SUITABILITY FOR SEED FARMING AS PART OF A TRAITS-BASED SELECTION TOOL FOR PROMOTING NATIVE COVER CROPS IN MEDITERRANEAN AGROECOSYSTEMS:

A CASE STUDY FROM SPANISH OLIVE ORCHARDS.

Stephanie Frischie, Borja Jiménez-Alfaro, Cándido Gálvez

UNIVERSITÀ DI PAVIA

SEMILLAS SILVESTRES

NASSTEC

PEOPLE

MARIE CURIE ACTIONS

Stephanie Frischie[1,2], Borja Jimenez-Alfaro[3], Cándido Galvez Ramirez[1]

1 Semillas Silvestres, S.L., Córdoba, Spain
2 Department of Earth and Environmental Sciences, University of Pavia, Italy
3 German Centre for Integrative Biodiversity Research (iDiv), Halle-Jena-Leipzig, Germany

SPECIES SELECTION TOOL: BEHIND THE SCENES

1. Background
   - Habitat
   - Restoration goals
2. Approach
3. Results from seed farming evaluation
4. Forthcoming selection tools

Context

Native seed company in Spain recognizes an emerging market and unmet need for seeds of native herbaceous species to use as understory in woody crops

+

NASSTEC grant to develop native seed industry and research

=

PhD project to identify suitable native species for the application and how to commercially produce seeds

→

DATA FROM THAT RESEARCH IS THE FOUNDATION FOR A FUTURE SELECTION TOOL USED BY FARMERS AND NATIVE SEED COMPANIES

Context

Native seed company in Spain recognizes an emerging market and unmet need for seeds of native herbaceous species to use as understory in woody crops

+

NASSTEC grant to develop native seed industry and research

=

PhD project to identify suitable native species for the application and how to commercially produce seeds

UNIVERSITÀ DI PAVIA

DATA FROM THAT RESEARCH IS THE FOUNDATION FOR A FUTURE SELECTION TOOL USED BY FARMERS AND NATIVE SEED COMPANIES

Background

Olive cultivation

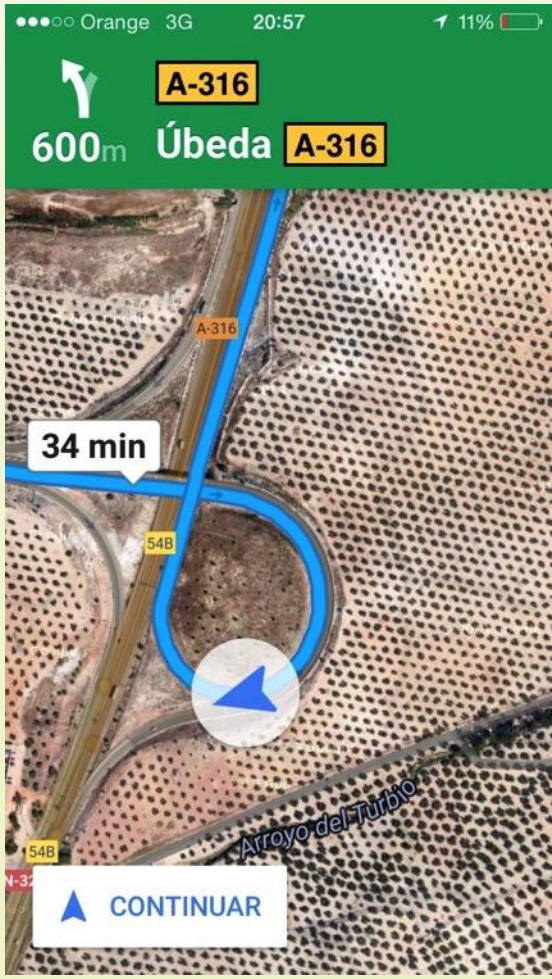
- *Olea europaea* subsp. *europaea*
- Perennial woody crop
- Native to Mediterranean Basin
- Adapted to poor soils and drought
- Wind-pollinated flowers in April
- Fruit set during dry summer period, harvest Oct-Dec
- Fruits are perishable, mechanically removed from trees and taken to mill within hours
- Hundreds of varieties for microconditions of soil, climate, end use, plantation system
- Water availability and pests are main limits to production

Background

Olive production

Background

Olive production



Background

Agriculture and biodiversity in Spain

80% of global production from Spain (2x more than next producer, Italy)

80% of Spanish production from Andalusia
30% (2.6 m ha) of land area in Andalusia

EuroStat 2014.

Background

Agriculture and biodiversity in Spain

soil seedbank

Taxon	Number of germinated seedlings	Percent of total germinated seedlings
Spergularia sp.	1279	51%
Pulicaria paludosa	535	21%
Conyza spp.	327	13%
Anagallis arvensis	105	4%
Galium aparine	144	6%
Apiaceae	83	3%
Other	47	2%
Total	2520	100%

85%

Background

Agriculture and biodiversity in Spain

BARE SOIL

↑ ecological simplification

↑ soil erosion

↓ sustainability and long-term productivity

Land Use Policy 42 (2015) 683–694

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Vulnerability of olive orchards under the current CAP (Common Agricultural Policy) regulations on soil erosion: a study case in Southern Spain

E.V. Taguas[a,*], J.A. Gómez[b]

[a] Rural Engineering Department, University of Cordoba, Campus Rabanales, Leonardo Da Vinci building, 14071 Cordoba, Spain
[b] Agronomy Department, Institute for Sustainable Agriculture, Consejo Superior de Investigaciones Científicas, Alameda del Obispo s/n, Cordoba, Spain

Background

Agriculture and biodiversity in Spain

COVER CROPS

↓ ecological simplification

↓ soil erosion

↑ sustainability and long-term productivity

Cover crops in Spanish olive orchards

- Current species/varieties available to farmers are forage legumes, grasses and brassicas from temperate Eurasia.

  excess biomass + phenology + water use =

- Poor fit with Med climate and olive farming

  high maintenance & cost (tillage, mowing, herbicide) =

- Low acceptance rates

Cover crops in Spanish olive orchards

Photo: A. Bianchi

Need for cover crops species which:

- have short life cycle in winter, senesce at onset of summer dry season
- protect soil from erosion
- host beneficial insects
- are suitable to seed increase for sufficient seed supply

Background

Interest in native cover crops

Germination trials of annual autochthonous leguminous species of interest for planting as herbaceous cover in olive groves

Gema Siles*, Juan A. Torres, Luis Ruiz-Valenzuela, Antonio García-Fuentes

Departamento de Biología Animal, Biología Vegetal y Ecología, Área de Botánica, Facultad de Ciencias Experimentales, Universidad de Jaén, Paraje Las Lagunillas s/n., Jaén, Spain

Agriculture, Ecosystems and Environment 217 (2106) 119-127

Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (INIA)
http://dx.doi.org/10.5424/sjar/2014123-5255

Spanish Journal of Agricultural Research 2014 12(3): 633-643
ISSN: 1695-971X
eISSN: 2171-9292

RESEARCH ARTICLE

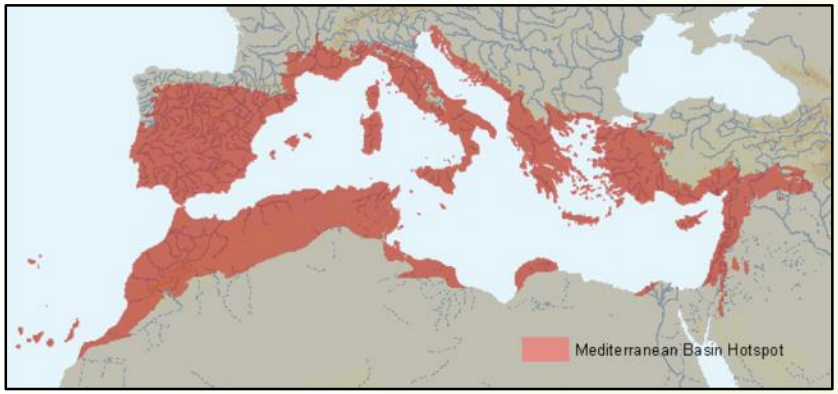
OPEN ACCESS

Natural vegetation management to conserve biodiversity and soil water in olive orchards

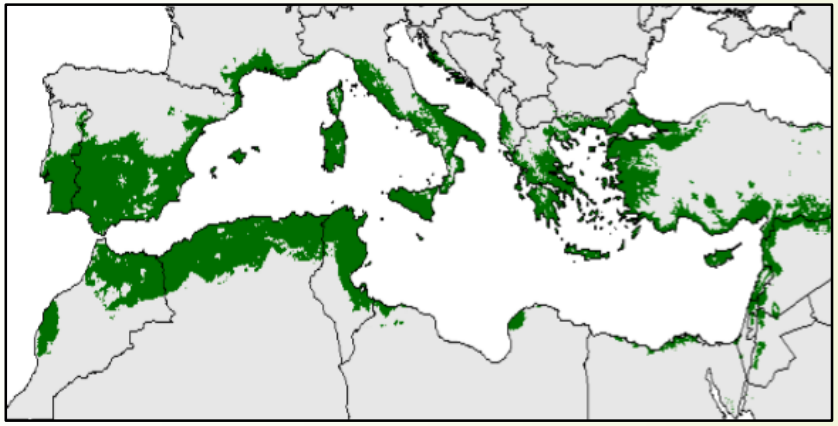
Maria P. Simoes[1,2], Anabela F. Belo[1,2]*, Carla Pinto-Cruz[1,2] and Anacleto C. Pinheiro[1,3]

Background

The Mediterranean Basin biodiversity hotspot area is nearly the same as olive cultivation



Biodiversity hotspot



Ecological niche for olive cultivation

Myers et al. 2000; IUCN; Oteros 2014

Context

Native seed company in Spain recognizes an emerging market and unmet need for seeds of native herbaceous species to use as understory in woody crops

+

NASSTEC grant to develop native seed industry and research

PhD project to identify suitable native species for the application and how to commercially produce seeds

DATA FROM THAT RESEARCH IS THE FOUNDATION FOR A FUTURE SELECTION TOOL USED BY FARMERS AND NATIVE SEED COMPANIES

PhD project
Developing a new use for native species/seeds

Cover crops in Mediterranean woody crops

Species selection methodology:

- criteria
- data

Criteria of interest

Traits related to criteria

Evaluation of criteria

Future development tool(s)

PhD project
Developing a new use for native species/seeds

Criteria/traits of interest

Screening native species to sow as cover crops based on suitability to:

1. olive orchard environment
2. seed increase
3. biodiversity and sustainable agrosystems

Approach

- Industry in its infancy
- Low-hanging fruit
- Define traits of interest
- Species pool
- Compile database with traits from the literature and sort
- Collect data on additional traits in field and lab experiments from upper species in sorted list
- Combine traits data into a species selection index

Meli et al. 2014 Applied Vegetation Science 17
Graff and Mcintyre 2014 Austral Ecology 39:8
Sacande and Berrahmouni 2016 Restoration Ecology 24:4

Approach
Species filter

Agroecosystem species pool:

Inventory of cultivated habitats in Cordoba Province
979 taxa

Pujadas 1984

Filtering based on general criteria:

Angiosperms	977 taxa
Native	894 taxa
Annuals/therophytes	518 taxa
Olive orchard habitat	304 taxa

- species/ecotypes are adapted to the sites

Working species pool 304 taxa

Approach
Selection Index

- Host of pathogens (Verticillium, Xylella)
- Plant height
- Winter annual
- Germination niche (temperature, storage and water stress)
- Associations with invertebrate functional groups

Data collection

Plant-Insect associations for biocontrol of olive fly pest

Insect associations with native forbs to provide bio-control and biodiversity in olive orchards.

Collaboration: Dr. Mercedes Campos
Spanish High Council for Scientific Research. Granada, Spain

Status:

- Samples have been identified, counted and put into functional groups.
- Currently analyzing data to assign High, Medium or Low values to plant species for beneficial insects

Approach
Selection Index

- Host of pathogens (Verticillium, Xylella)
- Plant height
- Winter annual
- Germination niche (temperature, storage and water stress)
- Associations with invertebrate functional groups

→ Species Selection Index of suitability based on seed farming traits

- Growth habit and cover
- Fruit height at maturity
- Dispersal window
- Ease of seed cleaning

Context

Native seed company in Spain recognizes an emerging market and unmet need for seeds of native herbaceous species to use as understory in woody crops

NASSTEC grant to develop native seed industry and research

PhD project to identify suitable native species for the application and how to commercially produce seeds

DATA FROM THAT RESEARCH IS THE FOUNDATION FOR A FUTURE SELECTION TOOL USED BY FARMERS AND NATIVE SEED COMPANIES

Seed Farming Traits

Expected outcomes

- Commercially available seeds of native species to sow as cover crops.
- Protocols for seed production
- Selection Tools:
  - Flow chart or website for seed producer to use with farmer to tailor seed mixes to crop and site.

Seed Farming Traits

Questions

What are appropriate seeding rates?

What should the row spacing be?

How soon do seedlings emerge?

When is the flowering period?

How long is the window for seed harvest?

What considerations for weed management?

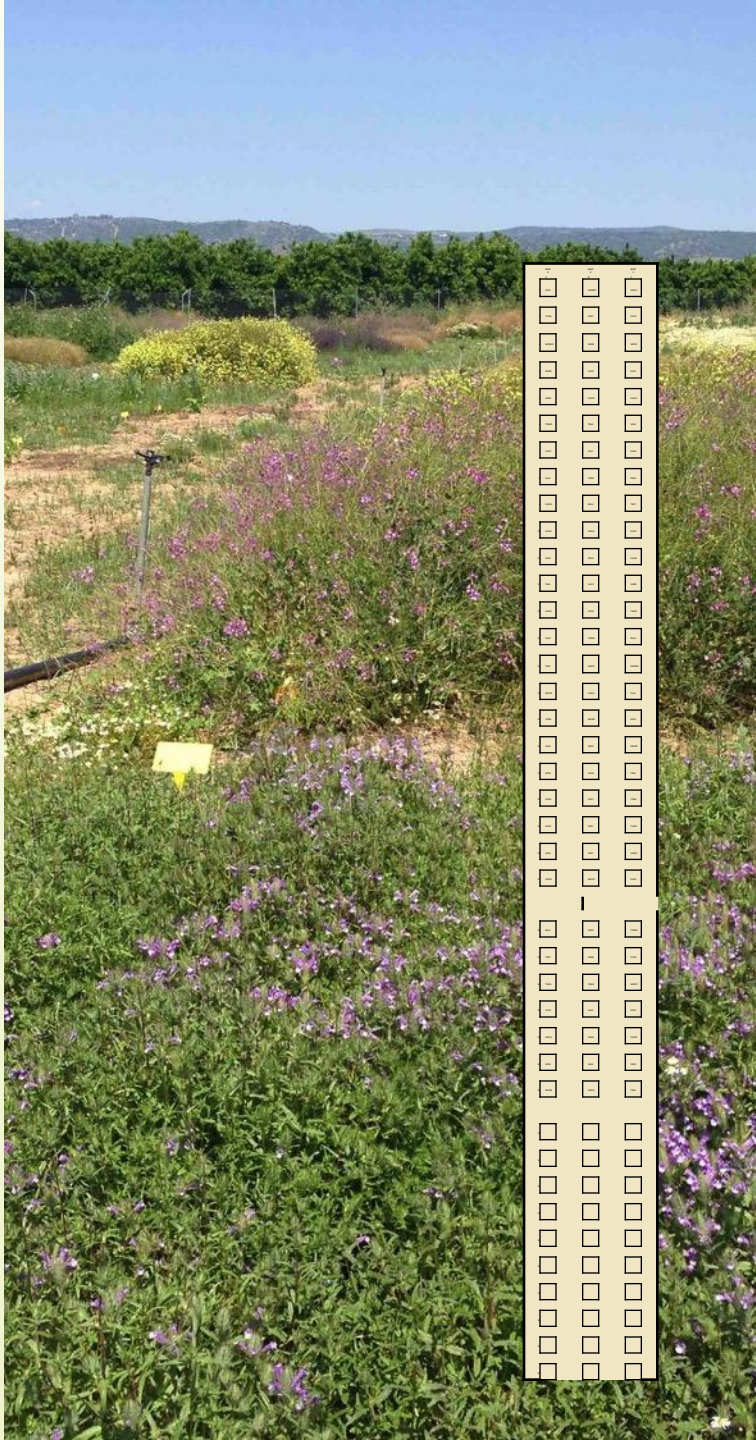
Can a combine be used to harvest the seeds?

Experimental design

Seed Farming Traits

Dec 2015 - June 2016

- 30 species
- 3m x 3m plots replicated ins
- Random assignment of plots



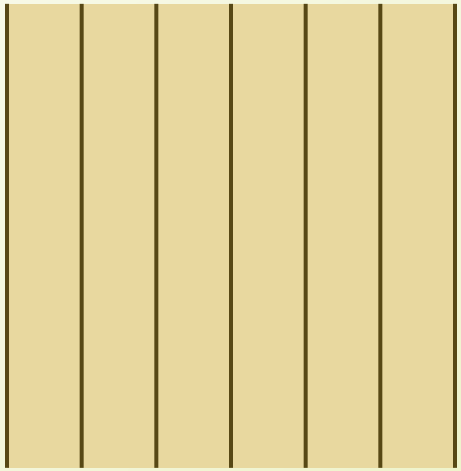
Experimental Design
Seed Farming Traits

Anarrhinum bellidifolium (L.) Willd.	Plantaginaceae
Anthemis cotula L.	Asteraceae
Anthyllis vulneraria L.	Fabaceae
Biscutella auriculata L.	Brassicaceae
Calendula arvensis M.Bieb.	Asteraceae
Capsella bursa-pastoris (L.) Medik.	Brassicaceae
Cleonia lusitanica (L.) L.	Lamiaceae
Crepis capillaris (L.) Wallr.	Asteraceae
Echium plantagineum L.	Boraginaceae
Glebionis segetum (L.) Fourr.	Asteraceae
Helianthemum ledifolium (L.) Mill.	Cistaceae
Medicago orbicularis (L.) Bartal.	Fabaceae
Medicago polymorpha L.	Fabaceae
Misopates orontium (L.) Raf.	Plantaginaceae
Moricandia moricandioides (Boiss.) Heywood	Brassicaceae
Nigella damascena L.	Ranunculaceae
Papaver dubium L.	Papaveraceae
Salvia verbenaca L.	Lamiaceae
*Scabiosa atropurpure*a L.	Caprifoliaceae-Dipsacaceae
Silene colorata Poir.	Caryophyllaceae
Silene gallica L.	Caryophyllaceae
Stachys arvensis (L.) L.	Lamiaceae
Tolpis barbata (L.) Gaertn.	Asteraceae
Tordylium maximum L.	Apiaceae
Trifolium angustifolium L.	Fabaceae
Trifolium hirtum All.	Fabaceae
Trifolium lappaceum L.	Fabaceae
Trifolium stellatum L.	Fabaceae
Tuberaria guttata (L.) Fourr.	Cistaceae
Vaccaria hispanica (Mill.) Rauschert	Caryophyllaceae

Grasses evaluated in parallel PhD project

Experimental Design

Seed Farming Traits



3m x 3m plot
7 rows per plot
50 cm spacing between rows
Seeding rate target of 400 seeds/m2

Seed Farming Traits

Data for 30 spp

- Sowing rate
- Row spacing
- Establishment density
- Site prep and weeds
- Growth form
- Phenology
- Fruit height at maturity
- Seed quality for 2 harvest dates
- Seed yield / area

Initial Results: Suitability to seed farming
Cultural practices – Density score(0-5), cover class, growth habit

2=light
uneven incomplete
upright

3=ideal
uneven incomplete
rosette

3=ideal
uneven complete
creeping

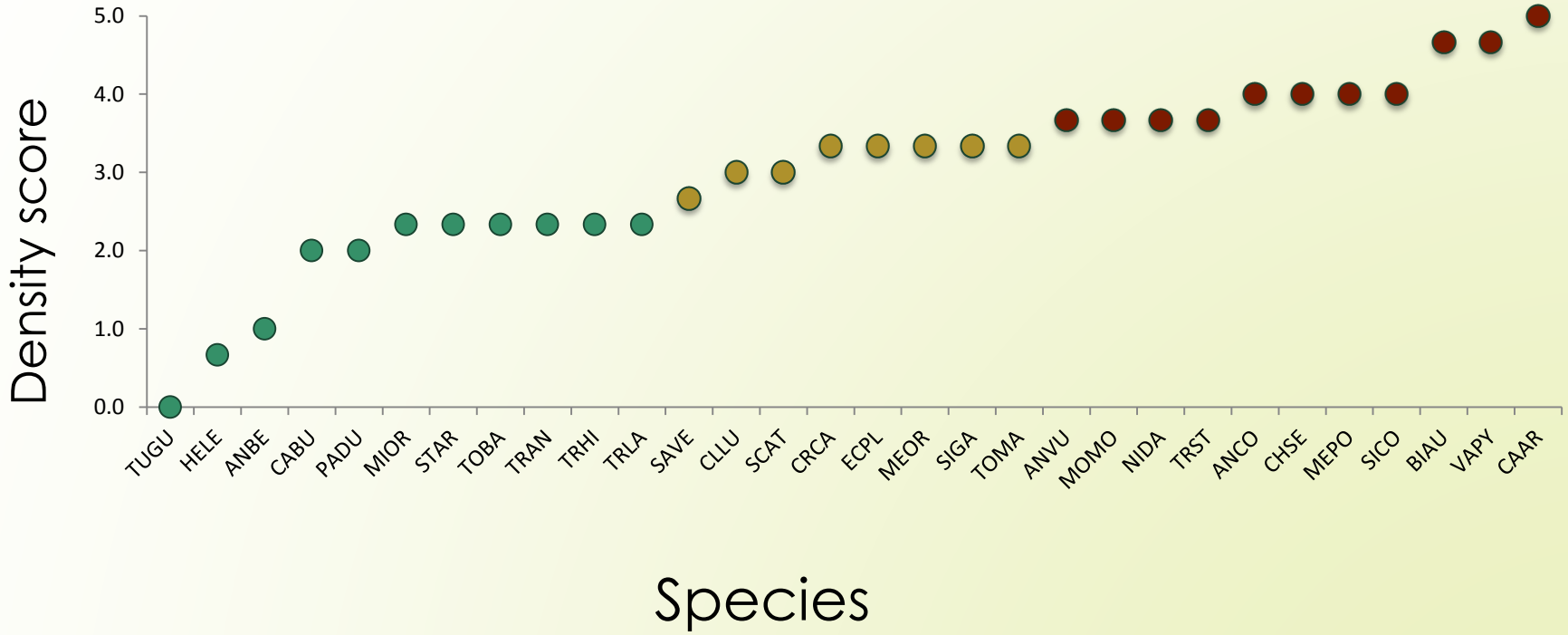
3=ideal
uneven complete
bushy

4=thick
rows
upright

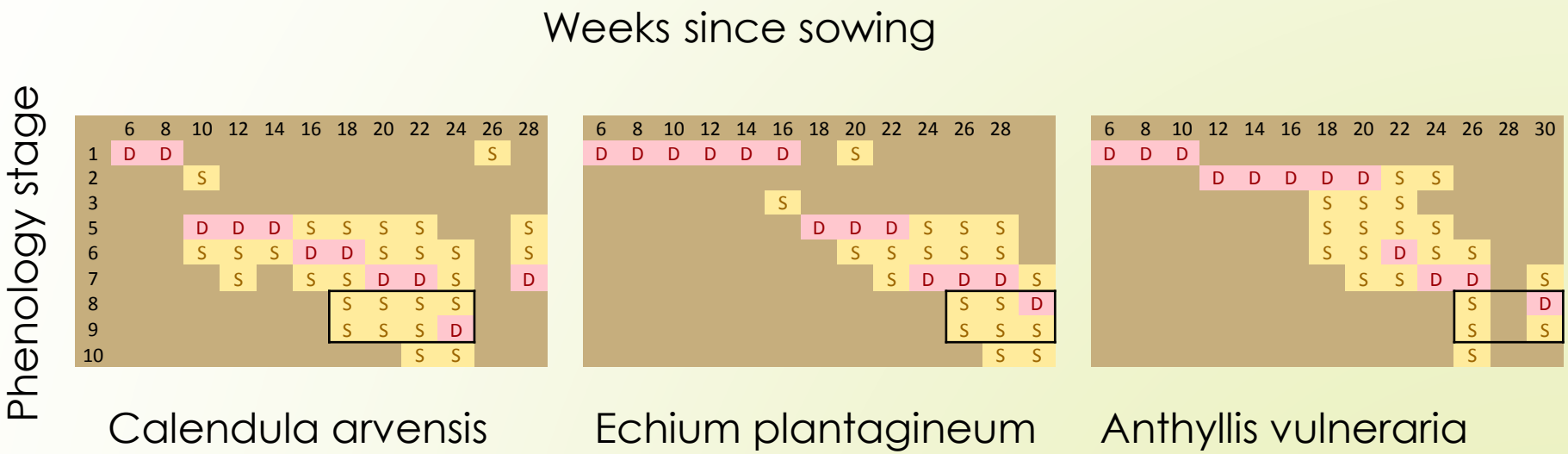
5=too dense
complete
bushy

Initial Results: Suitability to seed farming

Cultural practices – Distribution of Density scores across species

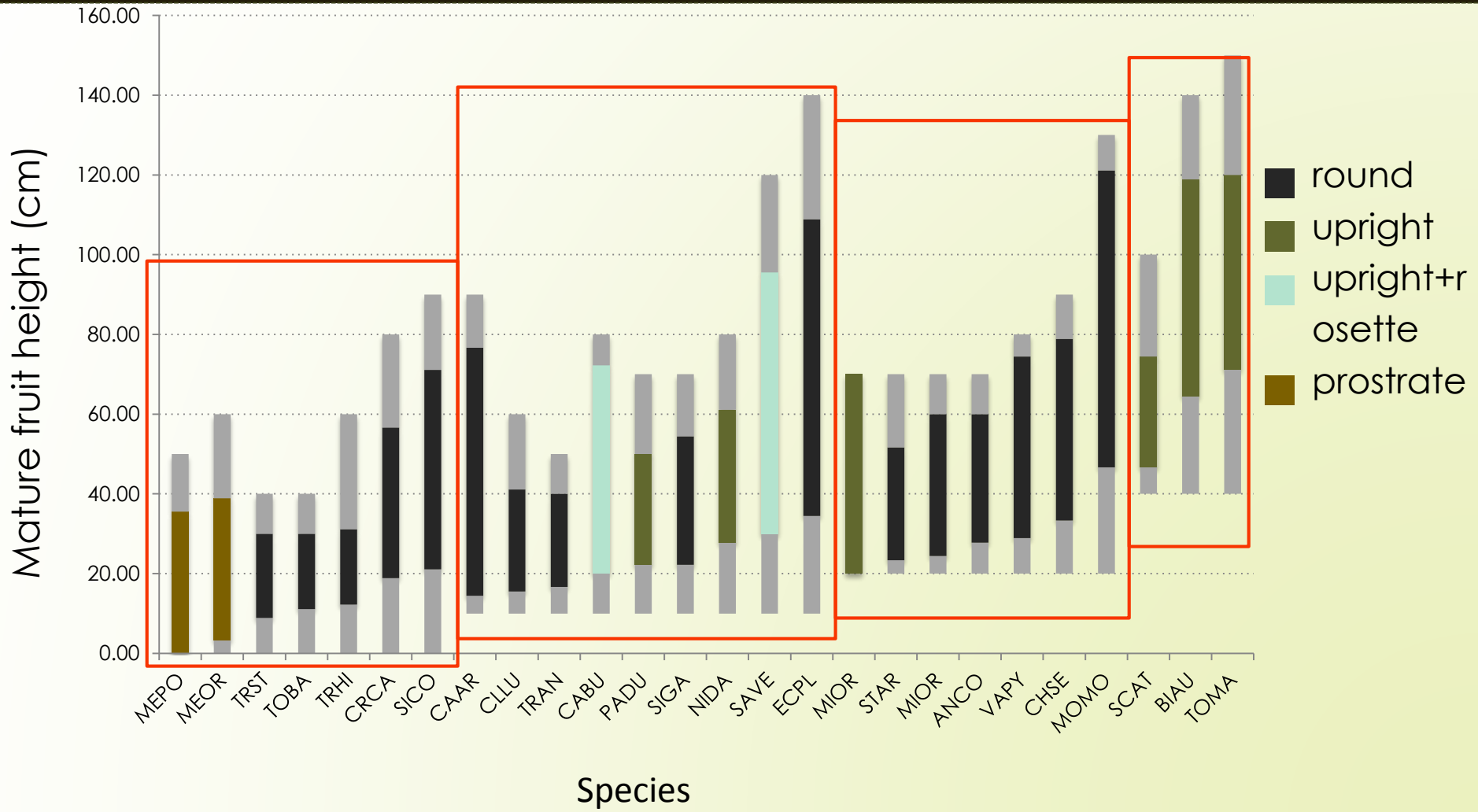


Initial Results: Suitability to seed farming
Phenology under cultivation
Dispersal and harvest window



Results: suitability to seed farming

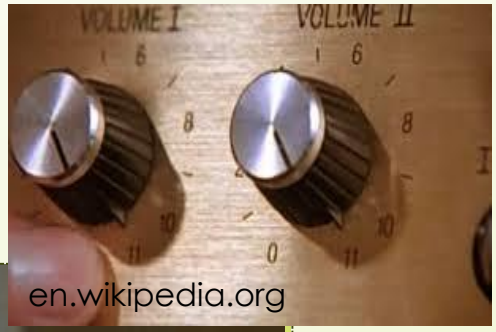
Average max and average min height of mature fruits + growth habit



Additional Seed increase suitability traits to be included:

- Seed yield / area
- Mechanized harvest
- Ease of seed cleaning

Categories, indexes, classes, MCDA….


VOLUME I
VOLUME II
en.wikipedia.org


"These go to 11."
lybio.net


Speed
Control
10


Speed
Control
11


CE
SEED PROCESSING
HOLLAND
P.O. Box. 32 1600AA Enkhuizen Holland
Tel. +31 228353000 Fax. +31 228353001
www.seedprocessing.nl
info@seedprocessing.nl
Type : 4111.10.00.2
Serialnumber : 29104
Year of constuction : 2010
Weight : 33 Kg
Noise level :
Voltage :230 Volt - 1 Phase + 0 + Ground - 50 Hz
Installed capacity : KVA
Power: A
Read the manual before switching on

Context

Native seed company in Spain recognizes an emerging market and unmet need for seeds of native herbaceous species to use as understory in woody crops

+

NASSTEC grant to develop native seed industry and research

=

My PhD to identify suitable native species for the application and how to commercially produce seeds

→

DATA FROM THAT RESEARCH IS THE FOUNDATION FOR A FUTURE SELECTION TOOL USED BY FARMERS AND NATIVE SEED COMPANIES

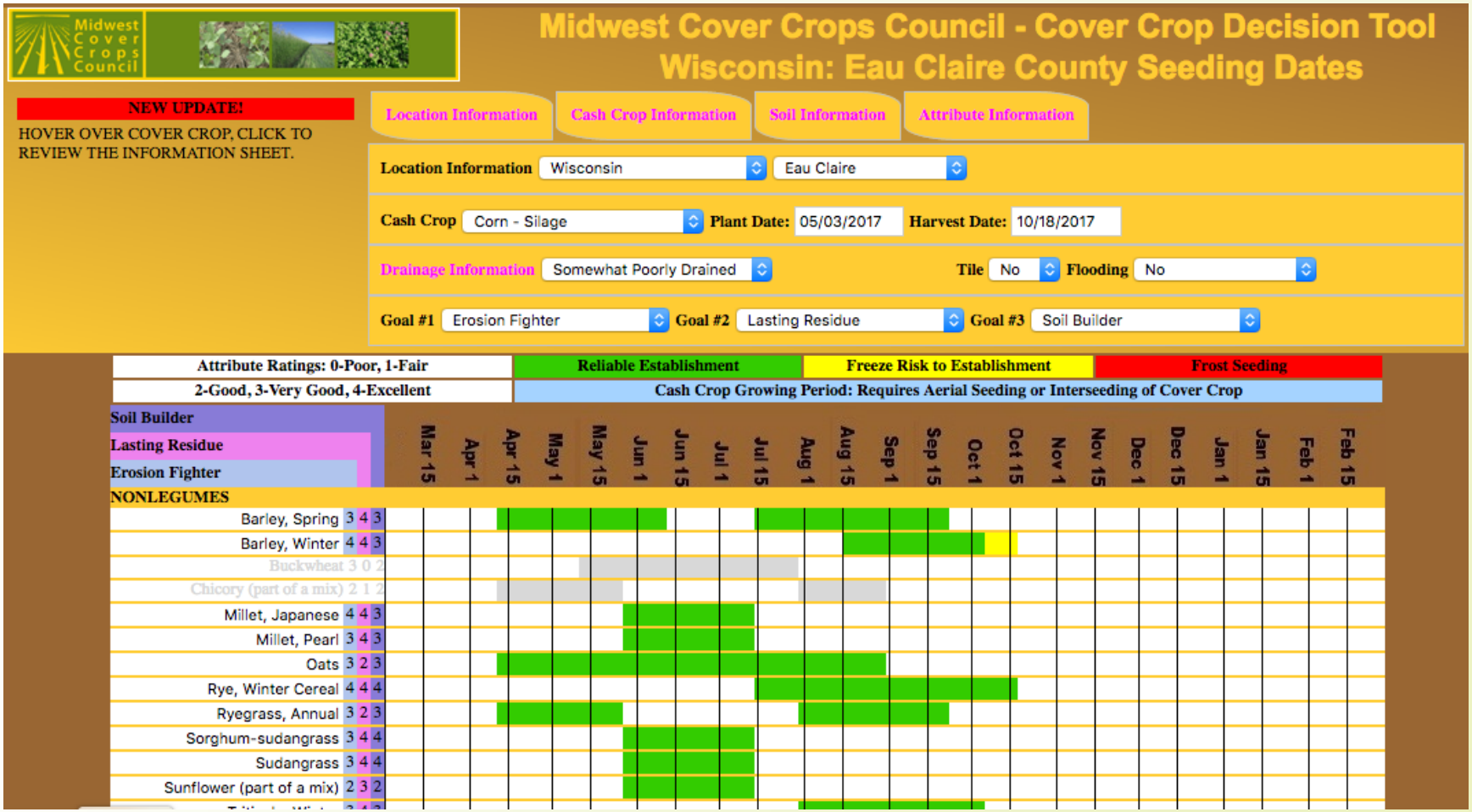
Status

Seed Increase Traits

OUTPUTS

- Selection methodology and Index of suitability (multi-criteria decision analysis)
  -> scientific publication
- Cultural and processing practices
  -> native seed producer manual

Example selection tool

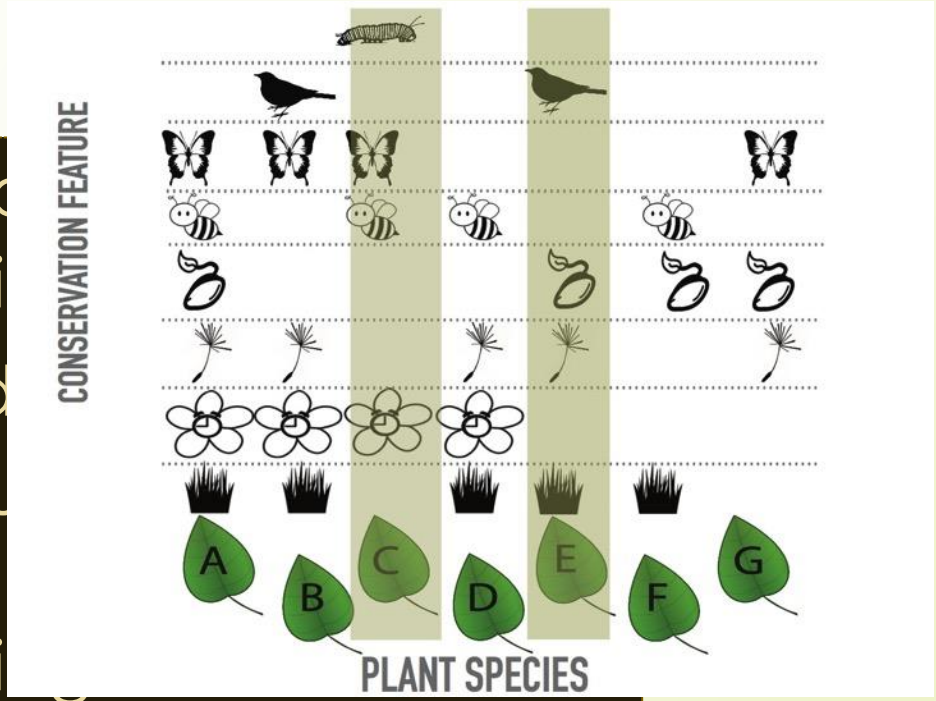


Decision support tool for Europe: The RE-SPROUT Database

MARXAN
conservation solutions

MUSE

- Marxan- c
  prioritizati
- Expected
- Open-sou
  platform
- Connecti
  ecology, restoration, and seed producers



Emma Ladouceur
emmala@gmail.com

@re_sprout

In collaboration with:

Patrick Huber, UC Davis, US

Jennifer McGowan, CEED, AU

Hugh Possingham, TNC, US

ACKNOWLEDGEMENTS

Rafael Alcalá Hererra
Joaquín Baena Urbano
Mercedes Campos Aranda
António Flores
Matías Hernández González
Emma Ladouceur
Adolfo López
Ángela Medrán Viñas
Joaquín Moreno-Chocano García
Francisca del Río Mohedano
Rafa Soler Díaz

Funding from European Union's Marie Skłodowska Curie Initial Training Network **NASSTEC** (**NA**tive, **S**eed **S**cience, **TE**chnology and **C**onservation) grant #607785

stephanie@semillassilvestres.com
nasstec.eu/forum/esr-2a

The preceding presentation was delivered at the

2017 National Native Seed Conference

Washington, D.C. February 13-16, 2017

This and additional presentations available at http://nativeseed.info

NATIVE SEED NETWORK

Institute for Applied Ecology