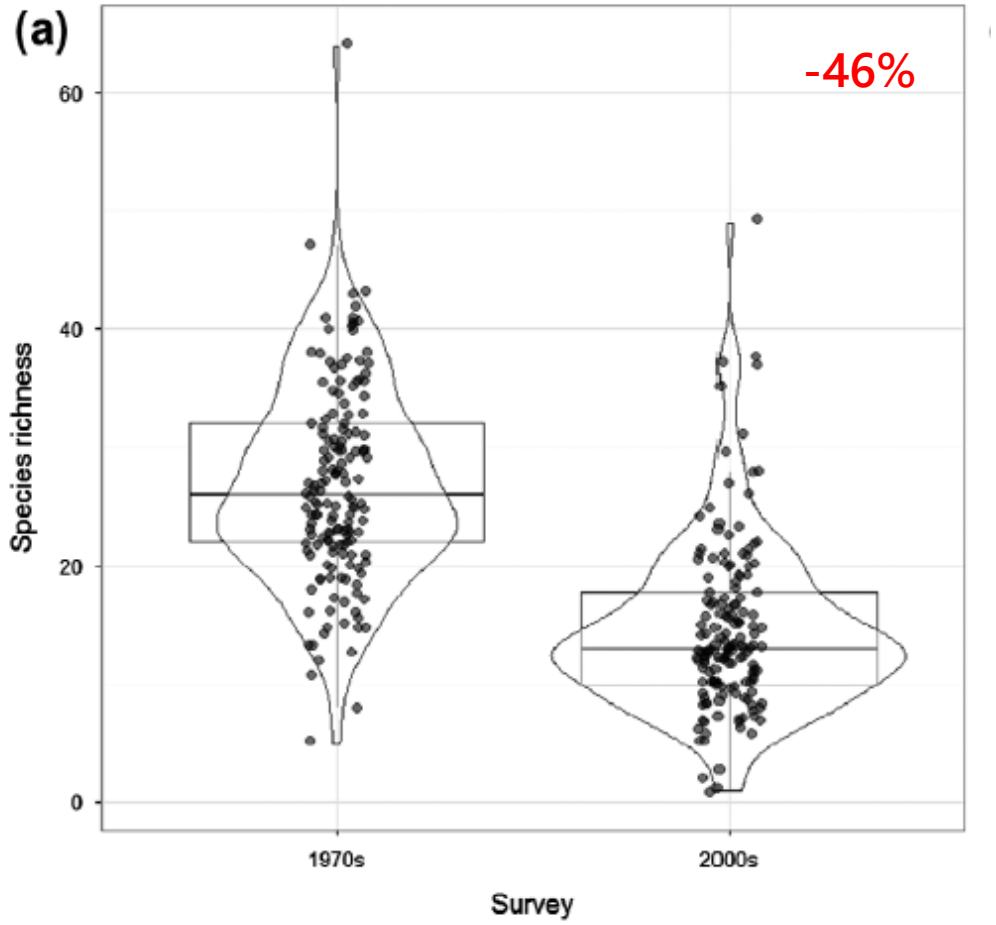
Chemical weeding

Mixed management

1960 1970 1980 1990 2000 2010 2020 …

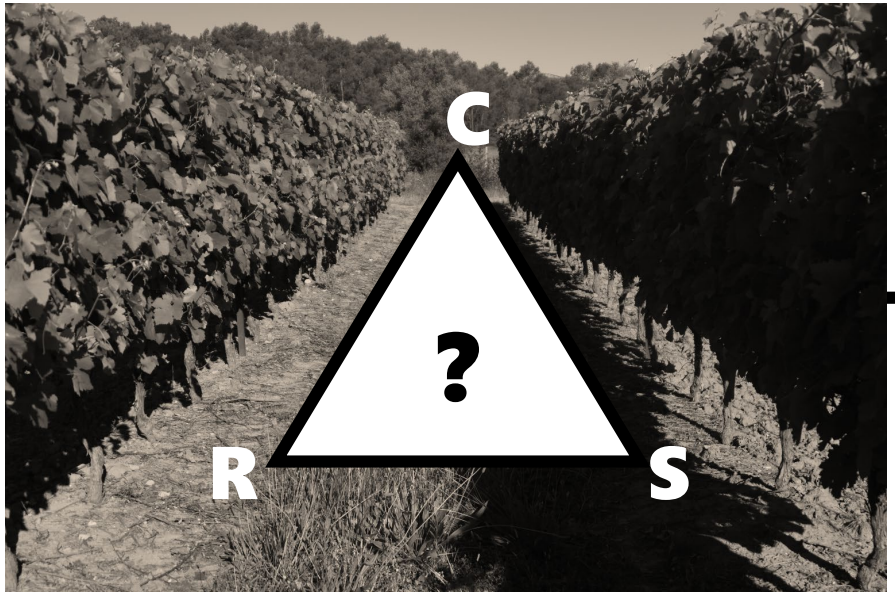
Barralis et al. (1983), Maillet (1981)

… impacted weed richness

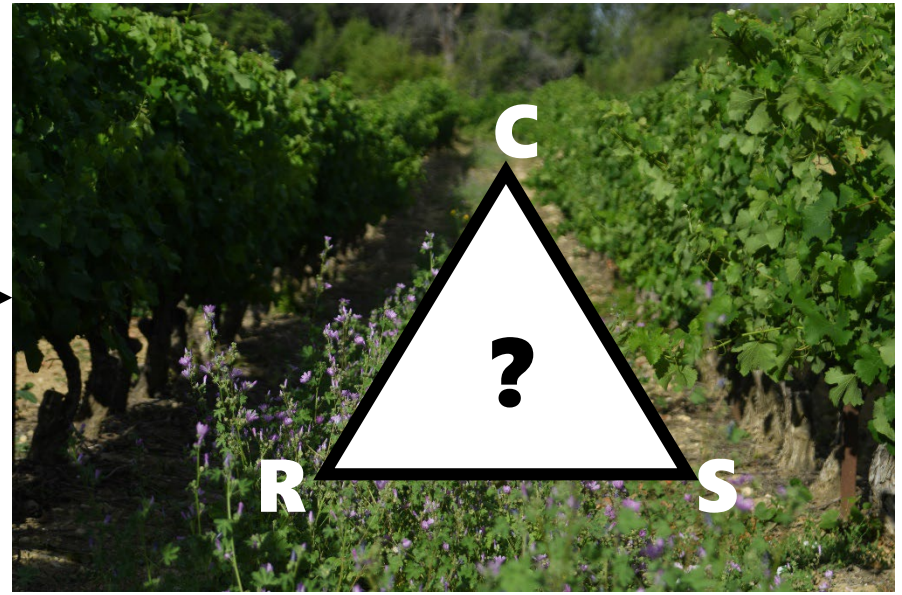


Fried et al. (2016)

But what about Grime's strategies ?



1980s



2020s

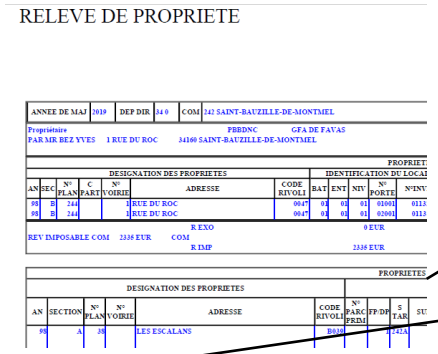
MATERIALS AND METHODS

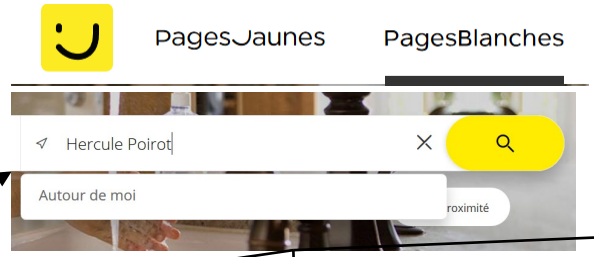
« Maillet » network

40 plots with known 1980s flora

From GPS coordinates of vineyard plots to weed management practices since the 1980s: 135 phone calls later

Tax department





Existing phone number

No phone number available but family in village

No phone number available

Send a letter

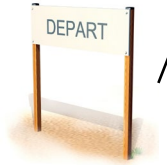
Knock on doors

Give phone number

Call to request permission to go into plot

Family call in village

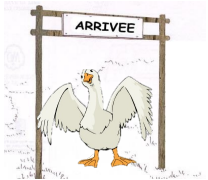
Does not want to give phone number



The vine no longer exists

Farmer says YES

Farmer says NO



Characterization of practice trajectories and recent practices

TRAJECTORIES

Tillage on R : yes/no
Tillage on IR : yes/no

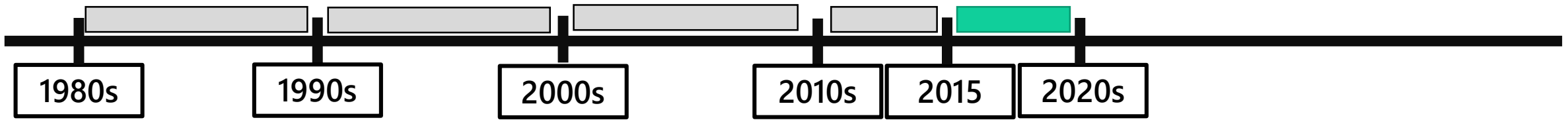
Chemical weeding on R : yes/no
Chemical weeding on IR : yes/no

Mowing on R : yes/no

RECENT PRACTICES

Date of each pass for each practice, tillage depth, herbicide dose...

Grouping of plots with identical weed management:
(1) Mostly tillage
(2) Chemical weed control in majority
(3) Tillage (IR) + Chemical weed control (R)
(4) Mowing (IR) + Tillage (R)



Characterization of practice trajectories and recent practices

S. Poulet

M. Alvanitakis

A. Orvoire

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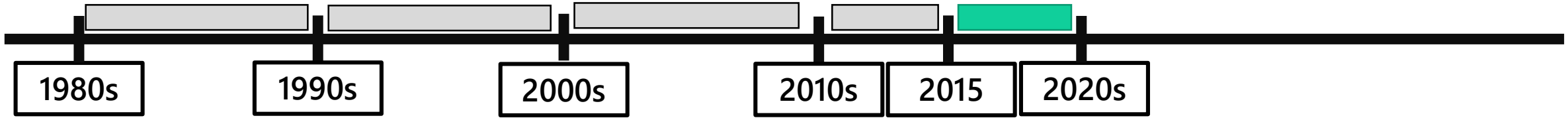
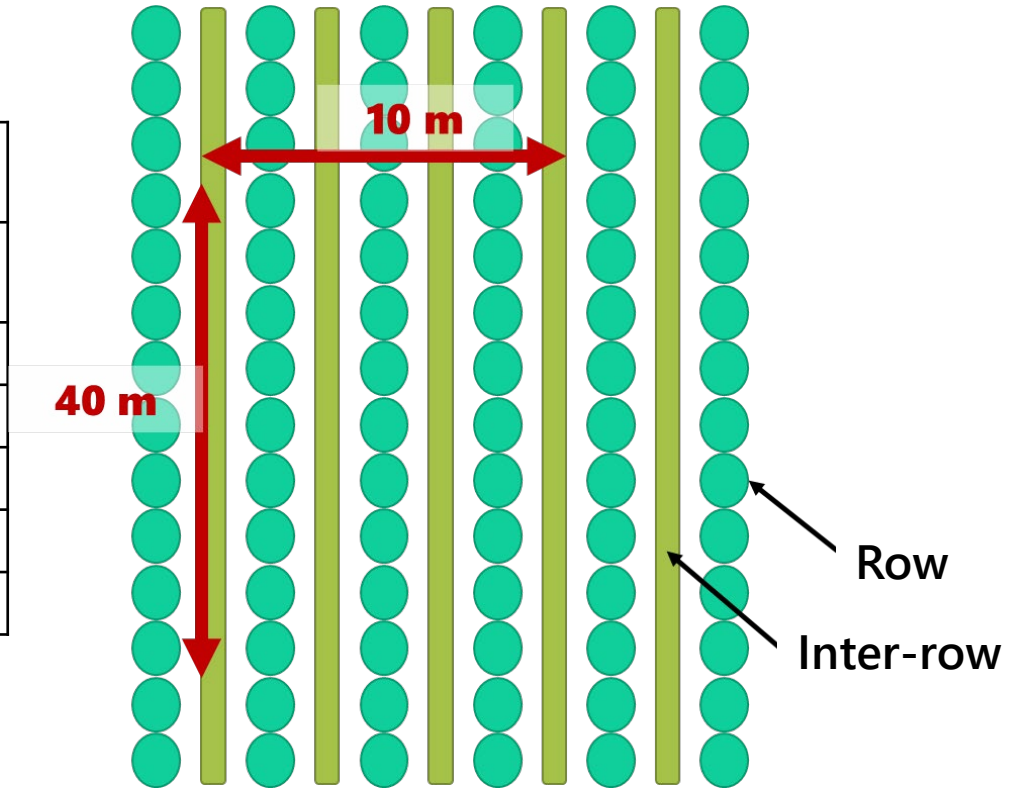
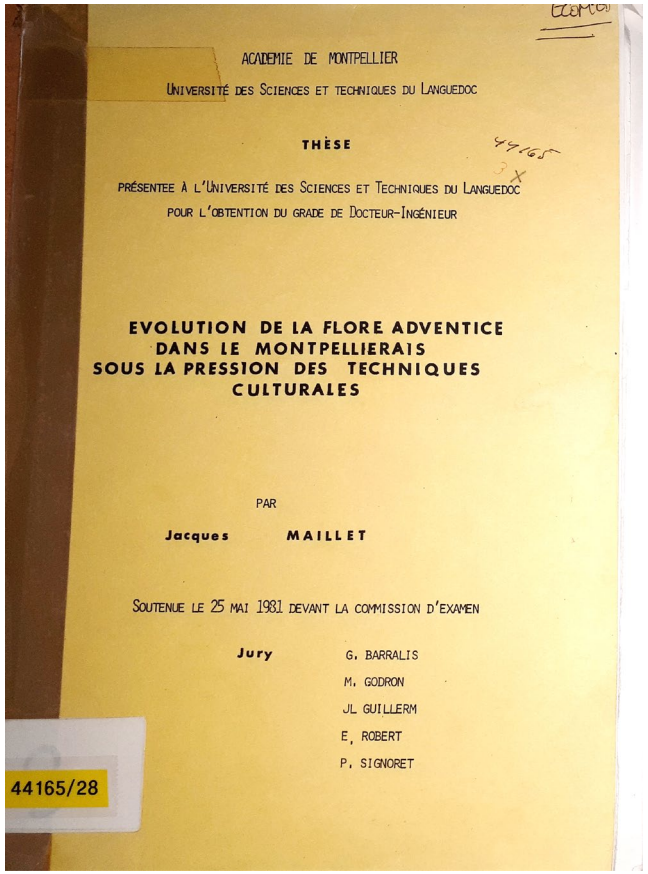


The method of floristic surveys Barralis (1976)

Barralis coefficient	Number of individuals per m^2
+	1 individual observed on the 400 m^2
1	1
2	1-2
3	3-20
4	21-50
5	> 50



M.-C. Quidoz



ACADEMIE DE MONTPELLIER

UNIVERSITÉ DES SCIENCES ET TECHNIQUES DU LANGUEDOC

THÈSE

PRÉSENTEE À L'UNIVERSITÉ DES SCIENCES ET TECHNIQUES DU LANGUEDOC
POUR L'OBTENTION DU GRADE DE DOCTEUR-INGÉNIEUR

EVOLUTION DE LA FLORE ADVENTICE
DANS LE MONTPELLIERAIS
SOUS LA PRESSION DES TECHNIQUES
CULTURALES

PAR

Jacques MAILLET

SOUTENUE LE 25 MAI 1981 DEVANT LA COMMISSION D'EXAMEN

Jury G. BARRALIS
M. GODRON
JL GUILLERM
E. ROBERT
P. SIGNORET

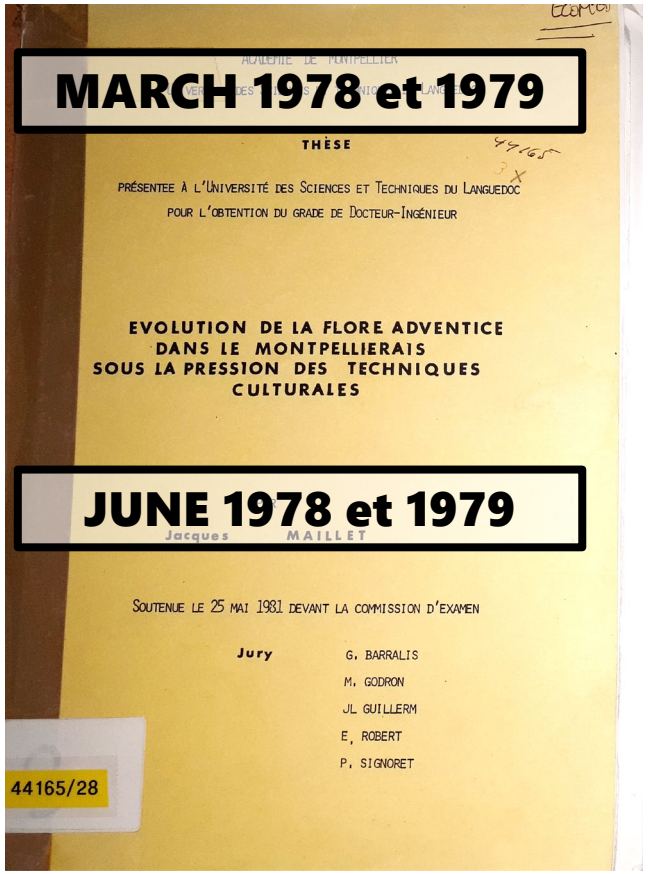
44165/28

MARCH 2020 and 2021

JUNE 2020 and 2021

OCTOBER 2020 and 2021

M.-C. Quidoz



MARCH 1978 et 1979

JUNE 1978 et 1979

OCTOBER 1979

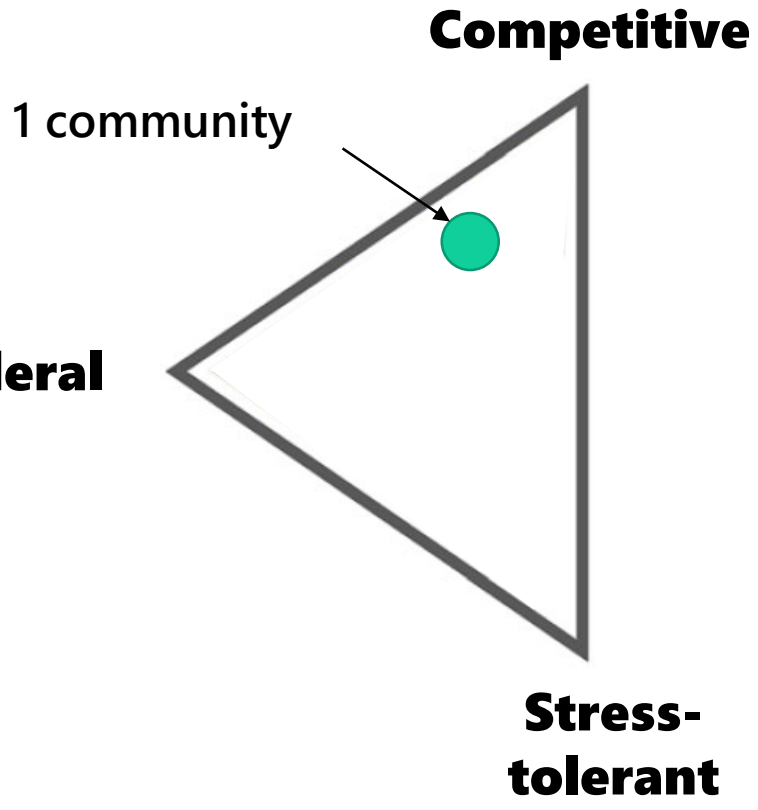
MARCH 2020 and 2021

JUNE 2020 and 2021

OCTOBER 2021

Traits

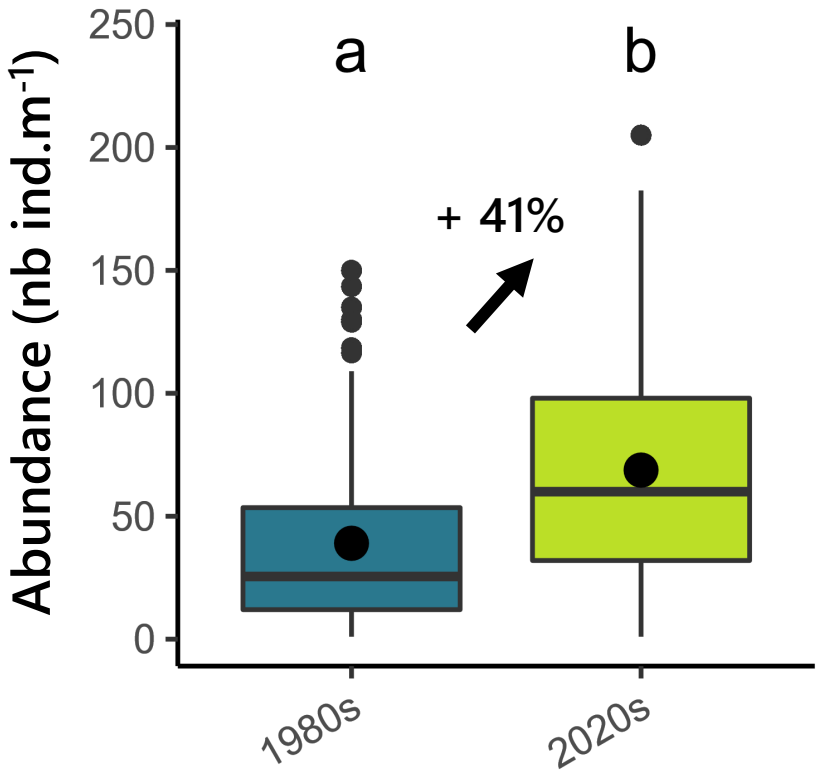
TRAIT MEASUREMENT COMPLETED BY DATABASE EXTRACTIONS



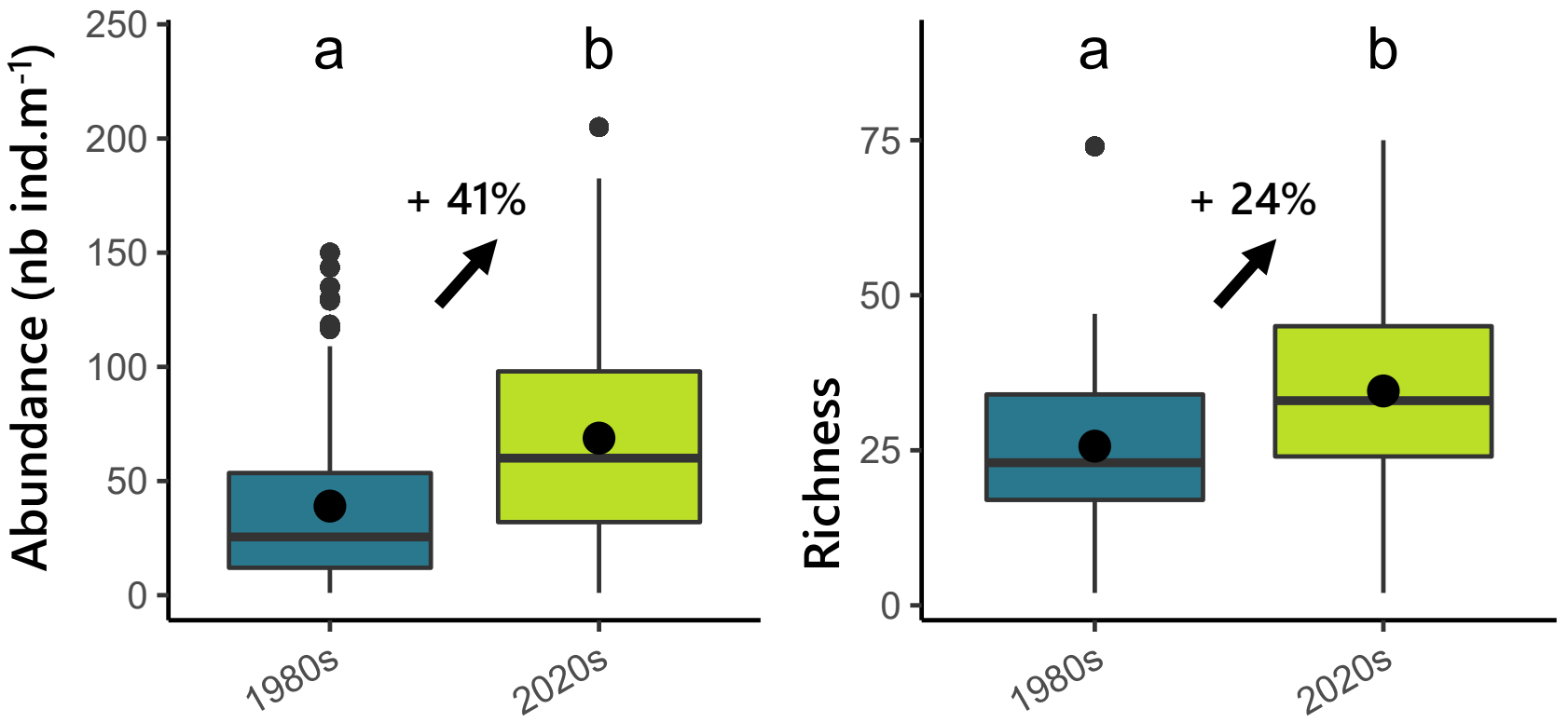
Pierce et al. (2017) ; Li & Shipley (2017)

RESULTS

More abundant current weed communities...



… with more species



Increasing, decreasing and stable species

INCREASERS
n= 116/423

Medicago polymorpha
+ 98% in abundance
+ 85% in frequence

Increasing, decreasing and stable species

INCREASERS
n= 116/423

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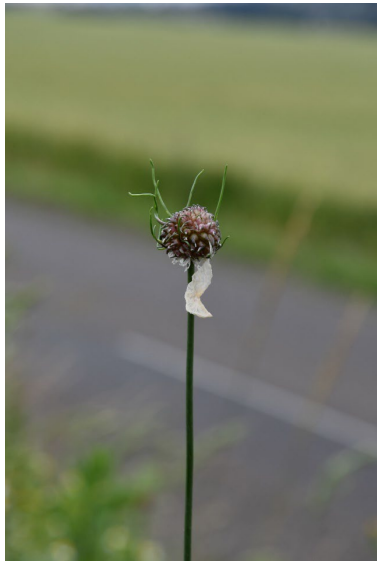
+ 85% in frequence

DECREASERS
n=73/423

Allium vineale
-84% in abundance
-42% in frequence



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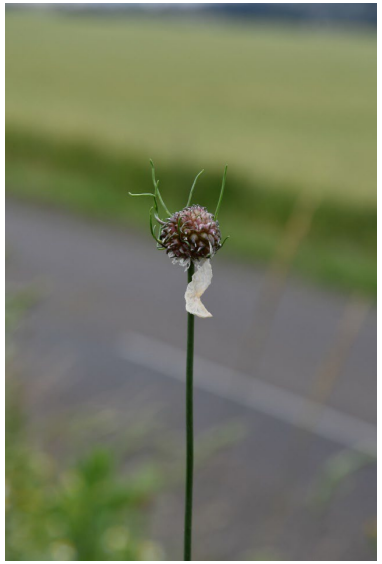


STABLE
n= 234/423

Lolium rigidum
+7% in abundance
-12% in frequence

What changes in the environment and farming practices in 40 years ?

1980s

What changes in the environment and farming practices in 40 years ?

2020s

What changes in the environment and farming practices in 40 years ?

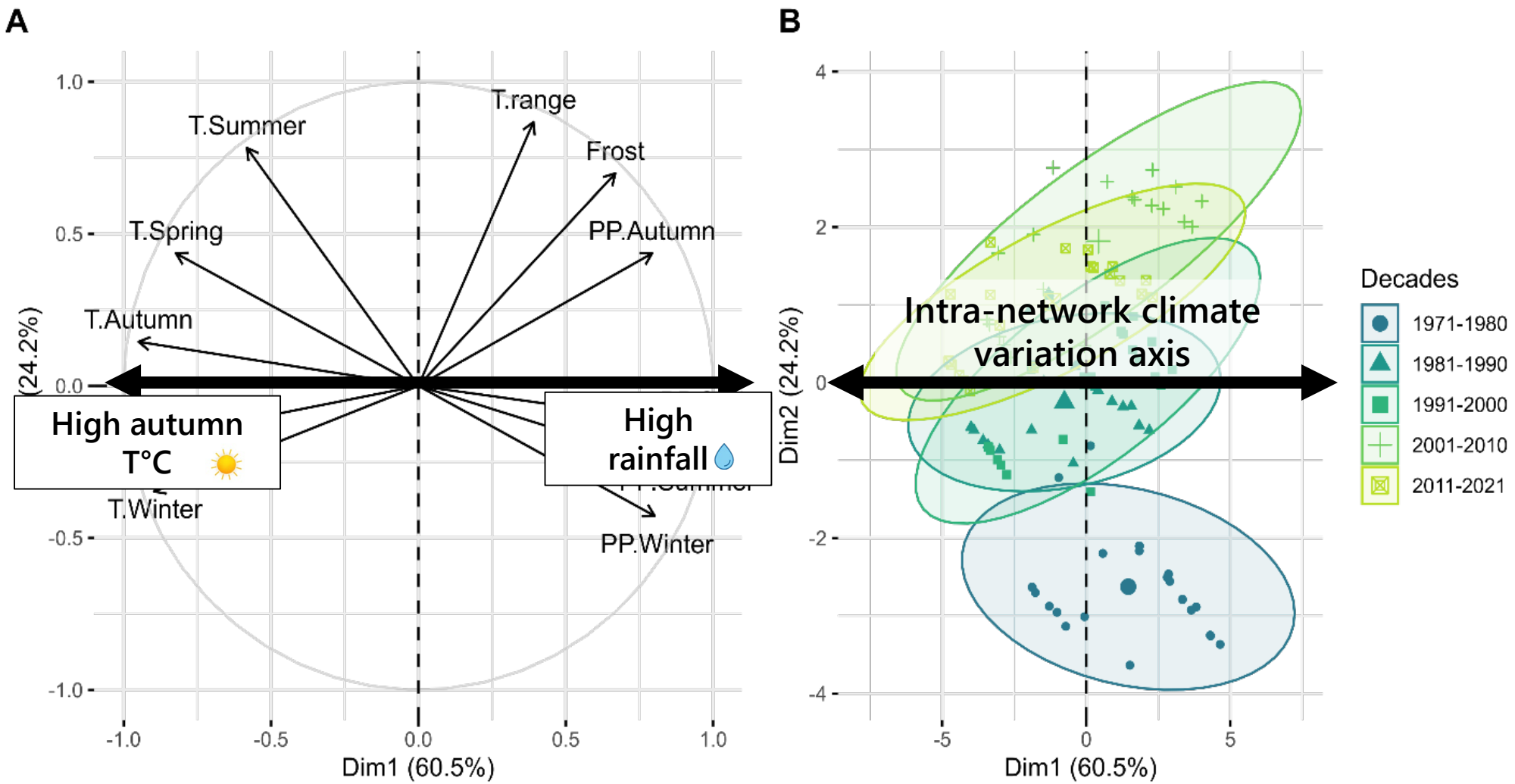
1980s

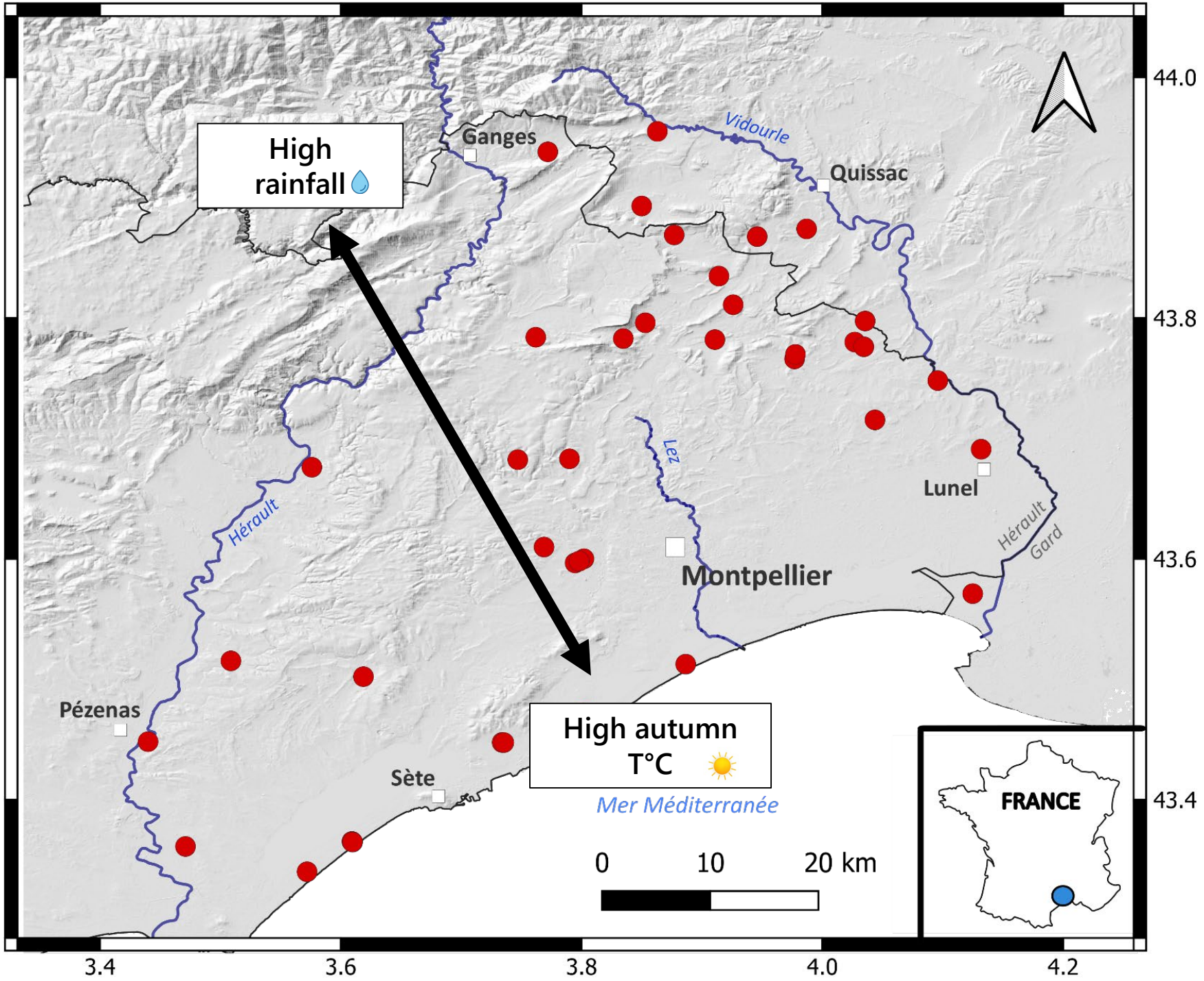
What changes in the environment and farming practices in 40 years ?

Climate change ?

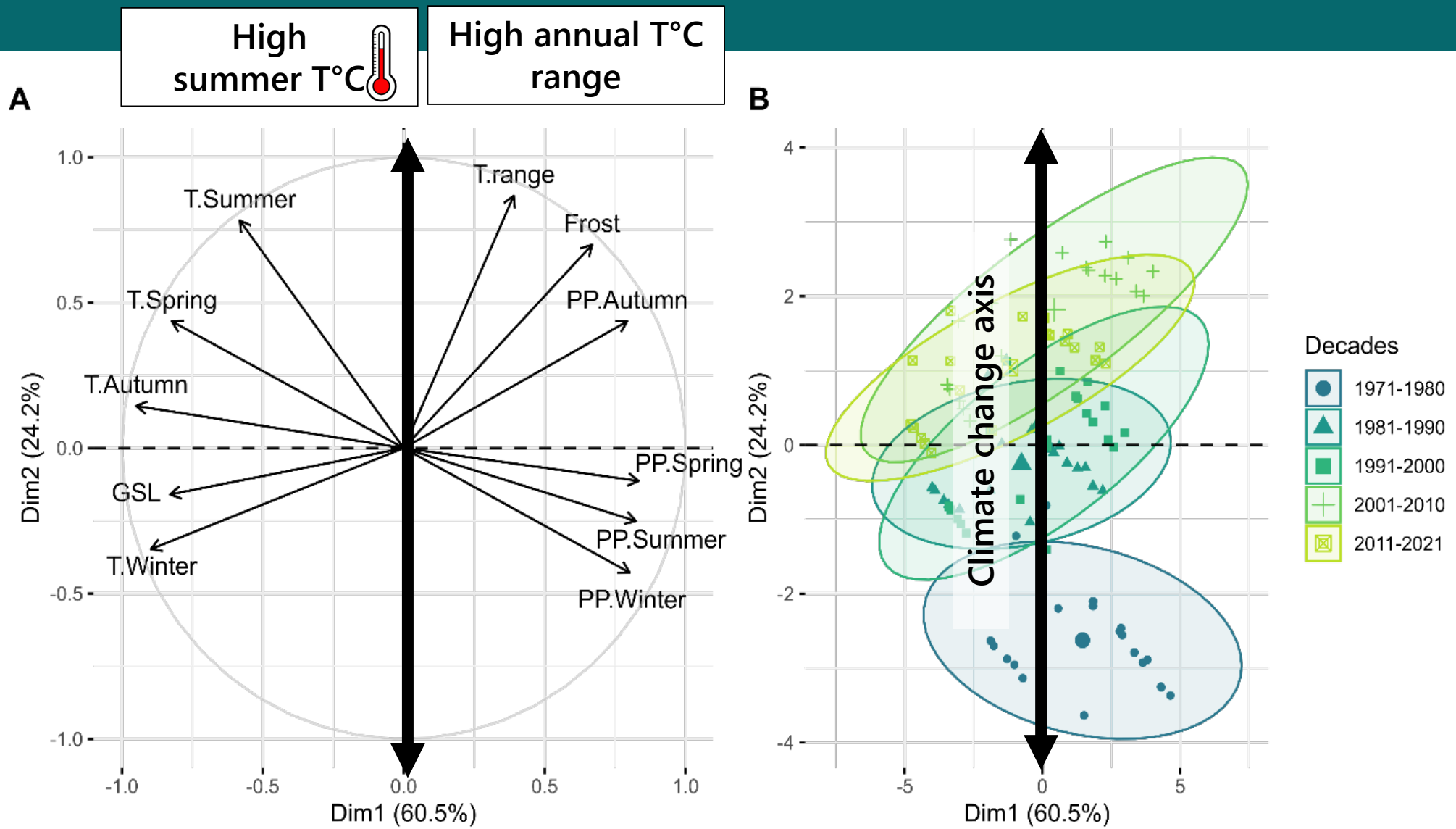
2020s

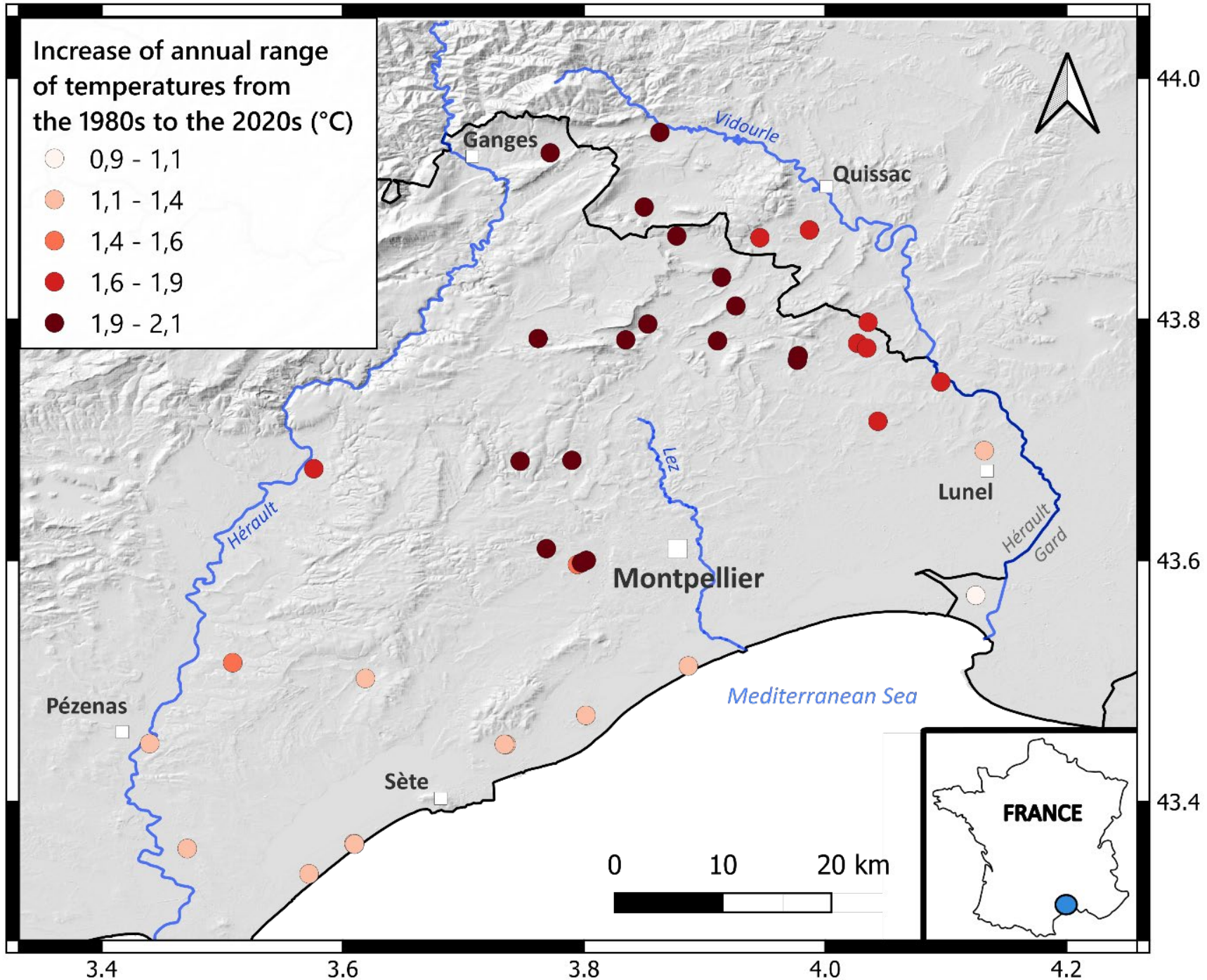
Climate change ?




High rainfall
High autumn T°C
Ganges
Quissac
Vidourle
Lez
Lunel
Montpellier
Hérault
Gard
Pézenas
Sète
Mer Méditerranée
0 10 20 km
FRANCE
44.0
43.8
43.6
43.4
3.4
3.6
3.8
4.0
4.2

Le changement climatique ?




Increase of annual range of temperatures from the 1980s to the 2020s (°C)
0,9 - 1,1
1,1 - 1,4
1,4 - 1,6
1,6 - 1,9
1,9 - 2,1
Ganges
Vidourle
Quissac
Lunel
Hérault
Lez
Montpellier
Hérault
Gard
Mediterranean Sea
Pézenas
Sète
0
10
20 km
FRANCE
44.0
43.8
43.6
43.4
3.4
3.6
3.8
4.0
4.2

What changes in the environment and farming practices in 40 years ?

1980s

What changes in the environment and farming practices in 40 years ?

Climate change ✓
+ 2°C of summer T°C

2020s

What changes in the environment and farming practices in 40 years ?

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Climate change ✓
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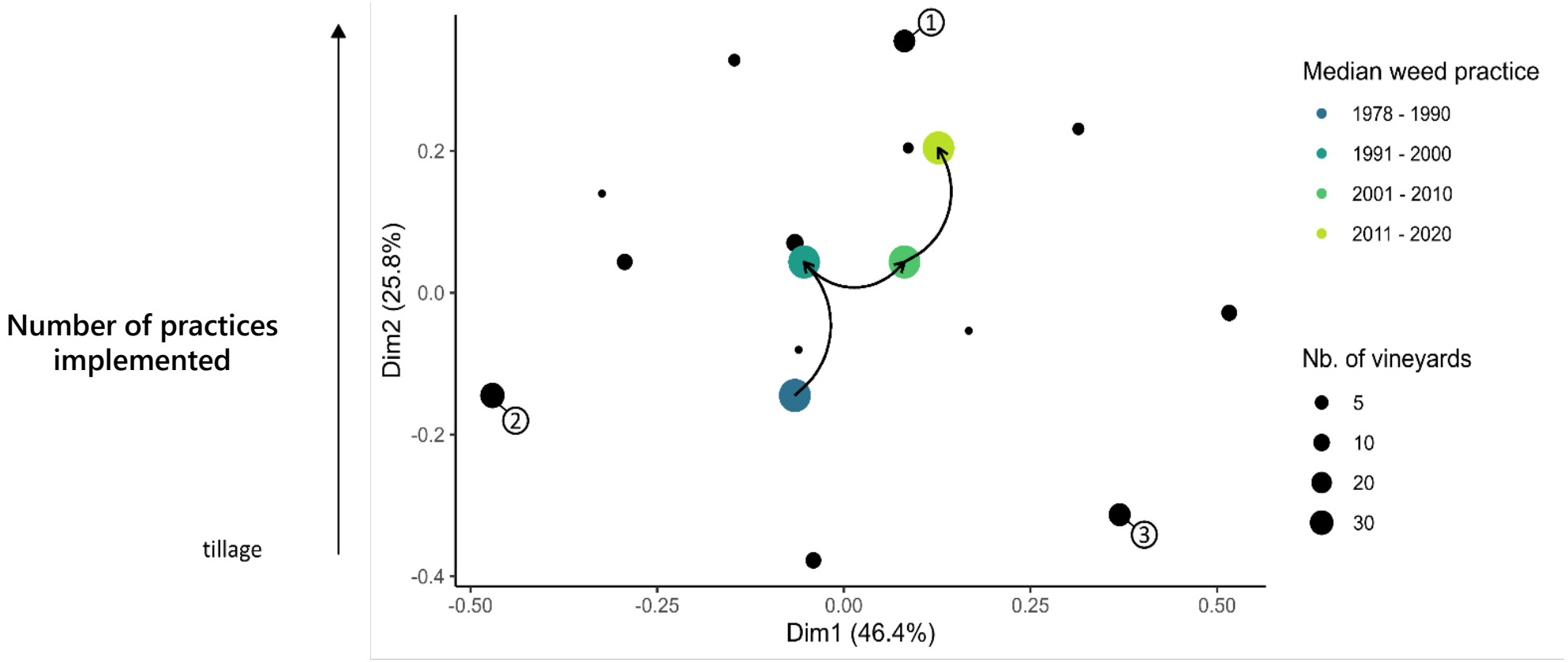
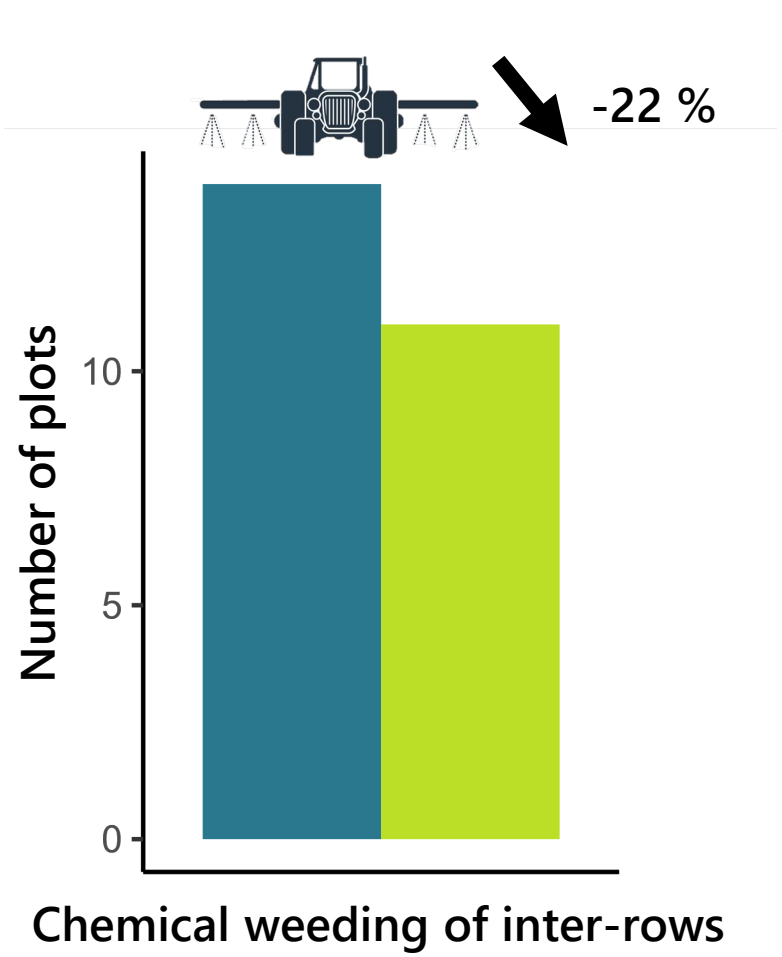
Weed management practices ?

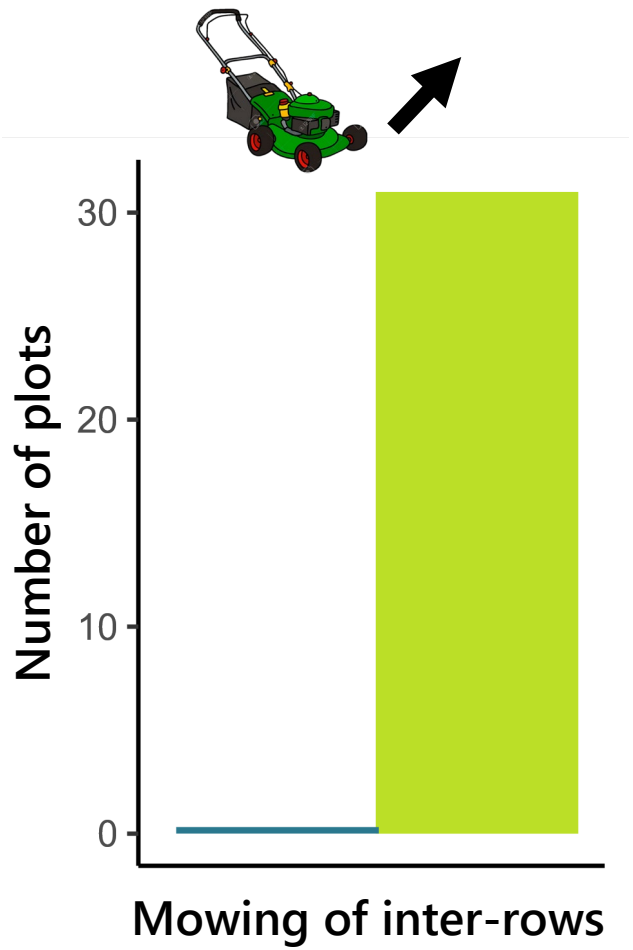
2020s

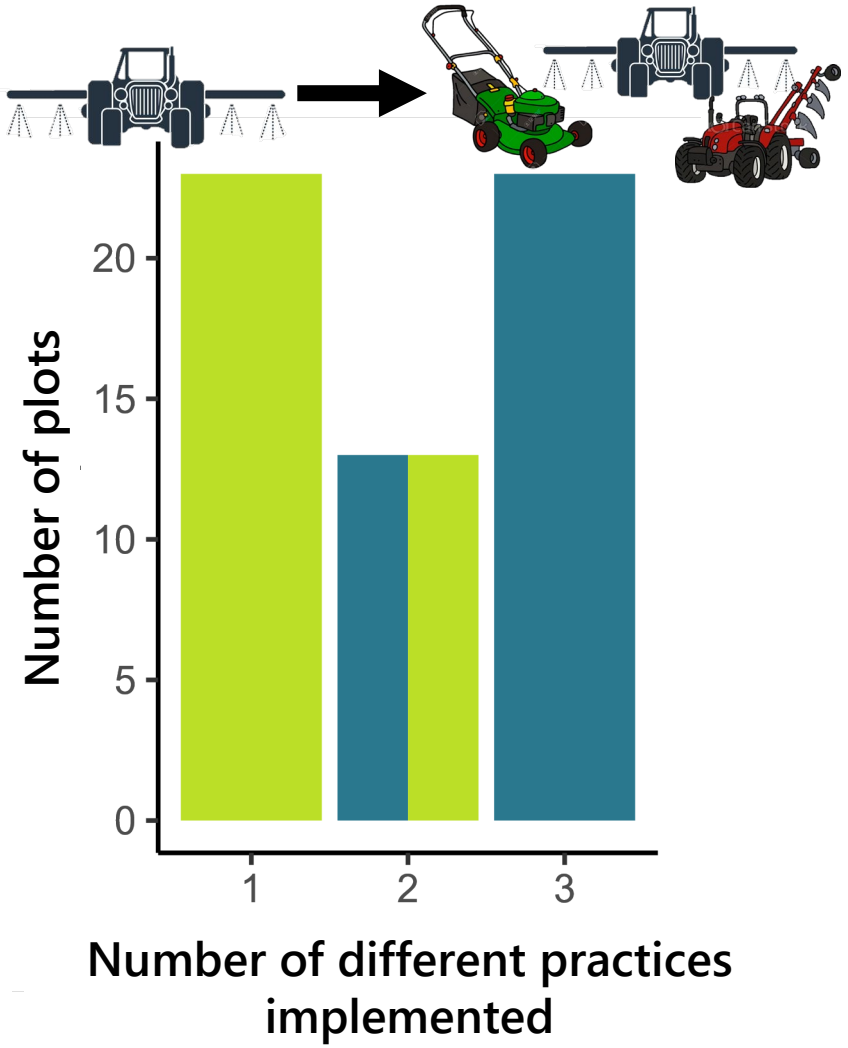
Characterization of practice trajectories



Changes in weed management practices over time







Management 1980 2020

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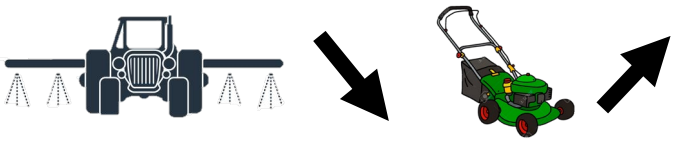
Climate change ✓
+ 2°C of summer T°C

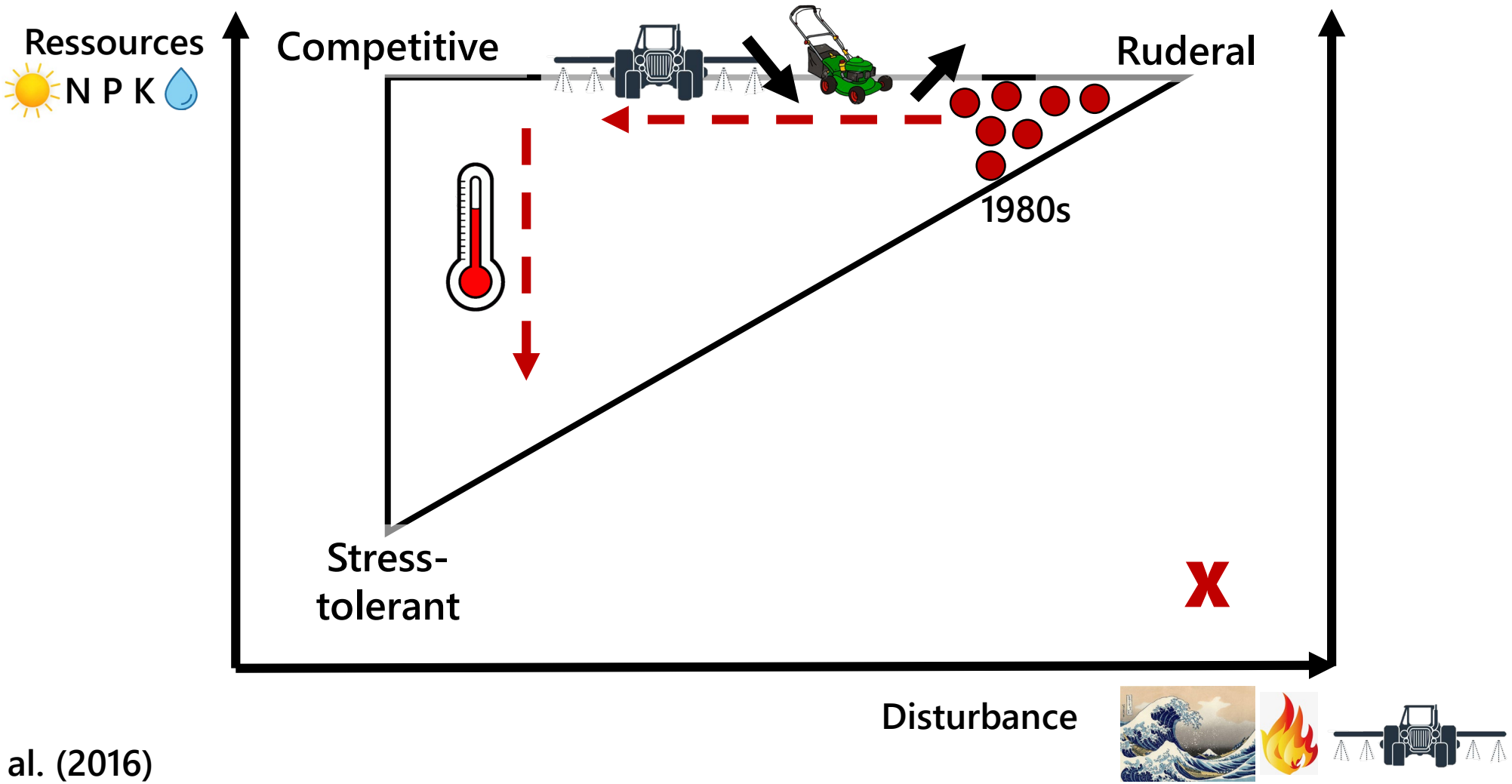
Weed management practices ✓



2020s

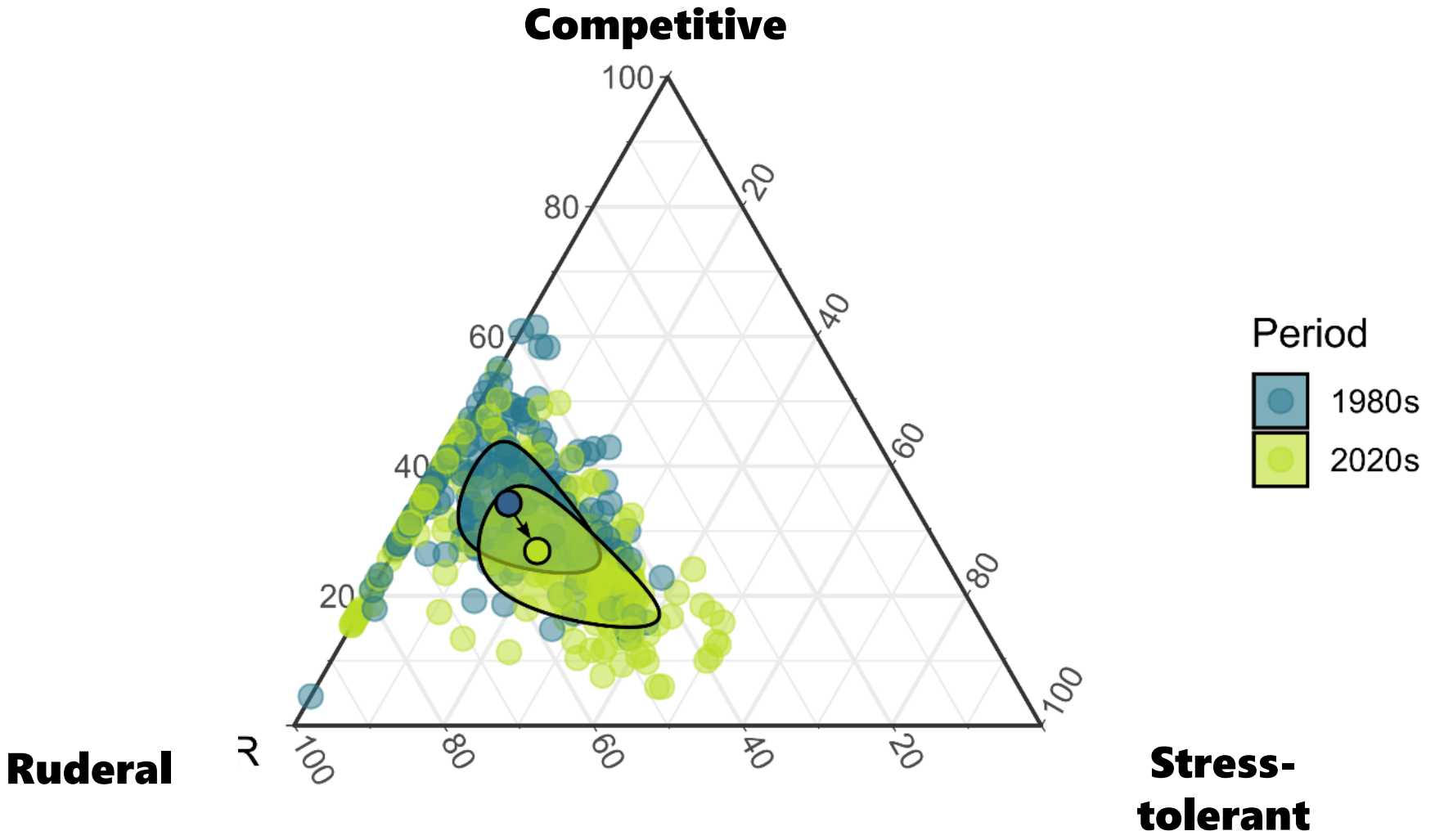
How have CSR strategies of weed communities changed from the 1980s to the 2020s ?

Hypothesis on the trajectory of community CSR strategies in response to climate and practice change



Kazakou et al. (2016)

CSR strategies of weed communities in Montpellier from 1980 to today



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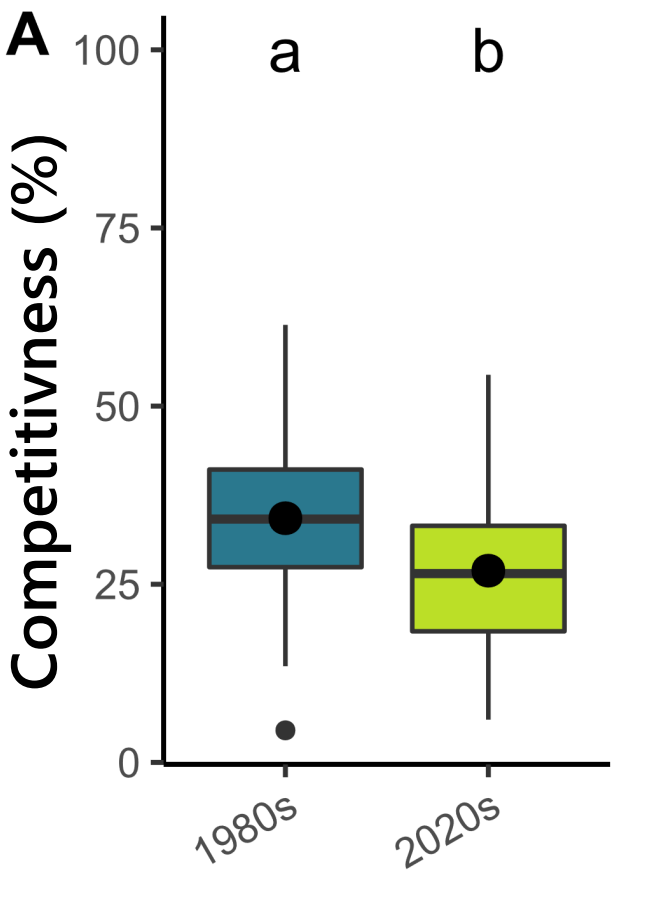
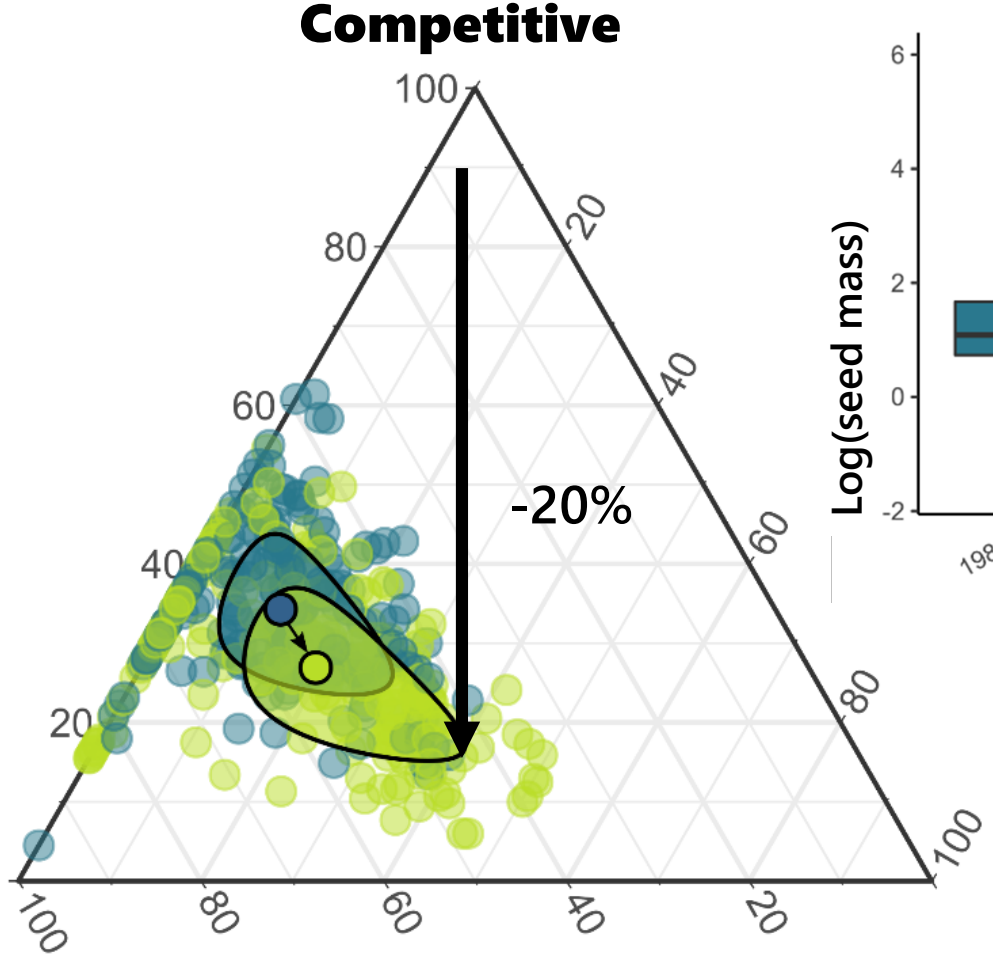
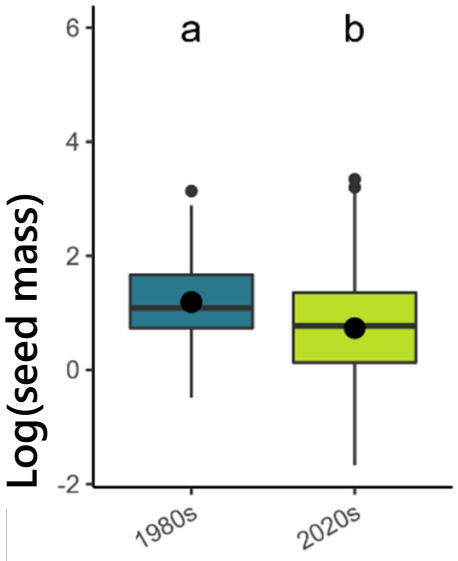
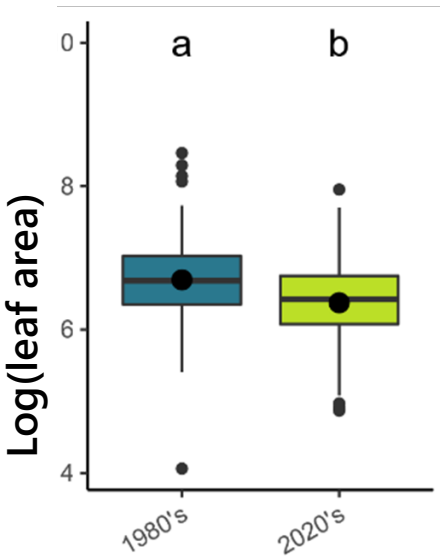
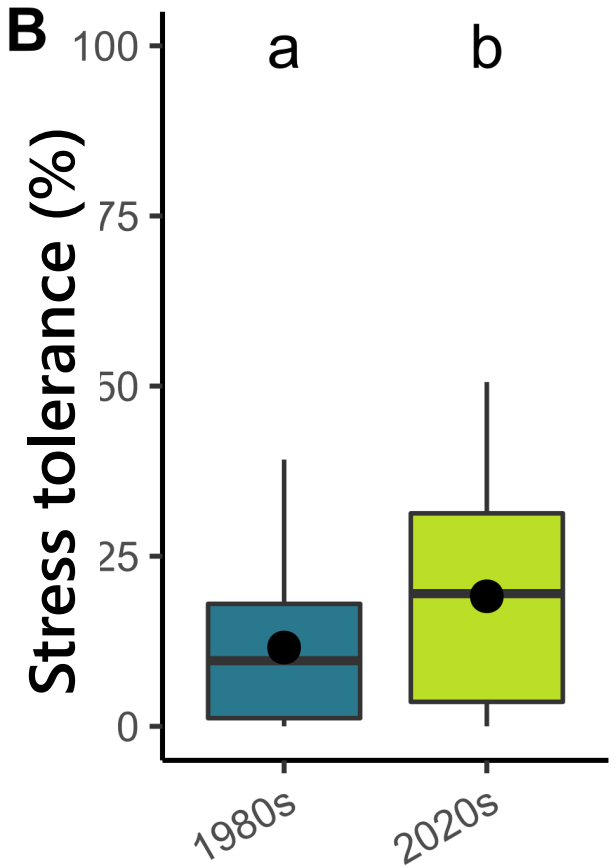


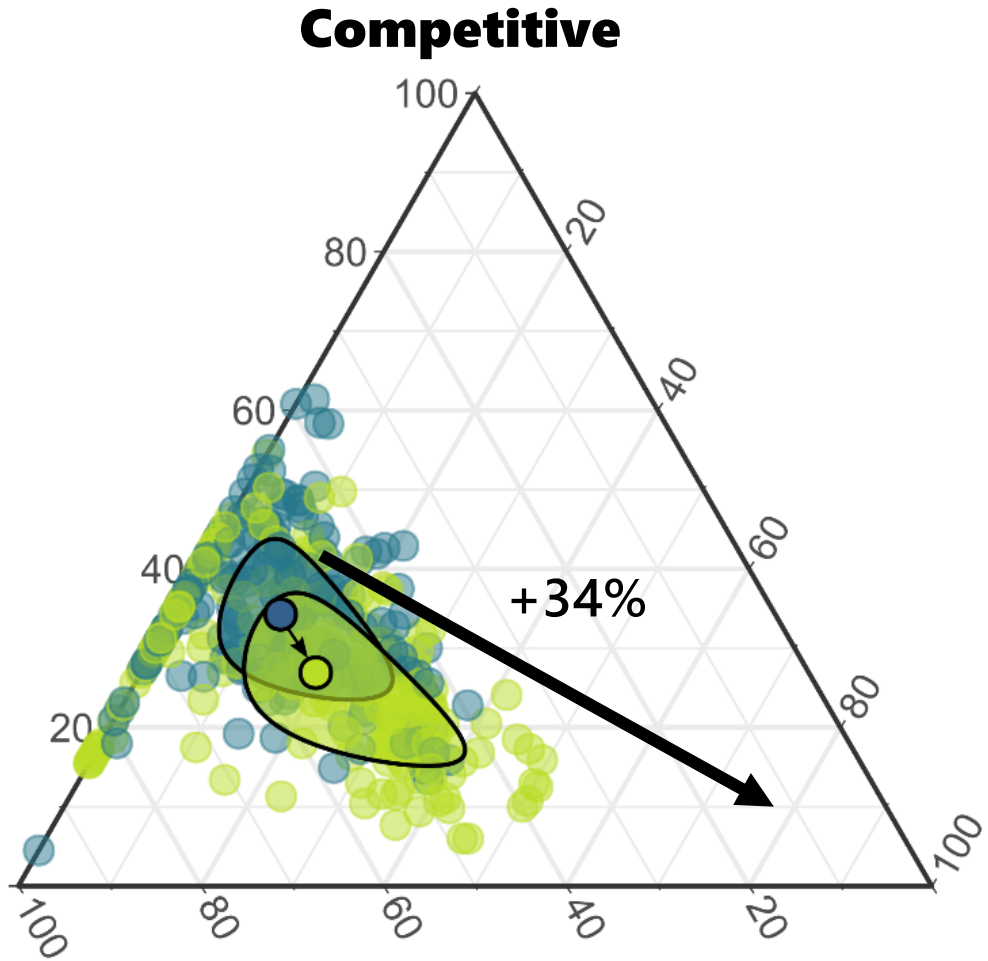


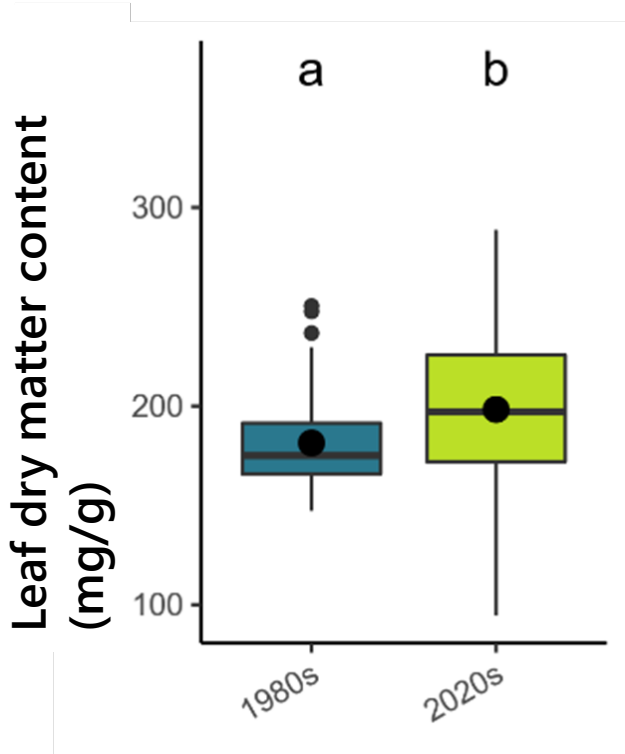




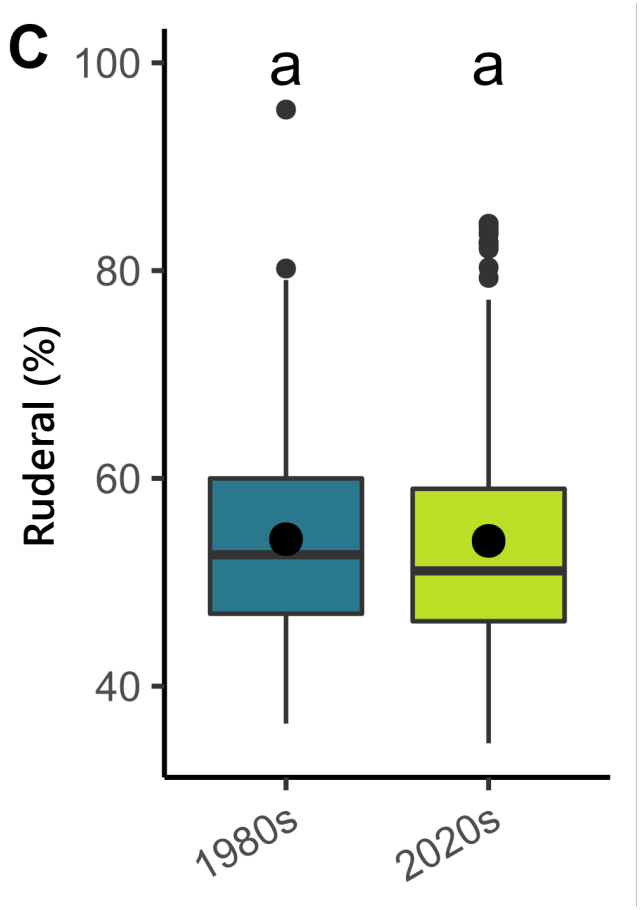
CSR strategies of weed communities in Montpellier from 1980 to today

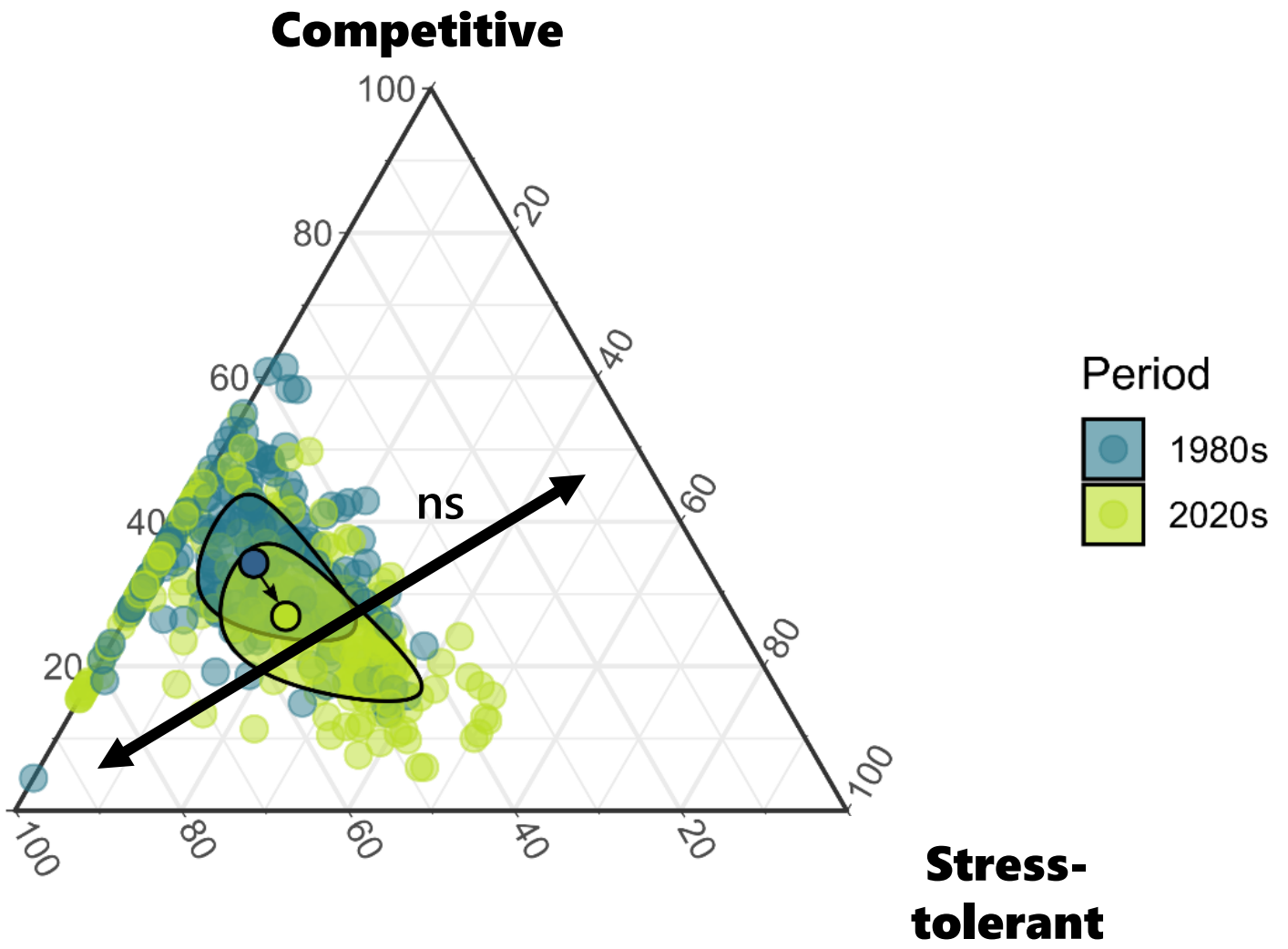






CSR strategies of weed communities in Montpellier from 1980 to today



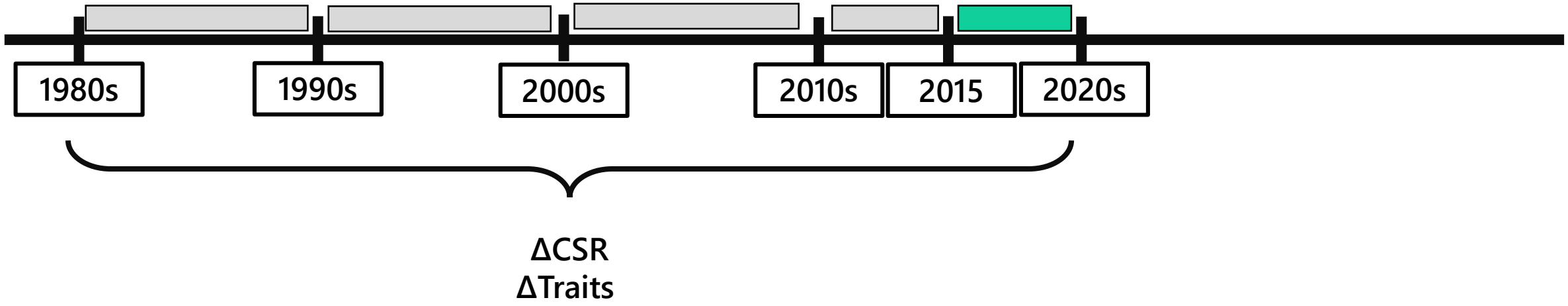


What effects do environmental and agricultural changes have on changes in CSR strategies of weed communities?

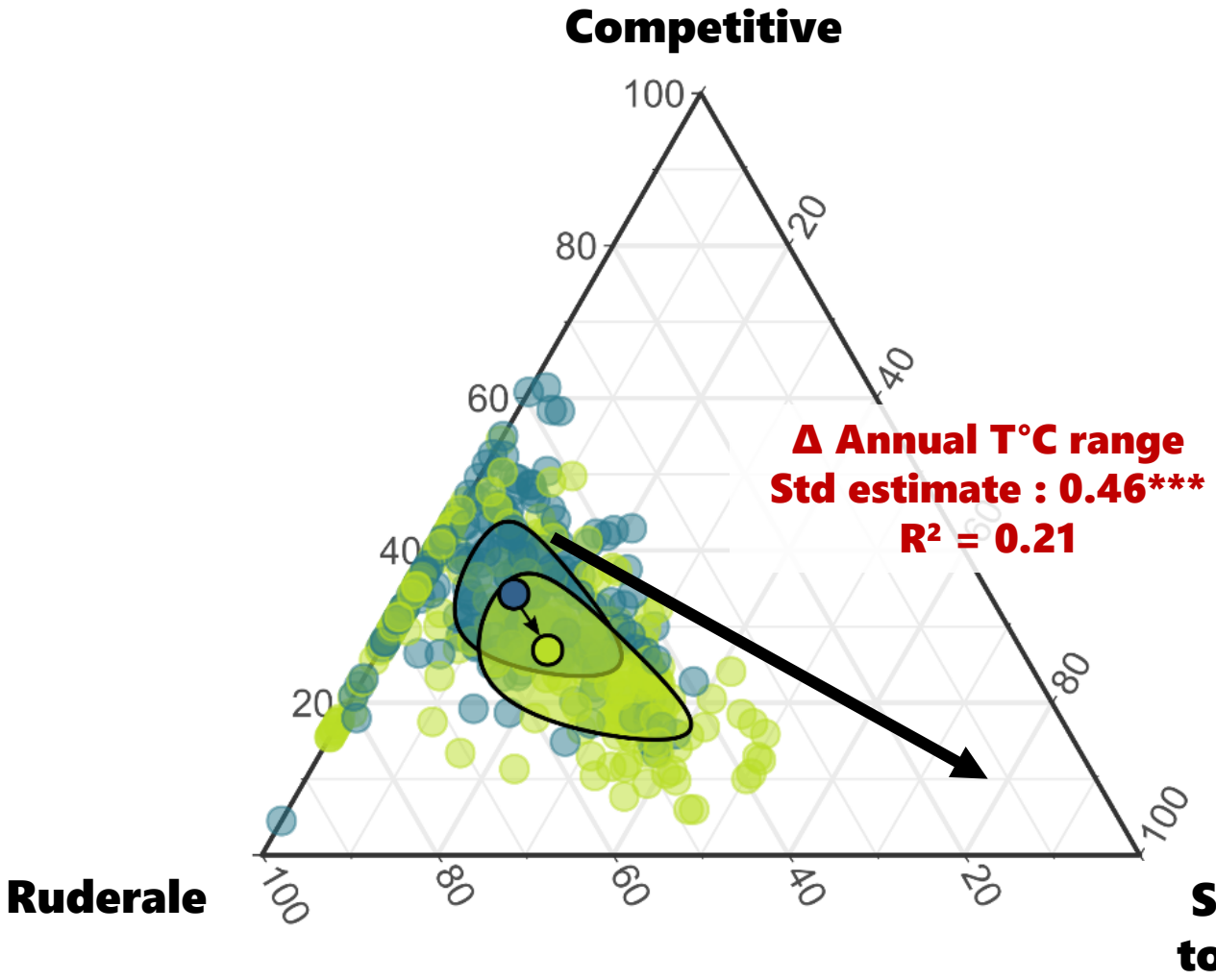
CLIMATE CHANGE
ΔAnnual T°C range

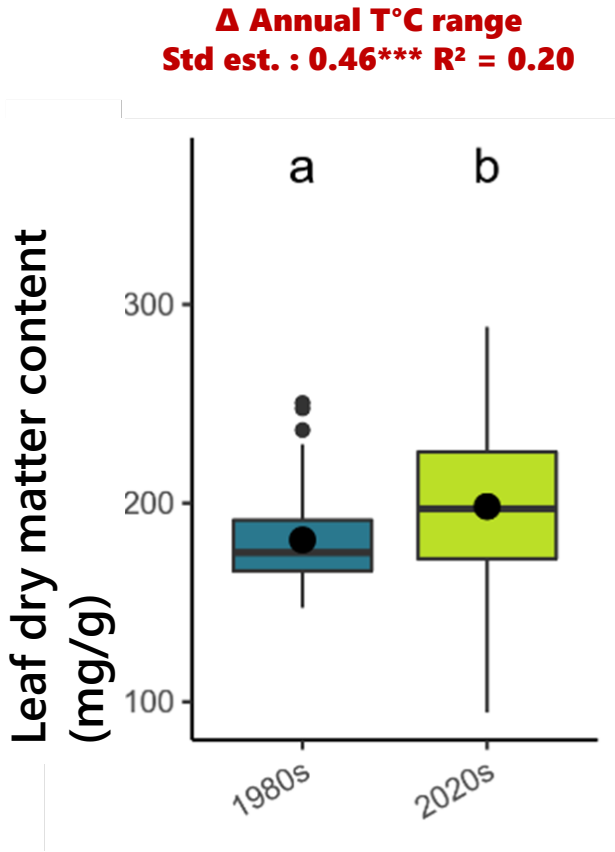
PRACTICE TRAJECTORY
Diversification of management practices
Nb of decades with herbicide application
Nb of decades with mowing application

RECENT PRACTICES
(1) Mostly tillage
(2) Chemical weed control in majority
(3) Tillage (IR) + Chemical weed control (R)
(4) Mowing (IR) + Tillage (R)

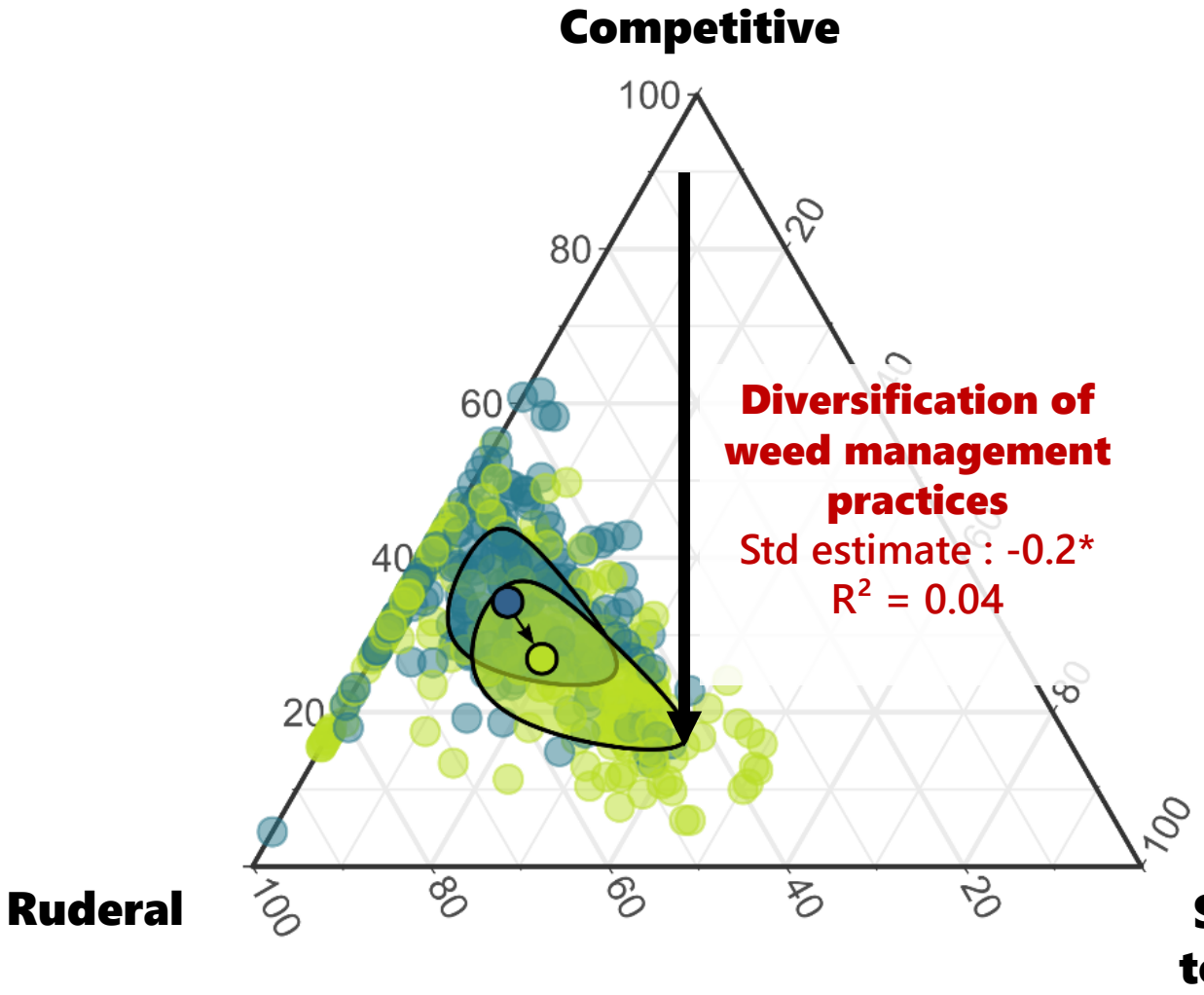


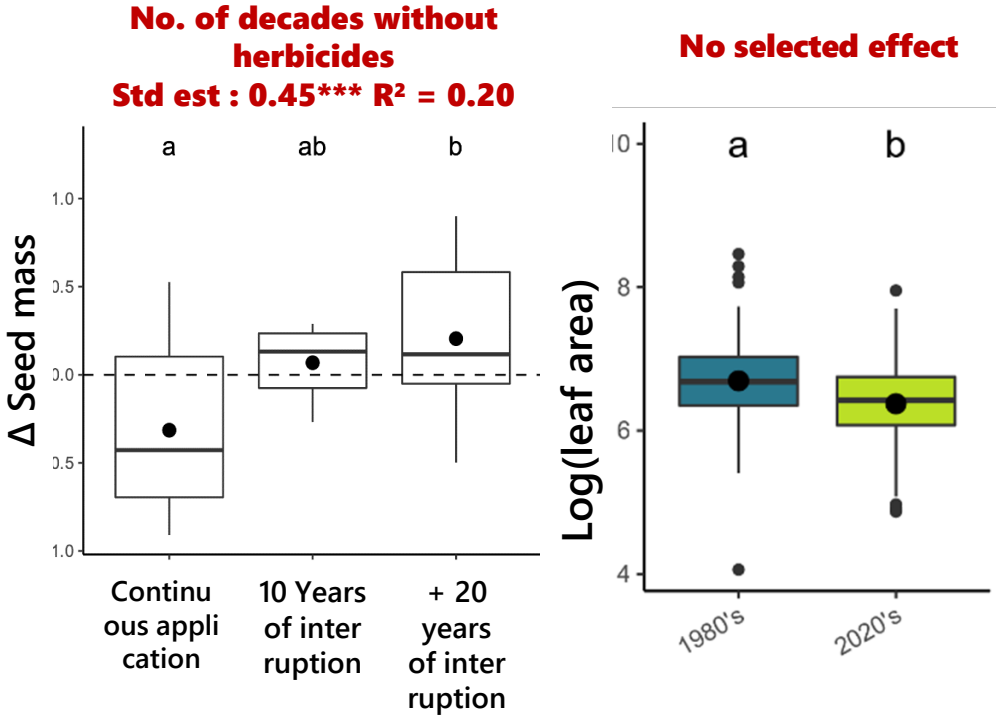
More stress-tolerant communities in response to CC intensity?





Less competitive communities in response to diversified management practices





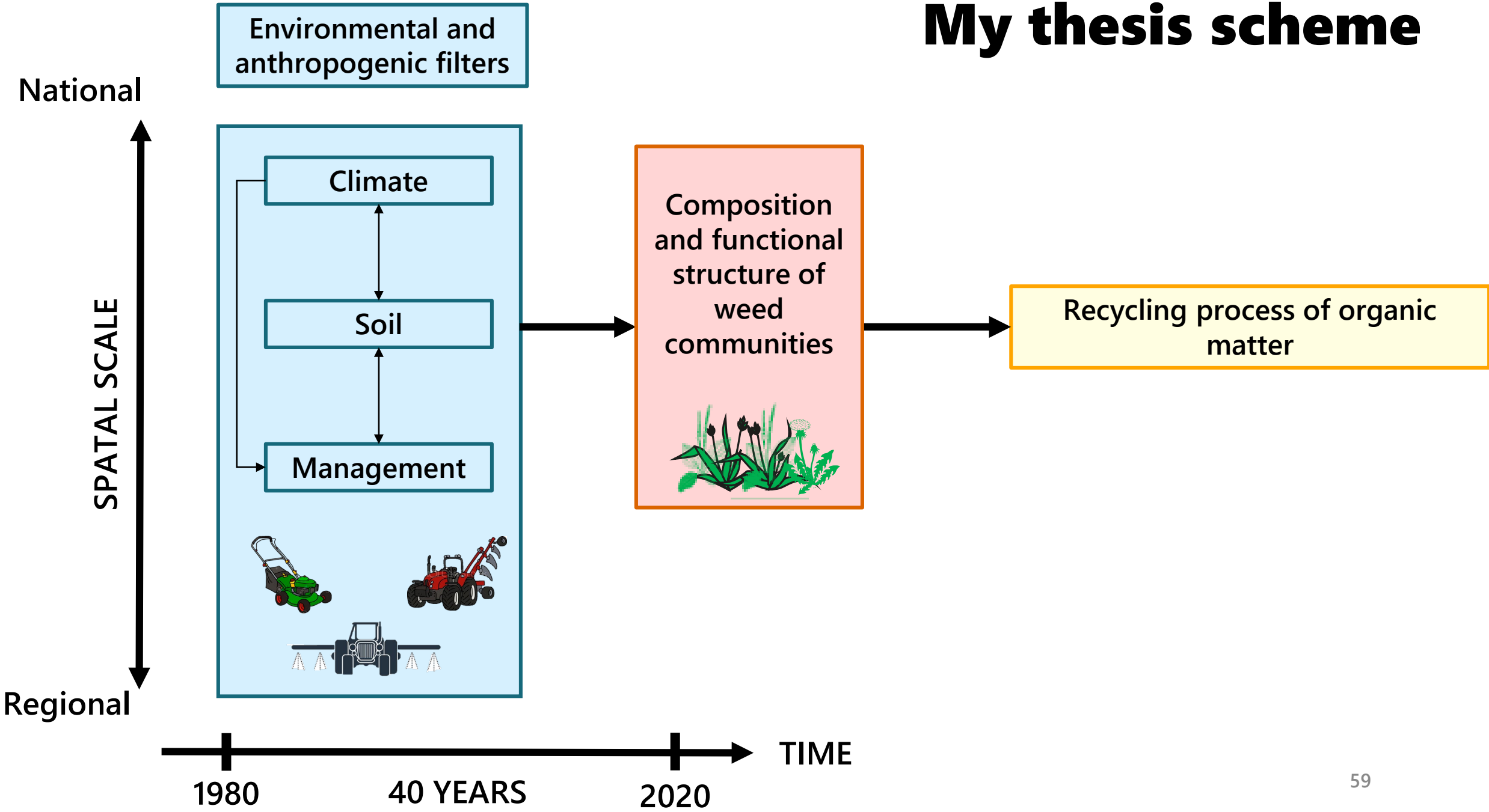
Take-home messages

- Current communities are less competitive than 1980s communities, induced by a diversification of weed management

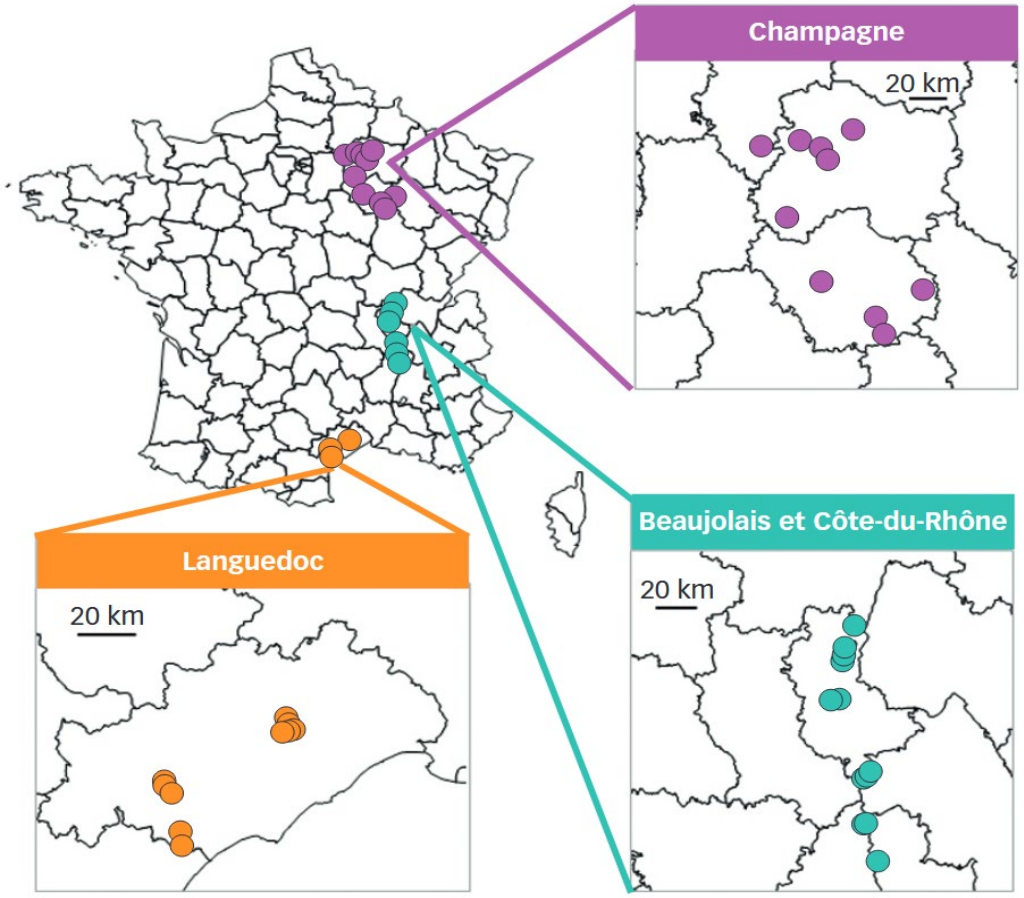
- Current communities are more stress-tolerant than 1980s communities, induced by an increase in annual thermal amplitude (*proxy* of climate change)

Discussion and perspectives

My thesis scheme

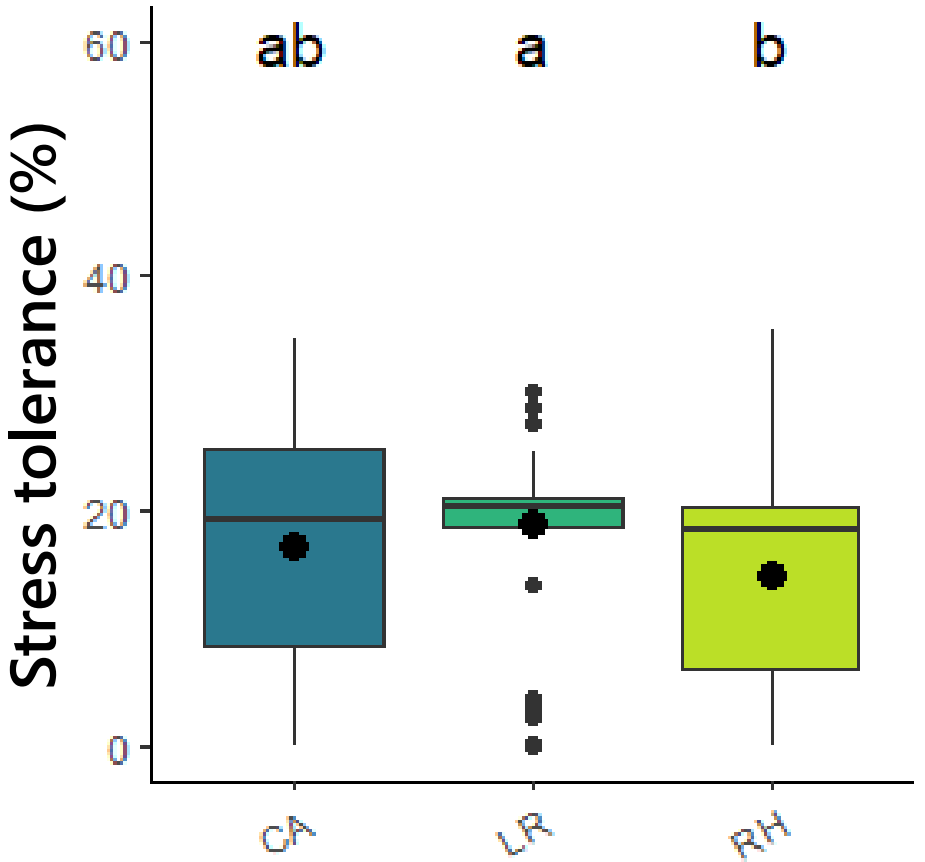


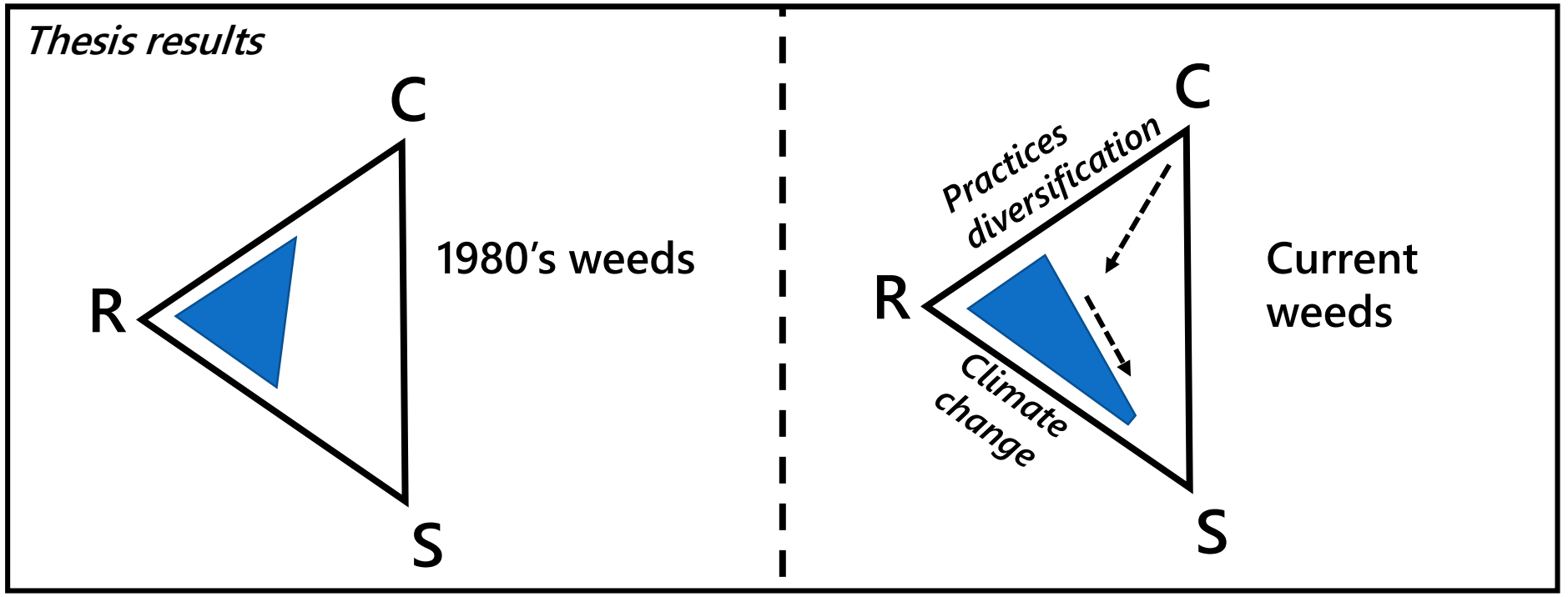
The national spatial gradient corroborates the results with the diachronic approach



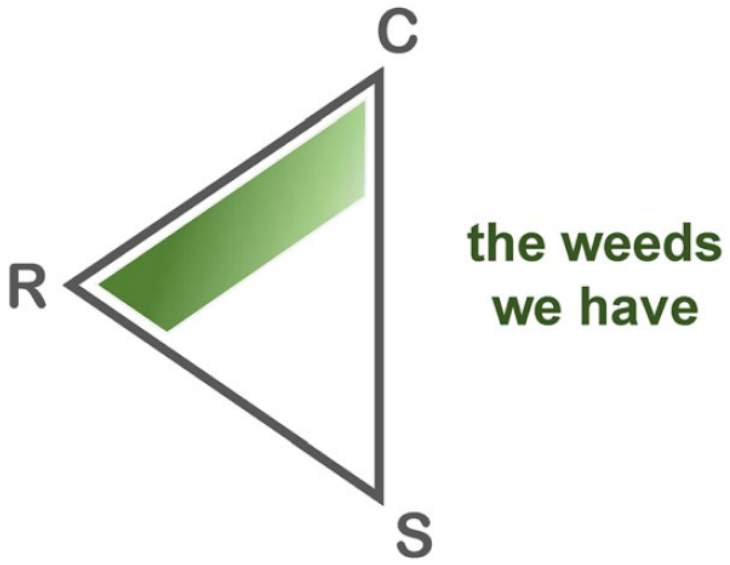
« Biovigilance Flore »

Fried et al. (2019)

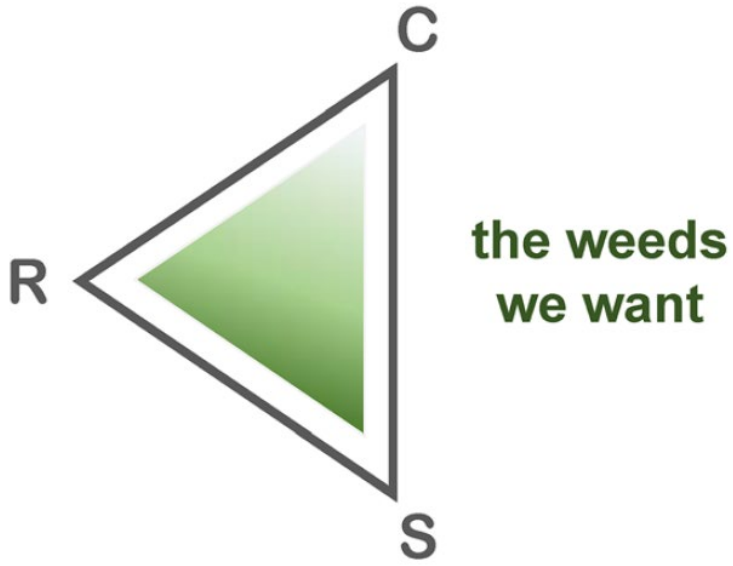



Thesis results
C
R
S
1980's weeds
C
Practices diversification
R
Climate change
S
Current weeds

MacLaren et al. (2020)

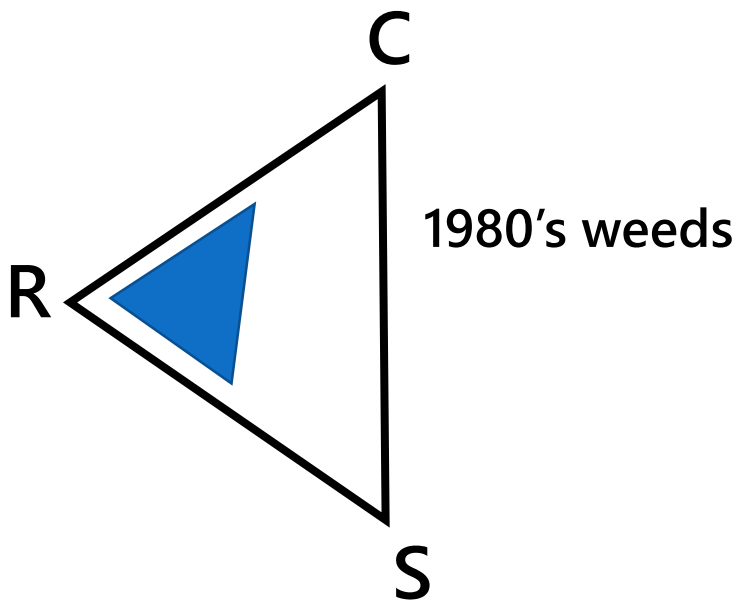


the weeds we have

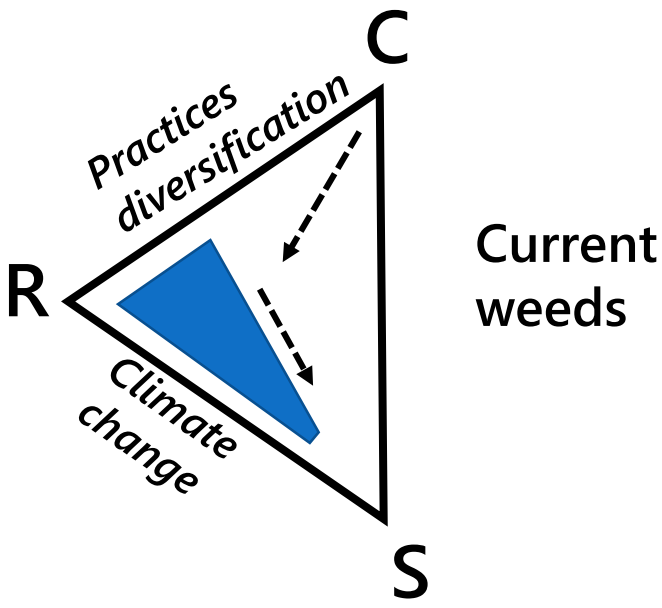


the weeds we want

Les résultats de la thèse



1980's weeds

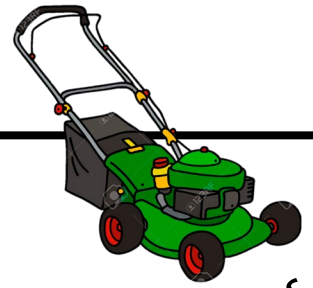


Current weeds

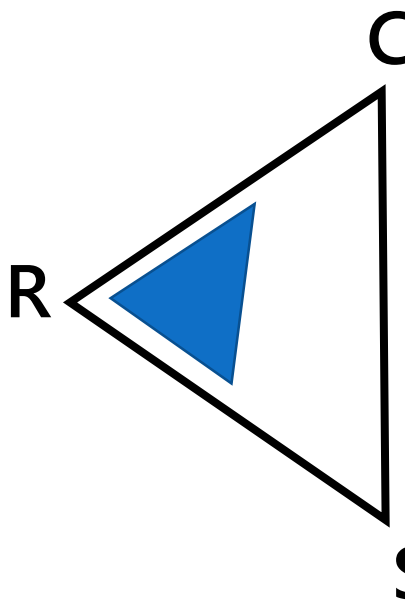
MacLaren et al. (2020)

the weeds we have

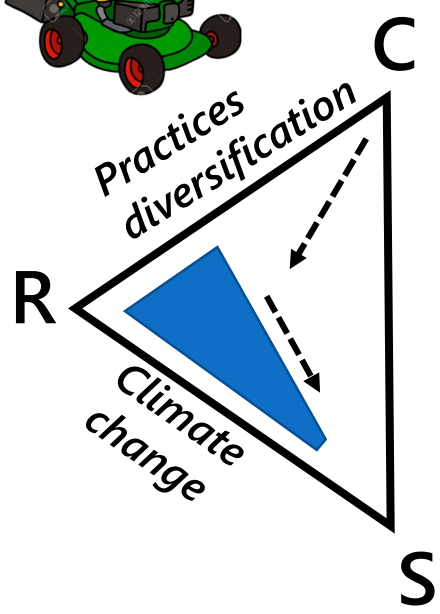
the weeds we want



Les résultats de la thèse

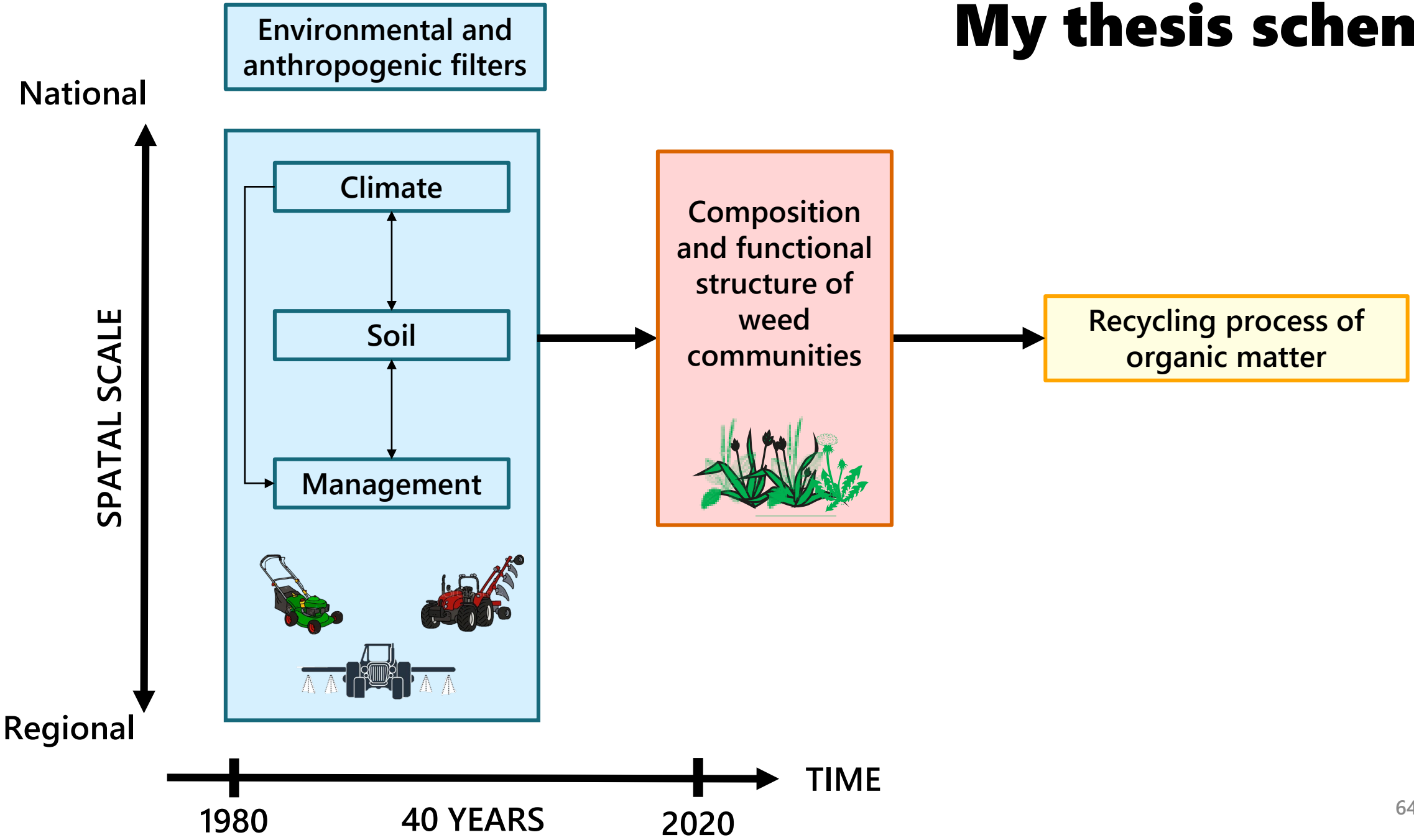


1980's weeds



Current weeds

My thesis scheme



Mowing, a promising practice for the installation of a favorable flora?

Richness x2

Microbial biomass
x2

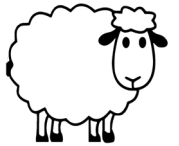
High decomposition potential
(12 %)

High biomass
+47 %

High proportion of legumes
+33 %

High nitrogen content
+46 %

Acceptable digestibility



Genty et al.
(2023)

Postdoc project

Post-doc project

- March to August 2023 in CBGP funded by Ecophyto GTP 500 ENI project
- Continuation of the post-doc of Laura Henckel (in UMR Agroécologie Dijon)
- Supervised by Christine Meynard and Guillaume Fried

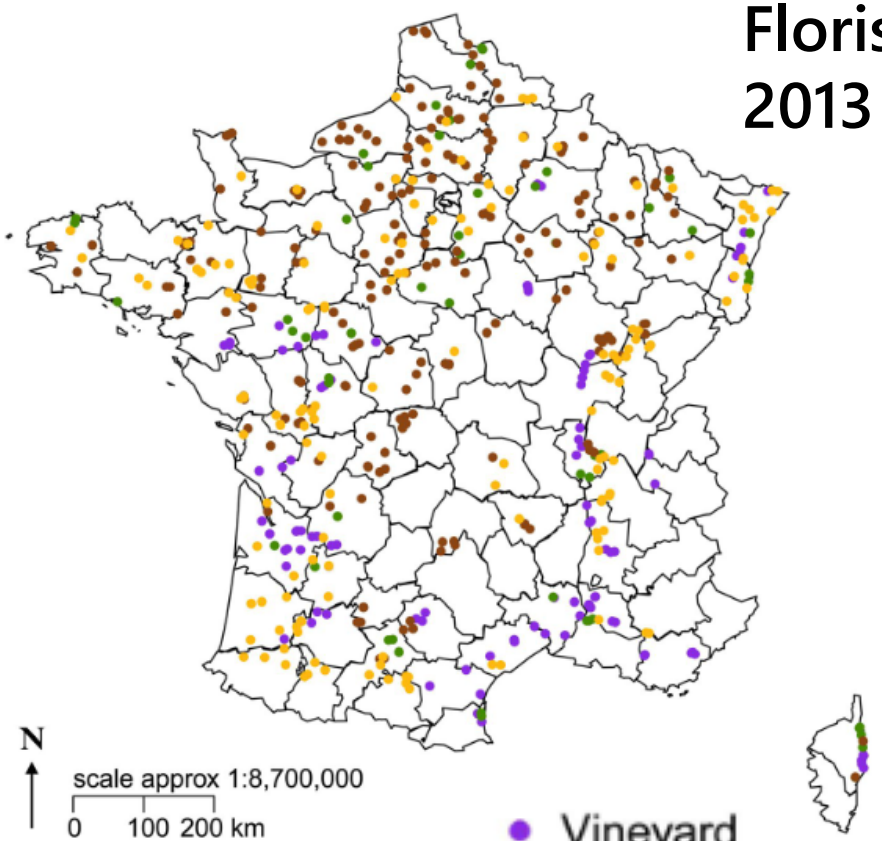
MINISTÈRE
DE L'AGRICULTURE
ET DE L'ALIMENTATION
Liberté
Égalité
Fraternité

ÉCOPHYTO
RÉDUIRE ET AMÉLIORER
L'UTILISATION DES PHYTOS

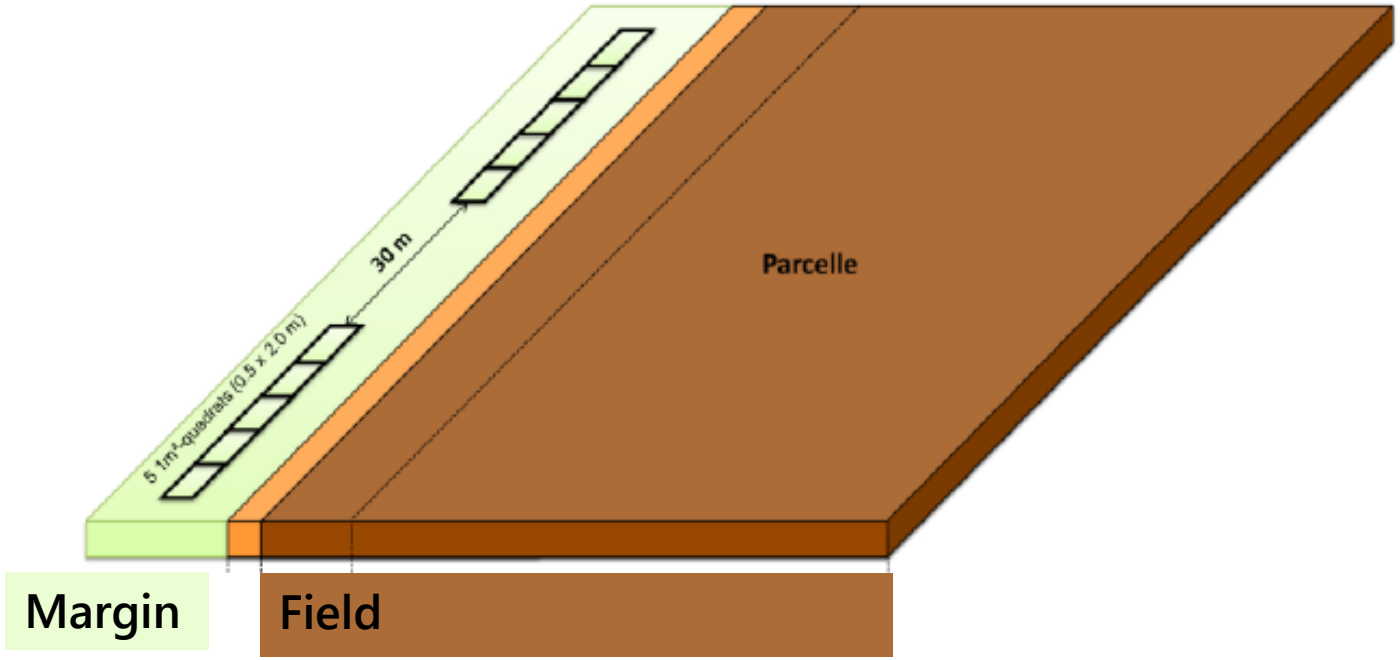
OFB
OFFICE FRANÇAIS
DE LA BIODIVERSITÉ

500 ENI network

Floristic surveys from 2013 to 2018

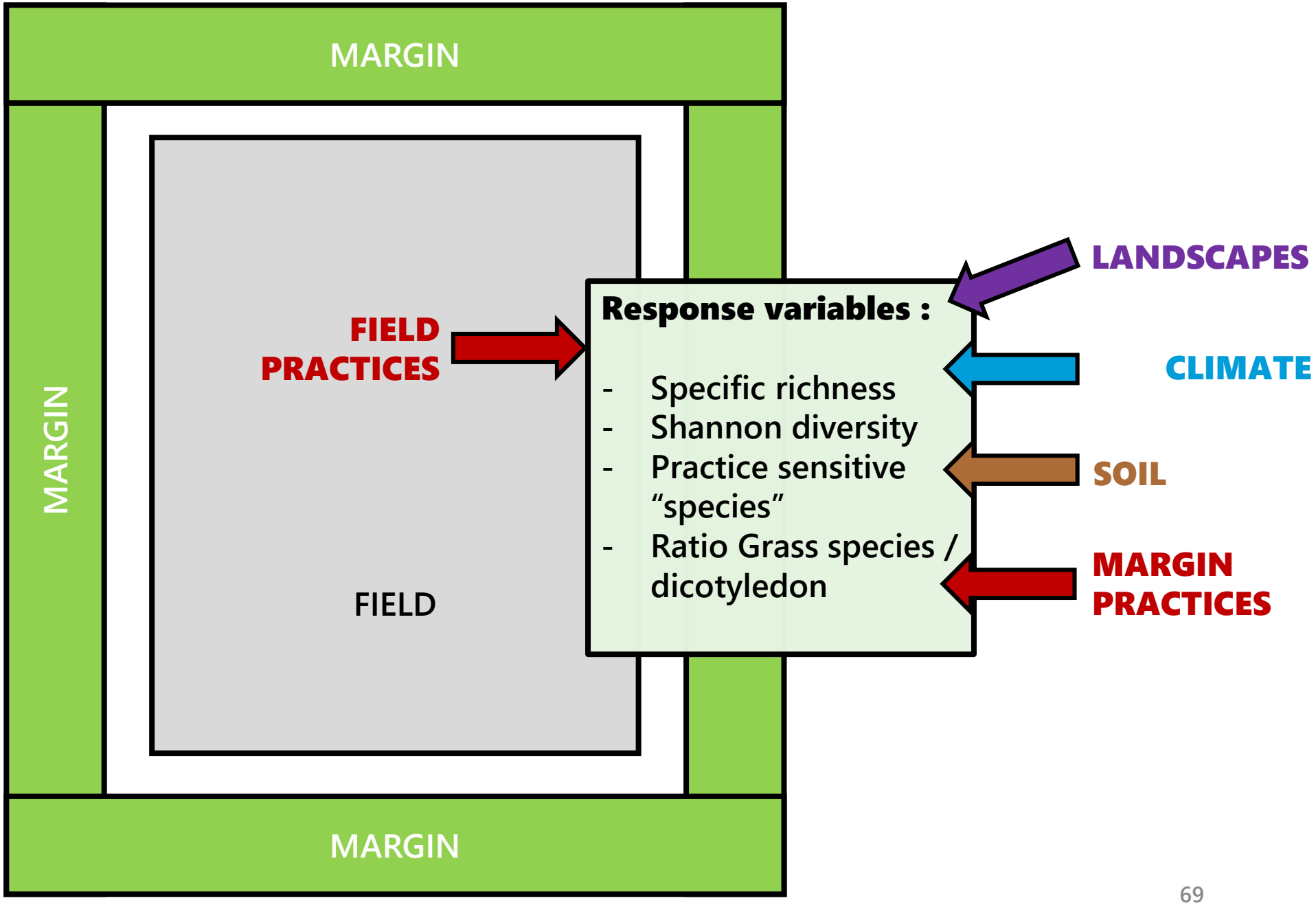


Andrade et al. (2020)

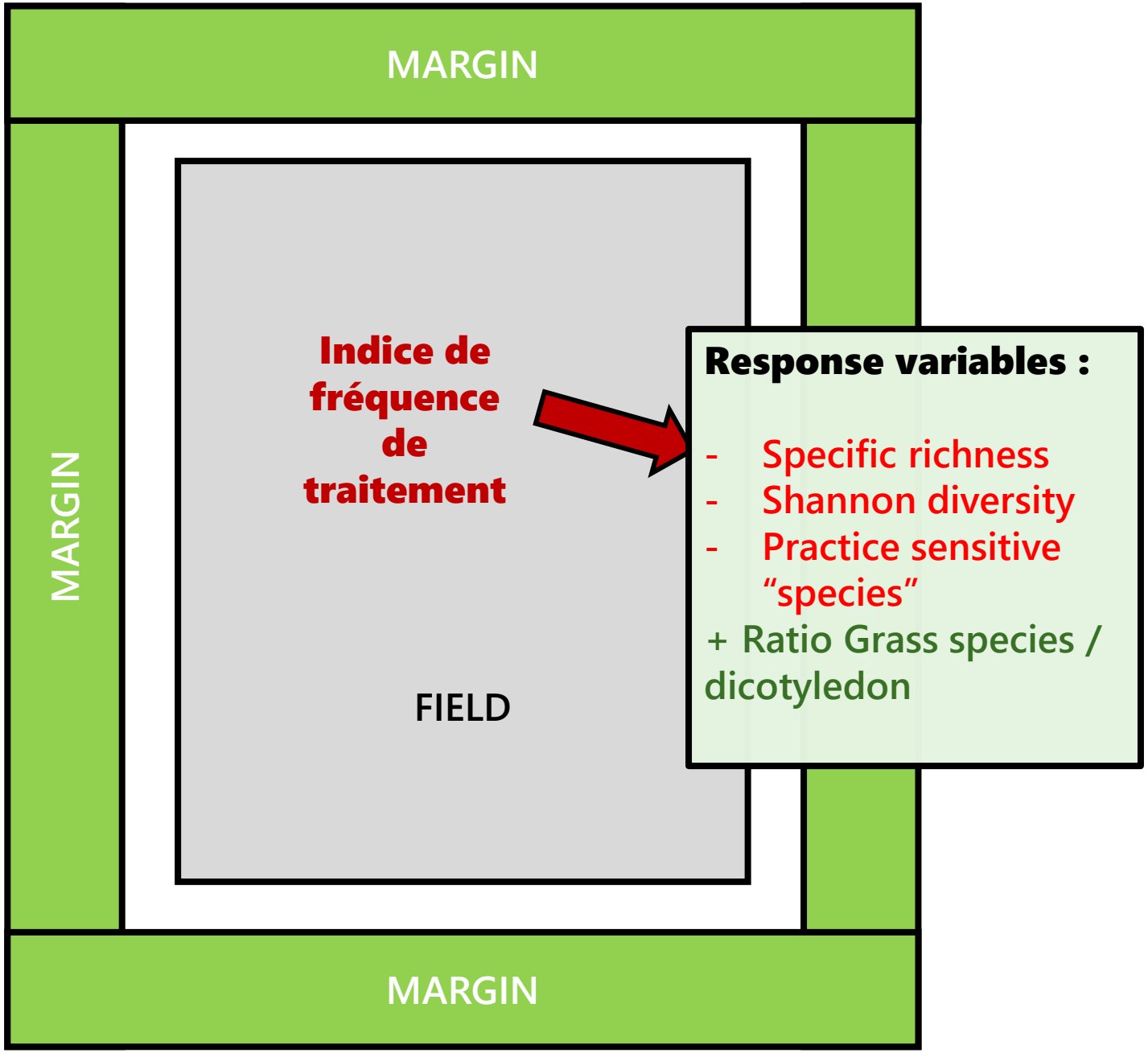


Plant sampling

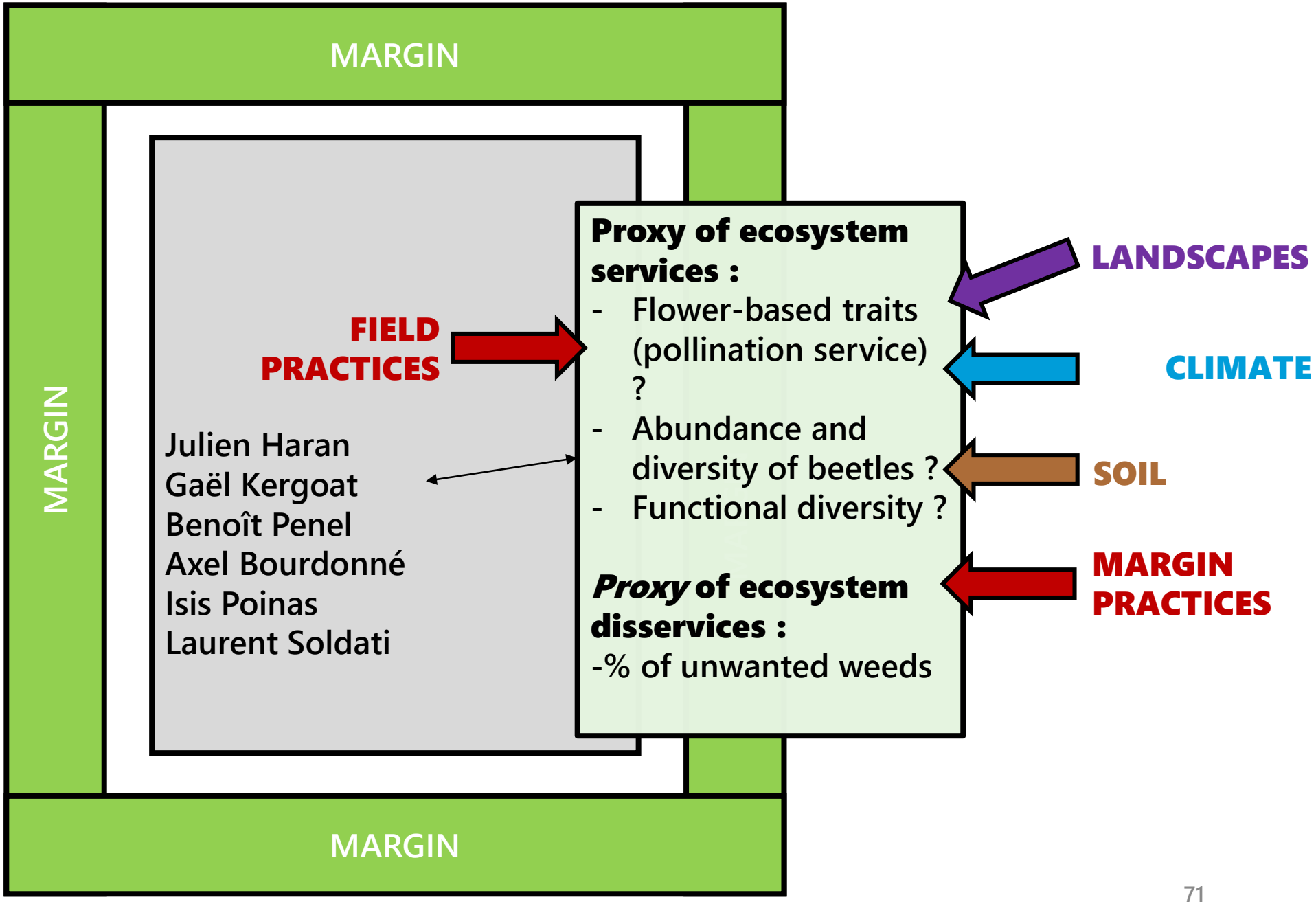
Analyses already done (1st part of the postdoc Henckel et al. *in prep*)

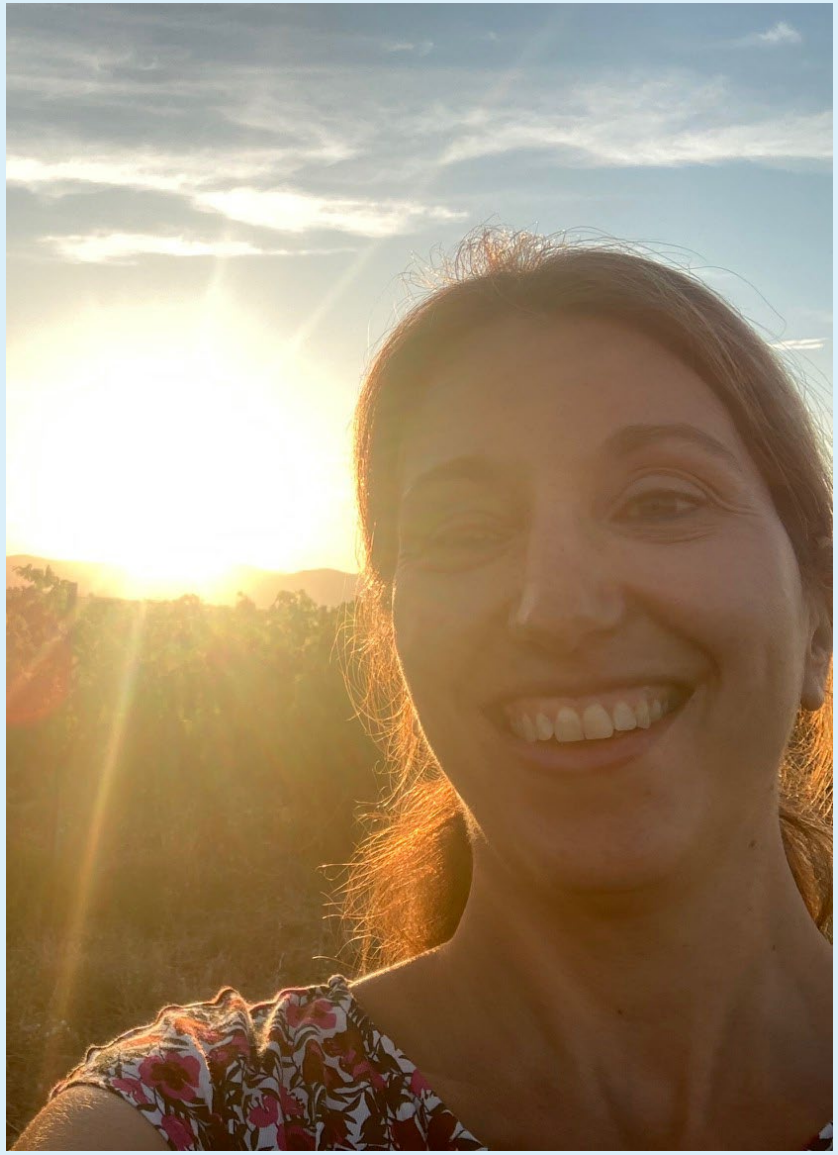


Analyses already done (1st part of the postdoc Henckel et al. *in prep*)



Postdoc project





THANK YOU !