Cover crops on olive orchards (Spain)

Cubiertas vegetales en olivar para reducir la erosión

**DESCRIPTION**

The technology involves soil management with cover crops (natural or spontaneous) in the streets of an olive grove to evaluate their effectiveness against soil loss by water erosion and its effect on production and quality of virgin olive oil.

Three types of covers have been used within the olive streets, applying herbicide on the trees.

A cover of grasses, barley (Hordeum vulgare), another cover legume sainfoin (Onobrychis viciifolia) both planted annually in November, and a cover of Brachypodium distachyon just planted the first year, and managed to harvest to allow reseeding. Finally, we have applied a deeper tillage in November as control treatment.

The purpose of cover crops in the olive streets is to reduce or even stop soil loss caused by erosion occurring on the bare ground. Furthermore, the effect of each of the covers on the olive harvest and on the quantity and quality of virgin olive oil is evaluated.

The establishment consists of planting seeds of barley and sainfoin annually, Brachypodium the first year, and plowing the streets of the control treatment. The operation is the same for all treatments, consisting of one or two mowings in spring to avoid competition for water with the crop covers.

Herbicides are applied on olive trees in order to facilitate management under the tree such as collection tasks, application of treatments and pruning.

The plot is located in a research centre, so that its object is only applied research of this technique.

The soil is a Xeric-Haplogypsid, with a dominance of marl-gypsum. The topography is dominated by small hills and former terraces of the Tajo river.

The climate is Mediterranean-continental, with an average temperature of 13.8ºC and 395 mm of rainfall, which falls mainly in Autumn and Spring.

**LOCATION**

Location: Colmenar de Oreja, Madrid, Spain

No. of Technology sites analysed:

Geo-reference of selected sites

- -3.51919, 40.07314

Spread of the Technology:

Date of implementation: 10-50 years ago

Type of introduction

- through land users' innovation
- as part of a traditional system (> 50 years)
- during experiments/ research
- through projects/ external interventions
### 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**
- **Cropland** - Tree and shrub cropping

**Water supply**
- rainfed
- ✓ mixed rainfed-irrigated

**Number of growing seasons per year**: 1

**Land use before implementation of the Technology**: n.a.

**Livestock density**: n.a.

**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
- chemical soil deterioration - Cn: fertility decline and reduced organic matter content (not caused by erosion
- physical soil deterioration - Pc: compaction, Pk: slaking and crusting
- biological degradation - Bc: reduction of vegetation cover, Bh: loss of habitats, Bq: quantity/ biomass decline, Bs: quality and species composition/ diversity decline, Bl: loss of soil life
- water degradation - Ha: aridification, Hs: change in quantity of surface water, Hp: decline of surface water quality

**SLM group**
- improved ground/ vegetation cover

**SLM measures**
- agronomic measures - A1: Vegetation/ soil cover

### TECHNICAL DRAWING

**Technical specifications**
The olive orchard is of the variety "cornicabra" with a frame planting of 7 m x 6 m. On the streets different species have been planted (barley, sainfoin, Brachypodium distachyon) to study its effect respect to conventional tillage. On each side of the line of olive trees, a strip of 0.5m has been left without vegetation (treated with herbicide).

All cover crops are cut in spring, before they start to compete for water and nutrients with the crop (one or two passes, depending on the year). Mowed residues are left in the area to also protect the soil, encouraging nutrient recycling.

A selection of species or spontaneous vegetation have to be done, depending on the study area. In our case the best option seems to be sowing Brachypodium distachyon.

Location: Colmenar de Oreja. Comunidad de Madrid
Date: 15/10/2010

Technical knowledge required for field staff / advisors: moderate (The technique is simple, but requires a detailed management to avoid competition with the crop covers for nutrients and water.)

Technical knowledge required for land users: moderate (The technique is simple, but requires a detailed management to avoid competition with the crop covers for nutrients and water.)

Main technical functions: control of raindrop splash, control of dispersed runoff: retain / trap, improvement of ground cover, increase of surface roughness, improvement of surface structure (crusting, sealing), increase in organic matter, increase in nutrient availability (supply, recycling,...)

Secondary technical functions: control of dispersed runoff: impede / retard, improvement of topsoil structure (compaction), improvement of subsoil structure (hardpan), stabilisation of soil (eg by tree roots against land slides), increase of infiltration, increase / maintain water stored in soil.

Cover cropping
Material/ species: Barley
Quantity/ density: 280 kg
Remarks: 153 kg/Ha

Agronomic measure: Cover cropping
Material/ species: Sainfoin (Onobrychis viciifolia)
Quantity/ density: 37.5 kg
Remarks: 42 kg/Ha

Agronomic measure: Cover cropping
Material/ species: Brachypodium distachyon
Quantity/ density: 19 kg
Remarks: 40 kg/Ha

**ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS**

**Calculation of inputs and costs**
- Costs are calculated:
- Currency used for cost calculation: Euro
- Exchange rate (to USD): 1 USD = 0.75 Euro
- Average wage cost of hired labour per day: 48.00

**Most important factors affecting the costs**
Seed quality, seed predation, drought, etc.

**Establishment activities**

**n.a.**

**Establishment inputs and costs**

<table>
<thead>
<tr>
<th>Specify input</th>
<th>Unit</th>
<th>Quantity</th>
<th>Costs per Unit (Euro)</th>
<th>Total costs per input (Euro)</th>
<th>% of costs borne by land users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>ha</td>
<td>1.0</td>
<td>27.0</td>
<td>27.0</td>
<td>27.0</td>
</tr>
<tr>
<td>Plant material</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>seeds</td>
<td>ha</td>
<td>1.0</td>
<td>130.0</td>
<td>130.0</td>
<td></td>
</tr>
<tr>
<td>sainfoin seeds</td>
<td>ha</td>
<td>1.0</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Brachypodium seeds</td>
<td>ha</td>
<td>1.0</td>
<td>20.0</td>
<td>20.0</td>
<td></td>
</tr>
</tbody>
</table>

**Total costs for establishment of the Technology**

277.0

**Maintenance activities**
1. Sowing (Timing/ frequency: yearly)
2. Mowing (Timing/ frequency: yearly (or twice a year))

**Maintenance inputs and costs**
### NATURAL ENVIRONMENT

#### Average annual rainfall
- < 250 mm
- 251-500 mm
- 501-750 mm
- 751-1,000 mm
- 1,001-1,500 mm
- 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- > 4,000 mm

#### Agro-climatic zone
- humid
- sub-humid
- semi-arid
- arid

#### Specifications on climate
The average rainfall is around 300-350 mm, mainly in Autumn and Spring with erosive events in late Summer. Thermal climate class: temperate. There is a dry period from late May to late September.

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

#### Landforms
- plateau/plains
- ridges
- mountain slopes
- hill slopes
- foothills
- valley floors

#### Altitude
- 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
- not relevant

#### Soils
- Soil depth
  - very shallow (0-20 cm)
  - shallow (21-50 cm)
  - moderately deep (51-80 cm)
  - deep (81-120 cm)
  - very deep (> 120 cm)
- Soil texture (topsoil)
  - coarse/ light (sandy)
  - medium (loamy, silty)
  - fine/ heavy (clay)
- Soil texture (> 20 cm below surface)
  - coarse/ light (sandy)
  - medium (loamy, silty)
  - fine/ heavy (clay)

#### Topsoil organic matter content
- high (>3%)
- medium (1-3%)
- low (<1%)

#### Groundwater table
- on surface
- < 5 m
- 5-50 m
- > 50 m

#### Availability of surface water
- excess
- good
- medium
- poor/ none

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

#### Is salinity a problem?
- Yes
- No

#### Occurrence of flooding
- Yes
- No

### CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

#### Market orientation
- subsistence (self-supply)
- mixed (subsistence/commercial)
- commercial/ market

#### Off-farm income
- less than 10% of all income
- 10-50% of all income
- > 50% of all income

#### Relative level of wealth
- very poor
- poor
- average
- rich
- very rich

#### Level of mechanization
- manual work
- animal traction
- mechanized/ motorized

#### Sedentary or nomadic
- Sedentary
- Semi-nomadic
- Nomadic

#### Individuals or groups
- individual/ household
- groups/ community
- cooperative
- employee (company, government)

#### Gender
- women
- men

#### Age
- children
- youth
- 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
- 100-500 ha
- 500-1,000 ha
- 1,000-10,000 ha

#### Scale
- small-scale
- medium-scale
- large-scale

#### Land ownership
- state
- company
- communal/ village group
- individual, not titled
- individual, titled

#### Land use rights
- open access (unorganized)
- communal (organized)
- leased
- individual
- Regional Government

#### Water use rights
- open access (unorganized)
- communal (organized)
- leased

---

### Labour

<table>
<thead>
<tr>
<th>Labour</th>
<th>Unit</th>
<th>Quantity</th>
<th>Costs per Unit (Euro)</th>
<th>Total costs per input (Euro)</th>
<th>% of costs borne by land users</th>
</tr>
</thead>
<tbody>
<tr>
<td>labour</td>
<td>ha</td>
<td>1.0</td>
<td>18.0</td>
<td>18.0</td>
<td>18.0</td>
</tr>
</tbody>
</table>
### Access to services and infrastructure

#### IMPACTS

<table>
<thead>
<tr>
<th>Socio-economic impacts</th>
<th>decreased</th>
<th>✓</th>
<th>increased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop production</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>demands for irrigation water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>expenses on agricultural inputs</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>workload</td>
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</tbody>
</table>

Neither fruit nor olive oil production differed by the different cover crops or tillage.
Quantity before SLM: 0.06 m³ water/m³ soil
Quantity after SLM: 0.12 m³ water/m³ soil
Average value measured with probes in dry season.
Quantity before SLM: 16 l
Quantity after SLM: 2 l
The use of herbicide is limited to the line of trees.
Quantity before SLM: 3-4 labours per year
Quantity after SLM: 1
Tillage is not necessary, but there are other different labours with less work.

<table>
<thead>
<tr>
<th>Socio-cultural impacts</th>
<th>worsened</th>
<th>✓</th>
<th>improved</th>
</tr>
</thead>
<tbody>
<tr>
<td>health situation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cultural opportunities (eg spiritual, aesthetic, others)</td>
<td>reduced</td>
<td>✓</td>
<td>improved</td>
</tr>
<tr>
<td>SLM/ land degradation knowledge</td>
<td>reduced</td>
<td>✓</td>
<td>improved</td>
</tr>
</tbody>
</table>

By reducing labours, the emission of CO₂ into the atmosphere is reduced, and somehow mitigates global climate change. By reducing herbicide use reduces its danger and effects on health and the ecosystem.

Aesthetically is more valued an olive grove with vegetation cover, while increasing biodiversity.

The effects of vegetation cover can be observed in a few years, and the example could easily spread among farmers in the area.

<table>
<thead>
<tr>
<th>Ecological impacts</th>
<th>decreased</th>
<th>✓</th>
<th>increased</th>
</tr>
</thead>
<tbody>
<tr>
<td>water quantity</td>
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<tr>
<td>water quality</td>
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<td></td>
</tr>
<tr>
<td>surface runoff</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>evaporation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>soil moisture</td>
<td>decreased</td>
<td>✓</td>
<td>increased</td>
</tr>
<tr>
<td>soil cover</td>
<td>reduced</td>
<td>✓</td>
<td>improved</td>
</tr>
<tr>
<td>soil loss</td>
<td>increased</td>
<td>✓</td>
<td>decreased</td>
</tr>
<tr>
<td>soil crusting/ sealing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>soil compaction</td>
<td>increased</td>
<td>✓</td>
<td>decreased</td>
</tr>
<tr>
<td>nutrient cycling/ recharge</td>
<td></td>
<td></td>
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</tbody>
</table>

The amount of water that infiltrates is higher, reducing which reaches the surface runways.

Surface water drags less soil particles cover crops treatments, reducing water turbidity.

The amount of water which infiltrates cover crops is much greater than in the tilled soils, reducing the surface runoff.

In the dry season, when the vegetation parched, its effect is protective of evaporation of soil water.
Quantity before SLM: 0.06 m³/m³
Quantity after SLM: 0.12 m³/m³
Quantity before SLM: 1 kg/m² ye
Quantity after SLM: 0.17 kg/m²
Brachypodium is the cover that achieves maximal reduction of soil loss by erosion.
Quantity before SLM: 80 %
Quantity after SLM: 0
If it has been covered all the soil with vegetation, physical soil crust is not formed.
Si se ha cubierto todo el suelo, la costra física no aparece respecto del tratamiento de herbicida donde ocupaba gran parte de su superficie.

<table>
<thead>
<tr>
<th>nutrient cycling/ recharge</th>
<th>decreased</th>
<th>✓</th>
<th>increased</th>
</tr>
</thead>
<tbody>
<tr>
<td>soil organic matter/ below ground C</td>
<td>decreased</td>
<td>✓</td>
<td>increased</td>
</tr>
<tr>
<td>biomass/ above ground C</td>
<td>decreased</td>
<td>✓</td>
<td>increased</td>
</tr>
</tbody>
</table>
plant diversity | decreased | ✓ | increased
--- | --- | --- | ---
animal diversity | decreased | ✓ | increased
beneficial species (predators, earthworms, pollinators) | decreased | ✓ | increased
habitat diversity | decreased | ✓ | increased
pest/ disease control | decreased | ✓ | increased
fire risk | increased | ✓ | decreased

Off-site impacts | increased | ✓ | reduced
--- | --- | --- | ---
downstream flooding (undesired) | increased | ✓ | reduced
damage on neighbours’ fields | increased | ✓ | reduced

**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

The management of cover crops is a reduction of the labours, although these have to be more accurate than conventional (adapted to each time). By having cover crops, the farmer may gather olives at the time that suits him, to obtain maximum profitability, and not when the weather permits (heavy rains and / or continuous, make the machinery can not enter any time).

**CLIMATE CHANGE**

**Gradual climate change**

annual temperature increase | not well at all | ✓ | very well
--- | --- | --- | ---

**Climate-related extremes (disasters)**

| local rainstorm | not well at all | ✓ | very well
--- | --- | --- | ---
| local windstorm | not well at all | ✓ | very well
| drought | not well at all | ✓ | very well
| general (river) flood | not well at all | ✓ | very well

**Other climate-related consequences**

| reduced growing period | not well at all | ✓ | very well
--- | --- | --- | ---

**ADOPTION AND ADAPTATION**

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

| single cases/ experimental | 0-10%
--- | --- | --- | ---
| 1-10% | 10-50%
| 10-50% | more than 50%

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

| 0-10% | 10-50%
--- | --- | --- | --- | ---
| 50-90% | 90-100%

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

| Yes | No
--- | ---

**To which changing conditions?**

- climatic change/ extremes
- changing markets
- labour availability (e.g. due to migration)

**CONCLUSIONS AND LESSONS LEARNT**

**Strengths: land user’s view**

- It is a simple technique that greatly improves soil quality, while reducing erosion losses.
- This technique is cheap and easy to implement.

**Weaknesses/ disadvantages/ risks: land user’s view**

- The management change from what they have been done all their lives to a new land management culture.
- → Demonstrating that this technique improves soil and crop

Wocat SLM Technologies
Cover crops on olive orchards
- Soil moisture increases, favoring the production of olive fruit, in areas where water is limited.
- This technique facilitates olive harvest at the right time as determined by the farmer, as vegetation cover prevents soil mudding and facilitates access of machinery even when wet.
- Decreases the use of fertilization, as cover crops increase the amount of C and N in the soil.

**Weaknesses/ disadvantages/ risks: compiler's or other key resource person's view**
- Changing plot management and the need to be aware of the evolution of the cover, to determine the right time to mow.
  -> How to overcome
- Mistrust of olive growers regarding the effect that the cover has in the production of olive fruit or in the olive grove.
  -> Show plots with and without covers at the moment that olive trees have the fruit, and give production data, both in olive fruit as in olive oil.
- The need for using new machinery or different from the usual, as sowing or weeding machine.
  -> Provide financing for the acquisition of new machinery. If it would not be possible, in the early stages of implementation, facilitate the machinery to avoid investment by the farmer.

**REFERENCES**

Compiler
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Date of documentation: April 23, 2013

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Ramón Bienes - land user

Full description in the WOCAT database

Linked SLM data
n.a.

Documentation was facilitated by
- Institution
  - n.a.
- Project
  - n.a.

Key references
- Cubiertas vegetales en el olivar. Agricultura.Rodríguez Lizana, A. 2003: