



GRASSIFICATION

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Grassification

D1.1.1

Support development new type mowing head aimed at minimising dirt content via a co-creation strategy

Document Control Page

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General outline for the development of a new type mowing head

An important goal within the Grassification project is to use road side cuttings as feedstock for material and energy. The quality of the road side cuttings is therefore of importance. To serve that goal the Grassification project started the development of a new type mowing head in cooperation with the different partners to work towards a quality of grass cuttings useful as material and/or energy application.

Pro Natura is responsible for the support to the development of such a new type mowing head in co-creation with a mowing head constructor.

The steps towards the realisation to source and process qualitative feedstock material are the following:

D1.1.1: Prototype development of new type of mowing head

Partner responsible: **Pro Natura**

Other partners involved: Innec, Van Daele (observer)

Deliverable date: 1/7/2019

D1.1.2: Testing and comparison mowing head

Partner responsible: **Pro Natura**

Other partners involved: Innec, Van Daele (observer)

Deliverable date: 1/11/2019

D1.1.3: Demonstrating mowing head

Partner responsible: **Pro Natura**

Other partners involved: Innec, Inagro, Kent Wildlife, Delphy +observers

Deliverable date: 30/11/2020

Context

The development of the new type mowing head is situated in WP 1 of the Grassification project. This work package aims at optimising the process from mowing road side grass to separation in solid and liquid fraction. Through the development and demonstrations of innovative approaches best practices are developed and disseminated.

The demonstrations on the "cut-and-collect" phase aims at producing the best possible quality of input (minimising dirt content, specific ensilage techniques, etc.).

The novel mowing head will be tested and validated in an operational relevant setting for the target audience and proven market readiness. The support development new type mowing head will aim at minimising dirt content via a co-creation strategy. The performance of the new mowing head will be compared to comparable available machinery.

Within the Grassification project a set of quality criteria for alternate uses of grass biomass will be discussed and will be provided to equipment developers & field-test equipment as developed by machine builders to serve the needs of biomass refinery processes.

The tests, pilots, demonstration actions and feasibility studies will all be documented in a report. The report will describe the tests and comparison of performance of a new type of mowing head against existing experiences. The results will support the implementation for a more circular economy.

Objective of the development

The objective of the development was to co-create a mowing head (machine) with a constructor a mowing head that could deliver road side cuttings in such a quality that is usable for the use in material and energy applications.

Methodology

Selection of the parameters for development

The selection of the relevant parameters was discussed with the partners during the partner meeting on 20st of September 2018. During the discussion the partners stressed the importance of not only measuring criteria directly linked to the mowing head but also to the site selection. The parameters discussed during the meeting were the following:

- History of site
- Slope angle
- Soil
- Trash
- Varieties of grass and other plants determination
- Weather conditions
- Location (GPS track record)
- Dry matter content of fresh grass
- Nutrient content of fresh grass
- Trace metals e.g. Pb
- Expected yield/km

These parameters will be measured during the tests with the mowing head.

The parameters for a new mowing head were also discussed with a user of mowing heads, in this case the municipality Maldegem. The most important criteria are the following:

- Ecology is the starting point and most important asset
- A speed of minimal 6 km/h if possible
- A clear cut that do not smash or crush to much the plants
- Fast recovery of plants after mowing
- Higher cut, not lower than 7 cm, better 10 or even 12 cm cutting height
- Lowering considerable the intake of litter of any kind : plastic, cans, bottles, metal, Tetra Brik....
- Low sand content
- Low density of harvest grass

The final selection of the criteria that are taken into account for the development:

1. Real time analysis (elaborated by ProNatura)
 - Mowing height
 - Rpm
 - Speed
 - Tonnage, volume of the grass
 - Manipulability of the machine
2. Grass analysis (elaborated by UGent)
 - Sand 2%
 - Length of fibres
 - Dry matter content of fresh grass
 - Nutrient content of fresh grass
 - Trace metals e.g. Pb

Note on the impact of sand/soil in the grass

Grass clippings from roadside mowing sites could be a good feedstock for the upcoming bio refinery. Hence quantity is not an issue, every year thousands of tonnes is mowed along roadside all over Europe. Quality is however an important issue. Grass needs some minimal characteristics before it can be used in a bio refinery process.

One of the most important limiting traits is the sand content in the mowed grass clippings.

Sand has the property to be very abrasive and corrosive to machines and burners. Even when tried to wash out the sand, it can block, pipes, pumps and sewage systems.

Sand appears to arrive in two ways in the harvested clipping. In raining weather you would expect that any dirt would be washed away from the plant. This is true for the upper part of the plant, however, rain drops falling on the soil, splash up and can leave important traces of mud and sand at the lower parts of the plants.

In addition to that there is the mowing process. The grass clippings are sucked up into the loader behind the tractor. Depending on the force of aspiration, suction, will have an influence on the amount of intake of sand.

Controlling those settings during the mowing process could have an important influence on the sand intake.

The methodology of measurement of sand percentage in the grass is described in Appendix 1 (UGent).

Development of the new mowing head

Development in co-creation with Vandaele



Vandaele, as a constructor, has relevant experience in building flail mowers. The specific advantage of flail mowers is that they are suitable for various types of road side cuttings in a fluent way with relative ease to manoeuvre around possible obstacles. The disadvantage of the existing flail mower is the amount of dust that is taken with the cuttings. The high suction ratio is not favourable for biodiversity of the road side, but also not favourable for the quality grass as feedstock.

Working principle of the flail mower

The flail mowing head of Vandaele, three rows of flails rotate around a fixed central axle width 1,2m. Each row of flails is shifted in relation to the other row. Due to the centrifugal rotation the flails lift upward perpendicular to the rotating axle and cuts or smashes the grass fibres by the forces of the rotation.

Due to the rotation speed and force and the three rows of flails the grass and plants are rather shredder in small particles. Whereas a horizontal rotary mowing head more evenly cuts the plant on the set height, which results in a mix of longer and shorter plant fibres.



The mowing head is part to the mowing arm Pro Series. They can be mounted on almost every tractor brand. The arms are mounted in the middle of the tractor, between the front and the rear axle. The rear 3-point linkage remains available for other use. The arms are controlled by a very compact, electronic joystick. The range varies between 5,50 and 10 meter can be fixed on the right or left side of any tractor.

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If the clippings need to be collected a suction tube can be connected to blow the clippings into a loader, a bulk collection trailer, slow speed with a capacity of 25 m³ (also available 20 m³- 30 m³ or 35 m³). In front is a powerful ventilator to suck up the cut material. The Jumbo max is a self-unloading, with chain drive system on the bottom, with a capacity of 25 m³ (also available 30 m³ or 35 m³). The hatchback door is hydraulically operated. Completely equipped with flashing lights, alternating halogen lights, moving lights bar and camera at the back. Controlled by means of a joystick in the cabin.

Technical specification about the mowing arm and Jumbo master can be found here:

<http://www.vandaele.biz/GB-en/machine/mowers/mowing-arm-pro-series>

<http://www.vandaele.biz/GB-en/machine/mowers/jumbo-master>



A lateral view of the mowing head



Rear and frontal view of the mowing head in action.

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Specific developments in the prototype

With this prototype Vandaele experimented with the height. Vandaele has made some adjustments so the mowing head can't be set under 10cm of height, this is under any conditions the under limit. The operator can always choose to mow higher, but never lower. The reason for doing so, is that less force and energy is needed, resulting in lower consumption at a similar or even slight higher speed. As a second result Vandaele thinks it will lower the soil intake, and so lower the sand content in the harvested grass clippings.

Mowing pictures prototype mowing head Vandaele



Height is one of the main criteria that could have a result on the intake on soil particles during the mowing process.

For the design of the new prototype mowing head Vandaele has chosen for an option in which the operator cannot set the mowing head under a certain height. Vandaele has opted for the height mentioned in the Flemish legislation, Berm Decreet (Roadside Act): 10 cm.

Conclusions and lessons learned for the development of the mowing head

Soil and sand content less than 2% is one the critical criteria for high end use of grass clippings in the bio refinery production chain.

The first tests with the flail mowing head Vandaele is with 2,8% just above this limit. Using the height as important criteria to control the intake of soil, has worked out in a positive way.

Out of own experience Vandaele knew that height is an important characteristic in the mowing process. For the test they developed a prototype in which is impossible to mow lower than 10 cm height.

If practical use of the biomass after mowing is the main objective, we can conclude that mowing at a minimum height of 10 cm or higher considerable lowers the risk of soil intake.

Appendix

Appendix 1: Determination of sand in grass samples

- Weigh 200 g of fresh grass clippings in a bucket
- Fill the bucket with water to wash the clippings and remove the sand
- Transfer the clippings manually to a new bucket filled with water (x2) – sand will be in the remaining waters
- After manual removal of most part of the clippings, pass the remaining water from the three washing buckets through a 2mm sieve and recover the water that passes the sieve
- Rinse the sieve thoroughly to make sure all the sand goes into the washing water
- Decant the water with sand and remove the supernatant– may be done in several steps to avoid sand loss
- Transfer the solid material to a pleated filter
- Put the filters into crucibles and dry them at 100 °C
- After drying, transfer the crucibles into a furnace at 550 °C for 3h
- After ashing, add 3 mL of concentrated nitric acid and 3 mL of peroxide
- Heat the crucibles for 2h in a hot plate (150 °C) for destruction of the ashes
- Add water and allow the mixture to settle for 10 min; pipet off the supernatant (2x)
- Dry the remaining solids and weigh them – this is the sand

GRASSIFICATION consortium

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www.interreg2seas.eu/en/grassification