Annual report for 2018 to SLU EkoForsk

A cropping system without heavy tillage
Half the surface tilled – using row hoeing and under-sown subsidiary crops

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In this project we develop and evaluate a management strategy for reducing heavy tillage in cropping systems under organic farming. Reducing heavy tillage has shown to have several benefits to soil and environment, but often problems with weeds increase since deep ploughing is one of the most efficient ways to reduce the amount of weeds. In the proposed systems design we use under sown subsidiary crops (SC) and row-hoeing as measures to control weeds when ploughing is excluded during the cropping sequence spring cereal – winter cereal, in this case oat and winter wheat. SCs are sown in the oat crop and terminated by row-hoeing in spring, in winter wheat, the year after. Apart from weed control, the SCs also provide services such as nitrogen fixation and additional biomass production, which could potentially improve soil fertility.

In the project we will evaluate several services provided by the SCs. For a schematic overview of the experiments, see the uploaded poster from 2017. The results of oat yield and SC and weed biomass production during the growing season 2017, see previous report at EkoForsk's webpage (https://www.slu.se/en/Collaborative-Centres-and-Projects/ekoforsk-en/projects-2017-2019/cropping-system-without-heavy-tillage/). In this summary the result of wheat yield in the experiments that started 2017 and oat yield and SC and weed biomass production during the growing season 2018 are presented. Figures on yield and biomass (in Swedish) can be found in a presentation from "FoU 2019" at EkoForsk's webpage (https://www.slu.se/centrumbildningar-och-projekt/ekoforsk/projekt-2017-2019/odlingssystem/).

The experiments are carried out in two regions, Östergötland and Skåne. In each region two experiments are set up, one that started in 2017 and one that started in 2018. The experiments are two factorial, the first factor is SC placement, and the second factor is SC species mixture. In Östergötland there are also two reference treatments, stubble cultivation and ploughing in which the effect of direct seeding of winter wheat can be compared to the more common practices of soil tillage in organic farming in Sweden. Subsidiary crops where placed either in the cereal row, between two cereal rows or adjacent to the cereal row, allowing for one or two row-hoeing events during the growing season for the spring cereal. In the subsequent winter cereal row-hoeing is done twice in all treatments. The SC species mixtures are *Trifolium squarrosum* and *T. resupinatum* (annuals), *T. incarnatum* and *Vicia villosa* (annuals), and *T. pratense*, *T. repens* and *Medicago lupulina* (perennials). According to the plan, winter wheat should have been sown between the SC rows in autumn. However, due to very rainy weather in Östergötland the autumn 2017 the uncultivated soil was too wet and winter wheat

could not be sown and was replaced by spring wheat. In Östergötland, the experiments are on-station experiments and in Skåne the experiments are on-farm experiments with commercial machinery. Hence, the experiments differ in their design and in the use of technical equipment.

The year 2018 was a very dry year, which limited the growth of main crops as well as SC's. The biomass production of SC's in the main growing season was low for most of the early sown SC's and the late sown SC's had too little water to even germinate after sowing. However, the late sown SC's germinated in the end of July – beginning of August when the rain came. *Vicia villosa* was the only species that produced significant amounts of biomass in 2018, and it even produced more biomass than in 2017. The reason for the high biomass production of this species was most probably due to the fast development of the root system, giving these plants access to water deeper into the soil profile. Intercropping with *V. villosa* reduced oat yields significantly. Wheat yields were also strongly affected by the weather and was around 1.5 – 2 tons/ha in Skåne and 0.5 – 1.5 tons/ha in Östergötland. In Skåne yields did not differ significantly depending on the treatment, but had a tendency to be higher in treatments with SC's under-sown in the previous crop (around 2 tons/ha) compared to treatments without SC's (around 1.5 tons/ha). In Östergötland, yields were significantly lower in treatments that had had the annuals *T. incarnatum* and *V. villosa*, and perennials, *T. pretense*, *T. repens* and *M. luplina* as SC's, compared to treatments without SC's. Treatments with *T. squarrosum* and *T. resupinatum* did not show significantly lower yields. These SC's died during winter. This was probably due to the fact that we were not able to completely kill the SC's that had survived the winter in some plots in the spring. The sowing time did not seem to influence this, but the placement may have. The average wheat yields after these SC's where not reduced where SC's had been sown close to the row of oat. However, this is in contrast with the experience of the technical staff. They found these treatments to be the most difficult to remove the SC's in. Large weeds that germinated during the summer or autumn before also caused problems with the removal of SC's and sowing of wheat. Especially *Tripleurospermum perforatum,* caused problems due to its large size. Compared to the stubble cultivated and ploughed reference treatments the direct sown treatments had significantly lower yields. The average yield of the direct sown treatments was 1 ton/ha while it was 2 and 2.3 for the stubble cultivated and ploughed reference plots, respectively. The effect of the system on weeds is not discussed here since the weather had a larger impact on weed biomass than the tested treatments.