Tillage in Pesnica valley, Slovenia (Gregor Kramberger)

Mulch-till (Slovénie)

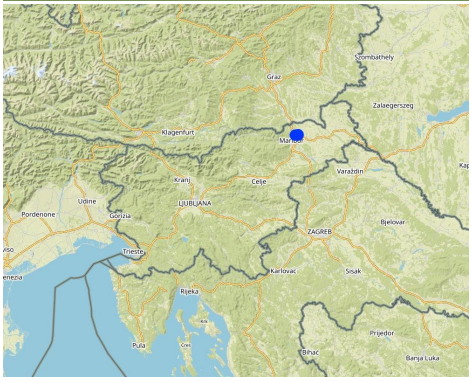
Konzervirajoča obdelava tal (mulch-till)

DESCRIPTION

Mulch-till is a method of farming that does not utilise a plough, and thus the soil is not turned over. Furthermore, at least 30% of the cultivated area remains covered with organic residues left over from the previous crop. There are multiple benefits to the soil and carbon dioxide emissions are reduced.

Mulch-till (also called "conservation agriculture" or "minimum tillage") is a method of land management with modified, less intensive tillage, where land is covered with plant residues year-round (at least 30% cover) or grass, energy consumption is reduced, and there is less trampling/ compaction of the soil because of fewer machine passes and the protected surface. Under mulch-till, special agricultural machinery and attachments are required. Disc harrows and chisel ploughs are used to loosen the soil, and direct drills are employed for seeding. Ploughs are not used and the soil is not inverted. This method of tillage is intended to maintain soil structure, build up humus, improve nutrient supply and soil moisture, increase soil microbiological activity and also to prevent soil erosion. Mulch-till reduces the number of work operations on the cultivated area. Because the soil is disturbed less, this minimises the exposure of soil organic matter to the air, and therefore decreases the formation and release of CO2 to the atmosphere.
The debate over whether ploughing is still necessary has been going on for quite some time. Both mulch-till and ploughing have their advantages as well as disadvantages. Research shows that mulch-till reduces soil erosion and compaction, and this has a significant impact on soil fertility. On the other hand, ploughing better inhibits the spread of weeds and certain types of diseases and pests.
Mulch-till requires complete replacement of machines/tools, and this is a considerable initial investment. Regular annual maintenance of the equipment is needed also. Mulch-till provides full benefits after a number of years, through making sure that minimal soil inversion and organic soil coverage is guaranteed. It also requires good planning of crop rotation, the use of a special seed drill and employment of herbicides after emergence (or surface hoeing). Users mention one advantage being the low costs for tillage, which is less expensive than ploughing, and the reduction of soil erosion on sloping terrain. However, they do not like the high investment for equipment, possible lost of yields and increase in weeds: all tend to arise at the beginning of implementation. Knowledge and experience are required, as the technology is quite demanding, so there are chances of failure.

LIEU



Lieu: Vosek, Jareninski dol, Pernica, Slovénie

Nbr de sites de la Technologie analysés: 2-10 sites

Géo-référence des sites sélectionnés
- 15.725, 46.6
- 15.72331, 46.60397
- 15.68969, 46.59931

Diffusion de la Technologie: répartie uniformément sur une zone (approx. < 0,1 km2 (10 ha))

Dans des zones protégées en permanence ?: Non

Date de mise en oeuvre: 2020

Type d'introduction
- [x] grâce à l'innovation d'exploitants des terres
- [ ] dans le cadre d'un système traditionnel (> 50 ans)
- [x] au cours d'expérimentations / de recherches
- [ ] par le biais de projets/ d'interventions extérieures

Tillage with a disk harrow after mulching maize residues left on surface. Preparation for sowing with a combined seeder. (Andrej Ropič)

Residues left over the surface of the field before sowing next crop (maize). (Andrej Ropič)

CLASSIFICATION DE LA TECHNOLOGIE

Principal objectif
- [ ] améliorer la production
- [x] réduire, prévenir, restaurer les terres dégradées
- [ ] préserver l'écosystème
- [x] protéger un bassin versant/ des zones situées en aval - en combinaison avec d'autres technologies
- [ ] conserver/ améliorer la biodiversité
- [x] réduire les risques de catastrophes
- [x] s'adapter au changement et aux extrêmes climatiques et à leurs impacts
- [x] atténuer le changement climatique et ses impacts
- [ ] créer un impact économique positif

L'utilisation des terres

Les divers types d'utilisation des terres au sein du même unité de terrain: Non

Terres cultivées
- Cultures annuelles: céréales - orge, céréales - maïs, céréales - blé d'hiver, cultures fourragères - trèfle, cultures fourragères - autres, légumineuses et légumes secs - autres, légumineuses et légumes secs - soja

Nombre de période de croissance par an: : 1

Est-ce que les cultures intercalaires sont pratiquées? Non

Est-ce que la rotation des cultures est appliquée? Oui

☐ créer un impact social positif

Approvisionnement en eau
- ☑ pluvial
- ☐ mixte: pluvial-irrigué
- ☐ pleine irrigation

But relatif à la dégradation des terres
- ☑ prévenir la dégradation des terres
- ☑ réduire la dégradation des terres
- ☐ restaurer/ réhabiliter des terres sévèrement dégradées
- ☐ s'adapter à la dégradation des terres
- ☐ non applicable

Dégradation des terres traité

érosion hydrique des sols - Wt: perte de la couche superficielle des sols (couche arable)/ érosion de surface, Wg: ravinement/ érosion en ravines

dégradation chimique des sols - Cn: baisse de la fertilité des sols et réduction du niveau de matière organique (non causée par l'érosion)

dégradation physique des sols - Pc: compaction

dégradation biologique - Bc: réduction de la couverture végétale, Bq: baisse de la quantité/ biomasse, Bl: perte de la vie des sols

Groupe de GDT
- Amélioration de la couverture végétale/ du sol
- perturbation minimale du sol
- gestion intégrée de la fertilité des sols

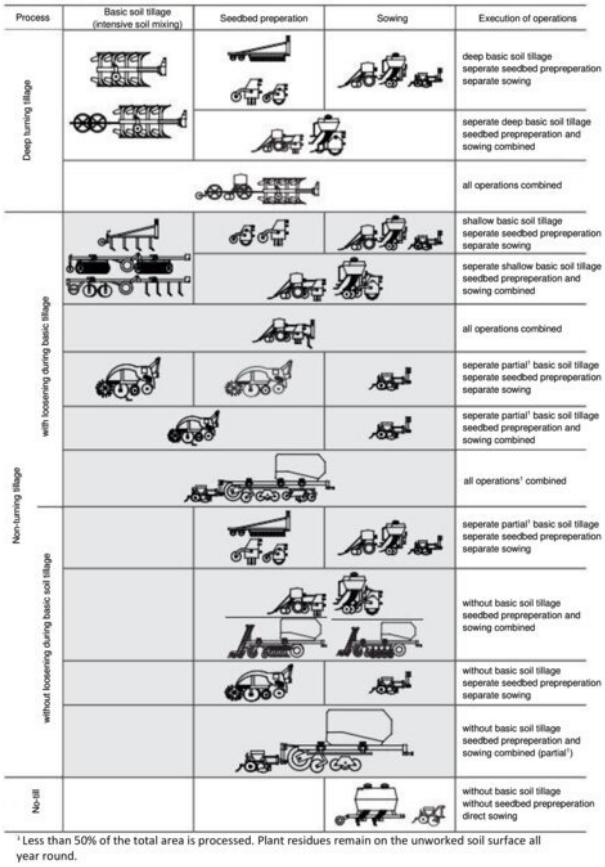
Mesures de GDT

pratiques agronomiques - A1: Couverture végétale/ du sol, A2: Matière organique/ fertilité du sol , A3: Traitement de la couche superficielle du sol (A 3.2: Reduced tillage (> 30% soil cover)), A6: Gestion des résidus des cultures (A 6.5: Résidus retenus)

DESSIN TECHNIQUE

Spécifications techniques

Whether it is low-till or conventional tillage depends on the tool use during soil tillage and how we use it. There are many implementation variants of conservation tillage that go by different professional names and definitions. Low-till is defined according to the depth of tillage, the intensity of soil layer mixing, the coverage of soil surface with harvest (organic) residues or intermediate tillage residues, according to the way tools move on the soil and the number of machine operations that are performed individually or combined (basic tillage, soil loosening seedbed preparation, pre-sowing tillage, sowing, ...). We focus on one version of low-till that we estimate has the greatest chances of being established in a short time in the case study area, which is so called »mulch-till«. We will concentrate on the term »mulch-till« which we define as a medium deep (10 cm) conservation tillage technique using chisel plow in combination with disk harrow. The coverage of the soil surface with residues must be at least 30% or higher. In addition, a special seeder is required to carry out "mulch" sowing (with moving parts). The success of mulch-till also depends on the combination with other implemented measures like crop rotation, cover crops, etc.



[1] Less than 50% of the total area is processed. Plant residues remain on the unworked soil surface all year round.

Author: Bodenbear beitung und Bestellung

MISE EN ŒUVRE ET ENTRETIEN : ACTIVITÉS, INTRANTS ET COÛTS

Calcul des intrants et des coûts
- Les coûts sont calculés : par superficie de la Technologie (taille et unité de surface : **1 ha**; facteur de conversion pour un hectare : **1 ha = 1 ha = 10,000 m2**)
- Monnaie utilisée pour le calcul des coûts : **EUR**
- Taux de change (en dollars américains - USD) : 1 USD = 0.97 EUR
- Coût salarial moyen de la main-d'oeuvre par jour : 90.90

Facteurs les plus importants affectant les coûts

It very much depends on the type of soil, what is the structure of the soil. In addition, the planning of the crop rotation and cover crops also affect the costs. As a result, weed development and subsequent herbicide use may be different.

Activités de mise en place/ d'établissement
1. Purchase of 2-row disc harrow (Calendrier/ fréquence: 1st year)
2. Purchase deep chisel plow (Calendrier/ fréquence: 1st year)
3. Purchase pneumatic seed drill combined with rotary harrow (Calendrier/ fréquence: 1st year)
4. Purchase pneumatic precision planter with rotating elements (Calendrier/ fréquence: 1st year)
5. Purchase cover crop seed drill (Calendrier/ fréquence: 1st year)

Intrants et coûts de mise en place (per 1 ha)

Spécifiez les intrants	Unité	Quantité	Coûts par unité (EUR)	Coût total par intrant (EUR)	% des coût supporté par les exploitants des terres
Equipements					
Purchase of 2-row disc harrow	piece	29,7	404,0404	12000,0	100,0
Purchase deep chisel plow	piece	29,7	101,0101	3000,0	100,0
Pneumatic seed drill combined with rotary harrow	piece	29,7	909,0909	27000,0	100,0
Pneumatic precision planter with rotating elements	piece	29,7	572,3905	17000,0	100,0
Cover crop seed drill	piece	29,7	151,5151	4500,0	100,0
Coût total de mise en place de la Technologie				**63'500.0**	

Coût total de mise en place de la Technologie en dollars américains (USD)	*65'463.92*	

Activités récurrentes d'entretien

1. Tractor operation and maintanance (Calendrier/ fréquence: It is used for all operations related to the technology (without cover crop seed drill operation)..)
2. Deep chisel plow operation and maintanance (Calendrier/ fréquence: 1 time per 5 years, on all cultivated field surfaces (29,7 ha), 1.0 h/ha.)
3. 2-row disc harrow operation and maintanance (Calendrier/ fréquence: 2 time per year, on all cultivated field surfaces (29,7 ha), 0.8 h/ha.)
4. Pneumatic precision planter with rotating elements operation and maintanance (Calendrier/ fréquence: 1 times per year, on 50 % of all cultivated field surfaces (14.85 ha), 1.3 h/ha.)
5. Cover crop seed drill operation and maintanance (Calendrier/ fréquence: 1 time per year, on all cultivated field surfaces (29,7 ha), 0.8 h/ha (combined with harrow).)
6. Pneumatic seed drill combined with rotary harrow operation and maintanance (Calendrier/ fréquence: 1 times per year, on 50 % of all cultivated field surfaces (14,85 ha), 1.4 h/ha.)
7. Purchase cover crop seed mixture Fruh (Calendrier/ fréquence: 1 time per year, on all cultivated field surfaces (29,7 ha).)

Intrants et coûts de l'entretien (per 1 ha)

Spécifiez les intrants	Unité	Quantité	Coûts par unité (EUR)	Coût total par intrant (EUR)	% des coût supporté par les exploitants des terres
Main d'œuvre					
Tractor operation	EUR/ha	29,7	18,144	538,88	100,0
Machine maintenance	EUR/ha	29,7	2,88	85,54	100,0
Equipements					
Machine avarage total costs of tractor operation and maintanance	EUR/ha	29,7	122,598	3641,16	100,0
Machine avarage total costs of deep chisel plow operation and maintanance	EUR/ha	29,7	4,36	129,49	100,0
Machine avarage total costs of 2-row disc harrow operation and maintanance	EUR/ha	29,7	30,432	903,83	100,0
Machine avarage total costs of pneumatic precision planter with rotating elements operation and maintanance	EUR/ha	14,85	29,744	441,7	100,0
Machine avarage total costs of cover crop seed drill operation and maintanance	EUR/ha	29,7	2,872	85,3	100,0
Machine avarage total costs of Pneumatic seed drill combined with rotary harrow operation and maintanance	EUR/ha	14,85	52,416	778,38	100,0
Matériel végétal					
Cover crop mixture Fruh	EUR/ha	29,7	66,768	1983,01	100,0
Coût total d'entretien de la Technologie				**8'587.29**	
Coût total d'entretien de la Technologie en dollars américains (USD)				*8'852.88*	

ENVIRONNEMENT NATUREL

Précipitations annuelles
- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [x] 751-1000 mm
- [x] 1001-1500 mm
- [ ] 1501-2000 mm
- [ ] 2001-3000 mm
- [ ] 3001-4000 mm
- [ ] > 4000 mm

Zones agro-climatiques
- [ ] humide
- [x] subhumide
- [ ] semi-aride
- [ ] aride

Spécifications sur le climat

Précipitations moyennes annuelles en mm : 1015.0
The most precipitation falls in summer, the months with the highest average precipitation are June and August, the least precipitation falls in winter, in January and February at least, and in principle more precipitation falls in autumn than in spring.
Nom de la station météorologique : Jareninski vrh (1981 – 2010)
Mean annual temperature in year 2014 Jareninski vrh is 11,9°C.

Pentes moyennes
- [ ] plat (0-2 %)
- [x] faible (3-5%)
- [x] modéré (6-10%)
- [ ] onduleux (11-15%)
- [ ] vallonné (16-30%)
- [ ] raide (31-60%)
- [ ] très raide (>60%)

Reliefs
- [ ] plateaux/ plaines
- [ ] crêtes
- [ ] flancs/ pentes de montagne
- [ ] flancs/ pentes de colline
- [x] piémonts/ glacis (bas de pente)
- [ ] fonds de vallée/bas-fonds

Zones altitudinales
- [ ] 0-100 m
- [x] 101-500 m
- [ ] 501-1000 m
- [ ] 1001-1500 m
- [ ] 1501-2000 m
- [ ] 2001-2500 m
- [ ] 2501-3000 m
- [ ] 3001-4000 m
- [ ] > 4000 m

La Technologie est appliquée dans
- [ ] situations convexes
- [x] situations concaves
- [ ] non pertinent

Profondeurs moyennes du sol
- [ ] très superficiel (0-20 cm)
- [ ] superficiel (21-50 cm)
- [x] modérément profond (51-80 cm)
- [ ] profond (81-120 cm)
- [ ] très profond (>120 cm)

Textures du sol (de la couche arable)
- [ ] grossier/ léger (sablonneux)
- [x] moyen (limoneux)
- [ ] fin/ lourd (argile)

Textures du sol (> 20 cm sous la surface)
- [ ] grossier/ léger (sablonneux)
- [x] moyen (limoneux)
- [ ] fin/ lourd (argile)

Matière organique de la couche arable
- [ ] abondant (>3%)
- [x] moyen (1-3%)
- [ ] faible (<1%)

Profondeur estimée de l'eau dans le sol
- [ ] en surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Disponibilité de l'eau de surface
- [ ] excès
- [x] bonne
- [ ] moyenne
- [ ] faible/ absente

Qualité de l'eau (non traitée)
- [ ] eau potable
- [ ] faiblement potable (traitement nécessaire)
- [x] uniquement pour usage agricole (irrigation)
- [ ] eau inutilisable

La qualité de l'eau fait référence à: eaux de surface

La salinité de l'eau est-elle un problème ?
- [ ] Oui
- [x] Non

Présence d'inondations
- [x] Oui
- [ ] Non

Diversité des espèces
- [ ] élevé
- [x] moyenne
- [ ] faible

Diversité des habitats
- [ ] élevé
- [x] moyenne
- [ ] faible

CARACTÉRISTIQUES DES EXPLOITANTS DES TERRES APPLIQUANT LA TECHNOLOGIE

Orientation du système de production
- [ ] subsistance (auto-approvisionnement)
- [ ] exploitation mixte (de subsistance/ commerciale)
- [x] commercial/ de marché

Revenus hors exploitation
- [ ] moins de 10% de tous les revenus
- [x] 10-50% de tous les revenus
- [ ] > 50% de tous les revenus

Niveau relatif de richesse
- [ ] très pauvre
- [ ] pauvre
- [x] moyen
- [ ] riche
- [ ] très riche

Niveau de mécanisation
- [ ] travail manuel
- [ ] traction animale
- [x] mécanisé/ motorisé

Sédentaire ou nomade
- [x] Sédentaire
- [ ] Semi-nomade
- [ ] Nomade

Individus ou groupes
- [x] individu/ ménage
- [ ] groupe/ communauté
- [ ] coopérative
- [ ] employé (entreprise, gouvernement)

Genre
- [ ] femmes
- [x] hommes

Âge
- [ ] enfants
- [ ] jeunes
- [x] personnes d'âge moyen
- [ ] personnes âgées

Superficie utilisée par ménage
- [ ] < 0,5 ha
- [ ] 0,5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [x] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1 000 ha
- [ ] 1 000-10 000 ha
- [ ] > 10 000 ha

Échelle
- [ ] petite dimension
- [x] moyenne dimension
- [ ] grande dimension

Propriété foncière
- [ ] état
- [ ] entreprise
- [ ] communauté/ village
- [ ] groupe
- [ ] individu, sans titre de propriété
- [x] individu, avec titre de propriété

Droits d'utilisation des terres
- [ ] accès libre (non organisé)
- [ ] communautaire (organisé)
- [x] loué
- [x] individuel

Droits d'utilisation de l'eau
- [ ] accès libre (non organisé)
- [x] communautaire (organisé)
- [ ] loué
- [ ] individuel

Accès aux services et aux infrastructures

santé	pauvre	bonne
éducation	pauvre	bonne
assistance technique	pauvre	bonne
emploi (par ex. hors exploitation)	pauvre	bonne
marchés	pauvre	bonne
énergie	pauvre	bonne
routes et transports	pauvre	bonne
eau potable et assainissement	pauvre	bonne

services financiers — pauvre ✓ bonne

IMPACT

Impacts socio-économiques

Production agricole — en baisse ✓ en augmentation
Some farmers report a slight drop in yield in first years after the implementation of the measure, but the farmer in the case study location didn't notice any difference in yield.

risque d'échec de la production — en augmentatio ✓ en baisse
Reduced risk, but with the wrong approach it can increase. For example, reduced risk due to unfavorable weather conditions, increased risk due to the possibility of weed development.

gestion des terres — entravé ✓ simplifié
Simplified soil tillage technology.

dépenses pour les intrants agricoles — en augmentatio ✓ en baisse
Reduced costs due to lower energy (fuel) consumption.

charge de travail — en augmentatio ✓ en baisse
Fewer hours dedicated for tillage.

Impacts socioculturels

sécurité alimentaire/ autosuffisance — réduit ✓ amélioré
Facilitated production with lower costs, motivation to do business in agriculture.

connaissances sur la GDT/ dégradation des terres — réduit ✓ amélioré
With positive effects more interest of the farmer in sustainable production.

Impacts écologiques

ruissellement de surface	en augmentatio ✓	en baisse
évaporation	en augmentatio ✓	en baisse
humidité du sol	en baisse ✓	en augmentation
couverture du sol	réduit ✓	amélioré
perte en sol	en augmentatio ✓	en baisse
accumulation de sol	en baisse ✓	en augmentation
encroûtement/ battance du sol	en augmentatio ✓	réduit
compaction du sol	en augmentatio ✓	réduit
cycle/ recharge des éléments nutritifs	en baisse ✓	en augmentation
matière organique du sol/ au dessous du sol C	en baisse ✓	en augmentation
couverture végétale	en baisse ✓	en augmentation
biomasse/ au dessus du sol C	en baisse ✓	en augmentation
diversité végétale	en baisse ✓	en augmentation
espèces étrangères envahissantes	en augmentatio ✓	réduit

diversité animale — en baisse ✓ en augmentation
Cover crops act as hiding places for various animals.

espèces bénéfiques (prédateurs, pollinisateurs, vers de terre) — en baisse ✓ en augmentation
Plants attract pollinators.

diversité des habitats	en baisse ✓	en augmentation
impacts de la sécheresse	en augmentatio ✓	en baisse
émissions de carbone et de gaz à effet de serre	en augmentatio ✓	en baisse

Impacts hors site

capacité tampon/de filtration (par les sols, la végétation, les zones humides) — réduit ✓ amélioré
Surface cover with plants.

dommages sur les infrastructures publiques/ privées — en augmentatio ✓ réduit
The soil is not carried into ditches and ponds.

ANALYSE COÛTS-BÉNÉFICES

Bénéfices par rapport aux coûts de mise en place

Rentabilité à court terme	très négative ✓	très positive
Rentabilité à long terme	très négative ✓	très positive

Bénéfices par rapport aux coûts d'entretien

Rentabilité à court terme	très négative ✓	très positive
Rentabilité à long terme	très négative ✓	très positive

The initial establishment and investment costs for implementing the technology are high, and in the short term, the benefits may not be very noticeable or even negative compared to conservative technology. However, the long-term benefits are more significant and positive. While there are recurring costs involved, such as maintenance expenses, they are considerably lower compared to the initial investment costs. The technology requires substantial upfront investment in equipment, which can initially outweigh the immediate returns. It takes time for the technology to mature and for the full benefits to be realized. As the system becomes established and optimized, the positive outcomes become more apparent over the long run. Additionally, the lower costs mentioned refer to the ongoing maintenance and operational expenses required to sustain the technology (machines), which are generally lower than the initial investment costs. These costs are often outweighed by the benefits gained from improved efficiency, reduced resource consumption, and other long-term advantages. Therefore, while the short-term returns may not be overwhelmingly positive, the investment in the technology pays off over time, with greater benefits and lower operational costs.

CHANGEMENT CLIMATIQUE

Changements climatiques progressifs

précipitations annuelles décroît — pas bien du tou ✓ très bien

Extrêmes climatiques (catastrophes)

pluie torrentielle locale	pas bien du tou	✓ très bien
canicule	pas bien du tou ✓	très bien
sécheresse	pas bien du tou ✓	très bien
glissement de terrain	pas bien du tou	✓ très bien

ADOPTION ET ADAPTATION DE LA TECHNOLOGIE

Pourcentage d'exploitants des terres ayant adopté la Technologie dans la région

- cas isolés/ expérimentaux
- ✓ 1-10%
- 11-50%
- > 50%

Parmi tous ceux qui ont adopté la Technologie, combien d'entre eux l'ont fait spontanément, à savoir sans recevoir aucune incitation matérielle ou aucun paiement ?

- 0-10%
- 11-50%
- 51-90%
- ✓ 91-100%

La Technologie a-t-elle été récemment modifiée pour s'adapter à l'évolution des conditions ?

- ✓ Oui
- Non

Added cover crop seed drill. more emphasis on cover crop.

A quel changement ?

- changements/ extrêmes climatiques
- évolution des marchés
- la disponibilité de la main-d'œuvre (par ex., en raison de migrations)
- ✓ added equipment/mechanization attachments to facilitate technology implementation, improved technology implementation with knowledge and experience

CONCLUSIONS ET ENSEIGNEMENTS TIRÉS

Points forts: point de vue de l'exploitant des terres

- Less depression, erosion and soil leaching.
- Cost and time (fewer passes, machine hours, less machine power required).
- Care for nature, sustain natural resources.

Faiblesses/ inconvénients/ risques: point de vue de l'exploitant des terrescomment surmonter

- A big investment in machinery. It is possible to start gradually with cheaper and simpler machines (also home-made).
- Adaptation of crop protection. Implementing integrated pest management (IPM).

Points forts: point de vue du compilateur ou d'une autre personne-ressource clé

- In the long term it enables the achievement of better soil conditions, in terms of appropriate ratios of water, air, nutrients, organic matter, microbial activity, pH, microbial activity, pH and other factors of soil fertility.
- Compaction and drying of the top layer of the soil is significantly less frequent and as a result losses of young plants are therefore smaller.
- It reduces the potential for soil erosion. A major threat to soil fertility is erosion processes (wind, water and other erosion), where the most fertile surface layers of the soil are carried away to other parts of the ecosystem that are not intended for food production.
- It brings advantages in terms of energy consumption and the possibility of carrying out production tasks in a shorter time and in difficult weather conditions. Conservation tillage tools typically operate in a shallower soil layer and mix less soil mass, it enables the use of tools with larger working widths and thus less unproductive driving in the field.
- Benefits in terms of reduced transfer of phytopharmaceuticals and nutrients excess from the cultivation area to water and other ecosystems.
- Reduced tillage improves soil quality, reduces nutrient leaching and lowers greenhouse gas emissions.
- Benefits in terms of bioavailability and nutrient uptake efficiency.
- Benefits in terms of greater adaptability of crops to extreme weather events.
- Benefits in terms of maintaining the overall biological diversity of the agricultural landscape and soil.

Faiblesses/ inconvénients/ risques: point de vue du compilateur ou d'une autre personne-ressource clécomment surmonter

- An increase in the occurrence of certain types of weeds and a high dependence on certain types of herbicides. Some studies show that the introduction of conservation tillage slightly increases losses from certain diseases and pests. For successful weed control, it is important to have a varied crop rotation, frequent sowing of cover crops and intercrops, and that the weeds never leave uncontrolled development on the stubble. The variegated crop rotation is meant as an obstacle that interrupts the development cycle of diseases and pests. How we handle harvest residues is also important. The more finely they are chopped by combines, mulchers or tools for vertical tillage before sowing, the faster they decompose and the worse the chances of harmful organisms developing on them. An evenly distributed mulch of harvest residues should remain, which prevents the emergence of new waves of weeds. These additional measures, together with mechanical weed control with new types of tools, allow limiting the weed population to a level that can be controlled with a limited range of herbicides.
- Investment costs in machines designed for the method of soil cultivation can be very high. An important obstacle in the introduction of conservation tillage is the large investments in new machinery... The value of purchasing these tools can well exceed the amount of 100,000 euros for an individual farm, which is a practically unfeasible investment for small farms. Small farms can take the transition to conservation farming only with the help of hired machinery services from neighbouring large farms that have been able to invest in new equipment. The subsidization of the purchase of machinery and also the economic legal status of the farm in terms of VAT calculation play an important role.
- It is necessary to replace all the tools used by farmers according to the old methods of tillage. It is necessary to purchase adapted cultivators, harrows, looseners and especially seeder drills. Increase in the supply of relatively inexpensive machines from manufacturers from Eastern Europe and Turkey, which can increase the availability of this equipment to smaller farms.
- In the first years of the transition period, there may be a significant reduction in yields and poor financial results. There is a yield reduction and financial stress during the transition period to the new system. The transition from conventional cultivation to conservation tillage is usually difficult and risky. Growers must be financially strong in order to make the transition, and the areas under alternative cultivation systems must increase gradually when they really master the new cultivation technique. Good financial support during the transition period is very important for small farms with weak investment assets. Targeted education and training is necessary, as technological errors due to lack of knowledge regarding the implementation of conservation cultivation in different soil types can be economically very fatal.
- A small increase in the seeding rate (10 to 15 %) is often recommended to compensate for losses caused by diseases and pests at the time of plant emergence. A necessary cost that must be accepted (higher sowing rate for the main crops and additional crops – cover crops) for the successful implementation of the measure.

RÉFÉRENCES

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Date de mise en oeuvre: 26 avril 2022

Dernière mise à jour: 11 juillet 2023

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Description complète dans la base de données WOCAT
https://qcat.wocat.net/fr/wocat/technologies/view/technologies_6241/

Données de GDT correspondantes
sans objet

La documentation a été facilitée par

Institution
- Chamber of Agriculture and Forestry of Slovenia – Institute of Agriculture and Forestry Maribor (KGZS) - Slovénie

Projet
- OPtimal strategies to retAIN and re-use water and nutrients in small agricultural catchments across different soil-climatic regions in Europe (OPTAIN)

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