

LegumeGap: Increasing productivity and sustainability of European plant protein production

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Rationale

- Protein self-sufficiency
- Diversification
- Reduction in fertilizer and pesticide use
- Reduction in GHG emissions
- Sustainable diets
- Prevention of land degradation and biodiversity loss



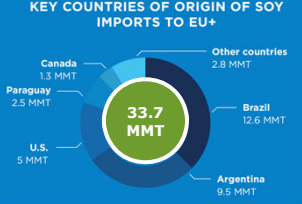
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EU and legumes


MILLION TONNES USED FOR FEED, FOOD & BIOFUELS IN THE EU+

| | Food Use | Technical use | Feed Use | Biodiesel | Other uses | Total |
|----------------------|----------|---------------|----------|-----------|------------|-----------------|
| Soybeans (MT) | 241 | | | | 696 | 937 |
| Soymeal (MT) | | | 30,885 | | | 30,885 |
| Soybean Oil (MT) | 1,325 | 228 | | 628 | 176 | 2,357 |
| Total use EU+ | | | | | | 34.4 MMT |


KEY COUNTRIES OF ORIGIN OF SOY IMPORTS TO EU+




| | |
|-----------------|-----------------|
| Other countries | 2.8 MMT |
| Brazil | 12.6 MMT |
| Argentina | 9.5 MMT |
| U.S. | 5 MMT |
| Paraguay | 2.5 MMT |
| Canada | 1.3 MMT |
| Total | 33.7 MMT |



337 MMT
global soy production



127 M
hectares total production



19.4 MMT
of this is FEFAC SSG compliant soy

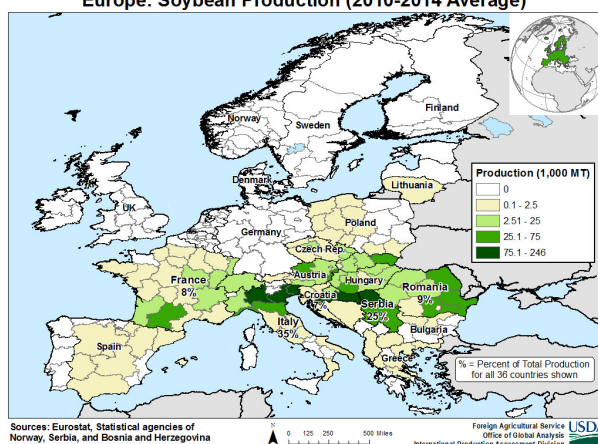
<https://www.idhsustainabletrade.com/uploaded/2019/04/European-Soy-Monitor.pdf>



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EU and legumes

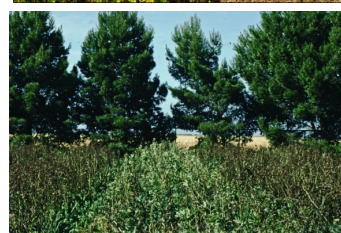
Europe: Soybean Production (2010-2014 Average)



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Knowledge gaps

- Inadequate investment in breeding
- Sub-optimal management practices
- Gaps in farmers' knowledge
- Variable yields





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LegumeGAP objectives

1. Quantify and characterize yield gaps
2. Identify optimal cultivars
3. Develop optimal management practices
4. Analyse the components and underlying factors of the legume yield gap
5. Evaluate potential and trade-offs of legume production at field and EU scales



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WP2: Cultivars



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What's available? Cultivars

- Characterization of germplasm:
 - Phenology, N fixation, stress response
- Field experiments:
 - 10 soy bean cultivars
 - 3 faba bean cultivars
 - Spain – Germany – Poland
- Derive possible cropping range



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WP2: Cultivars

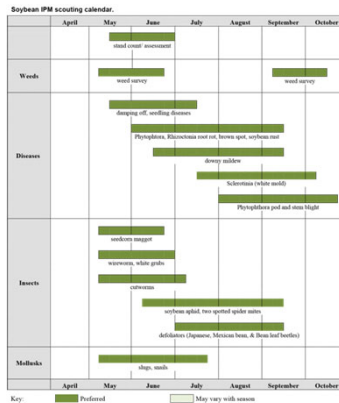
WP3: Optimal
management



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What's available? Practices

- Review of management practices:
 - Crop/cultivar choice
 - Inoculation of seed with Rhizobia
 - Pest-disease-weed management
 - Reduced tillage, use of cover crops, intercropping
 - irrigation
- Analysis of long-term experiments:
 - Germany, Finland, UK, France
- Testing novel practices
 - Based on review
 - Germany, Spain, Poland, Latvia
- Overview of optimal management strategies per region
- Synthesis of factors influencing yield instability



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Environmental Stratification of Europe

Environmental Zone

- ALN - Alpine North
- BOR - Boreal
- NEM - Nemoral
- ATN - Atlantic North
- ALS - Alpine South
- CON - Continental
- ATC - Atlantic Central
- PAN - Pannonian
- LUS - Lusitanian
- ANA - Anatolian
- MDM - Mediterranean Mountains
- MDN - Mediterranean North
- MDS - Mediterranean South

Northwest:
Autumn & spring sown
faba bean, soybean

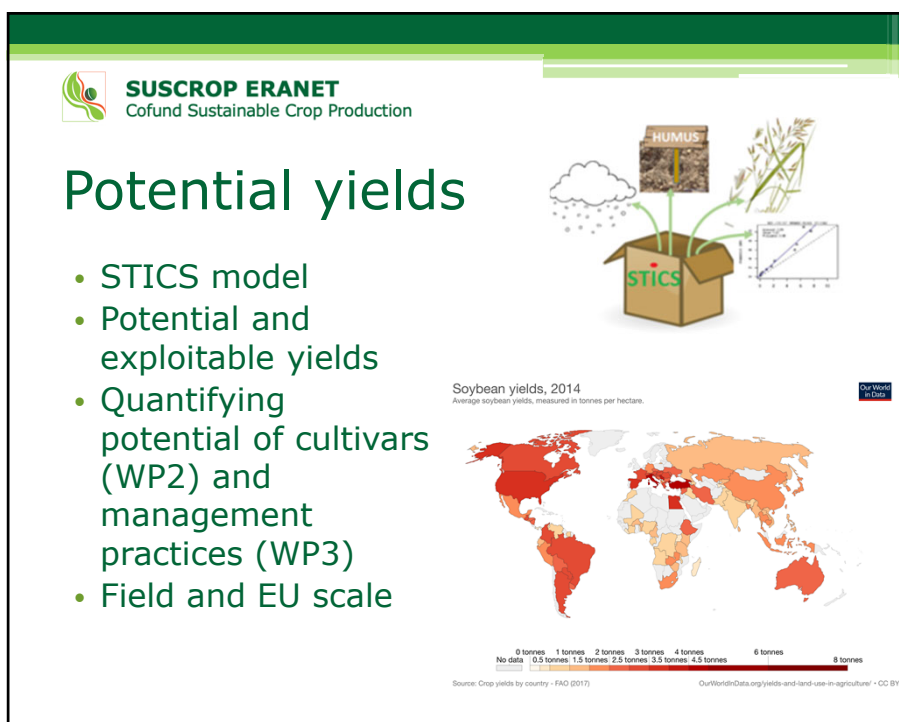
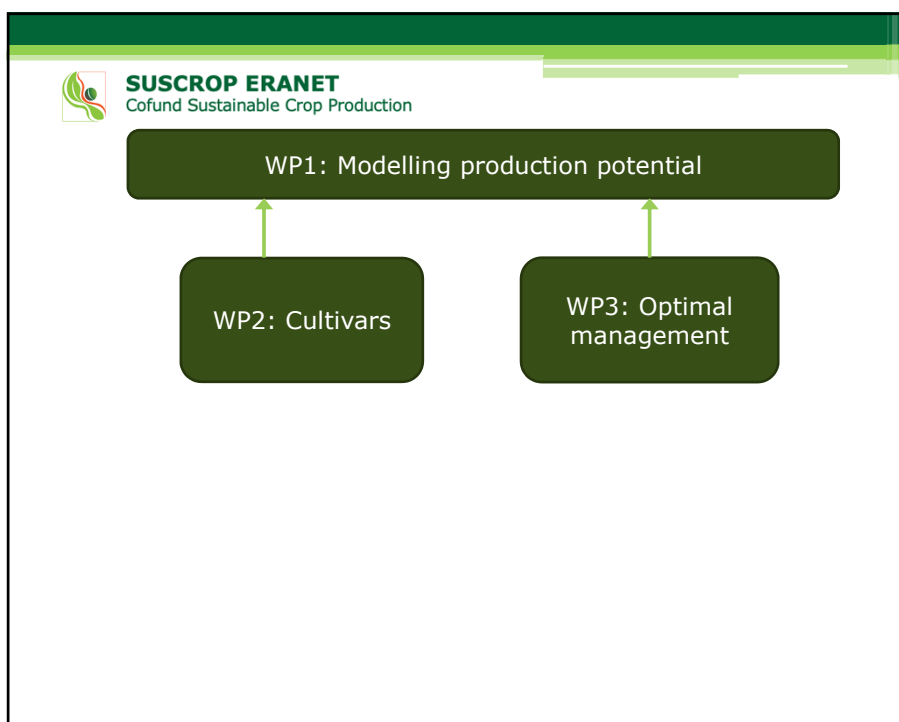
South:
Cool-season, autumn-
sown faba bean,
Irrigated soybean

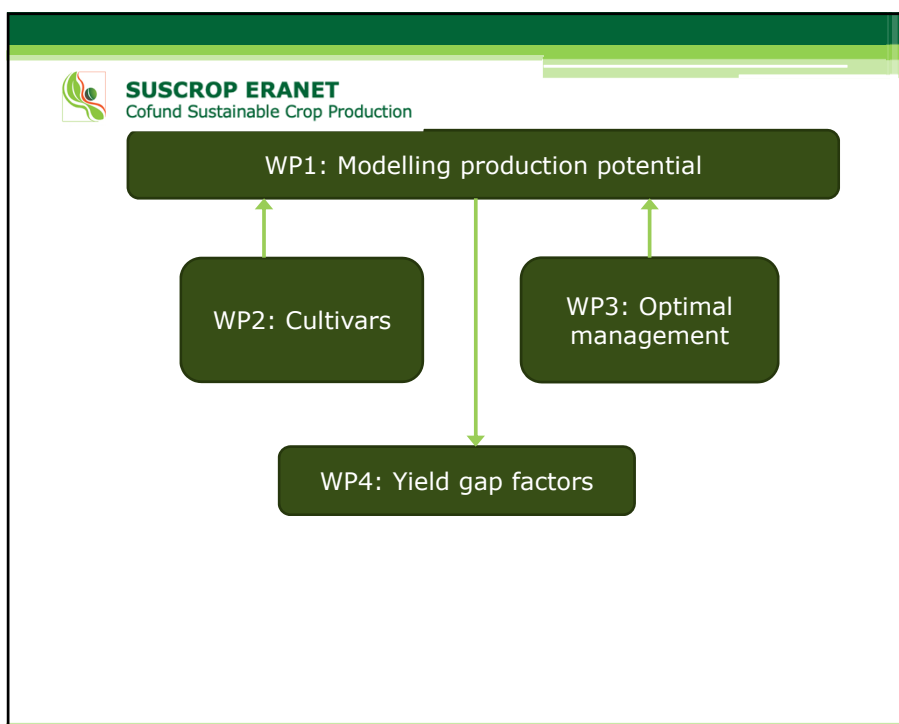
Northeast:
Spring-sown, cool-
season faba bean

Central:
Warm-season soybean;
Spring-sown faba bean



Map from Metzger et al 2005





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Yield gap factors

- Test cases: disentanglement of yield gap factors
- Modelling: Manageable vs unmanageable
- Survey: Knowledge yield gap

M.K. van Ittersum et al. / Field Crops Research 143 (2013) 4-17

Production situation

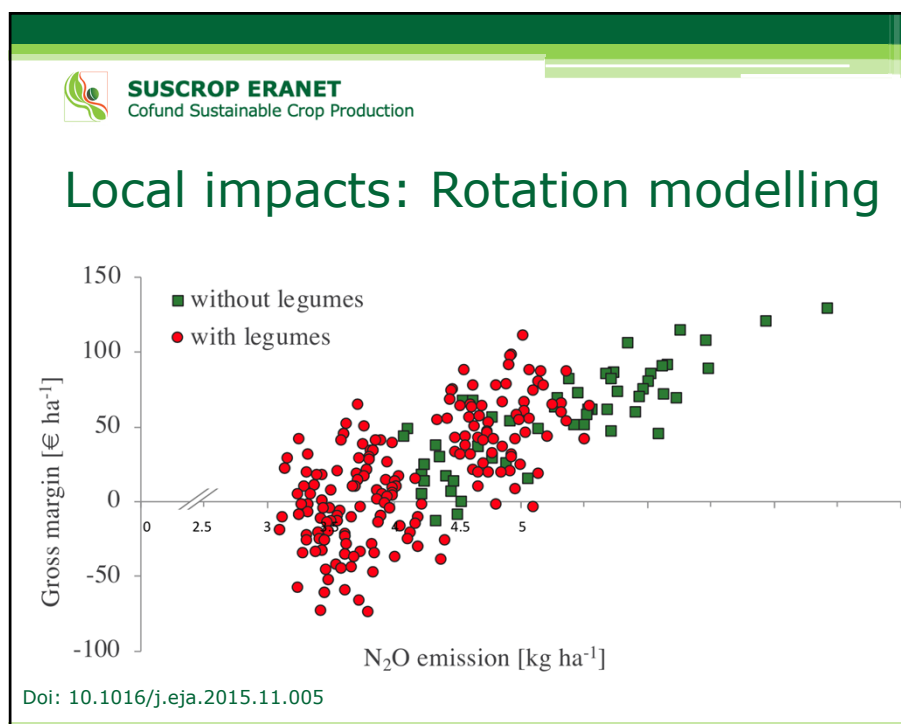
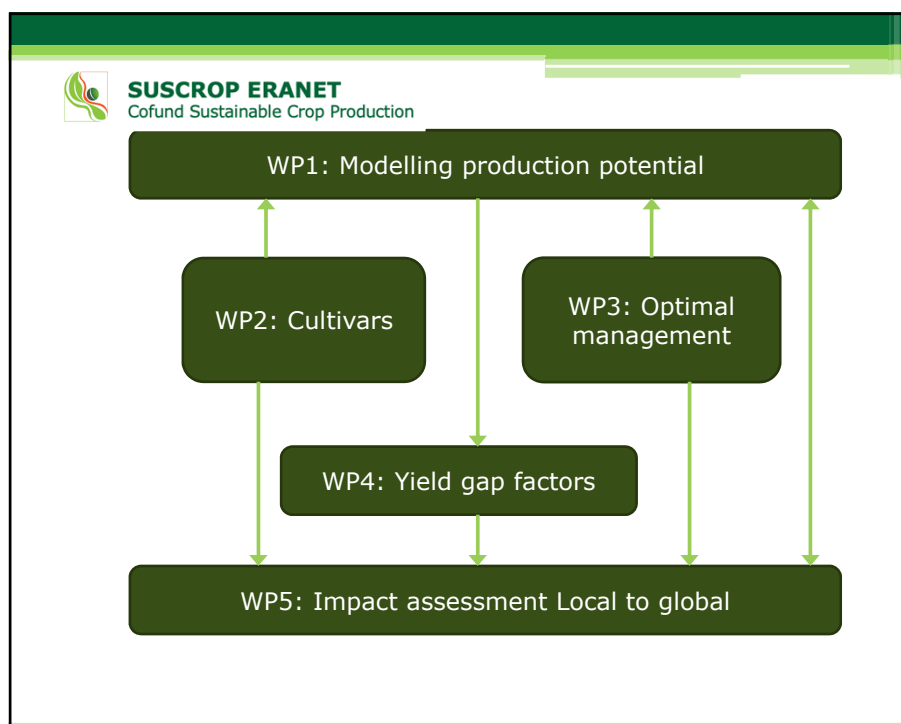
Production level (Mg/ha)

Defining factors: CO₂, Radiation, Temperature, Cultivar features

Limiting factor: Water

Limiting factors: Water, Nutrients

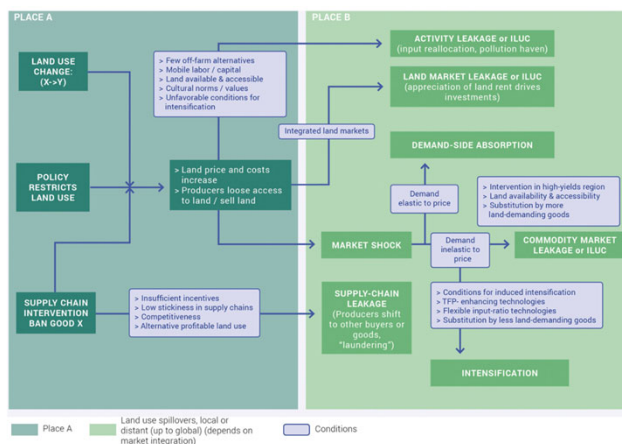
Reducing factors: Weeds, Pests and diseases, Pollutants





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Displaced impacts



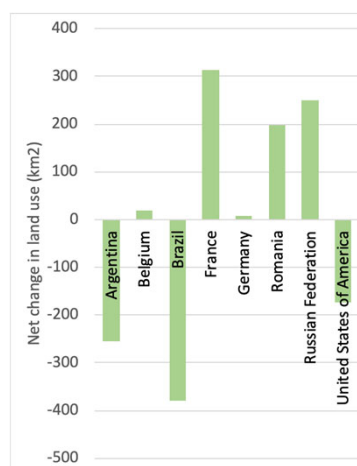
Doi: 10.1016/j.gloenvcha.2018.08.006



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Displaced impacts: example

- Introduce soy in Dutch arable rotations:
 - Maize, Wheat, Sugar beets, Grass, Potatoes
 - Once in 3 years
- 87038 ha / year, 305 kton
- At the cost of:
 - 63 kton sugar beets
 - 707 kton maize
 - 197 kton wheat
- Unchanged consumption: shift in import
 - Key trade partners
 - Total: 21 km² land use saving





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2. Identify optimal cultivars
3. Develop optimal management practices
4. Analyse the components and underlying factors of the legume yield gap
5. Evaluate potential and trade-offs of legume production at field and EU scales
6. **Propose appropriate legume production strategies for Europe**
 - **Cultivars**
 - **Field and knowledge management**
 - **Location**



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Thank you

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<https://www.suscrop.eu/projects-first-call/legumegap>

www.vital.environmentalgeography.nl

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