Food and Agriculture Organization of the United Nations

Cover crop and residue management in Conservation Agriculture in East Asia and Pacific Regions

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Summary

This practice describe how cover crops can help to improve the resilience of the crop system against weather variability and climate hazards and minimize soil nutrient losses. This in the long run will benefit the soil quality and hence, all the aspects of farmer's livelihoods related to better crop yields.

Description

Conservation Agriculture (CA) is an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment.

The three fundamental principles of CA are:

1. Direct planting of crop seeds,
2. Permanent soil cover, and
3. Crop diversity.

Conservation agriculture systems start each year with the production and distribution of crop residues or an additional cover crop. Erroneously, it is often thought that Conservation Agriculture can only be successfully implemented if herbicides are applied.

Fortunately, the creativity and persistence of many farmers and researchers has led to the current situation in which a lot of knowledge and equipment exist to manage cover crops without the use of herbicides.

1. Effects of successful residue management

1.1 Vegetative material adequately managed

- adds organic matter, which improves the quality of the seedbed and increases the water infiltration and retention capacity of the soil;
- fixes carbon by capturing carbon dioxide from the atmosphere and retaining it in the soil;
- buffers the pH of the soil and facilitates the availability of nutrients;
- feeds the carbon cycle of the soil;
- captures the rainfall and thus increases the soil moisture content;
- protects the soil from being eroded and increases its resistance to extreme weather events; and
- reduces the evaporation of soil moisture.

1.2 Residues badly managed

- provoke an unequal drying of the soil and thus a delay in the warming-up of the seedbed or uneven germination of the crop;
- interfere with sowing and fertilizing activities; and
- hinder the emergence of seedlings.

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2. Distribution of residue on the plant

In conservation agriculture, residues should be manipulated from harvest onwards. It depends on the following cover crop whether or not the residues should be distributed equally over the field or left intact so climbing cover crops like mucuna can use the maize stalks for support. An equal distribution of residues provides homogenous temperature and humidity conditions. If residues are not distributed more or less equally on the soil surface, this may cause the following problems:

- bad placement of the seeds at sowing, resulting in an uneven germination;
- a cold and wet seed environment favours the development of pests and diseases; and
- allelopathy (is a biological phenomenon by which an organism produces one or more biochemicals that influence the growth, survival, and reproduction of other organisms) may be encouraged.

3. Timing issues

It is important to choose the precise moment at which the vegetative cover is controlled, because most of the species used can regenerate if their growth is interrupted prematurely. Alternatively, seeds of the cover crop can germinate if the plants are allowed to mature, as may happen with oats, rye, chickpea, vetches and forage radish. There are, however, species and rotations where cover crops are purposely brought to maturity to establish a seed bank which will allow the cover crop to grow automatically once the cash crop is harvested.

The best moment to control the majority of cover crop species is at the full flowering stage when they have accumulated maximum biomass. In the case of legumes, the pods from the first flowering should be already formed but not yet mature. Vetches should have some mature pods. Oats and rye can be best managed at the milk stage. Horse radish can be slashed at any growth stage, but in systems of direct sowing and minimum tillage, seeds should be green and physiologically immature to avoid the germination of new plants.

Both sunn-hemp and pigeon pea need to be controlled before flowering due to a high re-growth rate and excessive wood development in the stems. The most adequate way to manage the cover crops depends on the objective of the cover crop and the possibilities of the farmer.

If the requirement is for the dead mulch to cover the soil for as long as possible, the best way to manage the biomass is by using a knife-roller, chain, sledge (a land vehicle with a smooth underside or possessing a separate body supported by two or more smooth, relatively narrow, longitudinal runners that travels by sliding across a surface) or herbicides.

When the decomposition process has to start immediately in order to release the nutrients it is recommendable to slash or mow the cover crop. In some cases it might be necessary to complete this with herbicides. The period between slashing, or other management practice, of the cover crop and seeding of the commercial crop (maize, beans, soya, etc.) can affect the production level of the crop. This is related to some of the substances that are released during decomposition of the cover crops.

These can harm the germination of the crop seeds, or sometimes even delay the development of subsequent crops. This is called allelopathy (see the description above). In general, management of leguminous cover crops and horse radish

ten days before planting of maize gives the highest yield responses. Horse radish produces the least fluctuation in crop yield in relation to cover crop management. The maize yield on cover of grass species, like oats and Italian ryegrass, increases with an increase in the number of days between managing the cover crop and seeding the maize.

This is related to a reduction of nitrogen immobilization and allelopathic effects over time and different levels of lignin (a complex chemical compound most commonly derived from wood) and hemicelluloses (presents along with cellulose in almost all plant cell walls).

In case of direct seeding over the cover crop it is recommended to seed 8 to 12 days after managing the cover crop for cover crops with low to medium (Carbon-Nitrogen ratio = is a ratio of the mass of carbon to the mass of nitrogen in a substance. It can, be used in analysing sediments and compost) C/N ratio (12 to 22) and 12 to 20 days for cover crops with high C/N ratio (>24).

4. Validation of the practice

This practice has been applied in east Asia and the pacific regions. Cover crops can helped in improving the resilience of the crop system against weather variability and climate hazards and minimize soil nutrient losses. This in the long run will benefit the soil quality and hence, all the aspects of farmer's livelihoods related to better crop yields.

Adequate cover crop practices help to buffer the effect of erratic rainfall and mitigate moisture evaporation during droughts. Also helps water infiltration and increases water holding capacity, avoiding soil losses due to erosion and runoff.

Environmentally wise, cover crops have a positive effect being a practice that helps carbon fixation into the soil and maintaining the biodiversity of the ecosystem hosting fauna, flora and microorganisms that otherwise will be not present on a ploughed land.

5. Agro-ecological zones

- Tropics, warm

6. Related/Associated Technologies

- 7416;
- 7417; and
- 7418.

7. Objectives fulfiiled by the project

- Resource use efficiency
- Pro-poor technology