Cover crops in Brittany, France (Soil Care)

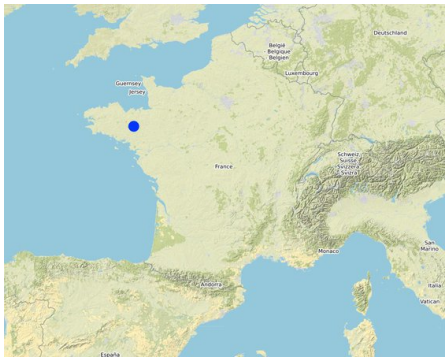
Vegetation cover management on an organic, mixed livestock-crop farm (France)

DESCRIPTION

Use of different mixes of plant cover for livestock fodder which are simultaneously favourable for biodiversity by improving soil health, and reducing the need for agrochemicals.

Agriculture in Brittany, in the north-west of France, is known for fish, beef, pork, poultry, vegetables and milk. Cover crops are used by farmers of Mauron, and the example described here is from a farm located in Morbihan in the basin known as Ploërmel. In this warm temperate area the average annual rainfall is 650-700 mm with an annual temperature of around 11°C.
There are three types of cover crops included in the rotation. These are selected on the basis of their benefits in relation to soil fertility and fodder production, in order to improve the farm's food self-sufficiency. There are three basic types of cover crops, as follows.
1) “Protein mixes” are composed of 35% faba (broad) beans, 26% oats, 17.5% peas, 17.5% vetch, and 4% clover. These are sown in early October after grass or maize are made into silage at the end of April.
2) "Green manure" cover crops are sown at the beginning of September after cereals, and are composed of various complementary species with the main objective of preserving and strengthening soil life (i.e. worm abundance), and winter feeding of heifers. For example, the commercial "Biomax" mix contains seeds of broad bean, vetch, clover, phacelia and radish. These cover crops are enriched by the presence of approximately 50% ryegrass regrowth, supporting the development of soil life.
3) Rapeseed is sown after cereals as a crop rotation feedstock and are made into silage.
Cover crops are either broadcast and rolled, or direct seeded depending on the conditions of the post-harvest plots. The seed drill used is equipped with discs to minimise soil disturbance as a reduced tillage technique, but more important in this respect is the presence of crop residues (i.e. straw). The seed drill is also equipped with tines.
The cover crops are grazed by heifers in a rotational 2-day paddock set-up. After grazing and regrowth of the ryegrass present, the fields may be left to develop into pasture, or seeded to crops using a minimum tillage drill.
The purposes are:
•Improved production
•Countered land degradation
•Protected watersheds
•Preserved biodiversity
•Adaptation to climate change/extreme events
The benefits are:
•Sustained ecosystem health: no pest and disease problems, good herd health
•Enrichment of the soil by the addition of carbon in organic matter and by the work of earthworms - favouring ecosystem functioning
•Protection of the soil and surface biodiversity because of maintained plant cover
•Increased weed control due to plant canopies and fertilisation effect of green manure
•Planted cover crops used as livestock feed during winter
The challenges are:
•Potential difficulties in establishing plant cover (especially in dry areas)

LOCATION



Location: Mauron, Brittany, France

No. of Technology sites analysed: single site

Geo-reference of selected sites
- -2.3189, 48.06079

Spread of the Technology: evenly spread over an area (approx. 10-100 km2)

In a permanently protected area?: No

Date of implementation: 2019; less than 10 years ago (recently)

Type of introduction
- ☑ through land users' innovation
- ☑ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☐ through projects/ external interventions

•Late sowing of cover crops reduces beneficial effects
•High costs of seed mixtures with high protein cover crops

Cover crops in Brittany, France (Soil Care)

Cover crop mowing for its removal

CLASSIFICATION OF THE TECHNOLOGY

Main purpose
- ☑ improve production
- ☑ reduce, prevent, restore land degradation
- ☐ conserve ecosystem
- ☑ protect a watershed/ downstream areas – in combination with other Technologies
- ☑ preserve/ improve biodiversity
- ☐ reduce risk of disasters
- ☑ adapt to climate change/ extremes and its impacts
- ☐ mitigate climate change and its impacts
- ☐ create beneficial economic impact
- ☐ create beneficial social impact

Land use

Land use mixed within the same land unit: Yes - Agro-pastoralism (incl. integrated crop-livestock)

Cropland
- Annual cropping: cereals - maize, cereals - rye, fodder crops - clover, fodder crops - grasses, fodder crops - other, legumes and pulses - beans, oilseed crops - sunflower, rapeseed, other
- Cover crops

Number of growing seasons per year: 1
Is intercropping practiced? Yes
Is crop rotation practiced? Yes

Grazing land
- Cut-and-carry/ zero grazing
- Improved pastures

Animal type: cattle - dairy, poultry
Is integrated crop-livestock management practiced? Yes

Species	Count
cattle - dairy	115
poultry	4500

Water supply
- ☑ rainfed
- ☐ mixed rainfed-irrigated
- ☐ full irrigation

Purpose related to land degradation
- ☑ prevent land degradation
- ☑ reduce land degradation
- ☐ restore/ rehabilitate severely degraded land
- ☐ adapt to land degradation
- ☐ not applicable

Degradation addressed

soil erosion by water - Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying, Wo: offsite degradation effects

chemical soil deterioration - Cn: fertility decline and reduced organic matter content (not caused by erosion)

physical soil deterioration - Pc: compaction

biological degradation - Bc: reduction of vegetation cover, Bq: quantity/ biomass decline, Bs: quality and species composition/ diversity decline, Bp: increase of pests/ diseases, loss of predators

water degradation - Hp: decline of surface water quality, Hw: reduction of the buffering capacity of wetland areas

SLM group

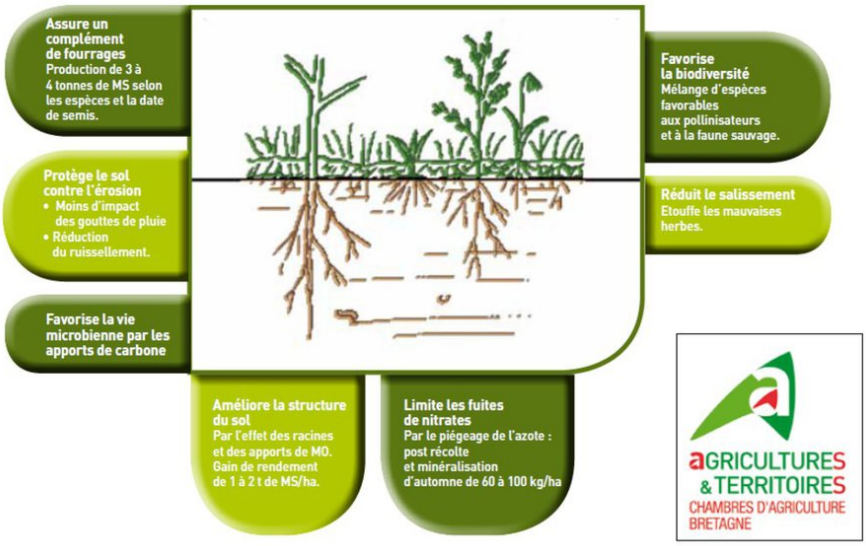
SLM measures

- integrated crop-livestock management
- improved ground/ vegetation cover
- integrated pest and disease management (incl. organic agriculture)

agronomic measures - A1: Vegetation/ soil cover, A2: Organic matter/ soil fertility, A3: Soil surface treatment, A4: Subsurface treatment

TECHNICAL DRAWING

Technical specifications
- broadcast sowing or direct sowing of species mixture in late August / early September or late September / early October
- protein mix: peas 40 kg / faba (broad) beans 80 kg / vetch 40 kg / clover 8 kg / oats 60 kg per hectare
- Biomax mix: radish 2 kg / clover 3 kg / faba (broad) bean 20 kg / phacelia 2 kg / vetch 10 kg per hectare
- Rapeseed mix: 8 to 10 kg per hectare



Author: Revue agricole Terra

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated: per Technology area (size and area unit: 1 ha)
- Currency used for cost calculation: €
- Exchange rate (to USD): 1 USD = 0.9 €
- Average wage cost of hired labour per day: Gross hourly minimum wage: €10.15 on 1 January 2020, i.e. €1,539.42 monthly on the basis of the legal working week of 35 hours.

Most important factors affecting the costs
Direct sowing equipment, destruction with 2 passes of rolling spade, cost of purchasing "biomax" mixture

Establishment activities
1. Soil preparation and subsequent sowing of rapeseed/rapeseed after harvest cereals (Timing/ frequency: End of August)
2. Soil preparation and sowing of the Biomax mixture after harvest cereals (Timing/ frequency: End of August)
3. Soil preparation and sowing of meslin after grassland or corn on the cob (Timing/ frequency: End of October)
4. Rapeseed/rapeseed grazing and growing of green manure (Timing/ frequency: December to March)
5. Meslin silage (Timing/ frequency: April)

Establishment inputs and costs (per 1 ha)

Specify input	Unit	Quantity	Costs per Unit (€)	Total costs per input (€)	% of costs borne by land users
Equipment					
Direct seeding (compil)	ha	40.0	60.0	2400.0	100.0
Broadcast sowing	ha	72.0	15.0	1080.0	100.0
Roller spade before sowing (1 pass)	ha	72.0	23.0	1656.0	100.0
Maceration by a roller with blades	ha	224.0	23.0	5152.0	100.0
Plant material					
Seeds - protein blend	ha	60.0	394.0	23640.0	100.0
Seeds - forage rapeseed	ha	17.0	28.0	476.0	100.0
Seeds - green manure "biomax" fertilizer	ha	18.0	60.0	1080.0	100.0
Total costs for establishment of the Technology				**35'484.0**	
Total costs for establishment of the Technology in USD				*39'426.67*	

Maintenance activities
n.a.

NATURAL ENVIRONMENT

Average annual rainfall
- ☐ < 250 mm
- ☐ 251-500 mm
- ☑ 501-750 mm
- ☐ 751-1,000 mm

Agro-climatic zone
- ☐ humid
- ☑ sub-humid
- ☐ semi-arid
- ☐ arid

Specifications on climate
Average annual rainfall in mm: 675.0
The farm is located on the commune of Mauron in Morbihan and is in an early agro-climatic zone. The average annual rainfall of 650-700 mm is the lowest in Morbihan. The average annual temperature of around 11°C and is also the lowest in Morbihan.

- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Name of the meteorological station: Ploermel
The climate of Mauron is warm and temperate. It is in the basin known as Ploërmel, the most continental of Morbihan with colder winters, hotter summers and rainfall of around 650-700 mm/year. Heavy showers fall all year round in the area of Mauron. Even in the driest months, rainfall remains fairly heavy.

Slope
- [ ] flat (0-2%)
- [x] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [x] plateau/plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [x] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [x] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [x] high (>3%)
- [ ] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [x] medium
- [ ] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [x] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to: both ground and surface water

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [x] high
- [ ] medium
- [ ] low

Habitat diversity
- [x] high
- [ ] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial)
- [x] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [ ] individual/ household
- [x] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [x] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [ ] medium-scale
- [x] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [x] leased
- [ ] individual
- [x] provisioning

Water use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Access to services and infrastructure

health	poor		✓	good
education	poor		✓	good
technical assistance	poor		✓	good
employment (e.g. off-farm)	poor	✓		good
markets	poor	✓		good
energy	poor	✓		good
roads and transport	poor	✓		good
drinking water and sanitation	poor		✓	good
financial services	poor	✓		good

IMPACTS

Socio-economic impacts

Crop production	decreased ✓ increased	Improved soil health and diversity with reduces pest issues
crop quality	decreased ✓ increased	Improved soil health and diversity with reduces pest issues
fodder production	decreased ✓ increased	Improved soil health and diversity with reduces pest issues
fodder quality	decreased ✓ increased	Improved soil health and diversity with reduces pest issues
animal production	decreased ✓ increased	Better diversity of fodder available is producing healthier and better quality animals
product diversity	decreased ✓ increased	Sward mix in cover crop is very diverse
drinking water quality	decreased ✓ increased	Cover crops reduce soil wash-off and other water quality related impacts
water availability for livestock	decreased ✓ increased	Cover crops reduce soil wash-off and other water related loss impacts
water quality for livestock	decreased ✓ increased	Cover crops reduce soil wash-off and other water quality related impacts
farm income	decreased ✓ increased	Improved crop and animal production
workload	increased ✓ decreased	Greater workload to rotationally graze and manage crop effectively in an organic system (i.e. can't rely on spraying to solve problems). Yet, benefits outweigh extra workload.

Socio-cultural impacts

SLM/ land degradation knowledge	reduced ✓ improved	Vastly improved understanding through SLM expert advice and practical learning from doing SLM technology.

Ecological impacts

water quantity	decreased ✓ increased	Cover crops help maintain soil moisture and reduce runoff through root system, improving water quantity held in field.
water quality	decreased ✓ increased	Cover crops reduce soil wash-off and other water quality related impacts
surface runoff	increased ✓ decreased	Cover crops reduce soil wash-off and other water quality related impacts
evaporation	increased ✓ decreased	Cover crops help maintain soil moisture and reduce runoff through root system, improving water quantity held in field.
soil moisture	decreased ✓ increased	Cover crops help maintain soil moisture and reduce runoff through root system, improving water quantity held in field.
soil cover	reduced ✓ improved	Cover crops design is to cover soil and reduce soil loss
soil loss	increased ✓ decreased	Cover crops design is to cover soil and reduce soil loss
soil crusting/ sealing	increased ✓ reduced	Cover crops design is to cover soil and reduce soil crusting
soil compaction	increased ✓ reduced	Reduced tillage techniques and less passes across fields with machinery as no spraying due to organic system reduces compaction.
nutrient cycling/ recharge	decreased ✓ increased	Selected species of cover crops help recharge nutrient availability in the soil
soil organic matter/ below ground C	decreased ✓ increased	Cover crop rooting system & waste inversion as green manure increases the soil organic matter below ground.

vegetation cover	decreased	increased	Cover crops design is to cover soil and reduce soil crusting
biomass/ above ground C	decreased	increased	Greater crop cover and thus more biomass above ground
plant diversity	decreased	increased	Well designed mixed cover crop seed mixes, although more expensive, provide a specialised plant diversity ideal for the farm system requirements.
beneficial species (predators, earthworms, pollinators)	decreased	increased	Certain cover crops can attract beneficial species and help control pests and diseases
habitat diversity	decreased	increased	A diverse vegetation supports greater habitat diversity
pest/ disease control	decreased	increased	Certain cover crops can attract beneficial species and help control pests and diseases
flood impacts	increased	decreased	Cover crops slow surface runoff and can hold a greater water capacity reducing flood risk and impact
landslides/ debris flows	increased	decreased	Cover crops slow surface run off and can hold a greater water capacity reducing potential for debris flows in storm events
drought impacts	increased	decreased	Cover crops slow surface runoff and can hold a greater water capacity reducing drought impacts
Off-site impacts			
downstream flooding (undesired)	increased	reduced	Cover crops slow surface runoff and can hold a greater water capacity reducing flood risk and impact
groundwater/ river pollution	increased	reduced	Cover crops slow surface runoff and can hold a greater water capacity reducing potential for debris flows and nutrient leaching downstream
buffering/ filtering capacity (by soil, vegetation, wetlands)	reduced	improved	Cover crops slow surface runoff and can hold a greater water capacity reducing potential for debris flows and nutrient leaching downstream

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	very positive
Long-term returns	very negative	very positive

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all	very well	Answer: not known
annual rainfall increase	not well at all	very well	Answer: not known

Climate-related extremes (disasters)

local thunderstorm	not well at all	very well	Answer: not known
local hailstorm	not well at all	very well	Answer: not known

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- single cases/ experimental
- 1-10%
- ✓ 11-50%
- > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- 0-10%
- ✓ 11-50%
- 51-90%
- 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- ✓ Yes
- No

To which changing conditions?

- climatic change/ extremes

Species are selected according to their ability to cover, feed and work the soil. To do this, species are chosen for their diversity and complementary according to their root system: tap roots, adventitious roots, surface lateral roots, etc. For the past 2 years, the Biomax green manure + RGA regrowth mix has been grazed by heifers.

☐ changing markets
☐ labour availability (e.g. due to migration)
☑ Livestock feeding, economic interest, societal expectations

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view
- Sustain ecosystem health: no pest and disease problems, good herd health.
- Carbon sequestration by enrichment of the soil with organic matter and by the work of earthworms favouring ecosystem functioning.
- Protection of the soil and surface biodiversity because of maintained plant cover.
- Increased weed control due to plant canopies and fertilisation effect of green manure.
- Planted cover crops used as livestock feed during winter.
- Sustained ecosystem integrity reduces/counters ecosystem degradation by using multiple ecosystem functions: Complementarity, Continuity of soil life, Green fertilizer essential in the farming system, Feeding the livestock.

Strengths: compiler's or other key resource person's view
- Multi-species cover is conducive to soil quality: production of a high above-ground and root biomass that promotes soil life, soil structuring at depth (tap roots) and on the surface (superficial roots) by the effect of organic matter inputs.
- Multi-species cover provides shelter and cover for small fauna: seeds for the winter survival of the fauna, plants that are tiered at different heights without being too dense for wild game to move around while being protected.
- The different families that can be planted under cover are:
  - Grasses are generally easy to grow and are valued by animals (oats, rye and sorghum).
  - Leguminous plants improve the performance of cover crops. They are regulating plants that trap nitrogen and fix it in the soil. This is then used by the crop that follows.
  - Cruciferous plants are to be reserved for cereal rotations without rapeseed or vegetables.
  - Compounds (nyger and sunflower) are interesting for biomass production.
- Well-developed canopies have a competitive effect against weeds (germination inhibition, smothering, allelopathy). The aim is to have a rapidly developing canopy. It is necessary to limit the risks of shot blasting by sowing the canopy on clean soil, especially for early sowing (especially for short-cycle weeds: ragwort, bluegrass, Persian speedwell).

  Some species have allelopathic effects, i.e. they secrete inhibiting substances (the intensity of the allelopathic effect is taken from the Sem-Partners catalogue, see bibliography):
  - Diploid oats: allelopathic effect not demonstrated. Little is known about the mechanisms and molecules involved.
  - Spring Oats, Fenugreek, Gesse, Moha : average allelopathic effect, mechanisms and molecules involved are not well known.
  - Camelina, Radish: strong allelopathic effect (glucosinolates).
  - Winter mustard, Spring mustard: action of glucosinolates against nematodes (Heterodera Schaati and Meloidogyne chitwoodi) in biofumigation.
  - Buckwheat (Sarrazin): strong allelopathic effect. Little is known about the mechanisms and molecules involved.
- A plant cover provides additional fodder, 3 to 4 tonnes of dry matter can be produced depending on the species and sowing date.

Weaknesses/ disadvantages/ risks: land user's view → how to overcome
- Difficulties in establishing cover: difficult lifting in dry areas
  → Conditions for successful plant cover
  Sow as soon as possible
  Take advantage of the humidity just after harvest
- Late sowing of cover crops: no or little flowering and therefore little beneficial effect → Early establishment of complementary species
- High cost of purchased seed of mixed protein cover crops
  → Self-production of farm-saved seed

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's view → how to overcome
- In order to increase the potential of the canopies for bees, it is necessary to sow in the first half of August for flowering in the autumn. Some species are rich in nectar or pollen: rapeseed, white mustard, phacelia, radish, sunflower, clover, vetch. However, some species have extra-floral nectar such as sunflower, vetch and faba beans. That is to say that they secrete nectar outside the flowering period. → Sow in the first half of August as soon as the cereals are harvested to take advantage of the residual moisture which is conducive to good emergence.
- The development of RGA on the farm. → Ploughing can slow down the development of RGA.
- The cost of destroying the canopy is high (45€/ha excluding labour) with the 2 cross passes of rolling spade. → 3) Cost of some tools for destroying the cover crops:
  Independent disc stubble cultivator 3m= 33€/ha
  Cultivator 3.5m = 20€/ha
  Mulcher 3m = 27 €/ha
  Cambridge roller 8m = 16€/ha
  Blade roller 3m = 17€/ha
  Assumptions: replacement value depreciated over 10 years + maintenance, tractor cost 20€/hour, labour not included
- Before grazing a multi-species canopy, it is advisable to check the absence of toxic species (e.g. buckwheat) → Not known
- The doses and costs of implementing protein blend cutlery in interculture are high. → - Adjusting Mixed Doses
  - Self-production of farm-saved seeds
  - Mixture with recommended doses
  (OBS: Do not exceed 120% pure dose)

REFERENCES

Compiler
Alan Radbourne

Reviewer
William Critchley
Rima Mekdaschi Studer

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Resource persons
Christiane Joubioux - co-compiler
Patrice Le Callonnec - land user
Sylvie Guiet - SLM specialist

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_5680/

Linked SLM data
n.a.

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- UK Centre for Ecology & Hydrology (CEH) - United Kingdom

Project
- European Interreg project FABulous Farmers

Key references

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- Couvert végétal, de réels avantages agronomiques, Terra 12 juin 2015: Terra 12 juin 2015
- Couverts végétaux, la destruction possible dès le 1er février, Terra du 15 janvier 2016: Terra du 15 janvier 2016

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- Liste de plantes attractives pour les abeilles, Ministères de l'agriculture et de l'alimentation, 2017: https://agriculture.gouv.fr/decouvrez-la-liste-des-plantes-attractives-pour-les-abeilles
- Implanter des cultures intermédiaires à effet allélopathique ou biocide, biofumigation: https://geco.ecophytopic.fr/geco/Concept/Implanter_Des_Cultures_Intermediaires_A_Effet_Allelopathique_Ou_Biocide,_Biofumigation