

Healthy soils and advantages of the cover crops

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Abstract: *Cover crops (green manure) brings not only immediate advantages like slowing erosion, suppressing weed growth, improving soil structure, increasing nutrients and water content and hindering some pests but also long term ones like decreasing erosion, air pollution, investment in mineral fertilizers and herbicides and increasing microbiological activity. The paper gives examples of good practices both for whole and row-crop grains. It also suggest a useful crop rotation for a period of five years.*

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1. Introduction

Increasing energy costs will have a profound effect on the economy in the forthcoming years, but at the moment it is hard to predict how fast the energy cost in agriculture will grow. The economy of green (cover) crops is rooted in the dynamics of nitrogen, i.e. how much nitrogen (N) is saved by the farmers as a consequence from its production by the green crops, what the costs, respectively fuel savings, etc.

In general, green crops bring a lot of benefits to the farmers [1,2]. Their main advantages are: delaying the erosion processes, improving soil structure, suppression of weeds, improving availability of nutrients and humidity, aiding pest control. At the same time, they can reduce costs, increase profits and even provide new income sources. The dividends on the investments in cover crops are enjoyed in the course of many years because their advantages grow in the long run.

The farmers should recognise the long term contribution of cover crops to the whole farm structure more and more often. Some of the most successful farmers are those who have seen the benefits and have committed to using cover crops, which work for them. For this purpose they reorganise their systems for soil treatment, in order to adapt better to the needs of the plants.

It is good to remember that every farm has unique structure and needs. There is no simple recipe for achieving the goals of the farmers. Tools for selecting and managing the best crops are sought and found.

2. The benefits of green crops

Green crops can increase the profit even during the first year. They can improve the overall state of the arable land and the whole farm. Moreover, effects that improve the soil accumulate over the years. Additionally, they lead to effects, which can hardly be determined purely financially such as reducing atmosphere pollution, erosion, weeds and pests [3,4,5,6].

Identifying these advantages can help everybody, who wishes to make long term decisions for his/her whole farm. In general, green crops have two main dimensions – ecological and economic.

By using green crops, producers protect their soil resources from erosion, facilitate the fight against weeds, and improve the circulation of nutrients and other useful activities. These considerable benefits differ in different locations and seasons, but at least two or three of them usually manifest themselves with any cover crop, for example:

- Reducing costs for mineral fertilisers. Fertiliser costs are reduced by adding nitrogen to crops, which accumulate it in the soil. Bean crops convert nitrogen from the atmosphere into nitrogen in the soil, which can be used by the plants. Crops grown in the field after bean crops can absorb from 30 to 60 percent of nitrogen (N), produced by them. It is with this percentage that fertilising with mineral nitrogen can be reduced. The value of bean crop nitrogen (N) is the easiest benefit for covering the costs, which can be estimated from both agronomical and economic point of view. This natural introduction into preserving fertility could justify using the cover crop;

- Reducing the need for applying herbicides and other pesticides. Cover crops suppress the development of weeds and reduce harms from diseases, pests and nematodes. Many of the cover crops have an effective impact on weeds by reducing their accessibility to water and nutrients. They provide residue or growing leaf mass, which blocks light, changes the light wave frequency and the surface soil temperature. They are a source of root exudates or compounds, which provide natural herbicide effect.

- Increasing microbiological activity. Through green crops, useful microbial life is ensured, which discourages pathogen microorganisms. For many soil diseases there is unsaturated soil environment. The natural development of useful pests and parasitoids is encouraged, which leads to reducing pest damage below economic thresholds. Compounds are produced, which reduce the nematode population. The development of useful nematodes is encouraged.

- Increasing yields and improving the quality of the production through improving soil health;

Preventing soil erosion; Cover crops improve soil through accelerating the infiltration of excess surface water. The structure of the mulled and degraded soil. Organic substances are synthesised, which encourage the useful microbial life. The circulation of nutrients is increased.

- Preserving moisture in the soil
- Helping to protect the farmers' personal health.

3. Basic principles in selecting green crops

Green (cover) crops provide many advantages but they cannot make wonders if their selection is not proper. The main points to be taken into consideration in their selection are:

- Identifying the current state of soil resources through carrying out the relevant analyses;
- Identifying the best time and place for covering the soil.

Sometimes it is obvious where and when cover crops should be used. The analyses can show that a field where corn will be grown needs nitrogen while the vineyard, which is usually on sloped terrains, needs erosion reduction activities or weed control.

For some purpose like long term soil conservation and improving its structure, it is necessary to apply the proper rotation table (see Fig. 1).

Vetch increases corn yield, for no-till grown corn, which is more than enough to cover the costs for its application. Besides, vetch can reduce the economic risk and will usually be more profitable than no-till grown corn after winter wheat.

Red clover, sown in a mix with oaths and vetch, can replace applying mineral nitrogen from 32 to 51 kg N/ha. A study in the USA shows that with two-year crop rotation the average corn yield is over 1.6 tonnes/hectare

Winter peas in combination with vetch and clover, can provide 80 to 100% of the subsequent needs of nitrogen for potato crops, as seen in a study in the North western part of the Atlantic.

Crop/ Field		Year				
		I	II	III	IV	V
Wheat	1	Wheat green crop +	Sunflower strip tilling +	Barley green crop +	Rapeseed green crop +	Corn Strip tilling +
Corn	2	Corn + Strip tilling	Wheat green crop +	Sunflower + strip tilling	Barley green crop +	Rapeseed + green crop
Barley	3	Rapeseed + green crop	Corn + Strip tilling	Wheat green crop +	Sunflower + strip tilling	Barley green crop +
Sunflower	4	Barley green crop +	Rapeseed + green crop	Corn Strip tilling +	Wheat green crop +	Sunflower + strip tilling
Rapeseed	5	Sunflower + strip tilling	Barley green crop +	Rapeseed + green crop	Corn Strip tilling +	Wheat green crop +
Crop/Field						

Fig. 1. Crop rotation in using green crops

Cereal-grain crops or grasses are especially good at extracting residue nutrients – especially of nitrogen N from the soil after harvesting. A large part of N is contained in plant residues and self-planters. The grain from the losses plus the plant residues can absorb a considerable part of the nitrogen up to three months after they have entered the soil. This finding can be used for applying cover crops before growing corn, reducing the total nitrogen loss, without causing loss of yield. This fact is confirmed by computer modelling done by USDA-ARS.

When needed, the crop rotation selected can be accompanied by information about rainfall, the periods of last spring and first autumn frosts, as well as other useful information.

One basic principle when using green crops is to look for and cover all periods when the soil is without plant cover and is subject to the effects of weather without any protection. In the case of the crop rotation suggested – 60% of the fields are covered by green crops and 40% undergo strip tilling, where 50 % of the soil surface is covered by plants.

When possible, other kinds of key information is added such as the quantity of rainfall, periods without frost and periods of peak load on labour and material resources.

In general, in each field should be sought free periods, when there are good conditions for creating cover crops.



Fig. 2. Soil surface with strip tilling

4. Examples of common niches in some systems for agricultural production

4.1. Winter niche

In many regions, winter crop sowing should finish at least six weeks before temperatures fall and soil freezes. Winter grain crops, rye in particular, are an exception and can be sown a bit later.

Green crops can be sown as second crops immediately after the main (summer) crop is harvested, when the weather is still suitable. In the cooler regions green crops that are tolerant to shading until the main crop has been harvested can be used. Small seed plants like clover do not need much moisture to germinate and they can sprout with small gaps through the remaining plant residues. The larger seeds need a few days of moisture in order to germinate.

When changing the crop rotation ratio with the so called “market oriented crops”, in the beginning of the season, the vigorous growth of the green crops can cause water stress, increase the risk of diseases, caused by lower air circulation in the soil or create new risks of pest attacks. In this case, changing sowing standards and times is recommended. In this way, green crops are “kept” in their development until the moment, when the main crop goes into a technical maturity stage, i.e. the leaves and the stem begin turning yellow. From that moment on the exposure to sunshine starts improving and the green crop continues its development without being affected by the yields of the main crop.

4.2. Summer niche

Many of the crop rotations implemented involve the opportunities and challenges of the crops grown. When two types of crops are grown in the same field and year, there should be an interval of three to eight weeks between the early sown/planted and the late sown/planted crops. Fast developing spring crops require erosion control, weed control, control of organic matter (humus) as well as nitrogen (N). For this purpose, the self-sown plants from the previous crop + fodder peas can be used. In this case it is most convenient to apply strip tilling of the soil for green crops.



Fig. 3. Strip tilling of the soil for green crops - front view



Fig. 4. Strip tilling of the soil for green crops - back view

Mulching with green crops can facilitate some soil treatments. Bringing the plants down to the soil surface regulates water evaporation, and, respectively, soil's humidity.

White clover can be a good choice when growing sweet corn and tomatoes. Perennial rye grass and other less aggressive grasses can be used for bean crops, tomatoes and other vegetables.

5. Unused benefits

The hedge is one benefit that is not used enough when cultivating agricultural crops. It can replace fences successfully and has a number of advantages such as:

- Suppressing weeds;
- Providing a favourable habitat for regulating biological equilibrium;

It is not possible to use plants yielding fruit, nuts, etc., for building a hedge. For this purpose it is necessary to apply appropriate pruning;

6. Key moments when applying green crops

To manage green crops effectively, it is necessary to answer a few questions:

- How will green crops be planted?
- What will the weather be like at the time of their planting?
- What will the temperature and humidity of the soil be at that time?
- How vital other crops will be in combination with green crops?
- Should the green crop develop more slowly than the main one or be high and grow vigorously?
- At what temperature intervals will it develop?
- Will the low winter temperatures destroy it?

- How will the green crop be destroyed?
- Is there a back-up plan if the green crop creates unforeseen situations such as going out of schedule of cultivation?
- Are there material and labour resources available?

7. Practical tips when choosing the appropriate green crop

After determining the time and place for using the green crops, it is necessary to identify the specific requirements.

7.1. First example

Situation: An orchard located over a sloped terrain.

Needs: Plant cover to reduce soil erosion.

Requirements:

- Introducing nutrients and organic matter, attracting useful organisms;
- Repelling rodents, nematodes or other pests;
- Not using any of the available water and the nutrients in the soil at periods critical for the development of the orchard plants;
- Not creating much nitrogen in the soil, and thus stimulating growth of trees or prevent their hardening during the winter period;
- Being easy to maintain;
- Being available all year round or planted annually;
- Being low-growing and needing minimal attention and care;
- Releasing some nutrients during the year but not too many;
- Having a root system, which enhances the root system of the main crop.

Suggestion: Combination of bean crop – peas + spring wheat or spring barley. Taking the green crop down to the soil surface as a mulching layer.

7.2. Second example

Situation: Wheat to be cultivated before corn. Insufficient rainfall after harvesting the wheat – up to 40 mm.

Needs: Winter cover for soil protection, which can supply nitrogen (N) for corn without losses in the next spring.

Requirements:

- Destroying the green culture before planting the main one, so that the former does not hamper the development of the latter;
- Leaving plant residues on the soil surface, so that they can reduce water evaporation from the soil;
- Leaving enough nitrogen in the soil so that there is no need for introducing additional mineral nitrogen during vegetation;

Suggestions:

- Vetch is good in the northeast, Midwest and partly in the south regions. Mixing it with rye or another grain crop improves its potential for controlling weeds and keeping the moisture.
- Red clover could be an appropriate choice.
- Forage peas could be used alone or in combination with another crop like self-sown wheat, which is a predecessor in this case.
- A very good effect is obtained when using a combination of forage peas + self-sown predecessor + additional introduction of microorganisms to the soil



Fig. 5. Corn with green crop between the rows



Fig. 6. Strip tilling of the soil after wheat

8. Conclusion

Using green crops has both short-term and long-term benefits for the soil, for the environment as well as for the farmers' expenses. It is important, however, to follow the main principles when choosing an appropriate green crop with the main goal being to provide a constant surface cover of the soil regardless if it is with alive plants or crop residue. It is also important to take into account the previous crop and the biological specifics of the current one in order to find the best possible match between it and the chosen green crop.

9. References

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