In the picture you see the machine that is used for non-inversion tillage (Harry Verstegen)

Non-inversion shallow tillage on sandy soils in the Netherlands (Netherlands)

Niet kerende, ondiepe grondbewerking op zandgronden in Nederland

DESCRIPTION

This technique can be applied in any crop rotation or soil. Tillage of the soils is done with special machines that do not turn over the soil (non-inversion), and the tillage depth can be more shallow than with conventional tillage (ploughing).

This technology is applied in Vredepeel (the Netherlands) on a sandy soil on arable fields. The technology is not by environment limited to these conditions, it could for example be applied on clay soils as well. It is applicable for various crop types. The main point of this technology is the specific machine that is used to do the tillage. The machine is called a rigid-tine cultivator. The machine can be purchased for a few thousand Euros, but in the Netherlands it is also possible to let a contractor do this tillage. The average tillage depth here is around 25 cm, dependent on the crops in the rotation. The purpose of the shallow non-inversion tillage is to keep the soil organic matter in the topsoil, and to disturb the soil as little as possible, which has as benefit that the organic matter levels in the topsoil can increase and soil life is maintained better. Overall, the soil structure in the topsoil will improve. This is also what the land users like about using the non-inversion tillage. The yields when using non-inversion tillage are similar to the yields of ploughed fields. The difficulty of this technology is the control of weeds, since the topsoil is not turned over, small weeds and seeds are not buried, and have a higher change to survive. This may make that more pesticide is used to control the weeds than when you plough the soil, therefore this tillage technique is less favorable amongst organic farmers. Also when grasses are a (large) part of the crop rotation non-inversion tillage might not be the best solution, since it is harder to destroy the grass when preparing the soil for the next crop.

LOCATION

Location: Vredepeel, de Peel, Netherlands

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 5.84793, 51.53943
- 5.84671, 51.54097

Spread of the Technology: evenly spread over an area (approx. 100-1,000 km2)

In a permanently protected area?:

Date of implementation: 2012

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

Close up of the non-inversion tillage machine. The pens in the front penetrate and thereby loosen the soil, the wheel at the back rolls over the soil to compact it a little bit at the end. (Harry Verstegen)

The non-inversion tillage machine in action. (Harry Verstegen)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [ ] improve production
- [x] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [x] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [x] 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

- Annual cropping: cereals - barley, cereals - maize, legumes and pulses - peas, root/tuber crops - potatoes, root/tuber crops - sugar beet, vegetables - root vegetables (carrots, onions, beet, other)

Number of growing seasons per year: 1

Water supply

- [ ] rainfed
- [x] 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 wind - Et: loss of topsoil

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

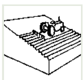
physical soil deterioration - Pc: compaction

biological degradation - Bl: loss of soil life

SLM group

- minimal soil disturbance

SLM measures



agronomic measures - A3: Soil surface treatment

TECHNICAL DRAWING

Technical specifications

The pictures show the machine at work, and what the soil looks like once the soil has been worked.
The machine type is SMS HKK 300, with 6 pins that work in the soil.
Dependent on the type of crop the soil is worked about 25 cm deep.

Author: Harry Verstegen

None

Author: Harry Verstegen

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **hectare**)
- Currency used for cost calculation: **Euro**
- Exchange rate (to USD): 1 USD = 0.87 Euro
- Average wage cost of hired labour per day: 160 euro

Most important factors affecting the costs

The investment costs for adapted machinery are the main factors affecting costs.

Establishment activities

1. adapt tillage mechanisation (Timing/ frequency: None)

Establishment inputs and costs (per hectare)

Specify input	Unit	Quantity	Costs per Unit (Euro)	Total costs per input (Euro)	% of costs borne by land users
Equipment					
adapted tillage machine	piece	1.0	2000.0	2000.0	100.0
Total costs for establishment of the Technology				**2'000.0**	
Total costs for establishment of the Technology in USD				*2'298.85*	

Maintenance activities

1. destruction of cover crops after winter (Timing/ frequency: once per year)
2. one additional tillage operation instead of ploughing (Timing/ frequency: once per year)

NATURAL ENVIRONMENT

Average annual rainfall

- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [x] 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
- [x] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate

Average annual rainfall in mm: 850.0
Name of the meteorological station: volkel the Netherlands

Slope

- [x] flat (0-2%)

Landforms

- [x] plateau/plains

Altitude

- [x] 0-100 m a.s.l.

Technology is applied in

- [ ] convex situations

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

- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

- [ ] 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.

- [ ] concave situations
- [x] not relevant

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

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

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

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

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

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

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

Water quality refers to:

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

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

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

Habitat diversity
- [ ] high
- [x] 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
- [ ] 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
- [ ] 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
- [ ] 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
- [x] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled

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

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

Access to services and infrastructure

	poor				good
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

The fields with non-inversion tillage and conventional ploughing are right next to each other, and with the same crops, no effects on crop production were found.

crop quality

decreased ✓ increased

The fields with non-inversion tillage and conventional ploughing are right next to each other, and with the same crops, no effects on crop quality were found.

expenses on agricultural inputs

increased ✓ decreased

More shallow tillage needs less power from the machines, but on the other hand more tillage operations to destroy the crop.

Socio-cultural impacts

Ecological impacts

surface runoff

increased ✓ decreased

Since the soil structure will improve, the infiltration capacity of the soil also improves.

soil organic matter/ below ground C

decreased ✓ increased

Expectations are that soil organic matter content in the (top) soil will increase, but so far no significant results were found on that.

beneficial species (predators, earthworms, pollinators)

decreased ✓ increased

In general soil biodiversity increased, mainly fungal biomass and bacterial biomass.

Off-site impacts

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

Climate-related extremes (disasters)

local rainstorm — not well at all ✓ very well

ADOPTION AND ADAPTATION

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

- [x] 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%
- [x] 91-100%

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

- [ ] Yes
- [x] 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

- The technology has been used for 5 years now. Yield were expected to decrease but did not.
- There is a minor advantage in fuel costs, however this is compensated with additional labour needed.
- Carbon stratification (higher content in the topsoil (0-15 cm)) was expected to change but did only minorly.
- Water infiltration and topsoil protection is still expected to improve.

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

- The change in tillage is effecting various other agronomic activities which need to be adapted. building up of experience
- There is a higher weed pressure improved mechanical/chemical weed control. Maybe the weed pressure will stabilize the coming years
- Problems with destroying cover crops development of new techniques to destroy the cover crop

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

- Higher soil biodiversity
- On the long term increased carbon sequestration
- Better top soil protection against acces of rainfall, improved infiltration and water holding capacity. Improved drought resistance

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

- It takes a long period until effects are measurable, this makes it hard to convince farmers. longt term monitoring
- Very little practical experience with non inversion tillage in the Netherlands communication and exchange experiences

REFERENCES

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Date of documentation: July 19, 2017

Last update: June 5, 2019

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Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_2958/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- Stichting Dienst Landbouwkundig Onderzoek, Wageningen University & Research Centre (DLO) - Netherlands

Project
- Interactive Soil Quality assessment in Europe and China for Agricultural productivity and Environmental Resilience (EU-iSQAPER)

Links to relevant information which is available online
- website Beter Bodembeheer: www.beterbodembeheer.nl