Olive Oil world Congress | 24

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GOBIERNO DE ESPAÑA MINISTERIO DE ECONOMÍA, COMERCIO Y EMPRESA

ICEX

#alimentosdespaña

EL PAÍS MÁS RICO DEL MUNDO

GOBIERNO DE ESPAÑA MINISTERIO DE AGRICULTURA, PESCA Y ALIMENTACIÓN

COVER CROPS AS A SOIL CARBON STORAGE TOOL

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Escuela Técnica Superior de Ingeniería Agronómica y de Montes

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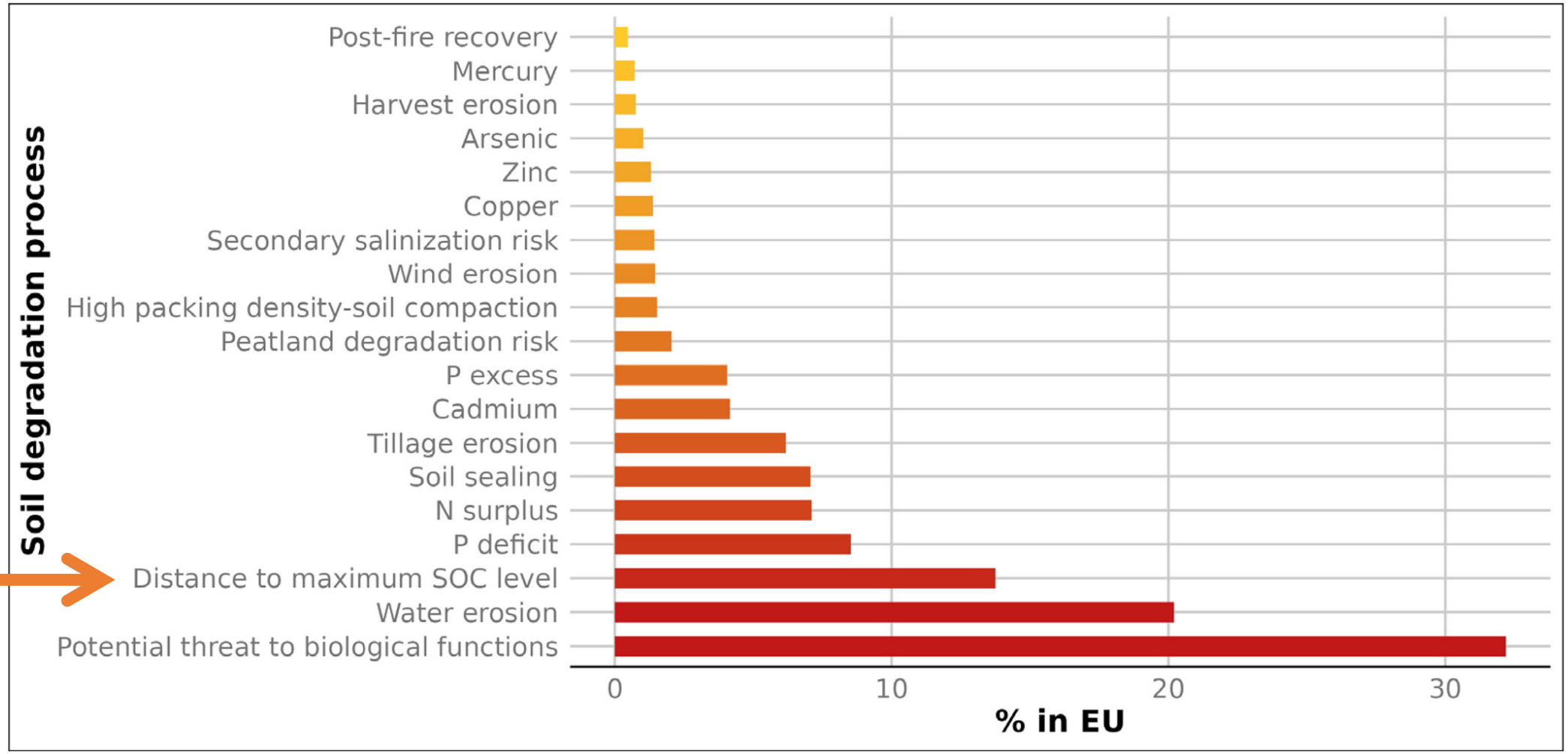
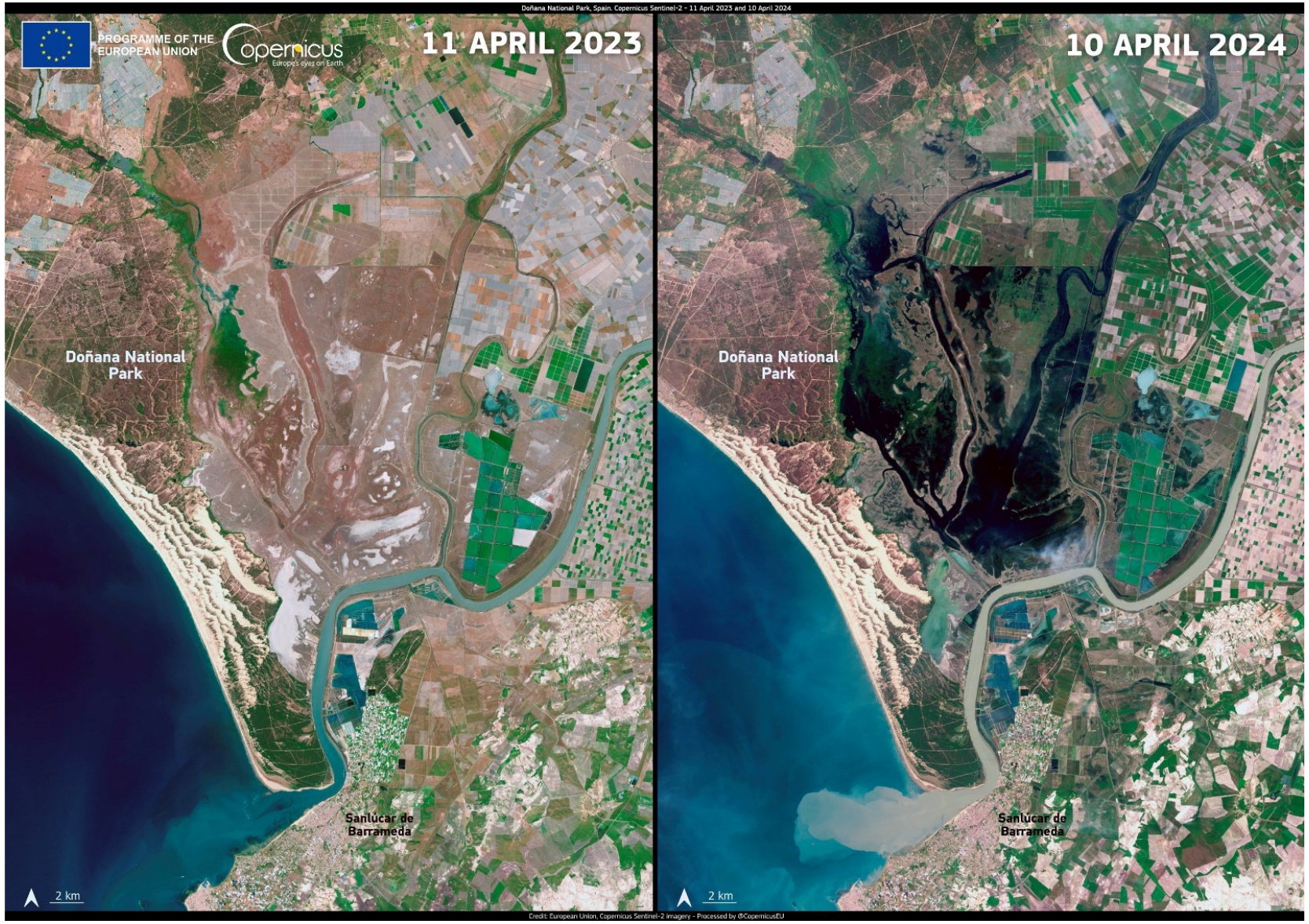
Life


Every
5 seconds
the equivalent of one football pitch of soil is eroded.
Food and Agriculture Organization of the United Nations



Source: Panagos et al, 2024.
https://bsssjournals.onlinelibrary.wiley.com/doi/full/10.1111/ejss.13507

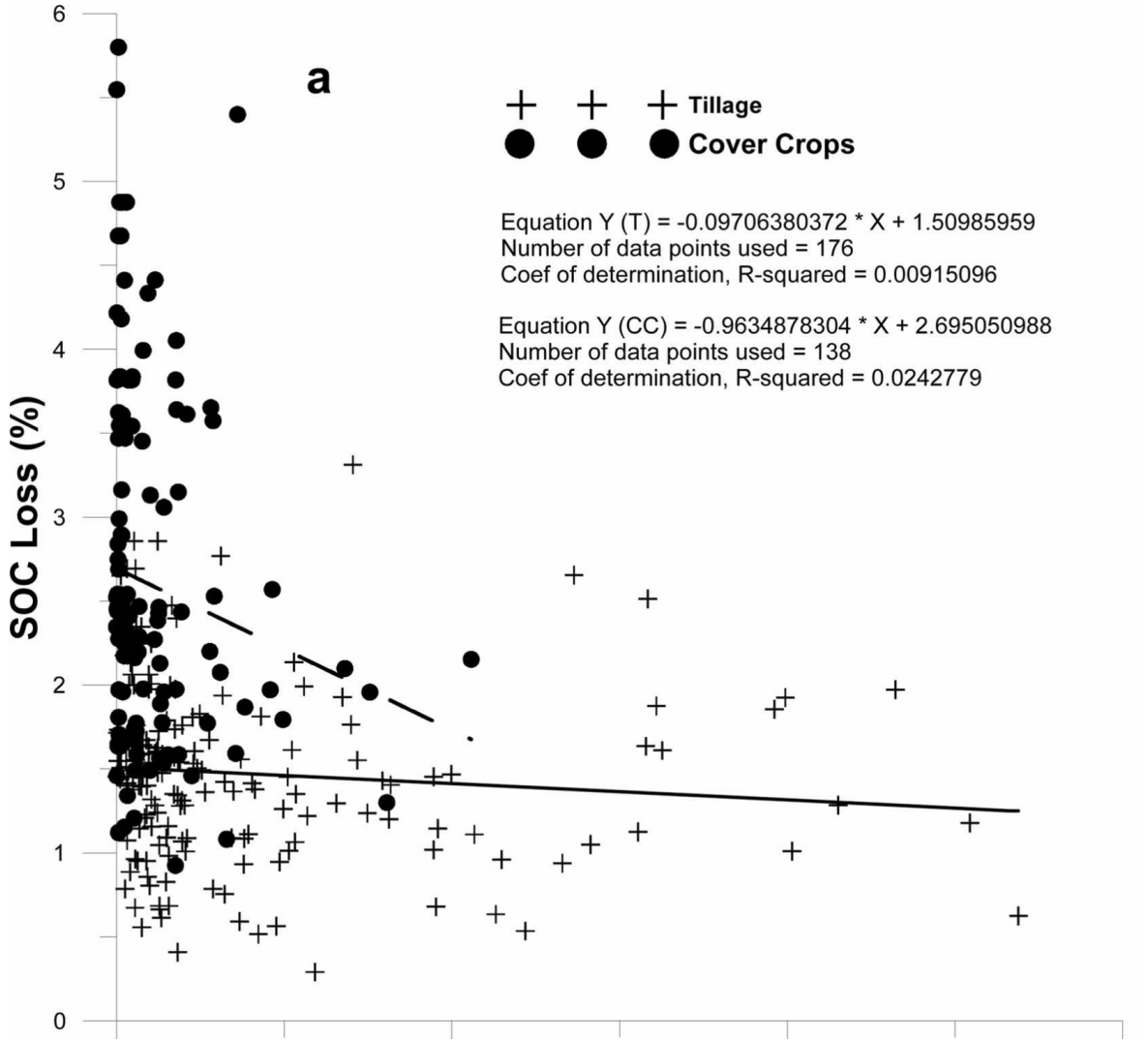

Doñana National Park, Spain. Copernicus Sentinel-2 - 11 April 2023 and 10 April 2024
PROGRAMME OF THE EUROPEAN UNION
Copernicus
Europe's eyes on Earth
11 APRIL 2023
Doñana National Park
Sanlúcar de Barrameda
2 km
10 APRIL 2024
Doñana National Park
Sanlúcar de Barrameda
2 km
Credit: European Union, Copernicus Sentinel-2 imagery - Processed by ©CopernicusEU

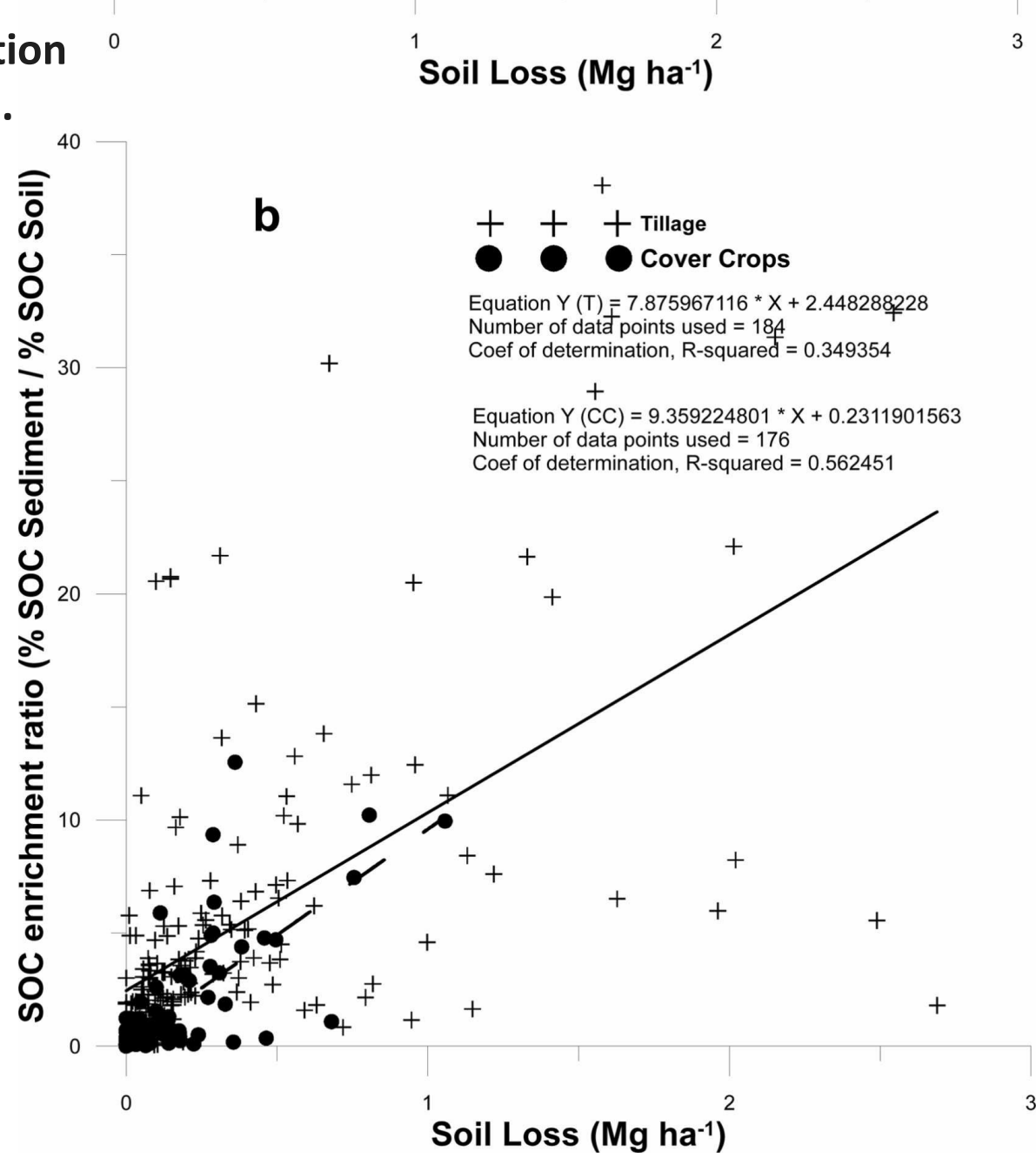

Doñana National Park
Sanlúcar de Barrameda
Doñana National Park
Sanlúcar de Barrameda

In olive orchards: two interlinked strategies

- Not to loose the carbon que have in our soils
- Increase soil organic carbon through groundcovers

a) Concentration of SOC associated with sediment, as a function of soil loss. b) SOC enrichment ratio, as a function of soil loss.





Source: Márquez et al, 2024.
https://www.sciencedirect.com/science/article/pii/S0167198723002726?pes=vor#fig0015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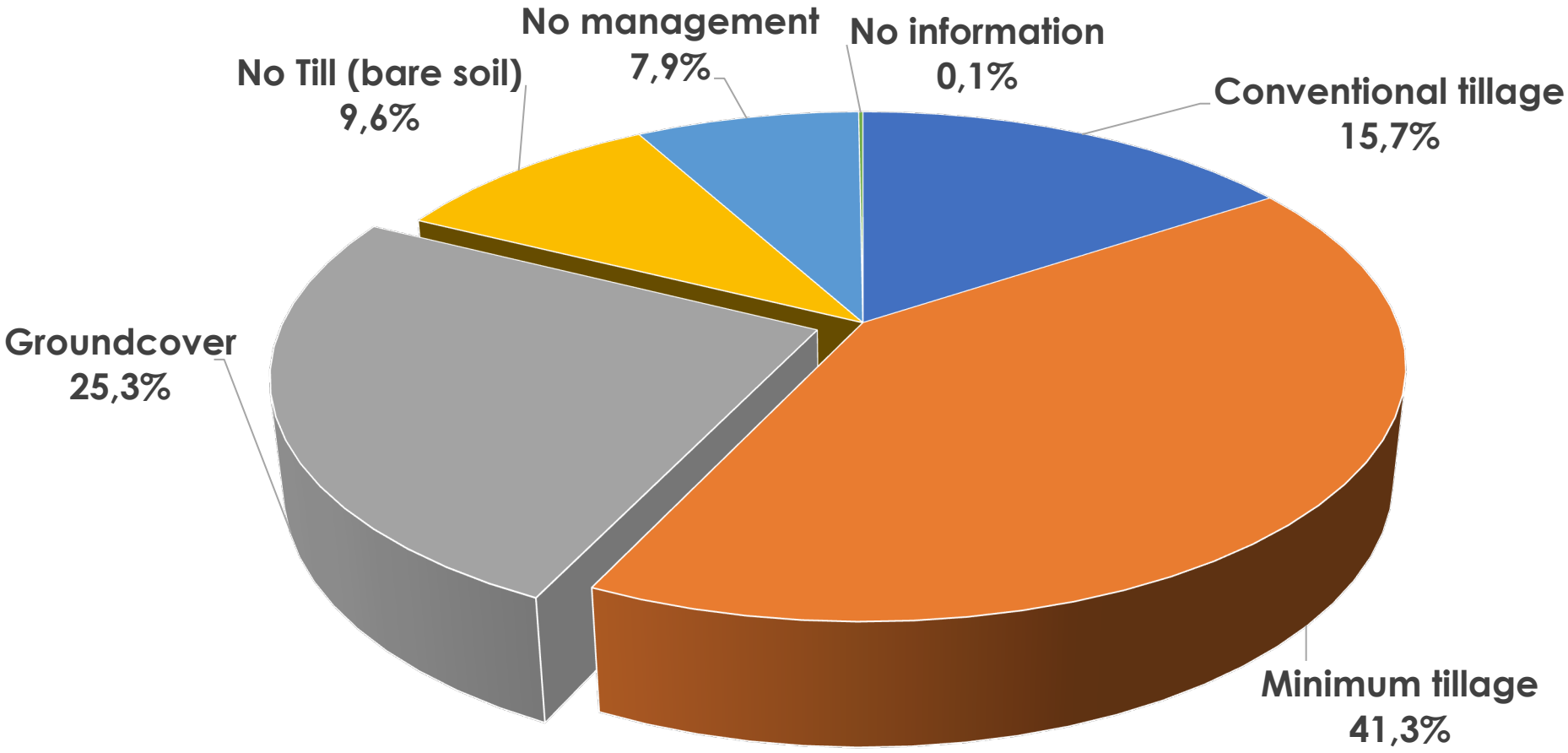
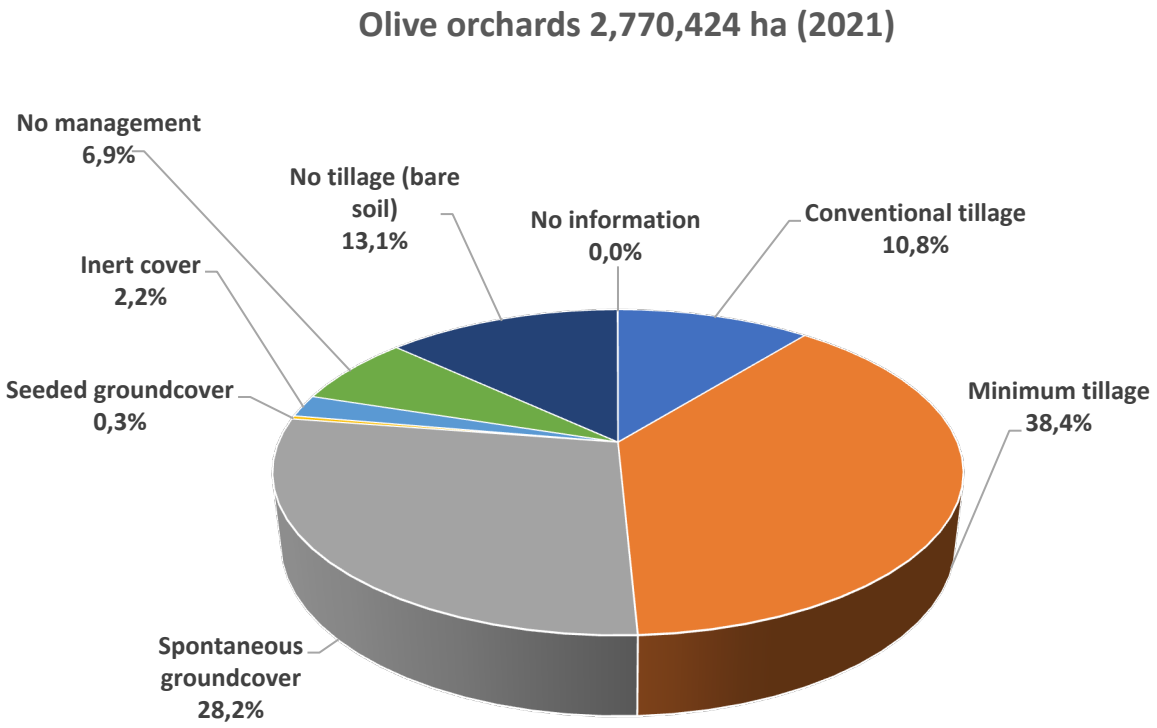
Soil management systems in woody crops in Spain - 5,339,550 ha (2021)



OLIVE ORCHARDS IN SPAIN



Olive (2021)	Adoption (ha)	Fraction Irrigated	Production (tonnes)
Table olives	76,771	45%	718,192
Dual aptitude olive	120,319	37%	NA
Mill olives	2,573,334	31%	7,543,039

Source: ESYRCE 2021, Ministry of Agriculture, Fisheries and Food, Government of Spain

TYPES OF GROUNDCOVERS	Olive orchard (%) with groundcovers in Spain (MAPA) 2013 (30.4%)	2021 (30.7%)
Spontaneous vegetation	95%	92%
Seeded	1%	1%
Inert cover	4%	7%

Source: ESYRCE 2013, 2021, Ministry of Agriculture, Fisheries and Food, Government of Spain

BUT IN 2023… A NEW POLICY HAS HITTED

Datos de solicitudes 2023: https://www.fega.gob.es/es/noticias/node-15307

- 75% explotaciones los han solicitado, cubriendo el 86% de la superficie declarada.
- Se ejecutará el 100% del presupuesto asignado y se aplicará con carácter generalizado degresividad
- De esos 19 Mha que han solicitado ERs, 2,4 Mha se corresponden con las prácticas de cubiertas

  (según ESYRCE habría unos 1,4 millones de hectáreas en 2021, centradas en olivar y en Andalucía)

	Ha solicitadas	Ha estimadas	% SOLICITADA 2023/ ESTIMADA 2023
Ecorregímenes de AC: cubiertas vegetales y cubiertas inertes en cultivos leñosos en terrenos llanos **(Pendiente menor al 5%).**	712.755,2	1.022.015,7	70%
Ecorregímenes de AC: cubiertas vegetales y cubiertas inertes en cultivos leñosos en terrenos de pendiente media **(Pendiente igual o mayor al 5%, hasta el 10%).**	582.601,7	637.195	91%
Ecorregímenes de AC: cubiertas vegetales y cubiertas inertes en cultivos leñosos en terrenos de elevada pendiente **(Pendiente igual o mayor al 10% y bancales).**	1.082.710,2	881.158	123%
TOTAL	**2.378.067,2**	**2.540.368,3**	**94%**

Andalucía destaca para esta práctica con 1.518.725 ha solicitadas, lo que representa cerca del 64% del total solicitado.

- % Solicitada 2023/ Estimada 2023:
  - CCAA por encima del %total nacional: AND, CANT, GAL, CyL
  - CCAA entorno al % total nacional: ARA, EXT,
  - CCAA por debajo del % total nacional: CAT, NAV PV, AST, BAL, CLM, MAD, MURC, RIOJ, VAL

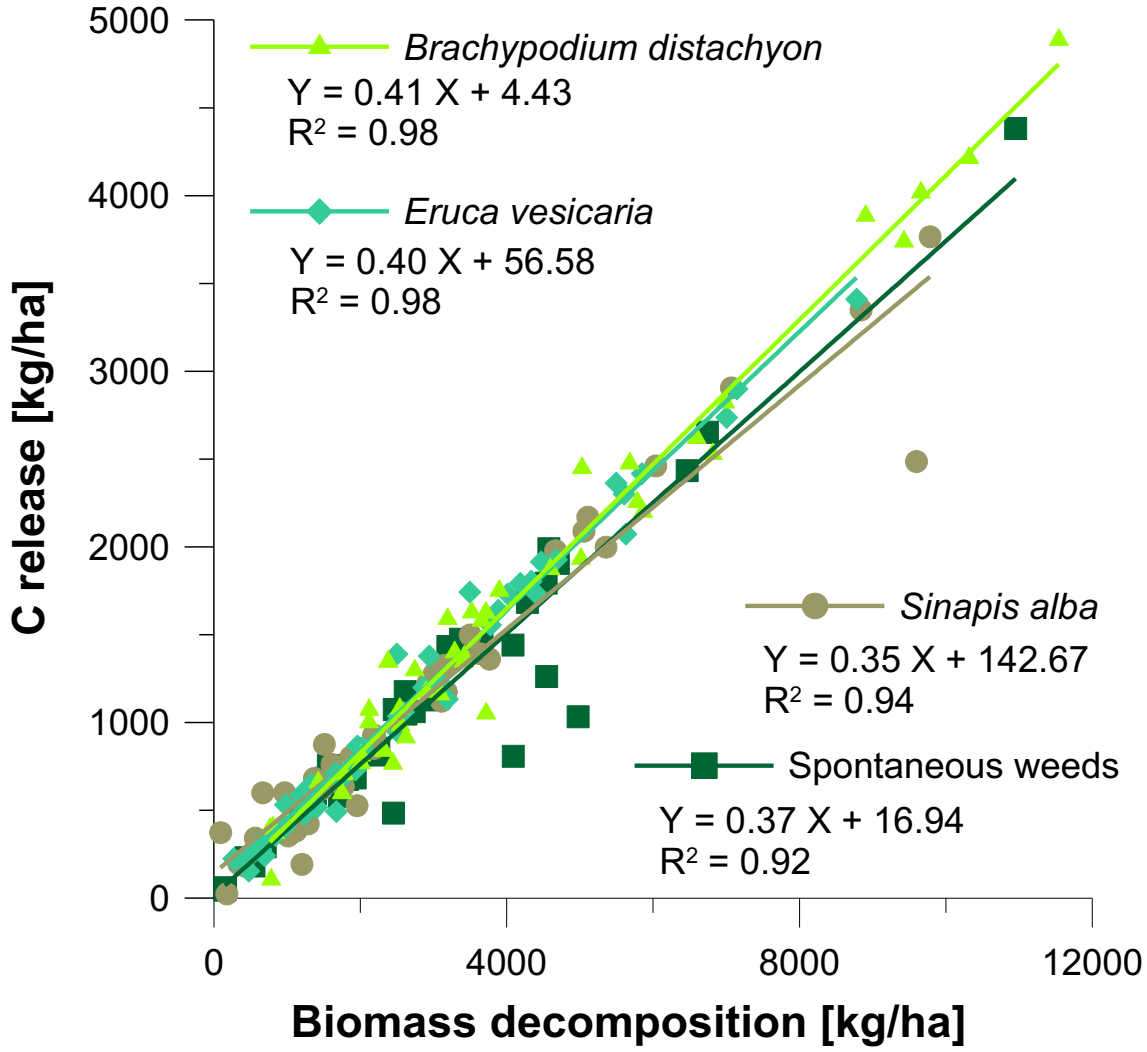
GOBIERNO DE ESPAÑA
MINISTERIO DE AGRICULTURA, PESCA Y ALIMENTACIÓN

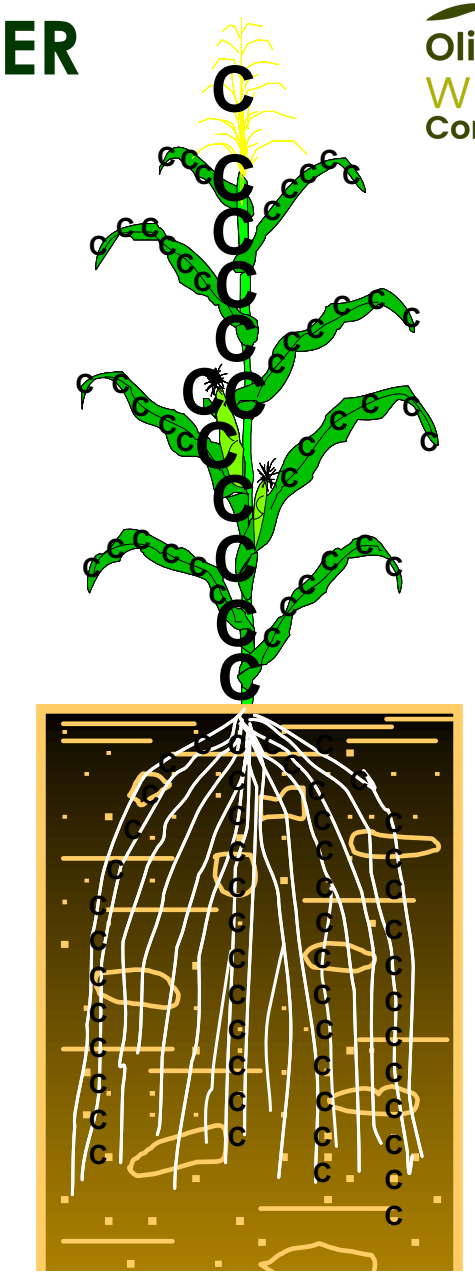
TIPOS DE SUPERFICIE	PRÁCTICAS POSIBLES A REALIZAR
PASTOS HÚMEDOS	• PASTOREO EXTENSIVO (P1) AC • ISLAS DE BIODIVERSIDAD o SIEGA SOSTENIBLE (P2) Agroec
PASTOS MEDITERRÁNEOS	
TIERRAS CULTIVO (TC) DE SECANO	• ROTACIÓN DE CULTIVOS CON ESPECIES MEJORANTES (P3) Agroec • SIEMBRA DIRECTA (P4) AC
TIERRA CULTIVO DE SECANO HÚMEDO (TCS)	
TIERRA CULTIVO DE REGADÍO (TCR)	
CULTIVOS LEÑOSOS PENDIENTE <5%	• CUBIERTA VEGETAL SEMBRADA O ESPONTÁNEA (P6) AC • CUBIERTA INERTE (P7) AC
CULTIVOS LEÑOSOS PENDIENTES 5-10%	
CULTIVOS LEÑOSOS PENDIENTE ≥10% Y BANCALES	
CULTIVOS PERMANENTES (INCLUYENDO LOS LEÑOSOS)	• ESPACIOS DE BIODIVERSIDAD EN TC O CULTIVOS PERMANENTES Ó GESTIÓN LÁMINA DE AGUA EN CULTIVOS INUNDADOS (P5) Agroec

GROUNDCOVERS ARE DIVERSE

Source: Olipe

CARBON RELEASE OF COVER CROPS
AN OBVIOUS FACT: THE MORE BIOMASS, THE BETTER





Source: Repullo-Ruibérriz de Torres et al. 2021. Soil Tillage Res. 210, 104977

CARBON REMOVALS IN SOIL THROUGH GROUNDCOVERS

Gramineous & Cruciferous

Carbon sequestration in soil

Commercial farm
(8 × 4 m)

Soil Properties

Slope: 11%

SOM: 0.87%

$CaCO_3$: 30%

Cation Exchangeable Capacity: 0.23 molc kg^{-1}

Clay content: 50%

Bulk density: 1.32 t m^{-3}

Types of groundcovers

- **GRAMINEOUS**
- **CRUCIFEROUS**
- **SPONTANEOUS**

- **GRAMINEOUS**

Brachypodium distachyon

- **CRUCIFEROUS**

Eruca vesicaria

Sinapis alba

Assessments

- **Groundcovers biomass decomposition after mechanical mowing**
- **Carbon release through biomass**
- **Carbon sequestration into the soil (0-20 cm)**

IFAPA Instituto de Investigación y Formación Agraria y Pesquera

CARBON REMOVALS IN SOIL THROUGH GROUNDCOVERS

Gramineous & Cruciferous

Carbon sequestration in soil

Groundcovers above ground biomass (t ha^{-1})

GROUNDCOVER	Season 1	Season 2	Season 3	Season 4	Average
Brachypodium distachyon	7.32	11.04	4.14	5.68	**7.05**
Eruca vesicaria	2.96	7.46	4.36	4.06	**4.71**
Sinapis alba	3.14	6.13	5.76	4.33	**4.84**
Control	2.15	6.73	5.95	4.16	**4.75**

Carbon sequestration in soil (0-20 cm)

4 seasons **Grasses & Crucifers**	**C seq** tC ha^{-1}	**Annual C fixed** tC ha^{-1} yr^{-1}	**Annual CO_2 fixed** tCO_2 ha^{-1} yr^{-1}
Brachypodium	7.91	1.98	7.25
Eruca vesicaria	6.29	1.57	5.77
Sinapis alba	6.42	1.61	5.89
Control	6.28	1.57	5.76

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Source: Repullo-Ruibérriz de Torres et al. 2021. Soil Tillage Res. 210, 104977

CARBON REMOVALS IN SOIL THROUGH GROUNDCOVERS

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Legumes

Carbon sequestration in soil

Experimental farm
(6 × 5 m)

Soil Properties

Slope: 1.2%

SOM: 2.18%

$CaCO_3$: 16%

Cation Exchangeable Capacity: 0.14 molc kg^{-1}

Clay content: 16%

Bulk density: 1.30 t m^{-3}

Types of groundcovers

- **LEGUMINOUS**
- **SPONTANEOUS**

- **LEGUMINOUS**

Groundcovers managements:

- **Mowing**
- **Mowing + Incorporation**

Assessments

- **Groundcovers biomass before and after mechanical mowing or mowing + incorporation**
- **Carbon release through biomass**
- **Carbon sequestration into the soil (0-20 cm)**

Vicia sativa

Vicia ervilia

Vicia villosa

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CARBON REMOVALS IN SOIL THROUGH GROUNDCOVERS

Olive Oil world Congress

Legumes

Carbon sequestration in soil

Groundcovers above ground biomass (t ha^{-1})

MOWING

GROUNDCOVER	Season 1	Season 2	Season 3	Season 4	Average
Vicia sativa	6.28	6.87	4.57	5.03	**5.69**
Vicia ervilia	6.04	3.76	2.37	3.34	**3.88**
Vicia villosa	6.15	8.73	10.26	5.57	**7.68**
Control	1.40	2.52	2.62	6.63	**3.29**

MOWING + INCORPORATION

GROUNDCOVER	Season 1	Season 2	Season 3	Season 4	Average
Vicia sativa	6.94	7.85	3.33	2.66	**5.19**
Vicia ervilia	4.08	6.26	3.16	4.14	**4.41**
Vicia villosa	5.83	8.42	4.49	5.28	**6.00**
Control	2.42	1.99	3.33	4.61	**3.09**

Carbon sequestration into the soil (0-20 cm)

Legumes	4 seasons	**C removals**	**Annual**	**Annual CO_2 fixed**
Management	Species	tC ha^{-1}	tC ha^{-1} yr^{-1}	tCO_2 ha^{-1} yr^{-1}
Mowing	*Vicia sativa*	2.26	0.57	2.08
	Vicia ervilia	0.79	0.20	0.72
	Vicia villosa	4.33	1.08	3.97
	Control	-0.28	-0.07	-0.25
Mowing + Incorporation	*Vicia sativa*	4.86	1.21	4.45
	Vicia ervilia	1.41	0.35	1.29
	Vicia villosa	2.03	0.51	1.87
	Control	-1.01	-0.25	-0.92

IFAPA Instituto de Investigación y Formación Agraria y Pesquera

Source: Repullo-Ruibérriz de Torres et al. 2019. AGROFOR International Journal. 210, 104977

CARBON REMOVALS IN SOIL THROUGH GROUNDCOVERS

Pruning residues

Carbon sequestration in soil

Experimental farm
(8 × 8 m)

Soil Properties

Slope: 1.7%

SOM: 1.96%

$CaCO_3$: 16%

Cation Exchangeable Capacity: 0.20 molc kg^{-1}

Clay content: 18%

Bulk density: 1.48 t m^{-3}

Assessments

- **Pruning residues biomass**
- **Carbon release through biomass**
- **Carbon sequestration into the soil (0-20 cm)**

Treatments

- **PRUNING RESIDUES**
- **SPONTANEOUS**

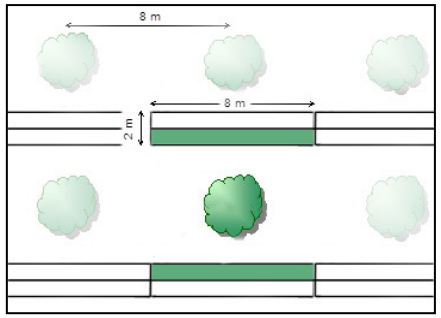
- **Pruning residues**

Pruning biomass	Biomass per tree (kg of DM)
Fine (≤8 cm)	25.0
Thick (>8 cm)	13.2

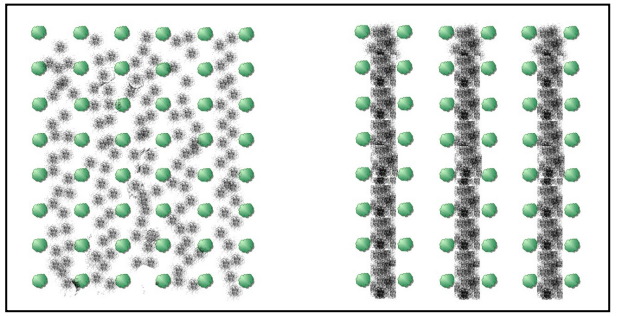
Fine Pruning biomass ≤8 cm

Thick Pruning biomass >8 cm

Associated surface per tree: 8×2 m



Treat. I & II Treat. III & IV



Source: Repullo et al. 2012. Soil Tillage Res. 124, 36–46

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CARBON REMOVALS IN SOIL THROUGH GROUNDCOVERS

Pruning residues

Pruning residues treatments (t ha^{-1})

Treatment	Fine (≤8 cm)	Thick (>8 cm)	Total (t ha^{-1})
Treatment I	15.64		15.64
Treatment II	15.64	8.24	23.87
Treatment III	31.27		31.27
Treatment IV	31.27	16.48	47.75
Control	0	0	0

Remaining above ground biomass during 4 seasons (t ha^{-1})

Treatment	Season 1	Season 2	Season 3	Season 4	Average
Treatment I	7.75	5.42	2.50	1.50	**3.54**
Treatment II	11.29	6.40	3.92	3.01	**5.17**
Treatment III	17.42	8.71	3.96	3.41	**6.98**
Treatment IV	27.20	11.96	11.48	9.58	**9.45**
Control	2.25	2.34	3.04	3.46	**2.77**

Carbon sequestration into the soil (0-20 cm)

4 seasons **Pruning residues**	**C removals** tC ha^{-1}	**Annual C fixed** tC ha^{-1} yr^{-1}	**Annual CO_2 fixed** tCO_2 ha^{-1} yr^{-1}
Trat. I	14.13	3.53	12.95
Trat. II	10.77	2.69	9.88
Trat. III	19.37	4.84	17.75
Trat. IV	19.64	4.91	18.00
Control	2.96	0.74	2.71

Source: Repullo et al. 2012. Soil Tillage Res. 124, 36–46

CARBON REMOVALS IN SOIL THROUGH GROUNDCOVERS

Carbon removals in 4 seasons. 0-20 cm

Gramineous

Cruciferous

4 seasons	C removals	Annual C fixed	Annual CO_2 fixed
Grasses & Crucifers	tC ha^{-1}	tC ha^{-1} yr^{-1}	tCO_2 ha^{-1} yr^{-1}
Brachypodium	7.91	1.98	7.25
Eruca vesicaria	6.29	1.57	5.77
Sinapis alba	6.42	1.61	5.89
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Leguminous

Legumes	4 seasons	C removals	Annual	Annual CO_2 fixed
Management	Species	tC ha^{-1}	tC ha^{-1} yr^{-1}	tCO_2 ha^{-1} yr^{-1}
Mowing	*Vicia sativa*	2.26	0.57	2.08
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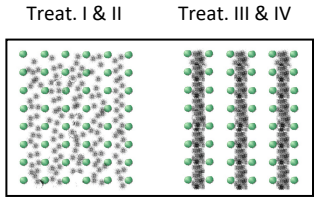
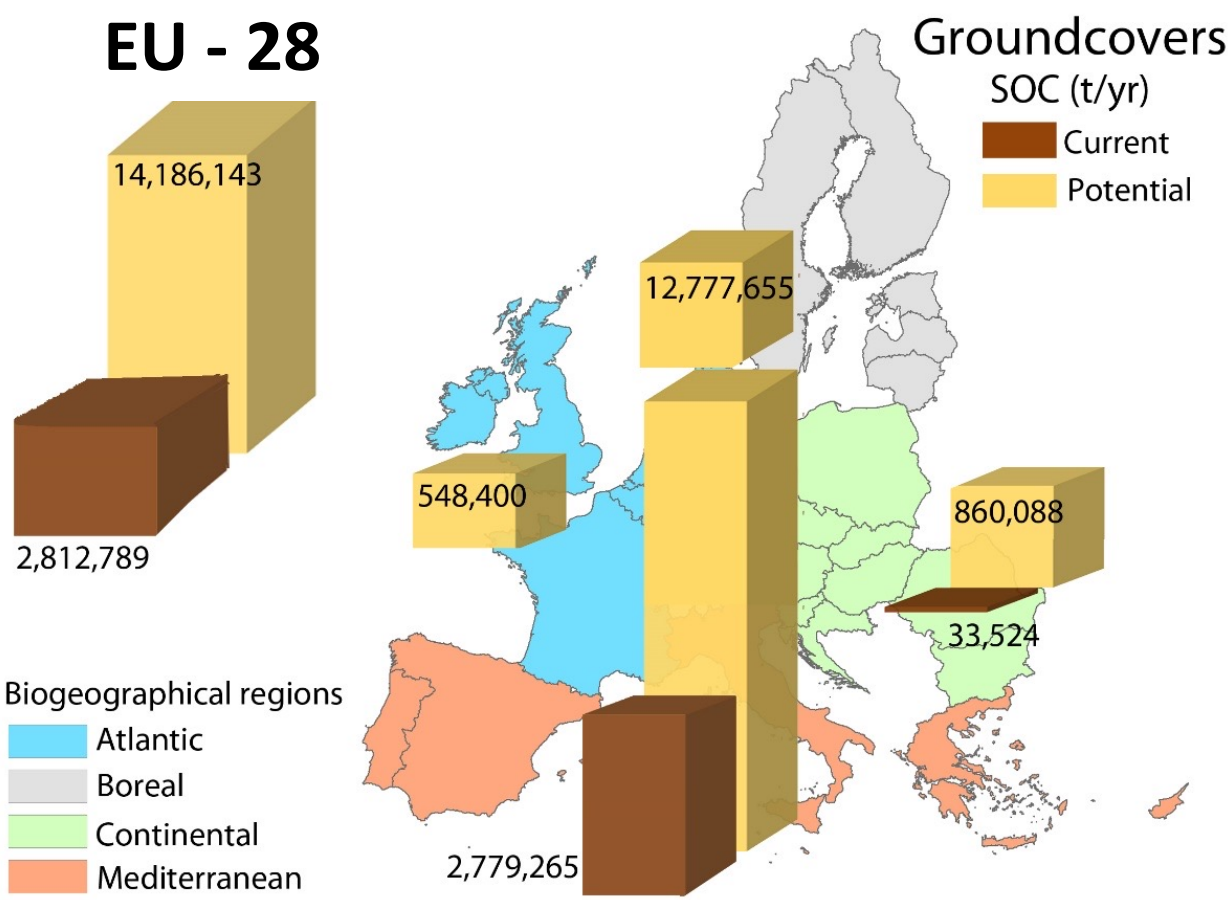


Main Factors affecting SOC increase:

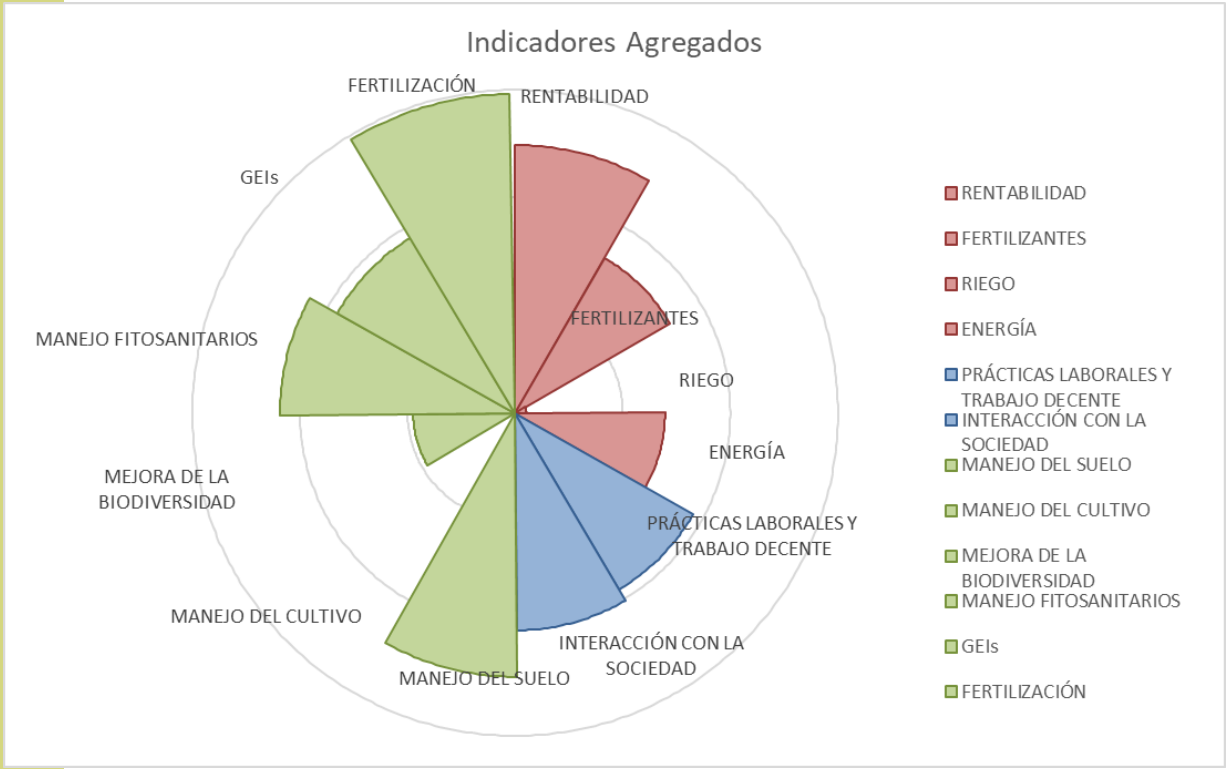
- Biomass – C input
- Clay content
- Initial C stock
- Width of groundcover strip

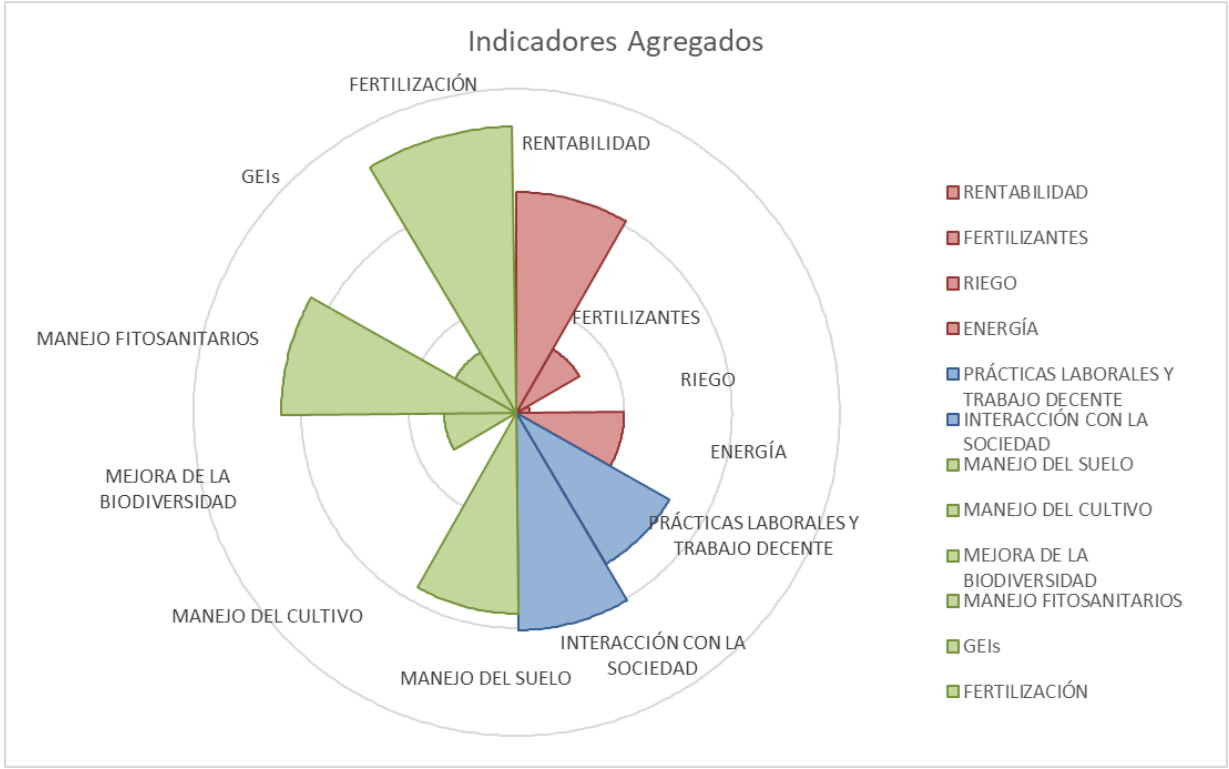
CARBON SEQUESTRATION POTENTIAL: A GROSS ESTIMATION



Source: ECAF (2017)

MEASURING THE SUSTAINABILITY OF COVER CROPS





2019/2020 season indicators “La Felipa” Farm (Cover Crops) (left) vs “La Felipa” Farm (Conventional Tillage) (right).

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Thank you!

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