maheklaster

Autumn catch crop in the ECRI experimental field, ECRI researcher Merili Toom. Photo by M. Ess

Multi-species catch crop mixtures in organic crop rotations

In the framework of the Maheklaster NGO project "Innovation in organic farming", one of the activities was catch crop experiments. The use of a multi species annual catch crops to increase soil fertility, reduce weeds and increase yield and crop quality is gaining ground in both organic and conventional production. However, experience and trials are still scarce in our conditions. In the framework of the organic cluster project, experiments were carried out both in the experimental fields of the Estonian Crop Research Institute (ECRI) and at organic producers in different regions. The aim was to find out the efficiency of using different multi-species catch crops as green manures and to provide technological recommendations.

In organic farming, the cultivation of catch crops or green manures is one of the most important methods of maintaining soil fertility. Traditionally, the choice of green manures used is limited - farmers still mostly use red or white clover, either in pure form or in a mixture with one-two grasses, mainly as an annual or biennial crop in rotation. In the case of catch crop mixtures, we expect that a more varied selection of species/varieties could give better results. The cultivation of catch crops sown after the harvest of main crop should be encouraged, which would also reduce the leaching of plant nutrients in the autumn-winter period.

The main objectives of catch crop:

- Increase the humus content of the soil by adding organic matter.
- Improve soil structure and water retention.
- Reduce settling density.

- Increase soil biological activity, which suppresses the presence of pests and promotes both overall soil biota activity and diversity.

As catch crops decompose in the soil, nutrients become available for subsequent crops, improving the stability of nutrient supply. Successful cultivation of catch crops also has the potential to reduce weeds, one of the major problems currently facing organic farming. Multispecies catch crop mixtures have a broader impact on the soil than leguminous grasses, which are currently grown predominantly as single species or in mixtures with some grasses.

Implementation of the field trials

The trials took place in ECRI's experimental fields and in the farms of Juppi in Tartu County, Põlgaste in Võru County and Kaspar Toomsalu in Viljandi County.

Multi-species catch crops were tested as follows:

- **Perennial catch crops** sown in spring (as separate crop or undersown to the main crop) and their impact on the following crop (winter wheat sown in autumn).
- **Annual catch crops** sown **in autumn** and their impact on subsequent crops (field pea sown in spring and winter wheat sown in autumn next year).
- **Catch cropped annual crops** sown in **spring** and their impact on the following crop (winter wheat sown in autumn).

In the ECRI trials, there were 4 different mixtures for each type of catch crop and 3 different mixtures for organic producers.

Plant species potentially suitable for organic catch crop in Estonia were included in the trials. All mixtures included legume crops to fix atmospheric nitrogen. Species were selected based on their suitability for crop rotation and their ability to produce maximum biomass under organic conditions, at the given sowing time and under the given conditions. An attempt was made to develop mixtures that could reduce the risks to the producer if some species in the mixture fail. Consideration was also given to the availability of seeds on the market and their acceptable cost.

The spring-autumn catch crop mixtures mainly consisted of annual crops (Tables 1 and 2).

Perennial catch crop mixtures consisted of:

- Perennials: red clover; pink clover; white clover; lupin; fodder galega; alfalfa; sainfoin; Italian ryegrass; common ryegrass; timothy; red ryegrass.
- Annuals: Alexandria clover, Incarnate clover, Persian clover; annual ryegrass; oats.

Table 1. Autumn catch crop (SVK) mixtures in production trials

		Sowing rate kg/ha		
Type	**Variety**	**SVK 1**	**SVK 2**	**SVK 3**
Phacelia		0,5	1	
Buckwheat	Aiva	3	6	
Spring vetch	Nitra	8	9	
Winter vetch	Hungvillosa	4	5	12
Broad beans	Jõgeva 90% + Boxer 10%	6	6	
Field peas	Dolores 50% + Kirke 50%	12	15	6
Clover Incarnate	Diogenes	0,5	1	3

Alexandrian clover	Akenation	0,5	1	3
Sunflower		0,5	0,5	0,5
White mustard	Braco	1,5	2,5	5
Tillage raddish	CCS 779	1	3	5
Italian ryegrass	Barextra	1	1	3

Table 2. Spring catch crop (KVK) mixtures in production trials

Type	Variety	Sowing rate kg/ha		
		KVK 1	KVK 2	KVK 3
Phacelia		1,5	0,5	
Buckwheat	Aiva	10	5	12
Spring vetch	Nitra	5	5	5
Winter vetch	Hungvillosa	5	5	5
Broad beans	Jõgeva	5	5	
Field pea	Dolores	10	10	
Clover Incarnate	Diogenes	1,5	0,5	
Alexandrian clover	Akenation	1,5	0,5	
Sunflower		2		
White mustard	Braco	2,5	2,5	2
Annual ryegrass	Bartigra	2		

Pre-sowing seed treatments of catch crops with biopreparations were used to improve plant growth and nitrogen fixation.
The experiments assessed the biomass formation of the catch crops, their impact on soil biota and their effects on the following crops of field pea and winter wheat. An economic calculation was also carried out, considering the costs associated with the use of catch crops and the additional gain or loss per hectare, considering the impact on the yield of the subsequent crop.
The experiments at the ECRI experimental field compared the effects of different types of catch crops, in the production experiments there was also a comparison with no catch crop.

Results

In the ECRI trial, the effects of different types of catch crops (perennial catch crops sown in spring; annual catch crops sown in autumn; annual catch crops sown in spring) and different mixtures of catch crops on the yield and quality of the subsequent crop were measured. The yields did not differ significantly and were mostly within the experimental error. However, there was a tendency that the yield of winter wheat was somewhat lower after perennial catch crops than after other types of catch crops. The latter was more evident in the trials in the farms, where yields were significantly lower after perennial catch crop than after annual catch crops. This can perhaps be explained by the relatively high amount of nitrogen required to decompose the biomass applied to the soil at one time and the longer decomposition time, i.e. the full potential benefits are not immediately apparent in the following year.

In the production trials (Juppi, Põlgaste and Kaspar Toomsalu farms), the same catch crop mixtures gave different results in different test locations. The differences were both in biomass (Figure 1) and in the effect on subsequent crops (Figures 2-4). Higher biomass, however, did not necessarily translate into higher yields of the main crop. E.g., in the case of a perennial catch crop with very high biomass, decomposition of grasses in the soil may use up nitrogen, making it unavailable to the following crop. In the farm trials, catch crops generally increased the yield of the succeeding crop

compared to no catch crop. In the case of high weed infestation, spring catch crop was effective in supressing the weeds.

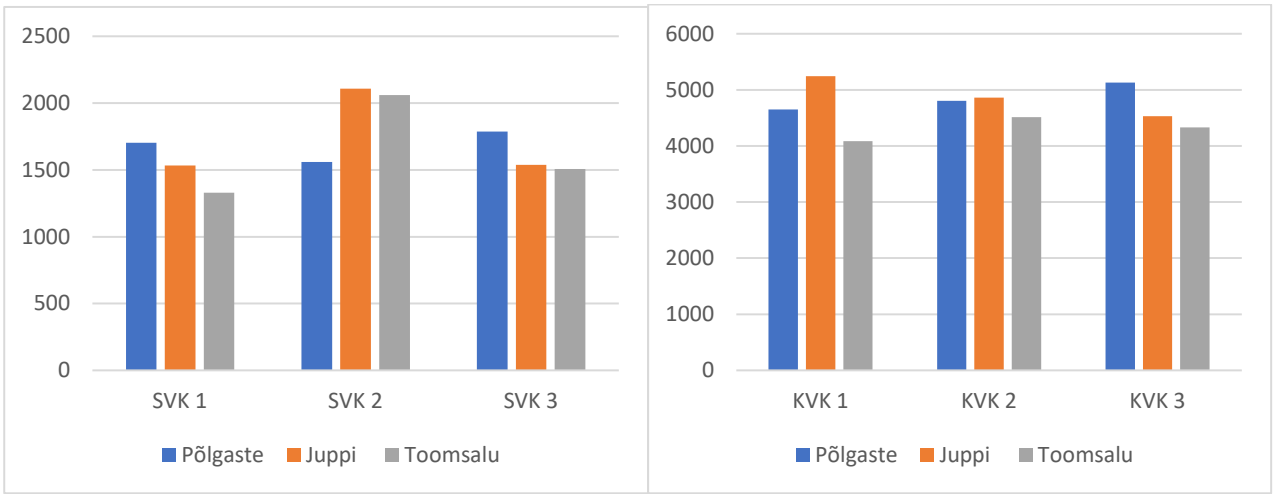

Figure 1: Catch crop biomass in kg/ha dry matter on different farms, autumn catch crops on the left, spring catch crops on the right.

In the autumn catch crop trial, the grain yields of field pea were higher after all three autumn catch crop variations than in the control in both Juppi and Põlgaste farms (Figure 2), but the different farms had the highest and also the lowest yields after different catch crop mixtures. Additional yield compared to the control was 453-1034 kg/ha averaged over the two experimental sites.

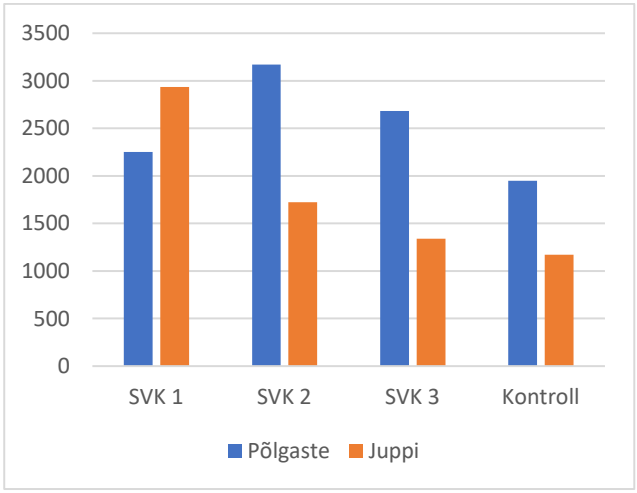

Figure 2: Pea yield after autumn catch crop at Juppi and Põlgaste farms.

In the case of winter wheat (Fig. 3), the highest yield increase was in the Põlgaste farm trial following a spring catch crop with nine species, where the yield was more than twice as high as in the control. In this experiment, both peas and winter wheat yields were the highest of all the catch crops. While the yields of field pea were higher after the catch crops at Juppi farm, the yields of winter wheat were quite similar to the control, and the same spring catch crop mixture that gave the highest yield of winter wheat at Põlgaste farm gave an even lower yield at Juppi farm than the control. In Kaspar Toomsalu farm, where the spring catch crop was followed by winter wheat, the winter wheat yield was higher than the control in all catch crop variants. The different growing conditions, different nutrient supply in the soil, also influenced the results of the catch crop.

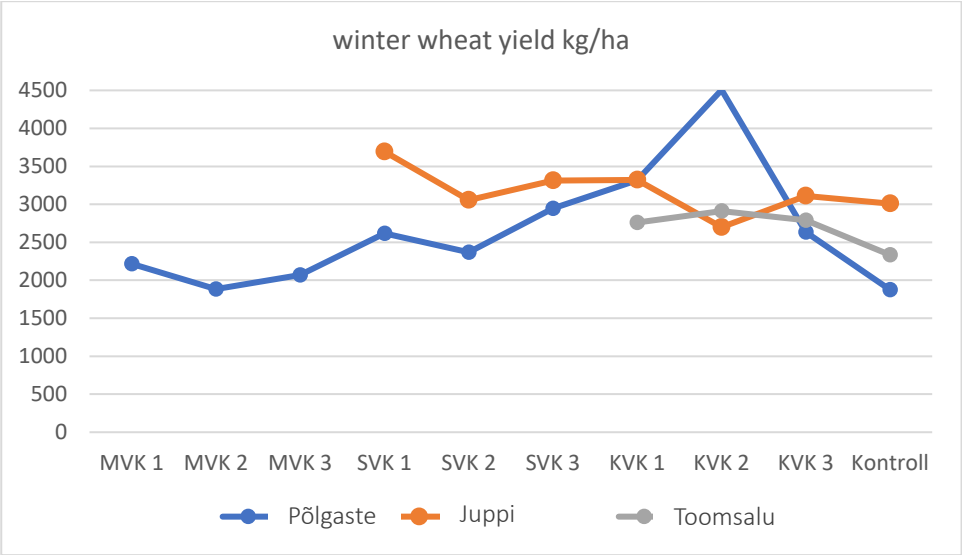

Figure 3: Wheat yield in production trials on different farms after different catch crops

In monetary terms, the best return was achieved with the multi-species autumn catch crop SVK1 at Juppi farm, where the cultivation of the catch crop provided a considerable yield increase for both field pea and winter wheat and an additional income of about 450€/ha in the cost/income summary of three growing years compared to the control, and with the multi-species spring catch crop KVK2 at Põlgaste farm, which provided a very high winter wheat yield and an additional income of about 380€/ha in the summary of three growing years. However, in the lower-yielding variants, including all the variants of the Kaspar Toomsalu farm, the cost of catch crop did not pay off in terms of the yield of the subsequent crop. However, this is a short-term view, because in the long run, catch crop should improve soil fertility (soil properties) and therefore improve yields in the long term.

While it would generally be most cost-effective to grow an autumn catch crop, in Estonian climate conditions it is not possible to do this after all crops in crop rotation. However, spring catch crops, which are seldomly used, can, especially in the case of weed problems, be a viable solution, which could be done without a plough to avoid costly tillage.

In conclusion, all the species used in the catch crops grew well in the mixtures and can be used for species selection in the mixtures. It was also confirmed that it is possible to grow different catch crops in organic production, including from an economic point of view, and that if successful, it can increase the yield of the subsequent crop. Also, spring catch crop in particular is a good way of suppressing weeds - both in the ECRI and in the fields of the production trials, it was possible to observe less weed infestation of the main crops in these areas even after the trials compared to before. It is also worthwhile experimenting with more species-rich mixtures for perennial catch crops than is currently the case.

Although interest in catch crop has increased significantly among both organic and conventional producers during the implementation of the trials, this topic certainly needs further research. On the basis of current experience, it can be said that multi-species catch crops have potential in Estonian organic production.

The full report can be found on the Maheklaster website https://maheklaster.ee/wp-content/uploads/2022/11/Lopparuanne_maheklaster_P3_lyhem.pdf

Margus Ess, Airi Vetemaa
Maheklaster MTÜ
maheklaster@gmail.com
www.maheklaster.ee

The activities were carried out within the framework of the sub-measure "Innovation cluster" of measure 16 "Cooperation" of the Estonian Rural Development Programme 2014-2020, supported by the European Agricultural Fund for Rural Development (EAFRD).