BLUEPRINT FOR LOCAL COMPOST PRODUCTION

1 INTRODUCTION

European agricultural soils are decreasing in soil organic matter. This degradation of the soil counteracts the beneficial functions of soil organic matter. A level of 2% soil organic matter is set as the limit below which soils become unstable, prone to structural deterioration, erosion and nutrient losses together with a reduction in crop yield. The soils in the European north-sea region are observed by horticulture extension workers to have a soil organic matter level of 1.5-2%. Regular addition of compost can increase this soil organic matter content which increases soil quality, crop growth, and counteracts the soil degradation in general.
Compost is produced by green (nitrogen rich) and brown (carbon rich) materials. These materials are not always both available at the farm. Because of these issues with availability of materials at the farm, it can be helpful to bring companies together in a composting network. By bringing these farms in a composting network, these separate residuals of the farm practices can be composted to high quality compost. In this way the network helps to get to a more circular farming culture. Keeping the network local avoids long transport distances, which means emissions of particulate matter and CO_2 are limited. So both, shorter transport distances and acquiring a useful end product are advantages for the companies involved in the composting network.
The use of compost has a positive influence on soil quality of farmland. Because of this the yields will be higher which results in a financial added value. In addition, the application of compost provides both an effect-oriented and source-oriented combating of climate problems. Effect-oriented because soils have a higher organic matter content, which has a positive effect on lots of physical soil properties e.g. makes them more able to retain the water and gives them a higher water infiltration capacity. Source-oriented because of the sustainable carbon storage in the soils.

2 COMPOSTING PROCESS

Composting is a process in which organic materials are transformed to compost by micro-organisms. The process runs according to following equation: organic material + O_2 → compost + CO_2 + H_2O + heat. This process also releases CH_4, NH_4 and some other gasses. Good process management is crucial to minimalize these emissions.
It is important to choose the right input materials and to mix them in the right proportion. Both carbon and nitrogen are important elements in the process. They ensure the development and growth of the micro-organisms that carry out the composting. Adding carbon is done by adding straw, wood chips, pruning

waste or woody clippings. Nitrogen is added by adding crop residues from vegetables or other residual flows of vegetables. These residual streams have high water content and ensure sufficient moisture in addition to nitrogen supply. In order to collect the necessary green and brown materials, a collaboration between different actors will have to be established. To establish this kind of collaboration it can be helpful to collect information from the neighbours who want to join the network, what kind of materials can be brought together and who can purchase the compost produced. Keep the right proportion, 60% brown materials and 40% green materials, in mind when putting together a network. To get compost of good quality at the end of the process, it is important to screen the different input materials. Check the freshness of the material, the presence of plastics, indigestible material and soil. Also check if the materials can be delivered on the right moment. Green materials which cannot be immediately brought into composting because they were delivered to early, will cause odour nuisance.
For an optimal start of the composting process a carbon-nitrogen ratio (C/N-ratio) of 25-35/1 is appropriate. This ratio is approached by the 60% brown and 40% green material ratio. During the first weeks it is possible to add extra green material in limited fractions. This extra supply of nitrogen and water has a positive effect on the breakdown process, which results in an increase of temperature. Because of odour nuisance it is recommended to cover the compost rill with an oxygen permeable compost cloth. This compost cloth protects the compost rill to becoming too moisture during rainy periods and against dehydration during drought periods.

Monitoring and process guidance
To receive a good end product of the composting process it is important to follow up a few parameters. In the reaction equation it can be seen that temperature, oxygen (O_2) and moisture are crucial parameters in the process. Monitoring this parameters must be done frequently and accurately, and results has to been registered.

Temperature
To obtain compost with good hygiene status (weed seeds and germs killed) it is important to meet the following conditions:

- At least 4 days in a row >60°C or 12 days in a row >55°C
- At least 45°C during:
    - 6 weeks = intensive composting with frequently turning
    - 10 weeks = more extensive composting

Temperature of the compost has to be measured daily, this can be done manually with a thermometer or with a data logger. It is important to do this measurements in the centre of the compost rill. When you do the temperature

measurements manually it is best to take the measurements in 3 places. Temperatures of more than 70°C are to be avoided because this high temperatures kill the useful micro-organisms. In smaller compost rills this high temperatures are rarely reached. The difficulty is rather to get the temperature high enough in these smaller compost rills. A solution for this difficulty can be fractionated administration of green materials.

Oxygen level

The oxygen level is also an important parameter that has to be measured. Micro-organisms need oxygen to break down the organic material into compost. Carbon dioxide (CO_2) is measured as a measure of the oxygen content. A high CO_2 content means a low oxygen content. The CO_2 content is determined with a CO_2-meter (ex. U.R.S. Landmanagement). This meter contains a fluid in which CO_2 can solve. Air is taken up at 10 cm above bottom of the compost rill with a hollow tube in the meter. CO_2 has a higherdensity than O_2, which leads to the CO_2 be at the bottom of the compost rill. Bring enough air from the compost to the meter by pumping 18 times. By turning the meter two times upside down the air will be mixed with the fluid. After stabilisation of the fluid, you can read the CO_2-concentration. When this concentration is higher than 16%, the compost has to be turned.

Moisture level

The decomposition of organic matter will release moisture. This moisture is important for the activity and survival of the micro-organisms. But moisture levels can't get too high because high moisture levels also implies low oxygen levels. When the oxygen level is too low, the composting process will not run in optimal conditions which leads to a higher risk of leaching of nutrients. The ideal moisture level of the compost rill is 30-40% during the whole process. At the start of the process this can even be 50-60%. An easy way to monitor the moisture level is the squeeze test. When compost is squeezed in your hand it has to be moist and stick together. When water runs out of the compost during squeezing this means the compost is too wet. This can be solved by bringing a limited fraction of woody materials to the rill. When compost doesn't stick together when squeezed, it means the compost is too dry. This can be solved by adding water to the rill. The best way to add water is doing this while turning the compost, so that water enters the core of the compost heap.

Sieving the end product

Before application of the compost it is recommended to sieve the compost. The non-decomposed woody fraction can clog the compost spreader. When immediately after application of the compost the plot is planted, this non-decomposed fraction can give difficulties during planting. An extra benefit of sieving the compost is the removal of any plastic impurities from the compost.

The large woody sieved pieces can be used in the next composting. An additional advantage is that this will also 'kickstart' the composting process.

The composting site

The ideal composting site consists of a sufficiently large and paved surface laid out at a slight slope. Percolate can be captured in a reservoir and can be used for wetting the compost rill when necessary. A sufficiently wide composting site give the opportunity to start more than one composting windrowat a time. This gives you the chance of producing bigger volumes of compost. You have to take into account a volume reduction of about 75%.
Moreover, leaving sufficient room to turn with the compost turner is recommended. Turning the compost is best done alternately, start turning the compost at the side where you ended last time.
In addition to space for the composting itself, space is also needed for storage of the input materials. The brown materials can be stored longer without the risk of leaching of the nutrients. Green materials are best added to the compost as soon as possible. Valuable nutrients and moisture are lost with longer storage times.

Materials needed

A tractor and a compost turner are the main equipment. As mentioned before the compost turner is important at start of the composting and during the whole composting process. At start the materials has to be mixed properly. During the process turning the compost is necessary to add oxygen and water, dissipation of excess heat or the mixing of new materials.
In addition to this tractor and compost turner you also need a thermometer and CO_2-meter for monitoring the compost rill during the composting process. In table …. the required materials for composting and the associated cost price are listed.

Materials	**Purchase price**
Tractor	At least 20 000 euro
Compost turner	40 000 euro Rent: +/- 75 euro
CO_2-meter	450 euro
Thermometer	250 euro
Compost covering cloth	+/- 2.5 euro/m²
Sieve	Rent or Purchase

3 LEGAL FRAMEWORK

A local composting network brings waste streams of different farmers together and processes them into useful raw materials. To do this processing various regulations have to be met. In this chapter the regulations that are relevant in Flanders are explained.

3.1 INTEGRATED ENVIRONMENTAL PERMIT

For the moment there are 2 possiblities for (farm)composting:

1. Only own input material and own use of the compost -> no environmental permit necessary
2. When you also want to compost waste streams not originating from the own company, the Vlarem II – regulation considers this type of composting as a nuisance activity. With a maximum capacity of 2000 m³, a class 2 permit has to be requested from the municipality. Within this permit different rubrics can be requested depending on the type of waste streams you want to compost. In the next table the different rubrics are shown, and the type of material in each rubric.

Rubric	Type material	Example
2.2.3a	Green waste	Clippings and pruning waste from maintenance of gardens and nature parks
2.2.3c	Organic waste from industry and farms	Crop residues, fruit vegetables form agricultural and horticultural companies. Pruning waste from tree nursery

From 2021 on, the different Flemish authorities are working together to develop a third category: farmcomposting in a composting network with a maximum of three participants. There will be slightly less strict conditions for an integrated environmental permit for a composting network. The final proposition is expected at the end of 2022.
To receive a permit, the site where you want to start composting has to meet several conditions. The most important points of attention are:

- Develop a clear work plan. In this work plan you describe how you will do the composting.
    - A manual for the composting. This should ensure an optimalcomposting processand to make high-quality compost. Describe when and how you will turn the compost. Register

everything in a compost diary together with the temperature (and other) measurements .
    - An overview of all farmers and organisations you will work together with
    - Type of waste stream and amount of every participator
    - A description of the site, place where you will be composting, the place for storage of the input materials and the end product.
- Prevent odour and dust nuisance by processing the green materials in composting as quick as possible. Turn the heap enough and cover them with a compost cloth.
- Make clear you are composting at the site. Place a sign of at least 1m². Together with the statement that it concerns composting, the following things must also be stated:
    - Name and address
    - Validity period of the permit
    - Address of the municipality
    - Telephone number of the fire brigade
- Percolate that is released during composting must be collected. To prevent leaching to the environment, composting has to be done on a paved surface with a drainage system. The captured percolate has to be used for wetting the compost windrow.
- The amount of input materials has to be weighted. Building the rills based on volume percentages gives you argument for asking a deviation. A good way of composting is 60% brown materials and 40% green materials based on volume. This makes it possible to make clear agreements in advance according the allowed volume per supplier.
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3.2 TRANSPORT OF THE WASTE STREAMS

Every transport of waste streams in Belgium to a composting site must be in possession of a transport form. The following identifications have to be filled in in this form:

- Date of transport and reference number
- the waste stream producer
- the composting company
- the transporter
- the waste processor (same as composting company)
- the waste stream

3.3 VLACO QUALITY CONTROL

A quality certificate is needed when you want to use the compost as secondary material. Without this certificate, the compost keeps the statute of waste. In

Flanders (Belgium) this certificate is issued by Vlaco. They grant an inspection certificate if the requirements of the "Vlarema annex 2.3.1" are met and the input, process, output and use of compost is according to the general regulation of certification (https://ovam.vlaanderen.be/c/document_library/get_file?uuid=e31d8121-1b85-b6d0-e710-4c89c2ae44cc&groupId=177281)
When you are part of a composting network it is mandatory to ask for a certificate from Vlaco. They will conduct an annual audit. During this audit the quality manual will be evaluated. This manual has to contain the following chapters. A description on how the company is committed to exercising the necessary quality policy rights quality when producing compost. This policy is evaluated every year. Also make some procedures for controlling and monitoring the input materials, the process and the end product.
The input materials must be of good quality. There are limits in the amount of heavy metals, PAH's and other organic substances. Exceedances of these parameters will become visible during end analysis of the compost. To evaluate the composting process and check if the hygienisation requirements are met, temperature and moisture measurements are necessary. When contaminations are detected it is important to be able to trace the contaminations. You have to find out where the contamination comes from. This can be done by registration of the amount and origin of every input material. Also register the place of storage of the input materials, the amount of the input material used. When compost is finished note the destination of the compost and the dose used. At the end of the composting process a sample has to be taken and analysed by an accredited laboratory and has to at least meet the requirements of the general regulation of certification.
When using the compost the dose is determined from the fertilizer standards. These standards impose limits to nitrogen and phosphorous. Nitrogen limit is based on the working nitrogen. For Vlaco certified green- and biowastecompost the working coefficient is 15% for other composts like farm compost the working coefficient is 30%. For Vlaco certified green and biowastecomposts only 50% of the P_2O_5 of the compost has to be counted.