Shallow rotary tillage (Michèle Mangen)

Shallow rotary tillage with microbial digestion (Luxembourg)

Flächenrotte

DESCRIPTION

Shallow rotary tillage with microbial digestion is a technique that is used to destroy cover crops and to manage stubble. The plant material is broken down to small pieces and incorporated into the surface layer of the soil. During the process bacteria and microbes are added to break down the plant material.

The use of the herbicide glyphosate for terminating catch/ cover crops or field forage is increasingly coming under criticism. Simultaneously there is a movement towards farming methods that preserve soil health by reducing deep tillage. Thus, farmers have developed a surface rotting system that protects soil while safely eliminating a cover crop. "Shallow rotary tillage with microbial digestion" is a technique that is used to destroy cover crops and to manage stubble. Overwintering catch crops/undersown plants or field forage are turned over in spring or autumn. The plant material is broken down to small pieces and incorporated into the surface layer of the soil (around 5 cm deep). By use of a field rototiller, the vegetation is mechanically destroyed and mixed with the soil particles. Depending on the activity of organisms in the soil, microorganisms may then be introduced to accelerate the decomposition process of the plant material. A second pass may be required after 7- 14 days. Aerobic decomposition of the plant material takes place on the surface/ within the top layer of the soil. The advantages of this surface rotting can be summarised as follows:
•No synthetic agents are used.
•The soil is not inverted but only superficially mixed.
•The soil structure and its pore system are preserved.
•Organic material is introduced into the soil and thus soil organisms are promoted.
The challenge with surface rotting is the weather. The soil must be sufficiently dry to avoid creating smear layers, but if it is too dry, the fuel input to power the machine increases. However, if the weather is too wet after rototilling, there is a risk of re-growth of the plants. The blades of the tiller must be sufficiently sharp to cut the vegetative core of the plants well. The use of effective microorganisms is not yet scientifically proven - and the price of these products is high: some farmers even produce their own microbially-rich "compost tea".

LOCATION

Location: Ösling, Luxembourg

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites
- 5.96316, 50.01247
- 5.77844, 49.90251

Spread of the Technology: evenly spread over an area (approx. 1-10 km2)

In a permanently protected area?: No

Date of implementation: 2020

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

Shallow till of cover crops for destruction. (Michèle Mangen)

Rotaty till close up (Michèle Mangen)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] 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
- [x] create beneficial economic impact
- [ ] create beneficial social impact

Land use

Land use mixed within the same land unit: No

Cropland

- Annual cropping
- Perennial (non-woody) cropping

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

Water supply

- [x] rainfed
- [ ] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [x] prevent land degradation
- [x] 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

physical soil deterioration - Pk: slaking and crusting

water degradation - Hq: decline of groundwater quality

SLM group

- improved ground/ vegetation cover
- minimal soil disturbance

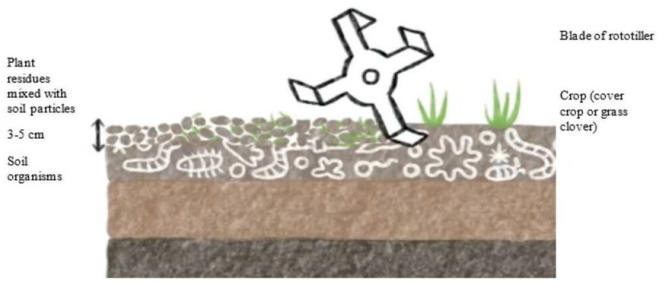
SLM measures

agronomic measures - A2: Organic matter/ soil fertility

TECHNICAL DRAWING

Technical specifications

Tillage depth: 5 cm
Speed of tractor: depending on soil type and soil conditions
Timing: Autumn or Spring before sowing of main crop
Number of applications: max 2



Author: Michèle Mangen

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **1ha**; conversion factor to one hectare: **1 ha = 2.4 acres**)
- Currency used for cost calculation: **Eur**
- Exchange rate (to USD): 1 USD = 0.91 Eur
- Average wage cost of hired labour per day: 280

Most important factors affecting the costs

Soil type defines speed of tractor and thus fuel, labour and recurrent maintenance costs.

Establishment activities

n.a.

Maintenance activities

1. Change blades of rototiller (Timing/ frequency: Depends on soil type and amount of stones in the soil.)
2. Agronomic: first tillage of field (Timing/ frequency: Before sowing main crop)
3. Agronomic: second tillage of field (optional) (Timing/ frequency: Before sowing main crop)

Maintenance inputs and costs (per 1ha)

Specify input	Unit	Quantity	Costs per Unit (Eur)	Total costs per input (Eur)	% of costs borne by land users
Equipment					
Tractor+Rototiller+labour	ha	1.0	105.0	105.0	100.0
Fertilizers and biocides					
Effective microorganisms (EM)	litre	150.0	1.5	225.0	100.0
Other					
Consumables (usage of tillers)	ha	1.0	45.0	45.0	33.0
Total costs for maintenance of the Technology				**375.0**	
Total costs for maintenance of the Technology in USD				*412.09*	

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

Average annual rainfall in mm: 800.0
October-January rainfall is > 75mm per month
March-April rainfall is lowest <70mm per month
Seasons with extreme heavy rainfalls (short and a lot of water are around May)

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
- ☐ footslopes
- ☐ 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

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

Water quality refers to: both ground and surface water

Is salinity a problem?

- ☐ Yes
- ☑ No

Occurrence of flooding

- ☐ Yes
- ☑ No

Species diversity

- ☐ high
- ☑ medium
- ☐ low

Habitat diversity

- ☐ 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
- [ ] average
- [x] rich
- [x] very rich

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

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

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

Gender
- [x] women
- [x] men

Age
- [ ] children
- [ ] 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
- [x] 50-100 ha
- [x] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

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

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

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

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] 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	Cover crop provides green manure for soil fertility
crop quality	decreased	increased	
land management	hindered	simplified	Less crusting issues with better water retention in soil
expenses on agricultural inputs	increased	decreased	Costs increased with undertaking new technology due to additional labour. Aim is to be cost neutral in future but using mechanical rather than chemical methods
workload	increased	decreased	Takes more time

Socio-cultural impacts

Ecological impacts

soil moisture	decreased	increased	Better water retention in soil with cover crops
soil cover	reduced	improved	
soil loss	increased	decreased	
soil crusting/ sealing	increased	reduced	
soil compaction	increased	reduced	
nutrient cycling/ recharge	decreased	increased	
soil organic matter/ below ground C	decreased	increased	
vegetation cover	decreased	increased	
biomass/ above ground C	decreased	increased	
beneficial species (predators, earthworms, pollinators)	decreased	increased	
flood impacts	increased	decreased	
drought impacts	increased	decreased	

Off-site impacts

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Benefits compared with maintenance costs

Short-term returns: very negative ☐☐✓☐☐☐☐ very positive

Long-term returns: very negative ☐☐☐✓☐☐☐ very positive

CLIMATE CHANGE

Gradual climate change

seasonal temperature increase: not well at all ☐☐✓☐☐ very well — Season: spring

seasonal temperature increase: not well at all ☐☐✓☐☐ very well — Season: autumn

seasonal rainfall decrease: not well at all ☐☐✓☐☐ very well — Season: spring

seasonal rainfall decrease: not well at all ☐☐✓☐☐ very well — Season: autumn

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
- ☐ changing markets
- ☐ labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Cover crop /fodder crop termination is without the use of glyphosate or the plough
- Water retention capacity of the soil is increased (resilience to drought increased)

Strengths: compiler's or other key resource person's view

- Soil health is increased.
- Farmers independence of external inputs is decreased
- Acceptance of field fodder and cover crops is increased

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- costs (fuel/time).
- timing and weather have a big impact on success experience

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

REFERENCES

Compiler
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Resource persons
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Thorsten Ruf - SLM specialist
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Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_6878/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- n.a.

Project
- European Interreg project FABulous Farmers

Key references
- Regenerative Landwirtschaft, Dietmar Näser, 2020, ISBN 978-8186-0695-4: Ulmer.de 34,95€

Links to relevant information which is available online
- Home Page of a German advisor: https://www.regenerative-landwirtschaft.de/
- Swiss home page of regenerative agriculture: https://agrar.em-schweiz.ch/flaechenrotte
- Austrian homepage of equipment seller: http://www.ackerfräse.at/