Research Institute of Organic Agriculture FiBL
info.suisse@fibl.org, www.fibl.org

Saxony5
Co-Creation Lab
Landwirtschaft und Biodiversität

Activities of FiBL – Działalność FiBL Szwajcaria

How to design a well balanced crop rotation in organic farming?

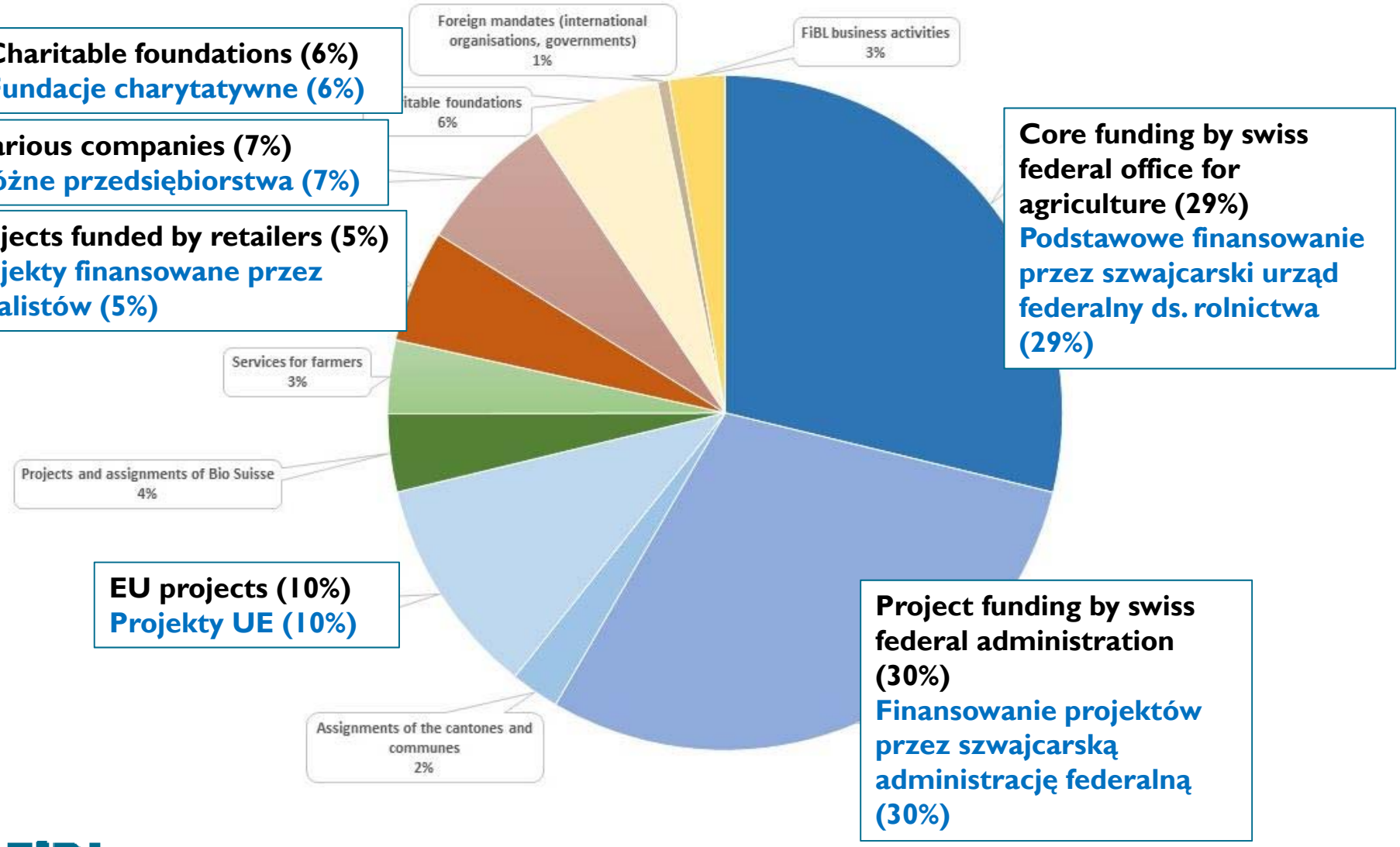
Knut Schmidtke, Professor for Organic Faming at HTW Dresden
Profesor Organic Faming w HTW Drezno
FiBL Director of Research, Extension & Innovation
FiBL dyrektor ds. badań, rozbudowy i innowacji

WUELS, 30 May 2021

FiBL Switzerland at a glance - FiBL Szwajcaria w skrócie

- Founded in 1973, private foundation - Założona w 1973 r., prywatna fundacja
- Around 220 employees - Około 220 pracowników
- 80 interns, B.A./Master/PhD students, apprentices - 80 stażystów, studentów studiów licencjackich, magisterskich i politechnicznych, praktykantów
- Research on over 200 Swiss organic farms - Badania nad ponad 200 szwajcarskimi gospodarstwami ekologicznymi

FiBL Switzerland financing (Budget 2019: CHF 27.5 Mio)
Finansowanie FiBL Szwajcaria (budżet 2019: 27,5 mln CHF)



Charitable foundations (6%)
Fundacje charytatywne (6%)

Various companies (7%)
Różne przedsiębiorstwa (7%)

Projects funded by retailers (5%)
Projekty finansowane przez detalistów (5%)

Core funding by swiss federal office for agriculture (29%)
Podstawowe finansowanie przez szwajcarski urząd federalny ds. rolnictwa (29%)

EU projects (10%)
Projekty UE (10%)

Project funding by swiss federal administration (30%)
Finansowanie projektów przez szwajcarską administrację federalną (30%)

Departments of FiBL Switzerland
Departamenty FiBL Szwajcaria

Soil Sciences

Nauki o glebie

Department of Soil Sciences -
Departament Nauk o Glebie

Soil fertility & climate- Płodność gleby i klimat

Nutrient management & symbiosis –
Zarządzanie składnikami odżywczymi i symbioza

Cultivation technique arable crops –
Technika uprawy rośliny uprawne

Departments of FiBL Switzerland
Departamenty FiBL Szwajcaria

Soil Sciences
Nauki o glebie

Crop Sciences
Nauki o uprawach

Department of Crop Sciences –
Departament Nauk o Uprawach Rolnych

Cultivation technique fruit and wine crops – Technika uprawy uprawy owoców i winorośli

Cultivation technique vegetable crops – Technika uprawy uprawy warzyw

Crop protection Ochrona roślin

Plant breeding - Hodowla roślin

Entomology & agroecology Entomologia i agroekologia

Example: Copper substitute - Przykład: Zastępca miedzi

FiBL laboratories: 3500 plant extracts are tested as an alternative to copper
Laboratoria FiBL: 3500 ekstraktów roślinnych jest testowanych jako alternatywa dla miedzi

Departments of FiBL Switzerland
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Soil Sciences
Nauki o glebie

Crop Sciences
Nauki o uprawach

Livestock Sciences
Nauki o zwierzętach gospodarskich

Department of Livestock Sciences -
Departament Nauk o Zwierzętach Gospodarskich

Livestock breeding –
Hodowla zwierząt gospodarskich

Animal welfare & housing –
Dobrostan zwierząt i warunki bytowania

Animal nutrition - Żywienie zwierząt

Animal health - Zdrowie zwierząt

Example: Animal welfare - Przykład: Dobrostan zwierząt

Testing of a multi-spectrum camera to investigate animal welfare
Badanie kamery wielospektralnej w celu zbadania dobrostanu zwierząt

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Nauki o glebie

Crop Sciences
Nauki o uprawach

Livestock Sciences
Nauki o zwierzętach gospodarskich

Socioeconomics
Socjoekonomia

Departement of Socioeconomic Sciences
Departament Nauk Społeczno-Ekonomicznych

Agri-food policy - Polityka rolno-spożywcza

Consumers & food - Konsumenci i żywność

Society & innovation – Społeczeństwo i innowacje

Sustainability - Zrównoważony rozwój

Departments of FiBL Switzerland
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Soil Sciences
Nauki o glebie

Crop Sciences
Nauki o uprawach

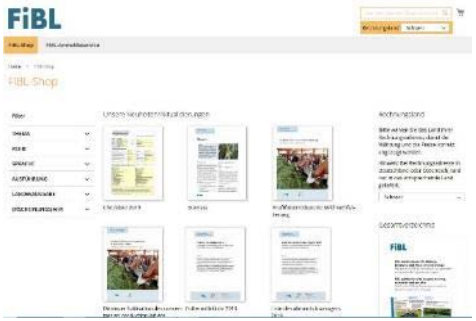
Livestock Sciences
Nauki o zwierzętach gospodarskich

Socioeconomics
Socjoekonomia

Extension, Training & Communication
Rozszerzenie, szkolenie i komunikacja

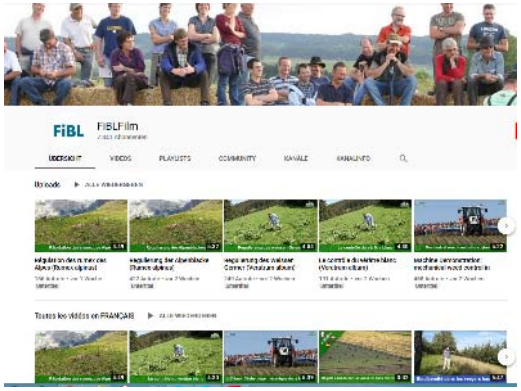
Dissemination and training
Upowszechnianie i szkolenie

Magazines in g/f/i - Magazyny w g/f/i



Technical leaflets - Ulotki techniczne

Online training manuals - Podręczniki szkoleniowe online



Online videos - Wideo online

Knowledge transfer into practice –
Transfer wiedzy do praktyki

Developing reduced tillage systems on-farm –
Opracowanie systemów uprawy uproszczonej w gospodarstwie rolnym

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Soil Sciences
Nauki o glebie

Crop Sciences
Nauki o uprawach

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Nauki o zwierzętach gospodarskich

Socioeconomics
Socjoekonomia

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Rozszerzenie, szkolenie i komunikacja

International Cooperation
Współpraca międzynarodowa

Departement of International Cooperation –
Odstąpienie od współpracy międzynarodowej

Focus areas - Obszary zainteresowania

Policy & sector Development –
Polityka i rozwój sektora

Tropical agriculture & agroforestry
Rolnictwo tropikalne i agroleśnictwo

Strategic market development –
Strategiczny rozwój rynku

Example: Breeding of organic cotton
Przykład: Hodowla bawełny organicznej

FiBL has been assisting organic farming organisations since 2011 with breeding, variety testing and seed propagation.
Od 2011 roku FiBL wspiera organizacje rolnictwa ekologicznego w zakresie hodowli, badanie odmian i rozmnażanie nasion.

FiBL group

1. FiBL Europe
2. FiBL Switzerland
3. FiBL Germany
4. FiBL Austria
5. FiBL France
6. ÖMKi in Hungary
7. FiBL Polska?

The World of Organic Agriculture 2019

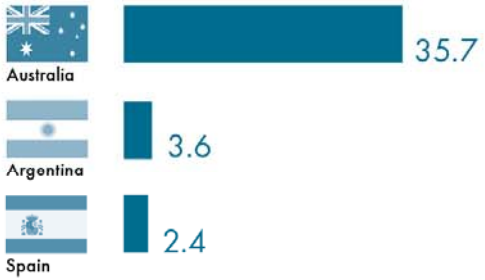
Organic Farmland 2019

72.3 m ha Organic farmland in million hectares

+1.6% From 2018

187 Countries with organic farming

Top 3 countries (land in million of hectares)



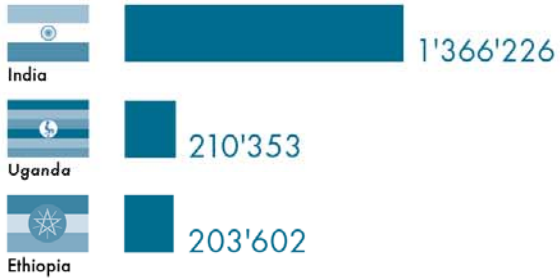
Organic Producers 2019

The number of organic producers is increasing

3.1 million Organic farmers

+13% From 2018

Number of producers: Top 3 countries

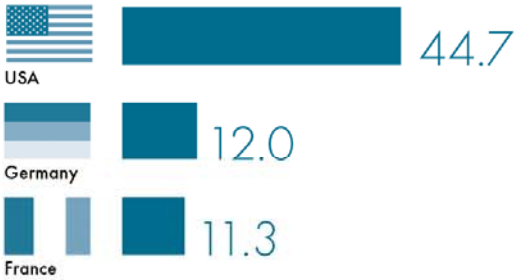


Organic Market 2019

The global market is growing and consumer demand is increasing

Over 106 Global organic food market in billion euros

Top 3 countries (market in billion euros)



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Source: FiBL survey based on national sources

More information: www.organic-world.net - statistics.fibl.org

ORGANIC FARMLAND 2019

World
72.3
million
ha

Australia
35.69
million
ha

1.5 % of the world's farmland is organic

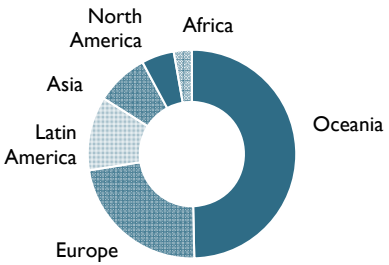
+555 %
since 1999

In Oceania there were 35.9 Mio ha, in Europe 16.5 Mio ha, and in Latin America 8.3 Mio ha.

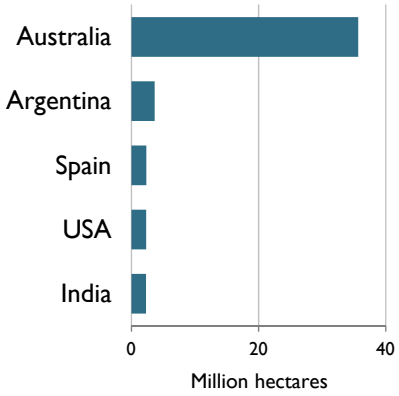
The ten countries with the largest organic agricultural areas represent 78% of the world's organic agricultural land.

16 countries have 10% or more of their agricultural land under organic management.

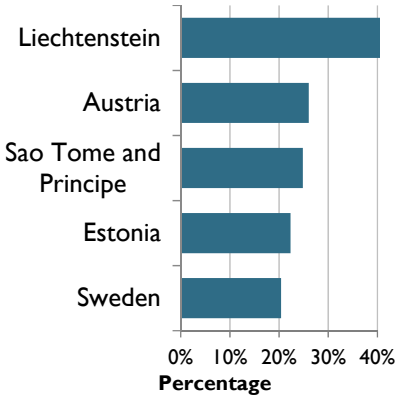
In 2019, over 1.1 million hectares more were reported compared with 2018.



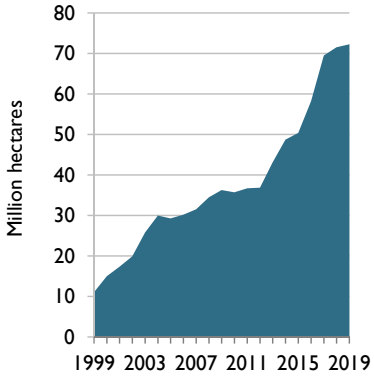
Distribution of organic agricultural land by region 2019



The five countries with the largest areas of organic agricultural land 2019



Top 5 countries with more than 10 percent of organic agricultural land 2019



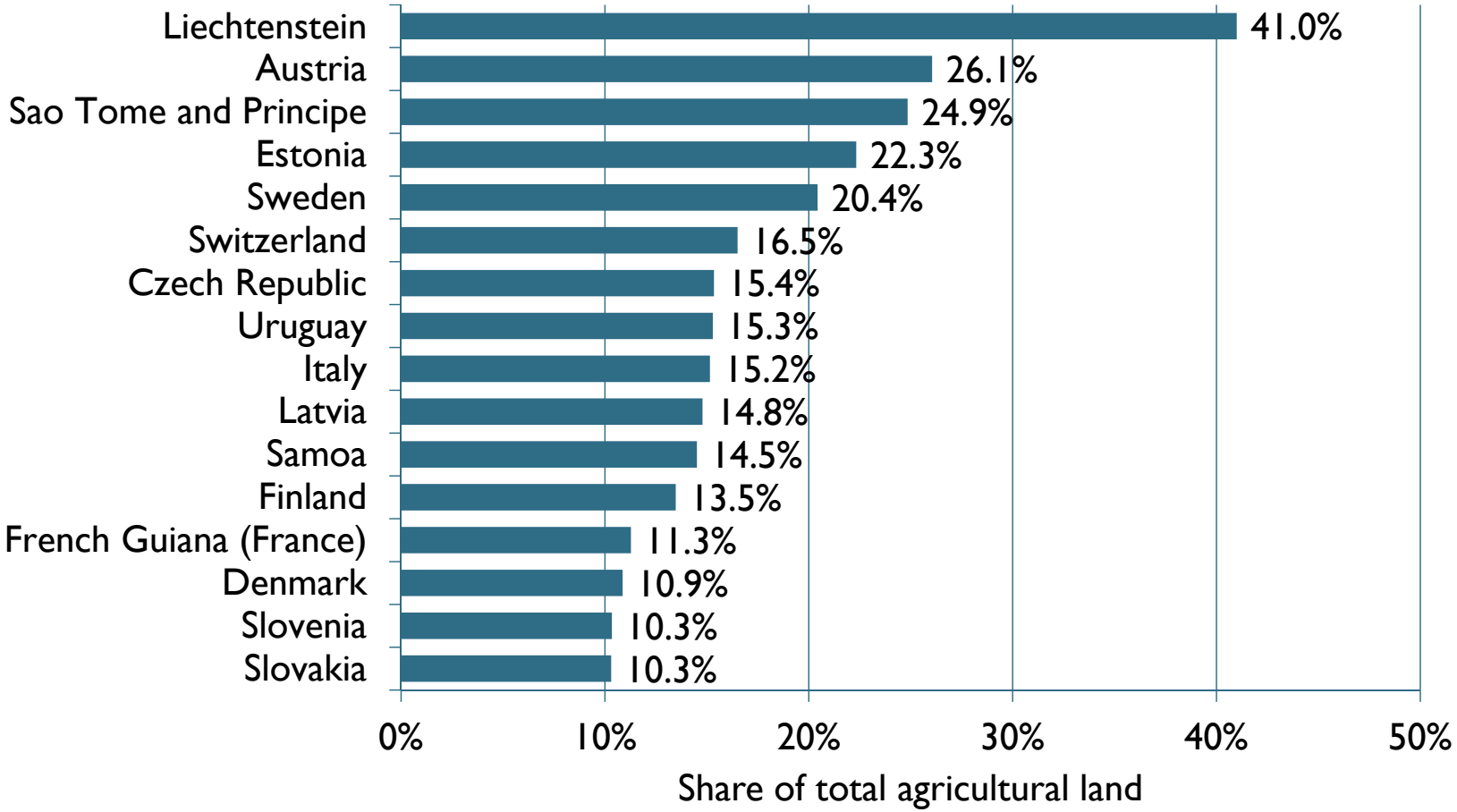
Growth of the organic agricultural land 1999-2019

FiBL www.fibl.org

Source: FiBL survey 2021 www.organic-world.net – statistics.fibl.org

Countries with an organic share of at least 10 percent of the agricultural land 2019

Source: FiBL survey 2021



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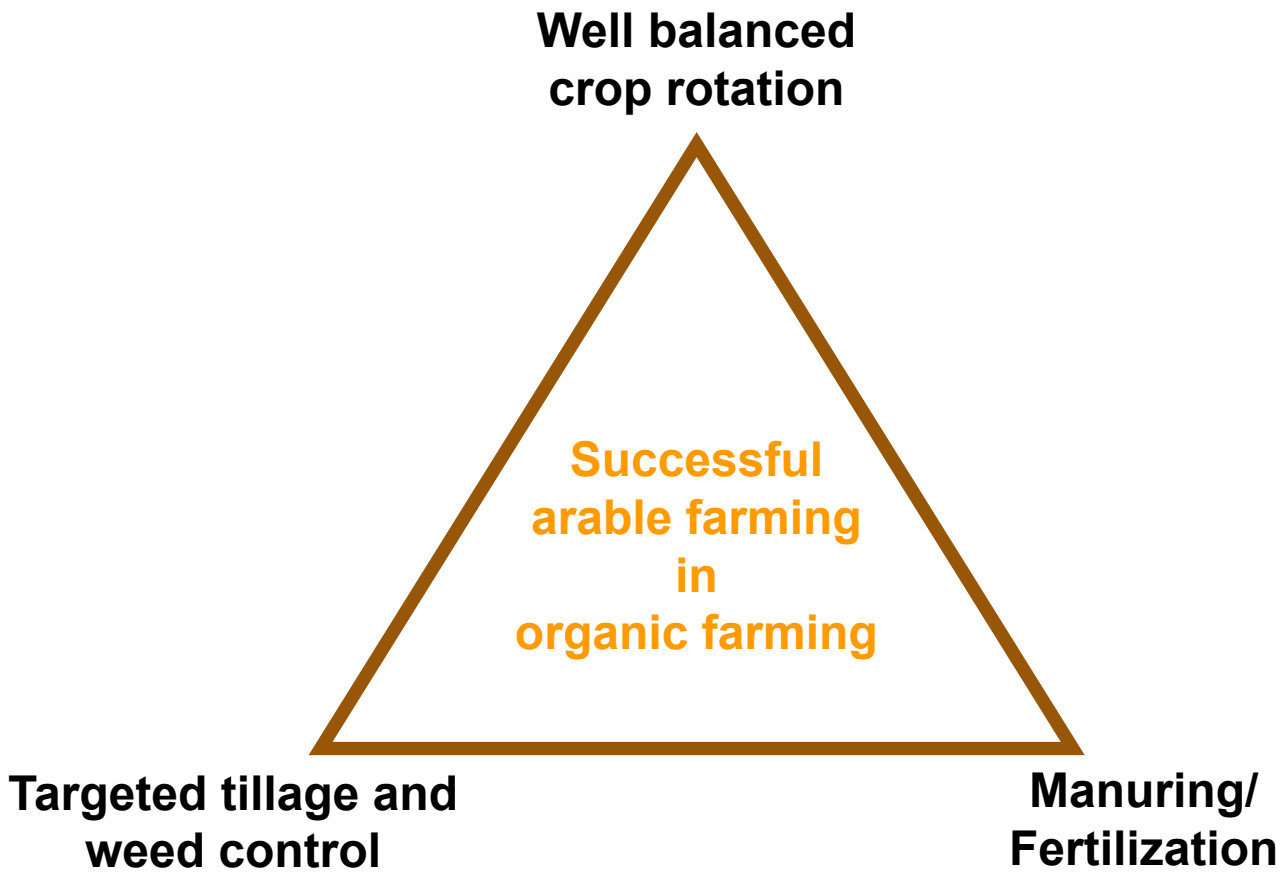
How to design a well balanced crop rotation in organic farming?

Knut Schmidtke

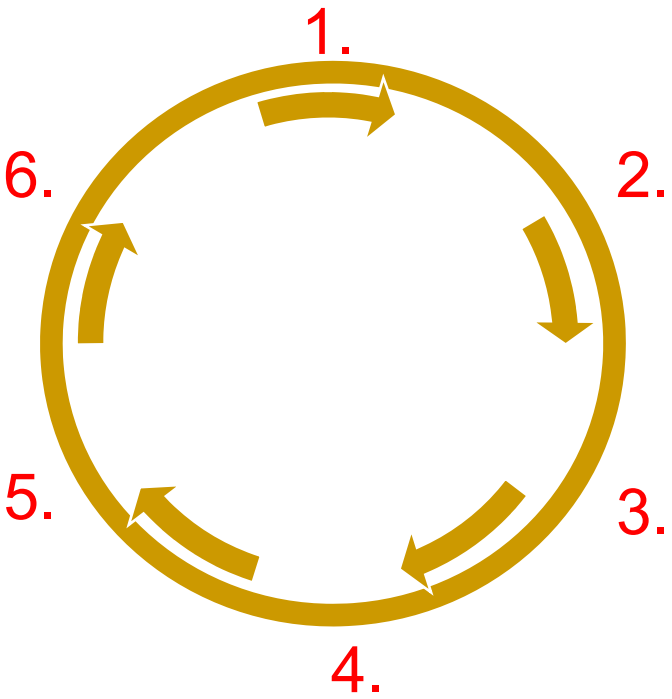
WUELS 26. March 2021

Three supporting pillars of successful arable farming in organic agriculture



Efficient crop rotation in organic farming

Red clover/grass



Faba bean

Table 1: Organic field trial Gladbacherhof (Leithold et al. 2015).

Rotation field (Year)	Mixed farm (cattle)
1 (2004)	Lucerne/red clover/grass (LRG)
2 (2005)	LRG
3 (2006)	Winter wheat
4 (2007)	Potato
5 (2008)	Winter wheat
6 (2009)	Winter rye

Table 1: Organic field trial Gladbacherhof (Leithold et al. 2015).

Rotation field (Year)	Mixed farm (cattle)	Cach crop Green fallow included
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3 (2006)	Winter wheat	Winter wheat
4 (2007)	Potato	Potato
5 (2008)	Winter wheat	Pea
6 (2009)	Winter rye	Winter rye

Table 1: Organic field trial Gladbacherhof (Leithold et al. 2015).

Rotation field (Year)	Mixed farm (cattle)	Cach crop Green fallow included	Cash crop Without Green fallow
1 (2004)	Lucerne/red clover/grass (LRG)	Oat	Oat
2 (2005)	LRG	Green fallow LRG	Faba bean
3 (2006)	Winter wheat	Winter wheat	Winter wheat
4 (2007)	Potato	Potato	Potato
5 (2008)	Winter wheat	Pea	Pea
6 (2009)	Winter rye	Winter rye	Winter rye
Forage legume	33,3 %	16,7 %	0 %

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5 (2008)	Winter wheat	Pea	Pea
6 (2009)	Winter rye	Winter rye	Winter rye
Forage legume	33,3 %	16,7 %	0 %
Grain legume	0 %	16,7 %	33 %

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2 (2005)	LRG	Green fallow LRG	Faba bean
3 (2006)	Winter wheat	Winter wheat	Winter wheat
4 (2007)	Potato	Potato	Potato
5 (2008)	Winter wheat	Pea	Pea
6 (2009)	Winter rye	Winter rye	Winter rye
Forage legume	33,3 %	16,7 %	0 %
Grain legume	0 %	16,7 %	33 %
Root crop	16,7 %	16,7 %	16,7 %
Cereals	50 %	50 %	50 %

Table 1: Organic field trial Gladbacherhof (Leithold et al. 2015).

Rotation field (Year)	Mixed farm (cattle)	Cach crop Green fallow included	Cash crop Without Green fallow
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6 (2009)	Winter rye	Winter rye	Winter rye
Shoot biomass (dt DM/ha)	98 (= 100 %)	89 (90 %)	73 (75 %)

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5 (2008)	Winter wheat	Pea	Pea
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Shoot biomass (dt DM/ha)	98 (= 100 %)	89 (90 %)	73 (75 %)
Shoot N (kg/ha)	191 (= 100%)	166 (87 %)	140 (73 %)

Table 4. Symbiotic N_2 fixation performance of an alfalfa-grass stand under cut use and green fallow use. (Loges, 2002)

	Cut use	Green fallow (Mulching)
N_2 fixation [kg je ha]	320	136

Table 1: Organic field trial Gladbacherhof (Leithold et al. 2015).

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Shoot biomass (dt DM/ha)	98 (= 100 %)	89 (90 %)	73 (75 %)
Shoot N (kg/ha)	191 (= 100%)	166 (87 %)	140 (73 %)
Δ soil N (kg per ha and year)	+ 7	-20	-57

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6 (2009)	Winter rye	Winter rye	Winter rye
Shoot biomass (dt DM/ha)	98 (= 100 %)	89 (90 %)	73 (75 %)
Shoot N (kg/ha)	191 (= 100%)	166 (87 %)	140 (73 %)
∆ soil N (kg per ha and year)	+ 7	-20	-57
Humus in soil (t per ha)	93 (= 100 %)	88 (95 %)	83 (89%)

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1 (2004)	Lucerne/red clover/grass (LRG)	Oat	Oat
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3 (2006)	Winter wheat	Winter wheat	Winter wheat
4 (2007)	Potato	Potato	Potato
5 (2008)	Winter wheat	Pea	Pea
6 (2009)	Winter rye	Winter rye	Winter rye
Profit (€ per ha and a)	750	473	468

1. Balanced crop rotation

a) At least 16% forage legumes and 30% legume main crops in the crop rotation: N-supply, regulation of canada thistle, humus supply

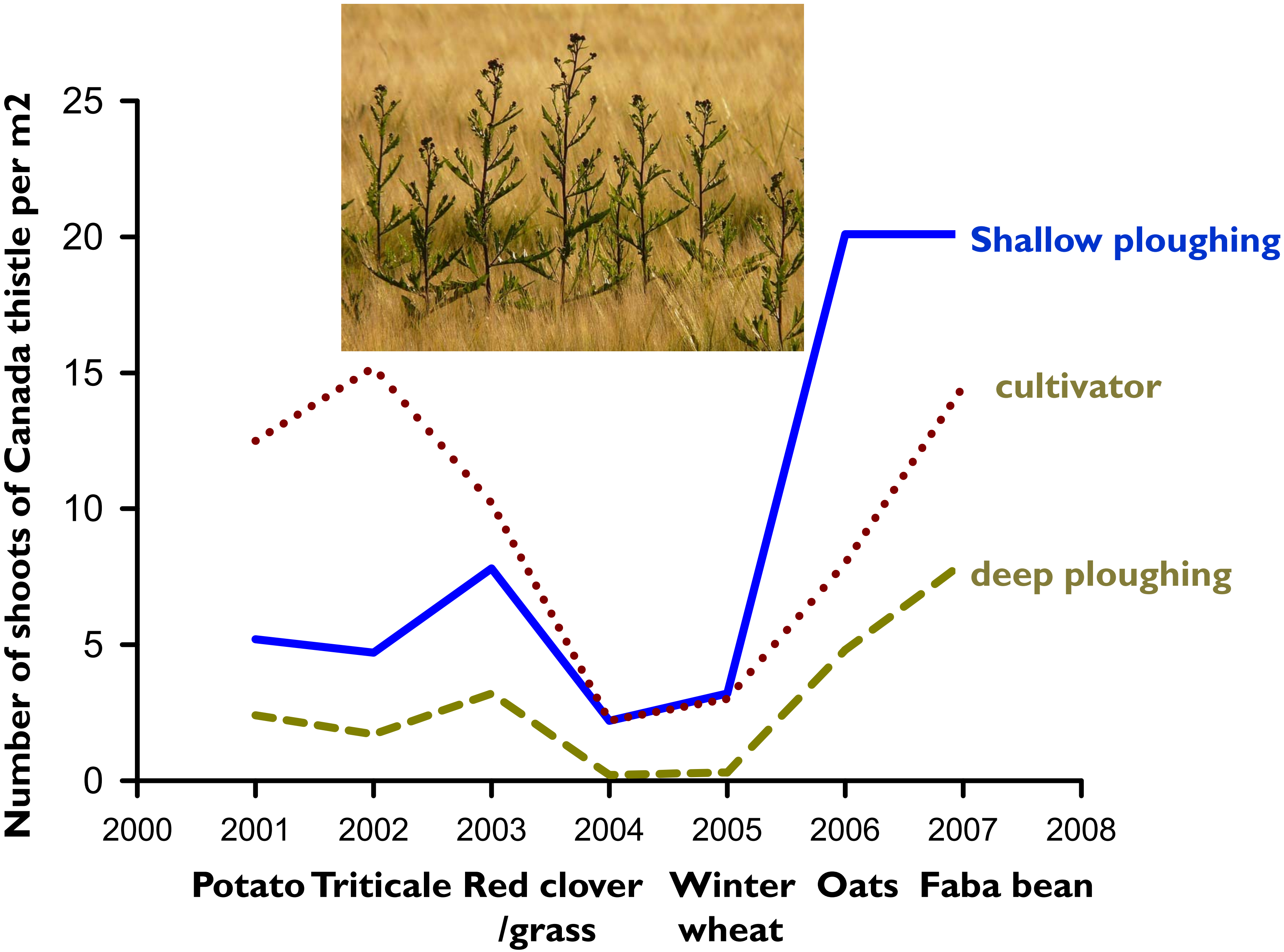

Fig. 1: Number of shoots of Canada thistle in the crop rotation: assessment on stubble (Pekrun & Claupein 2004, Gruber et al. 2010)

Optimal red clover stand

Table 2: Shoot and root dry matter yield and symbiotically fixed N_2 in shoot and root of alfalfa, red clover and persian clover in the 1st main year of use (Jung, 2003) Reinshof: alluvial loam.

	DM Yield [dt DM/ha]
Lucerne[1)]	207
Red clover[1)]	186
Persian clover[2)]	103

[1)] after sowing in August of the previous year

[2)] after seeding in April of the main year of use

Table 2: Shoot and root dry matter yield and symbiotically fixed N_2 in shoot and root of alfalfa, red clover and persian clover in the 1st main year of use (Jung, 2003) Reinshof: alluvial loam.

	DM Yield [dt DM/ha]	N_2 fixation [kg N/ha]
Lucerne[1)]	207	409
Red clover[1)]	186	361
Persian clover[2)]	103	165

[1)] after sowing in August of the previous year

[2)] after seeding in April of the main year of use

Measure: Whenever possible, provide for perennial instead of annual forage legume cultivation with alfalfa or red clover

N balance

Table 3. Symbiotically fixed N_2 amount, cuttings N and N balance of alfalfa, red clover and persian clover in the 1st main year of use (Jung, 2003) Reinshof: Alluvial loam.

	N_2 fixation [kg N/ha]	Cuttings N [kg N/ha]
Lucerne[1)]	409	368
Red clover[1)]	361	368
Persian clover[2)]	165	234

[1)] after sowing in August of the previous year

[2)] after seeding in April of the main year of use

N balance

Table 3. Symbiotically fixed N_2 amount, cuttings N and N balance of alfalfa, red clover and persian clover in the 1st main year of use (Jung, 2003) Reinshof: Alluvial loam.

	N_2 fixation [kg N/ha]	Cuttings N [kg N/ha]	N balance[3)] [kg N/ha]
Lucerne[1)]	409	368	+ 41 (+82)
Red clover[1)]	361	368	- 7 (+29)
Persian clover[2)]	165	234	- 69 (-52)

1) after sowing in August of the previous year

2) after seeding in April of the main year of use

3) In parentheses : N balance including rhizodeposition N (0.10 of N_2 fixation according to Landgraf 2016)

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Alfalfa undersown in cereals

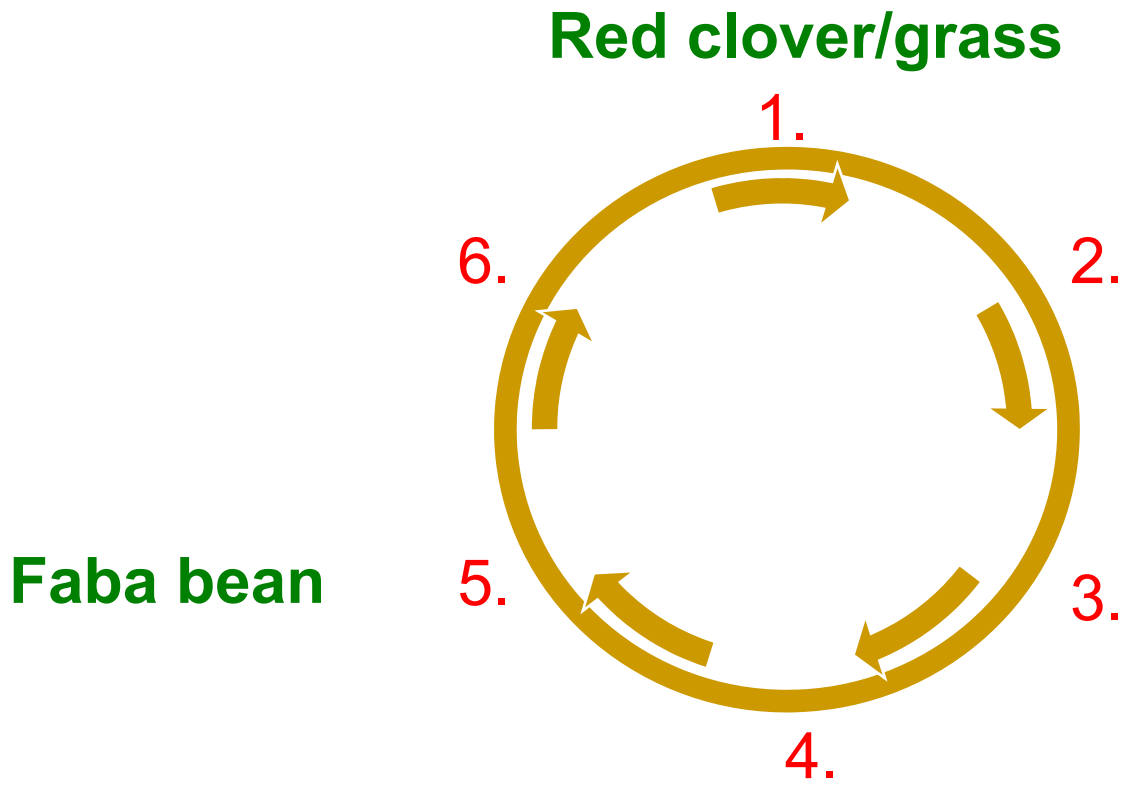
Alfalfa root in a clay soil

1. Balanced crop rotation

a) At least 16% forage legumes and 30% legume main crops in the crop rotation: N-supply, regulation of canada thistle, humus supply

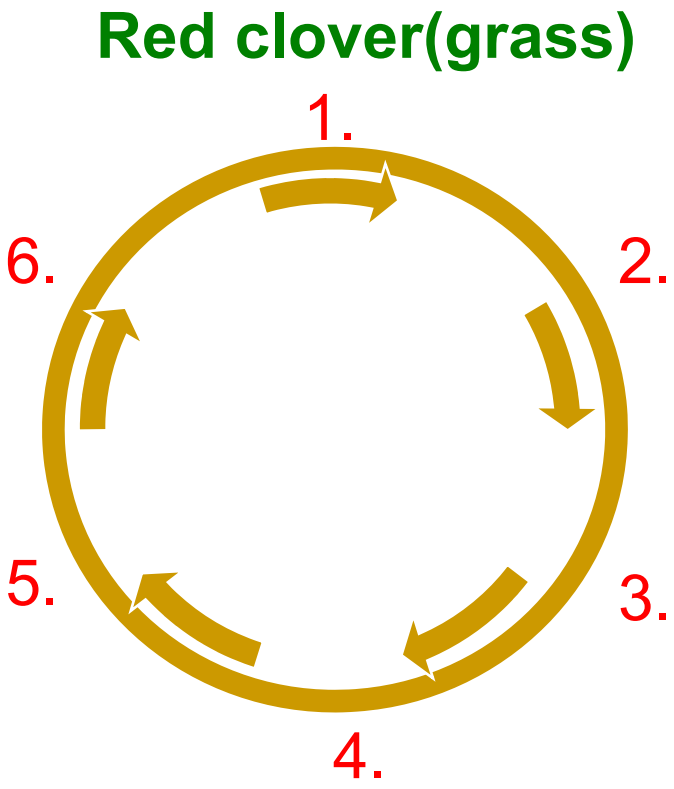
b) Consistently avoid crop rotation diseases of legumes

Efficient crop rotation in organic farming



1. Balanced crop rotation

Efficient crop rotation in organic farming



Pea

FiB .org

Figure 2. Diseases of pea (Finckh 2010)

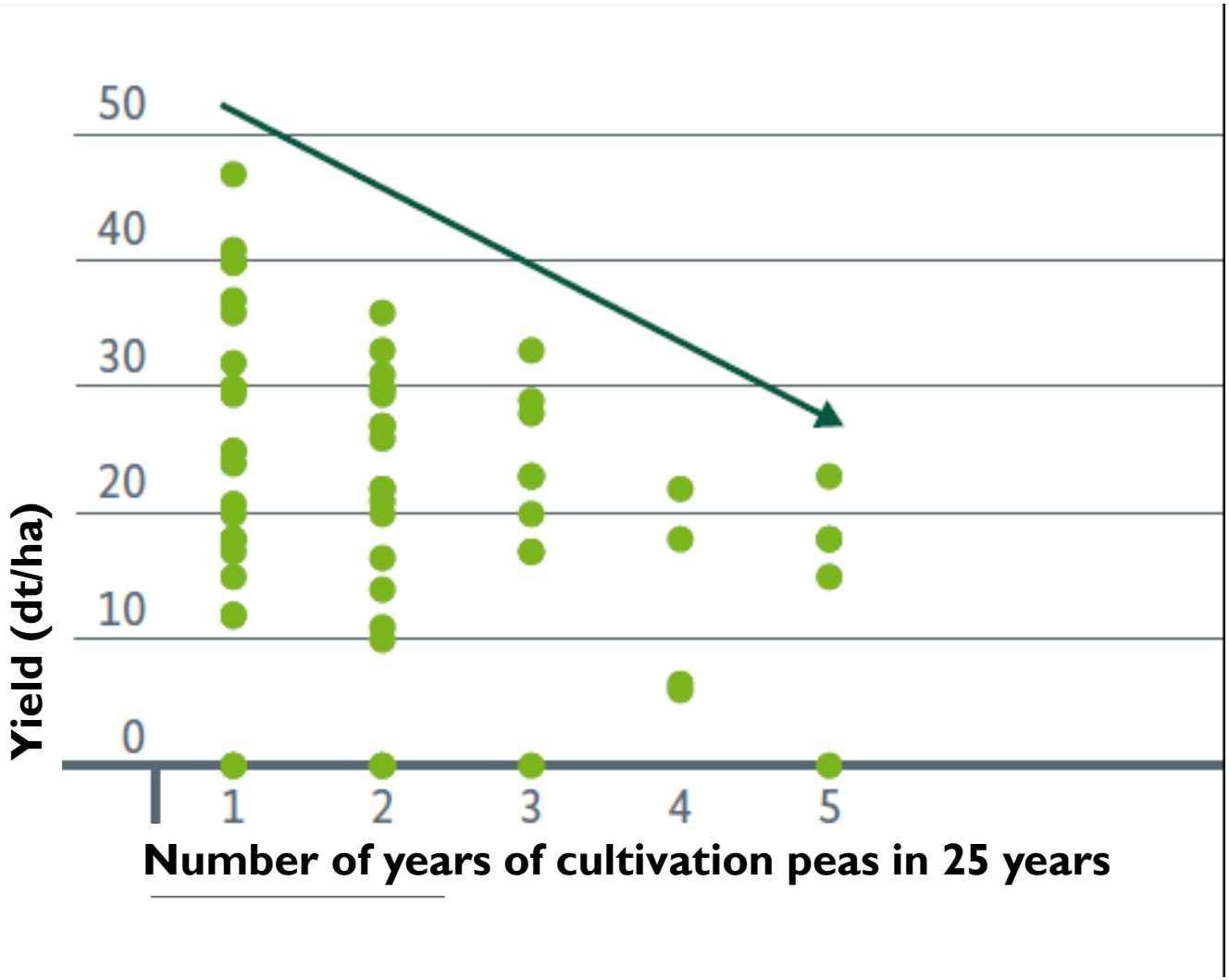


Figure 3. Grain yield of white-flowered grain pea in organic farming as a function of the frequency of pea cultivation in the past 25 years (Schmidt et al. 2014)

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bofru www.bodenfruchtbarkeit.org

Table 4. Recommended cultivation breaks for grain legumes in the main crop

Grain legume	Cultivation break (years)
Pea white flower	**6 to 9**
Pea, purple flower	5 to 7
Lupins	6 to 9
Faba bean	4 to 5

Völkel & Voigt-Kaute (2013)

Other host plants besides pea

- ***Mycosphaerella pinodes*: Vetch and lupin, faba bean, pea, lentil, phaseolus bean**
-

- ***Phoma medicaginis* var. *Pinodella*: Vetch, lupin, red clover, subterranean clover**

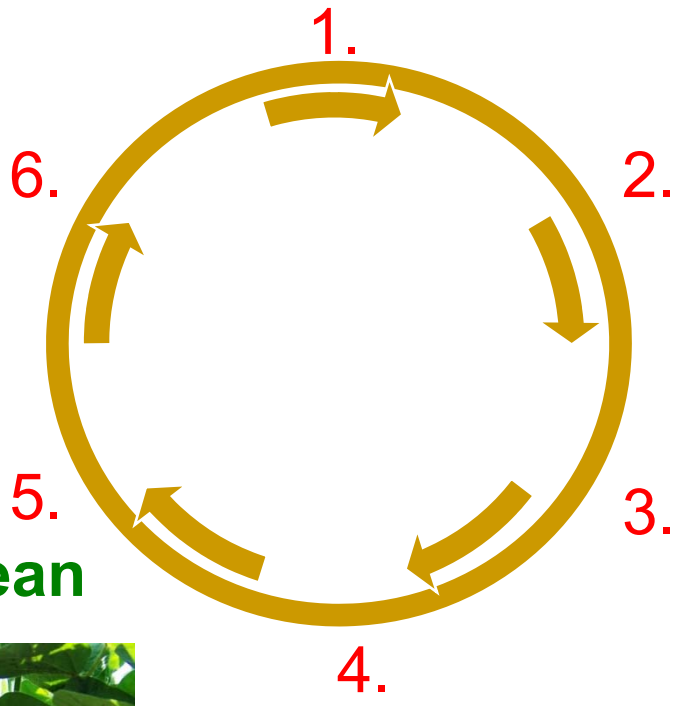
- (Aphanomyces euteiches): Lucerne, vetch, lentil, *phaseolus bean*, red clover, white clover subterranean clover

Table 4. Recommended cultivation intervals of grain legumes to forage legumes in the main crop production

Grain legume	Forage legume	Cultivation break (years)
Pea, white flower	Red clover (Lucerne)	6 – 9
Pea, purple flower	Red clover (Lucerne)	5 – 8
Lupin	Red clover (Lucerne)	6 - 9
Several grain legume species	White clover Yellow clover Swedish clover Serradella	2 - 4

Völkel & Voigt-Kaute (2013)

Efficient crop rotation in organic farming



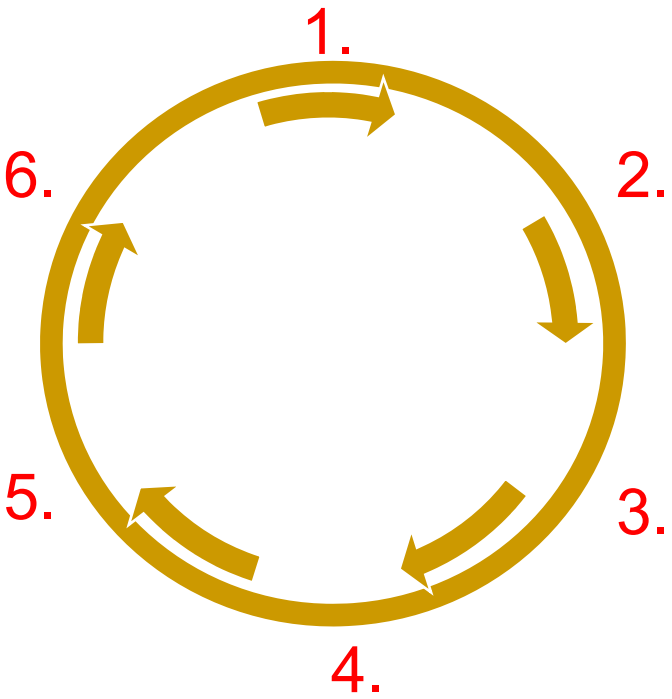
(5) Pea

(10) Soybean

FiBL

Efficient crop rotation in organic farming

Red clover/grass



Faba bean

1. Balanced crop rotation

Efficient crop rotation in organic farming

Winter rye

1. Red clover(grass)
2. Winter wheat
3. Corn
4. Winter triticale
5. Faba bean
6.

1. Balanced crop rotation

a) At least 16% forage legumes and 30% legume main crops in the crop rotation: N-supply, regulation of canada thistle, humus supply

b) Consistently avoid crop rotation diseases of legumes

c) Consistent alternation between spring sown and autumn sown crops in the crop rotation

d) Share of cereals in the crop rotation not higher than 60%

e) Options to replace the crop types if the basic framework points a) to d) are complied with

1. Balanced crop rotation

Efficient crop rotation in organic farming

Red clover/grass)

1.

2. Winter wheat

3. Corn

4. Winter triticale
Spelt

5. **Faba bean**

6. Winter rye
Winter barley

FiBL

Research Institute of Organic Agriculture FiBL
info.suisse@fibl.org, www.fibl.org

How to design a well balanced crop rotation in organic farming?

Knut Schmidtke

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