

Conception of a horse-drawn CombCut

In organic farming, weed control is, besides closed nutrient cycles and soil conditioning, of essential importance. For this purpose, the Swedish smallholder Jonas Carlsson invented in 2008 on his organic farm near Karlskrona, in the South-East of Sweden, the CombCut implement for selectively reducing weeds in various established crops. By using the physical difference between the plants at the right growing stage, just the weeds are cut and the crop is spared by a very simple mechanical system of motionless tilted razor sharp knives.

The principle of weed cutters is not new. In its summer issue 2016, the British Heavy Horse World magazine published an article about horse-drawn mechanical thistle-cutters which were manufactured on either side of the eastern Scotland-England border in begin of the 20th century. Another example of this technology can be found at the Åker exhibition of the Julita Gård open air museum, which is part of the Nordic Museum (Swedish: Nordiska museet). Here, a hand operated dandelion cutter is at display, which was invented by the Swedish agronomist Pehr Bolin in 1924 and sold at that time for 125 Swedish kronor under the name of Bolin's dandelion comb (Swedish: Bolins Maskroskam).

Unfortunately, as many great inventions of the horse and human powered farming era, this technology got somewhat forgotten in the past hundred years. But today, the raising interest in sustainable farming methods, let Jonas Carlsson patent and commercialize its invention. Formely known as Just Common Sense, his company has grown nowadays into the Lyckegård AB Group with a wide-ranging portfolio of implements for weed control, including machinery concepts from Sweden and Finland.

The fact that other European agricultural implement manufacturers have followed, by developing similar concepts, proves that the path taken is not wrong. A newer, already price awarded, implement from the German Zürn Harvesting company not only cuts the weed flowers, but even collects the clippings for reducing the seed potential on the treated area. However, by the high complexity of their drivetrains and finally also the price, these implements are out of question for farms using animal traction.

Another, not to be underestimated reason, for selecting the CombCut was that Jonas Carlsson was supporting the idea of a conversion into animal traction since the beginning. Advice and assistance were provided during the whole design process, among others by the complete CAD drawings of the original tractor implement, which enabled enormous time savings in the conception of the horse-drawn version.

After two meetings in May and August 2016 for discussing the technical feasibility of a horse-drawn version of the CombCut, the European network Schaff mat Pæerd got supplied in December 2016 a side section of an initially hydraulic operated CombCut implement for tractor use, which is currently available in 6 and 9 m width. By that, the working width of the implement to be converted into ground-drive was defined to 1,6 m. From this unit, only the knife bar with its three-dimensional knife angle adjustments and the brush comb were

maintained. The implement's new frame with spring loaded lifting device for the cutting unit as well as the whole drivetrain had to be redesigned. The double-sided toothed belt drive has a transmission ratio of 1: 5,09 in order to achieve a sufficient rotational speed of the comb, which cleans the blades from the cut material. Finger-type freewheel hubs on both ends of the comb regulate the torque transmission. These parts, which get hard to find in Western Europe, because of the nearly extinction of ground-driven implements, were kindly supplied by the Mainardi company of Abbiategrosso in Northern Italy. This company still manufactures ground-driven side-delivery hay rakes for the European and South-American market. A plunger-type clutch, integrated into the assembly of the freewheel and secondary toothed belt pulley, allows a disengaging the comb during transport.

In 2018, the project was advertised as a master-thesis at the Polytechnic University of Turin (Italian: Politecnico di Torino). However, even if currently animal traction finds some renaissance in Northern Italy, among others in the hilly Piedmont region, mainly by young people rediscovering the self-sufficient farms of their ancestors, linguistic barriers apparently prevented that this master-thesis got finally realized.

It should take until 2020 for the project to finally pick up speed, for two reasons. Since 2018, the Schaff mat Pæerd NGO was looking for suitable partners to start an EU-funded transnational Leader project titled "Horse Power – Innovation in small-scale agriculture and gardening". After failures in Italy and Portugal, the right partner was finally found in Skåne, the southernmost province in Sweden. Actually, the project is its preparation phase with Hälde Hästkraft, a full-time Swedish horse-entrepreneur, as the main partner and the Department of Earth Sciences - Natural Resources and Sustainable Development of Uppsala University, as external partner. The project is run under the umbrella of the Leader local action group Luxembourg West (Luxembourgish: Lëtzebuerg West), regrouping seven municipalities, one institution and eighteen associations from Western Luxembourg, and the Leader LAG PH, regrouping the communities of Perstorp and Hässleholm in Southern Sweden.

The second reason was that in September 2020, a student of the section of environmental sciences at the technical highschool Lycée Technique d'Ettelbruck in Luxembourg started in participating at the development of the horse-drawn CombCut as a teacher-supervised and self-initiated project during his final school year ending with a technical baccalaureate. The student's work consisted, beside basic computer drawings, mainly in the mathematical dimensioning of the drivetrain components and the lifting mechanism for the cutting unit as well as strength calculations for the frame. Furthermore, in a written project documentation, the pros and cons of the CombCut vs. other weed control methods were analyzed. Herein, the later use of the implement was limited to regulating docks, thistles and nettles on grassland.

All in all, 108 working hours were spent into the CAD drawing and about the same time into the manufacturing of most of the implement parts and the final assembly in the workshop of the Schaff mat Pæerd association in Luxembourg. By the fact that all parts are now available as computer files, some of the more complex parts of the lifting mechanism were laser cut. The tubular frame is still handmade of thin-walled structural steel. The total budget, excluding

the working hours, of the first prototype adds up to € 5.000,- which was co-financed by the Leader LAG Lëtzebuerg West.

Within the Leader project, the conception of this newly developed implement is part of a preliminary study, analyzing the benefits of computer aided design during the development process of state-of-the-art implements for smallholdings. A next step consists of field trials in Luxembourg and Sweden. Besides the design process, the testing will be computer assisted as well by multiple gauges like draft force, torque and movement sensors, offering the possibility to analyze the required tractive effort, the drivetrain efficiency and horse's working comfort. As part of another school project, the effectiveness of the CombCut system for grassland maintenance could be analyzed through targeted assessments.

Detailed documentations about the design process and the testing will be published mid 2021 and in 2022 on the project's webpage www.drafhorses.eu.