Conservation agriculture

What is conservation agriculture and why is it useful?

Conservation agriculture (CA) encompasses a set of complementary agricultural practices:

- minimal soil disturbance (through reduced or no-tillage) in order to preserve soil structure, soil fauna and organic matter;
- permanent soil cover (cover crops, residues and mulches) to protect the soil and contribute to the suppression of weeds;
- diversified crop rotations and crop combinations, which promote soil micro-organisms and disrupt plant pests, weeds and diseases.

Conservation agriculture aims to boost agricultural production by optimising the use of farm resources and helping to reduce widespread land degradation through the integrated management of available soil, water and biological resources combined with external inputs. Mechanical tillage is replaced by biological mixing of the soil, whereby soil micro-organisms, roots and other soil fauna take over the tillage function and soil nutrient balancing. Soil fertility (nutrients and water) is managed through soil cover management, crop rotations and weed management.

Disc harrow used for reduced tillage operations (Germany) (Source: Stephan Hubertus Gay)

Implementation

Conservation agriculture is typically implemented through the following steps, each of which lasts for two or more years.

- First phase. Inversion ploughing is stopped, and reduced or no-tillage techniques implemented instead. At least a third of the soil surface has to remain covered with crop residues, and cover crops should be introduced following the harvest of the main crop. Disc, spike or rotary harrows are used (direct drills in case of no-tillage). Yield reduction may occur.
- Second phase. Natural improvement of soil conditions and fertility occur thanks to the organic material originating from the natural degradation of residues. Weeds and pests tend to increase and must be controlled, chemically or by other means.
- Third phase. Diversification of the cropping pattern (crop rotations) may be introduced. The overall system stabilises progressively.
- Fourth phase. The farming system reaches an equilibrium and yields may improve in comparison with conventional farming. This reduces the need to use chemicals for weed and pest control, or to supplement fertility.

Farmers need training for each phase. Experience may be acquired in the field but yields and profits may be lower in the short term. The system is unsuitable for compacted soils, which may first require loosening.

Direct seeder (no-till equipment) in operation (Source: Jana Epperlein, Gesellschaft für konservierende Bodenbearbeitung e.V., Germany)

Benefits

Several benefits arise from the application of CA, some of which (improved yields, biodiversity, etc.) become obvious once the system reaches stability.

- The organic carbon stock, biological activity, above- and below-ground biodiversity and soil structure are all improved. Higher biological activity results in the formation of well-connected, mostly vertical soil macro-biopores that increase water infiltration and resistance to severe packing. Soil degradation – in particular soil erosion and run-off – is greatly reduced, often leading to increased yields. Reduced soil and nutrient losses, in combination with more rapid pesticide breakdown and greater adsorption (due to the higher organic matter content and biological activity) also result in improved water quality. Carbon dioxide (CO_2) emissions are lowered as a result of the reduced use of machinery and increased accumulation of organic carbon. CA practices could sequester between 50 and 100 million tonnes of carbon annually in European soils, the equivalent of the emission of 70-130 million cars.
- Labour and energy inputs related to land preparation and weeding are greatly reduced.
- Fertiliser requirements and soil restoration interventions are reduced.

Drawbacks

- Typically there is a transition period of five to seven years before a conservation agriculture system reaches equilibrium. Yields may be lower in the early years.
- If seasonal factors are not taken into account, the inappropriate application of chemicals may increase the risk of leaching due to the more rapid movement of water through the biopores.

Corn cultivated under no-tillage: residues from the previous crop are still visible under the corn canopy, covering the soil (Germany) (Source: Jana Epperlein, Gesellschaft für konservierende Bodenbearbeitung e.V., Germany)

- If crop rotations, soil cover and/or crop varieties are not adjusted to optimal levels, more chemicals may be needed to control weeds and pests.
- Nitrous oxide (N_2O) emissions increase in the transition period.
- Farmers need to make an initial investment in specialised machinery, and need to have access at a reasonable cost to cover crop seeds that are adapted to local conditions.
- Farmers need extensive training and access to skilled advisory services. Compared to conventional farming, a fundamental change in approach is required.

Success stories

In Europe, no-tillage accounts for up to a tenth of Finland and Greece's utilised agricultural area (UAA), and up to five percent in the Czech Republic, Slovakia, Spain and the United Kingdom. Reduced tillage is being implemented on almost half of the UAA in Finland and in the United Kingdom, and on a quarter of the UAA in Portugal, Germany and France. In the Midi-Pyrénées region (France) in 2006, on average three quarters of the winter crops and one quarter of the spring crops were under reduced tillage. In the same year, cover crops accounted for a fifth of the spring crops area, three times higher than in 2001.

Further reading

http://soco.jrc.ec.europa.eu
www.fao.org/ag/ca/
www.fao.org/ag/catd/
www.ecaf.org/First.html
http://kassa.cirad.fr/
www.sowap.org/

This fact sheet is based on the findings of the 'Sustainable agriculture and soil conservation' (SoCo) project. It is part of a package of ten sheets organised around the three main topics of the project. The sheets cover the following topics:

- Introduction:
  - Fact sheet no. 1: Linking soil degradation processes, soil-friendly farming practices and soil-relevant policy measures;

- Soil degradation processes:
  - Fact sheet no. 2: Water erosion and compaction;
  - Fact sheet no. 3: Organic matter decline;
  - Fact sheet no. 4: Salinisation and sodification;

- Soil-friendly farming systems and practices:
  - Fact sheet no. 5: Conservation agriculture;
  - Fact sheet no. 6: Soil-friendly tillage practices;
  - Fact sheet no. 7: Soil-friendly farm infrastructure elements;

- Soil-relevant policies:
  - Fact sheet no. 8: Requirement to keep land in good agricultural and environmental condition (GAEC);
  - Fact sheet no. 9: Agri-environment measures;
  - Fact sheet no. 10: Advisory services.

All SoCo fact sheets and project reports can be downloaded at: http://soco.jrc.ec.europa.eu.

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