White sweet clover (*Melilotus albus*)


Land as the main means of production in agriculture

In agricultural production, the main means of production is land. Since northern soils have formed after the latest ice age, they are young and thin.

The humus content in soils also decreases in the course of intensive land cultivation. Thin soil with low humus content is characterized by low fertility. The low fertility is primarily caused by the poor structure of the soil due to the low humus content, which becomes especially apparent in case of using modern heavy machinery.
The water carrying capacity of thickened soil with a poor structure is insufficient for ensuring competitive yields of crops. At the price of increasing the expenses on soil preparation and fertilization, it is possible to keep the level of crop yield up and even increase it for some time, but that does not change the final outcome. Hence, northern agriculture cannot rely on the same methods used in regions with black soil.

In the future, as one of the preconditions for receiving agricultural aid, one should monitor the changes occurring with respect to the fertility of soils. In this time and age when we have enough food, we should not waste the future possibilities for producing food. Instead, at this point it would be wise to increase the production potential of soils to ensure a food supply for our children in the future.

Soil humus – it is a resource, which ensures the availability of food in the future.

**Why green manure?**

As a result of incorrect crop rotation, the physical, chemical, biological, and finally also the economic characteristics of the soil deteriorate. For example, the yield of cereals is significantly lower when cultivated as a monoculture than it is in case of cultivating cereals after crops which facilitate their growth, such as green manure crops. Winter wheat is the most sensitive to cultivation as a monoculture, followed by spring wheat, barley, oat and winter rye. Thanks to the fact that the latter also grows in poorer conditions, northern people have learned to eat black rye bread.

Due to the specialization and concentration, the situation where there is great inequality between regions in the availability of manure and slurry is deepening. In the areas with little animal husbandry, it is rational to grow leguminous green manure crops, which enrich the soil with nitrogen in an environmentally friendly way, activate the microbiological activities of the soil and, most importantly, increase the humus content in the soil.
An appropriate crop must be selected to ensure the maximum yield of dry matter, improve the nutrient content in the soil and allow for cultivation at a low cost.

**Why white sweet clover?**

It does not necessarily have to be white sweet clover, other crops may be cultivated as well.

Here, we point out the advantages provided by cultivation of white sweet clover. When cultivated in Estonian conditions, white sweet clover provides the highest dry matter yield from non-acid soils compared to other green manure crops. Sown as a pure annual crop, white sweet clover – aided by *Rhizobiaceae* bacteria - takes from air and provides to the soil 247 kg of nitrogen per hectare of soil. For red clover, the same figure is 160 kg (Viil P., 2005). White sweet clover produces more dry matter than red clover or lucerne and is more weather resistant in Estonian conditions than the latter.

Thanks to its bulky roots which penetrate deep into the ground, white sweet clover can draw other additional nutritional elements for the crop from the deeper layers of the ground, such as P, K, and Ca, and enrich the soil of the ploughed layer with these, increasing the availability of these elements for plants with shorter roots.

White sweet clover can be cultivated with no additional fertilizing. There will also be a significant saving on the expenses of fertilizing in the cultivation of follow-up crops.

Expenses on seed are low, because the seed is cheaper than clover seed and, if cultivated as a biennial crop, just 7-10 kilograms of high quality seeds with good germination capacity per one hectare is enough.

The roots of the follow-up crops penetrate into the ground loosened by the roots of white sweet clover. By achieving a greater depth for roots than normal, the crops following white sweet clover can obtain more moisture and nutrients.
required for growing. The physical and chemical characteristics of sandy soils as well as clay soils improve.

As a result, there is a lower risk of nutrients being washed out of soils, characterized by low humus content and insufficient microbiological activity.

The water regime of the soil improves – the risk of excessive moisture on the fields decreases (puddles disappear) and the amounts of water available to plants increase. The soil becomes grittier and easier to cultivate.

White sweet clover does not practically lodge at all, and is thus relatively easy to mow and chop for the production of green manure or biogas.

Cultivation of white sweet clover increases the humus content in the soil.

White sweet clover has no diseases which require controlling and it is affected by just a few pests. The latter is also important for the cultivation of follow-up crops. For example, it is not recommended to grow clover as previous cropping in case of several vegetables. This is related to common diseases, which also have a negative effect on the preservation of vegetables later.

By using the best possible technology, the producer gains a competitive edge. As a disadvantage, the difficulties in harvesting white sweet clover for seed production caused by its long stalks can be mentioned. Even in case of mowing at the height of one meter. This issue, however, should be solved by seed grower.

**Who should cultivate green manure crops?**

Cultivation of green manure crops is inevitable in organic farming and in case of insufficient crop rotation, for example, in entities specializing in growing cereals or vegetables. The results of the study conducted in Estonia in 1997 – 1999 show that the yield of spring crops from poorly fertile soil when cultivated after white sweet clover increased by 87% on average (Viil P., 2005). Also, according
to the data provided by the producer Laheotsa OÜ, 60 t of potatoes for consumption was yielded from one hectare in Estonian conditions in 2010 after the cultivation of biennial white sweet clover. The average potato yield of the company is 40-45 t/ha.

How to cultivate?
White sweet clover may be cultivated as an annual or biennial crop. It can be sown as a pure crop or under cover crop. In the latter case, it is most rational to sow white sweet clover together with the cover crop to cut the expenses. In case of a cover crop which is harvested early, the length of the herbage in the autumn of the year of sowing is ca 0.5 m in Estonian conditions and the benefit in the form of the nitrogen produced with the help of \textit{Rhizobiaceae} alone exceeds the cost of the seed multiple times, not to mention other benefits. If sown as a pure crop, white sweet clover grows approximately one meter high by autumn. Even though the field provides no marketable products in the current year, it covers the area prescribed for the cultivation leguminous plants, enriches the soil with nitrogen and organic compounds.

Cultivation as a biennial crop and sowing under a cover crop may primarily be recommended to the cereal growers who have no problems with fulfilling the percentage of leguminous plants in the year of sowing, but who are also interested in significantly improving the qualities of their soil. In such case, the field provides no marketable products for just one year.

In order to reduce the washing out of nitrogen, the mass should be ploughed in as late as possible in autumn or even in the following spring (ViiL, P., 2005). In the second year, the herbage should be chopped before the ripening of the seeds at the latest. If the field is in bloom, care should be taken to avoid damaging bees.

It is efficient to grow white sweet clover for producing energy grass or biogas.
Estonia has long-standing experience in the production of white sweet clover silage. Although corn may produce more mass per hectare in case of heavy fertilization and correct maintenance, it is accompanied by multiple times higher production costs and more extensive overcropping, which largely neutralizes the expected result. In case of white sweet clover, it is the exact opposite – it requires no fertilization, intermediate cultivation, plant protection, and soil fertility improves in case of the cultivation of white sweet clover.

**About agricultural methods**

Even though white sweet clover requires a non-acid environment (pH over 6.2) for growing, tests have established that this mainly applies to the germination environment and young plants. Even relatively modest doses of lime fertilizers enable to increase the pH of the upper, relatively thin layer of soil enough to enable the sowing of white sweet clover in the soils with lower pH.

Green manure is mainly required in case of poorly fertile low humus soils. The humus which has been lost in the course of intensive agriculture also requires restoration.

White sweet clover grows well enough even in unfertilized soils. In case of sowing without any cover crop as an annual crop, it is not important whether it is sown with regular tillage, minimum tillage or direct seeding (Viil P., 2005).

White sweet clover seed which has been treated with the *Rhizobiaceae* of lucerne (*Rhizobium meliloti*) is sown to the depth of 2-3 cm, depending on the texture and moisture conditions of the soil. In Estonian conditions, it can be sown until mid-July. Only spring sowing is suitable in case of growing as an annual crop.
If grown as a biennial crop, 7-10 kg of certified rubbed seed with good germination capacity should be sown per hectare. If grown as an annual crop, 12-15 kg/ha.

Applying the standard 7 kg/ha, if 1000 seeds weigh 2 g, there are 350 seeds sown per square meter. White sweet clover is able to suppress couch grass and other perennial weeds only in case of sufficient density.

The seed germinates at just a few plus degrees. The shoots are damaged by ca 8 degrees of cold.

In case of spring sowing without any cover crop, white sweet clover grows ca 1 m high by autumn. If sown later, in mid-June, the height in autumn is approximately 0.7 m. In case of early sowing, there is a greater risk of weevils damaging the young plants and it may be necessary to apply pest control.

The best-suited cover crops are early spring cereals.

There is a high risk of white sweet clover growing over the cover crop (this has occurred even when sown in spring under winter rye sown the year before). It would be economically rational to sow with a combi-seeder together with a cover crop.

In case of a risk of white sweet clover growing over, spraying with MCPA with the dose of 0.8 l/ha has been used. In case of sowing without cover crop, it is also a cheaper solution to use this preparation in weed control on a field of white sweet clover instead of mowing. This stops the growth of white sweet clover for approximately one month. In order to avoid excessive damage to white sweet clover, the preparation should not be used at temperatures exceeding 23-25 degrees. The herbicide is also more damaging to the plants in a later stage of growth and with wider leaf surfaces.

The extent of the damage caused by weevils should be monitored and pest control carried out together with plant protection for the cover crop, if possible.

If cultivated as a cultured crop, in normal conditions, white sweet clover grows to
White sweet clover in different crop rotations

In case of organic farming where the use of chemical plant protection products as well as mineral fertilizers is prohibited, the cultivation of green manure crops has two objectives – to increase soil fertility and control perennial weeds. If grown as a biennial crop, white sweet clover can successfully fulfil both objectives. In case of sowing in spring without any cover crop, organic farmers should mow the field once or twice in the summer to prevent the ripening of weed seeds. White sweet clover cannot control weeds sufficiently if grown as an annual crop.

Cereal growers have the widest possibilities for the cultivation of white sweet clover. Depending on the situation, different options may be suitable for them – sowing with a cover crop or as a pure crop, cultivation as a less than annual, annual or biennial crop. Conditionally, white sweet clover can be described as a less than annual crop if it is sown under cover crop and the herbage is ploughed in or if it is destroyed chemically in the following spring at the latest to fertilize the crops to be sown.

I would like to describe this currently little-used, but promising, green and economically efficient option in more detail.

The seed should be sown at a relatively large sowing norm, for example, 15 kg of high quality seed per hectare. It is recommended to sow under cereals which are harvested early at the time of the last sowing. Further operations should be the same as described under agricultural methods.

Ploughing in or destroying the herbage with an herbicide (in case of using a direct seeder of cereals) in the following spring. Since the height of the herbage
is not likely to exceed 0.5 m, it is not necessary to chop – roll. The additional expenses related to the under-sowing of white sweet clover consist of the price of the seed and approximately 15% higher cost of sowing, the higher cost of MCPA compared to regular herbicides for cereals and the expenses on pest control against weevils.

We do not currently have any available test data to calculate the additional benefits, but let us for now conditionally proceed from the fact that, in normal conditions, there would be about a half of the amount of the dry matter and nitrogen produced that is produced by white sweet clover if cultivated as an annual crop without any cover crop. Therefore, the follow-up crop would also give a half smaller yield compared to the pure crop of white sweet clover, and fertilizers would also be saved in a by half smaller extent. At the same time, cereals harvest would still be received from the field in the year of sowing of white sweet clover, which would be complemented by direct aid for the crop. The established rules do not allow to count such under-sowing as the area which is required to be covered with leguminous plants, but it is possible to make the final decision on the spring following the year of sowing on whether to leave white sweet clover growing or sow a new crop on the field.

**Humus balance in crop rotation**

Let us presume that the humus content in the soil is 3% and the thickness of the ploughed layer 0.2 m. In such case, there is 2,000 m$^3$ of ploughed soil for a hectare with approximately 60 m$^3$ humus in it.

The crops which increase the humus content (tons per year per 1 ha of ploughed layer): lucerne, white sweet clover, lupine +2.0; Leguminosae-rich grass +1.5; cultural meadows +1.0; pea, bean, mixed grain +0.7; cereals undersown with leguminous plants with straw +0.9.

The crops which decrease the humus content (tons per year per 1 ha of ploughed layer): potato, vegetables -2.0; cereals, rape, turnip rape -1.0; annual
grasses -0.7; unplanted fallow land -2.5…-3 (E. Lauringson, L. Talgre, H. Roostalu, 2006)

Using the figures described above, it is possible to calculate according to the stage of crop rotation in which direction the health condition of the main means of production – the land – is changing.

There is no hope for a farmer to keep up with the competition if the health of his main means of production – the land – is poor and he does nothing to improve it. Unfortunately, problems are often not acknowledged until in deep trouble. When health deteriorates, the sooner you start with treatment the more efficient it is.

Conclusively

1. White sweet clover is a crop which can be significantly beneficial for the farmer in case of skilful cultivation, helping him keep up with the competition.
2. White sweet clover is the best crop for improving the fertility of poorly fertile, non-acid soils.
3. White sweet clover can be successfully used in the production of renewable biofuel: whether by burning the dried biomass or by producing biogas from the green mass (in fresh or ensilaged form).
4. Blooming white sweet clover is a good honey plant and the crop is thus grown by many beekeepers near their apiaries (Rohtla, 2001).

Fertile soil and the field in good shape are the basis of a farmer’s success!

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Bibliography: