Advantages of peat extraction for soil from an ecological, economic and social perspective with focus on Germany Tatjana

*1. General information*

Peat has formed in bogs through the accumulation of dead plant remains which have not been decomposed due to excess water. Peat consists of more than 30% organic matter. Moors are characterized by the presence of a layer of peat that is at least 30 cm thick (Landesamt für Bergbau, Energie und Geologie 2019).

Low and raised bogs are distinguished on the basis of their hydrology. Low moors are usually fed from nutrient-rich groundwater. Raised bogs, on the other hand, are characterised by rather nutrient-poor precipitation. Due to the fluctuating mineral and nutrient contents and sometimes high pH values, fen bogs are not suitable for the production of substrates for horticulture. They are used to a small extent for balneological purposes (bath therapy).

In contrast, raised bog peat from peat mosses, which are particularly widespread in the north and northwest of Lower Saxony, forms the raw material basis for peat and humus management. In Lower Saxony, about three quarters of the German raised bogs and the main focus of the German peat industry are located in about 210,000 hectares (Landesamt für Bergbau, Energie und Geologie 2019).

With a few exceptions, peat extraction in Lower Saxony is only possible on agricultural moors. Permission is granted by the lower nature conservation authorities. In doing so, the interests of regional planning must be observed, and the provisions of the Nature Conservation Act and the regulations based on it must be observed. According to law, the areas must be wetted and renatured after peat has been removed (Landesamt für Bergbau, Energie und Geologie 2019).

*2. Usage of peat*

Most of the peat is used in commercial horticulture and reaches the consumer markets as a substrate for cultivated plants or vegetables. Niche uses are peat for therapeutic applications or as activated carbon for filters (Aktion Moorschutz 2019).

*3. Advantages of Peat extraction from an ecological perspective*

What makes peat so irreplaceable is its lack of properties. It is airy, can absorb a lot of water and is otherwise neutral. It is called a "zero soil" that provides substrate manufacturers with a reliable carrier material that can be enriched with fertilizers and trace elements in a controlled manner. Peat thus has growth-promoting properties for plants (Welt – Wirtschaft 2015).

But these are the only positive ecological aspects of peat that have been found. The next paper will look at the negative environmental impacts, which are far greater and more significant.

*4. Advantages of Peat extraction for soil from an economic and social perspective*

In Germany alone, peat extraction currently secures 2500 jobs in peat-processing companies and 400,000 employees and 16,240 trainee jobs in horticulture throughout Germany. Around 90 companies are currently employed in peat processing, 56 of which are based in Lower Saxony (Warum- torf 2018).

The main customers are the approximately 60,000 companies with horticultural production and services (of which 34,000 are horticultural companies). This is the basis for horticultural production with a market volume of € 7.5 billion and around € 6.5 billion generated by corresponding services. In 2011, private consumers spent around € 14.6 billion on living greenery and garden hardware. The approximately 478,000 nurseries existing in Europe employ around 770,000 people (Altmann 2008: p. 91 – 96).

Germany is still a net motor exporter; it exports well over two million tonnes of peat a year and imports less than a million tonnes. In addition to the Dutch, the German substrate manufacturers are world leaders. They ship their soil in containers around the world. But sales figures have been declining for some years now (Welt – Wirtschaft 2015).

There are huge mining areas, especially in the Baltic States. And while peat cutters in Germany are on the brink of collapse, the construction of new peat mixing plants there is being promoted with EU funds (Welt – Wirtschaft 2015).

The German peat industry is therefore migrating. The Emsland company Klasmann-Deilmann, for example, market leader with an annual production of 3.7 million cubic metres and a turnover of 165 million euros, now operates five production companies for peat raw materials in the Baltic States. The ban from lower saxony, which refers to a prohibition for peat extraction, will only lead to a shift in the climate problem - to Scandinavia. And evenly into the Baltic States (Welt – Wirtschaft 2015).

It thus becomes clear that the peat industry is an enormous economic factor for Germany and that further companies will migrate to other countries as a result of the ban on peat extraction and the further decline in peat deposits. As a result, jobs will be lost and the number of unemployed will rise sharply, especially in areas where the peat industry is mainly based. As a result, the local population may be forced to relocate to other regions in order to pursue a profession. The social component of the peat industry is clearly visible here.

Disadvantages of Peat extraction from an ecological perspective Melanie

*1. About Peat*

Peat is partly decomposed plant. It composes from accumulation of nutrient and oxygen imperfection, acidity and waterlogging conditions. It is a spongy substance which is an effect of incomplete decomposition of plant residues in different stages of decomposition. Peatlands are areas with or without vegetation with naturally formed peat layer of 30 cm or more on the surface (Altmann, 2008). Under ideal circumstances sphagnum can grow 1 cm a year and after this has settled about 1mm of material remains. This means it takes at least 1000 years to form a peat layer of 1 metre thick (Bos et al., 2011). The peat types used to compose potting soil and peat substrates are known as raised bog peat. Raised bog peat was formed under the influence of rainwater with a low nutrient content. That shows in the chemical composition. The peat is acid (pH 3.2-4.4) and it hardly contains any plant nutrients. Salt content levels are low. There are different types of peat, as sphagnum peat, white peat, transitional peat, frozen black peat and black peat. They differ in their decomposition degree, the area they come from or their water capacity. There are also different extraction methods for peat. All extraction models involve clearance of the surface vegetation and drainage. Horizontal extraction is suitable for milled peat through grubbing out or milling. Vertical extraction generates sods and blocks which are cut from the peat profile. They are used for the production of fractions for coarse potting soil and peat substrates.

Peat is used in horticulture as a component of garden plan substrates, in agriculture for the production of garden soil and as an organic fertilizer, and in balneology as a material for baths and wraps. The use of peat for agriculture and horticulture is determined by the degree of decomposition, ash content, pH, the presence of carbonates, the density of the solid phase, bulk density and porosity (Kıtır et al., 2018). It is one of the most important growing media because of its air pockets or pores to supply oxygen to plant roots and allow for drainage. It is slight, clean, sterile, and does not include foreign material.

Peatlands occur worldwide on all continents from high cool-temperature altitude with permafrost to the tropics. For the accumulation of dead plant organic material in peat blogs waterlogged, acid and low-nutrient conditions are needed. Therefore, most peatlands are distributed over a wide range of cold, temperate and tropical climate conditions, which have a relatively high rainfall. Peat extraction in the EU is about 65 million ton/year in 2005. The largest overall peat producing countries in the EU are Finland, Ireland and Germany, harvesting 74% of the total production (Bos et al., 2011). In Finland and Ireland most of the extracted peat is used for energy purposes. However, most peatlands in Europe are used for agriculture. Horticulture, which is divided in edible plants and aesthetic plants, uses 42% of peat (Bos et al., 2011).

The amounts of peat produced in Austria are comparatively negligible with a 5-year average of 45.000 m3. For 2005 Austria reported a total raw peat consumption of 0,175 million m3 of which 77% was imported (Altmann, 2008).

*2. Disadvantages of peat*

Although peat has many advantages (especially economic and social) which are already mentioned in the paper before, there are also some important (ecological) disadvantages which have to be considered.

**Impacts of peat extraction on biodiversity:**

Peatland forms unique features in the landscape which contain specific biodiversity. Industrial extraction of peat involves the total removal of the vegetation, significant drainage and subsequent removal of the upper layer of peat. This results in large areas of bare peat. Many peatlands with particular biodiversity enjoy a high level of protection due to European legislation. However, there is extraction from peatlands without particular biodiversity values. Taft et al. (2019) argues that according to current soil depths, it will only take about 80-160 years before many horticultural peatlands are degraded completely.

**Impacts of peat extraction on carbon storage:**

Peatland globally constitutes a major carbon store. It represents the second-most globally important carbon stock after oceans. About 3% of the total land area are covered with peat (Taft et al., 2019). Peat extraction removes carbon stored in the peat system. It could happen that all carbon from the peat will be freed into the atmosphere as CO2, which is a major problem due to increasing CO2 concentration in the atmosphere. A rough calculation shows that 1 m3 of peat, which is equivalent to 140kg of soil, contains 81 kg carbon, which is then oxidised into about 0,25 ton CO2 (Bos et al., 2011). While the carbon dynamics of peat bogs are complicated, there is much evidence to suggest that near- natural peat bogs have far more favourable carbon balances than degraded peatlands (Alexander et al., 2008).

**Impacts of peat extraction on water management:**

Peatlands are formed where moisture surplus exist, they consist of 90% of water. The water sources are rainfall, catchment runoff and groundwater. Peatlands are vulnerable to land use changes as land use impacts hydrology. For example, artificial drainages are built to increase the horizontal flow. Over time this drainage will affect the hydrological equilibrium of the entire hydrological system. They can reduce water input which can result in peat decay and wetland disappearance. Peat extraction also destroys the hydrology of the bog, this can impose severe constraints on the effectiveness of restoration conditions (Alexander et al., 2008). Nonetheless, restoring peatland functionality is key to reducing colouration and improving raw water quality.

*3. The future of peat*

Because of the increasing scarcity of peatlands and further legislation on the extraction of peat supply bottlenecks may develop. Some of the sites will gradually become depleted and the particular peat qualities will diminish. These will lead to new peat extraction sites outside the EU. There are numerous of waste products that can replace in part or in total the peat after proper treatment, and, solve the problem of their disposal. Alternatives to peat are mainly based on bark of various types, mushroom, compost, straw, vegetable remains, wood products, sewage sludge and a range of more novel materials (Robertson, 1993). Sewage sludge for example contains a lot of organic substances and is therefore very valuable (Zawadzińska and Salachna, 2018). Of course, it will need investments in new systems and time for implementing these new materials. However, due to the need to conserve habitats and species associated with peatlands and the increasingly recognised quest for environmental sustainability, the sector should actively explore alternatives of peat. Fortunately, the pressure for adopting new growing media alternatives to peat steadily increases, that’s why it is almost sure that sooner or later the use of peat alternatives is going to increase.

Advantages of Compost over Peat-use Constantin

The process of composting can be described as the decomposition of organic material by means of microorganism. Provided there is a sufficient supply of water and air, the cellulose fibres in plants are first changed into short-chain fibres through biological decomposition and then transformed from a rigid structure into a rather lose form (Reinhofer, Lettmayer, & Taferner, 2005). The final product of this process is called compost. Composting can either be performed in open systems, where the composting is performed in outdoor facilities, or in closed systems, where the composting is performed in enclosed containers or buildings with exhaust gases being treated in biofilters. Open systems are primarily applied in single or collectively composting (i.e. private (collaborative) composting of single to multiple households) as well as in low quantity agricultural and commercial composting. In commercial terms, closed systems come into action at processing volumes bigger than 3.000 tons/year and in connection with odour-intensive materials. Furthermore, closed systems require a certain minimum throughput because of economic reasons (e.g. fix costs) but also for technical reasons (minimum size of machinery) (Strüger-Hopfgartner, no date b).

Substantial materials for composting are materials such as biogenic waste from separated collection, communal sewage, waste from cemetery waste, green waste as well as manure (Strüger-Hopfgartner, no date a). While composting is a common practice in many private households, it also finds commercial application in agriculture and commercial application in gardening, for instance for fertilizing purposes as a substitute for peat. In that regard, in Austria the commercial procession of compost has to follow an orderly composting procedure which is described in the directive ‘Stand der Technik der Kompostierung’ by the Federal Ministry for agriculture, forestry, environment and water management (Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft [BMFUW], 2005).

Compost has become increasingly attractive as a substitute for conventional mineral fertilizers and peat material in agriculture and gardening. Among other, this might be due to the fact, that compost carries a variety of advantages compared to the others, when it comes to the purpose of fertilizing. For instance, compost is a carrier of many nutrients, trace elements and humus and has a high cation exchange capacity, which allows for better binding of nutrients. Hence, compost is a good fertiliser for the soil. Furthermore, it enables to close natural material cycles by returning carbon dioxide into the soil (Bayerisches Landesamt für Umwelt [LfU], 2017). Also, while in most mineral fertilizers plant nutrients are often rapidly released, such that there is a risk of over-fertilization, the plant nutrients contained in compost are rather slowly released. Consequently, by using compost, plants become less vulnerable to diseases and pests, compared to conventional mineral fertilizers. In that regard, the composition of carbon and nitrogen in the soil (C:N composition) is of high importance, as it determines the rate of decomposition of the material. In that respect, a C:N rate of 25:1 to 30:1 is perceived as optimal for building up stable humus compounds (Strüger-Hopfgartner, no date a). Lastly, compost does not carry a risk of wash out of redundant nutrients into groundwater (Magistratsabteilung 42 [Wiener Stadtgärten], no date).

However, although compost contains many nutrients, it is not per-se a fertilizer. In fact, its nutritional value is rather linked to its stimulating effect on soil organism. In doing so, compost allows for large savings in terms of nutrient enrichment (i.e. eutrophication) by replacing mineral fertilizers (Boldrin, Hartling, Laugen, & Christensen, 2010).

When it comes to emissions, compost has a lower contribution to greenhouse gas emissions than peat and mineral fertilizers. This does not only account for greenhouse gas emissions occurring in the production but also in the transportation. That is because the processed biological waste and soil often only requires short transport routes, due to its local production (Magistratsabteilung 42, no date). Comparing with this, peat may not only be problematic regarding its extraction procedure, which requires large interventions in eco-systems and leads to large-scale release of carbon emissions but also due to its long transport routes (Umweltbundesamt, 2018). Therefore, in relation to the use of one ton of peat, using compost as a substitute would contribute to savings of 183 kg CO2-eq/ton using biowaste (Brinkmann et al. 2004, referred in (Boldrin, Andersen, Møller, Christensen, & Favoino, 2009a)) or 192 kg CO2-eq/ton using garden waste (Boldrin et al. 2009b, referred in (Boldrin et al., 2009a)), considering mass loss during composting process. Furthermore, (Mathis, Amrein, Eymann, & Stucki, 2015) came to the result, that the greenhouse gas potential of compost is comparably lower (180 kg CO2-eq/m3) than of peat (250 kg CO2-eq/m3). However, although compost bears potential to have a lower overall environmental impact than peat, its impact may be significantly higher depending on heavy metal emissions that occur during the utilization phase of the compost (Boldrin et al., 2010; Mathis et al., 2015).

However, taking CO2 absorption into account, (Lampert, Tesar, & Thaler, 2011) estimated that composting nevertheless has a positive greenhouse gas balance regarding open system composting (47,4 kg CO2-eq/ton) as well as for partly closed systems (35,7 kg CO2-eq/ton). This is mainly caused by methane and nitrous oxide occurring during the composting process. However, in comparison to peat, compost can be considered as a rather renewable source as its regeneration time is significantly shorter than of peat.

In accordance with the Austrian Fertilizers Regulation, there are limitations for the use of compost in soil- and growing medium. Only bark humus as well as composted plant-based material from agriculture and green space areas are permitted (Reinhofer et al., 2005). Moreover, in order to function as sufficient peat substitute, respective materials have to meet various requirements. According to (Reinhofer et al., 2005) these are: a material structure which enables permanent aeriation a high water holding capacity and (if possible) no fertilizing effect for special applications in commercial horticulture. Furthermore, using compost as a substitute for peat in plant cultivation may not inevitably be problem-free. (Reinhofer et al., 2005) further mention, that compost cannot function as a pure substitute for peat in plant cultivation, due to its variable nutrient composition in terms of nutritional value or salt content, but also because of its structural features, such as volume weight and stability. In regard to economically competitiveness, (English Nature/RSPD, no date) considers, that composting is only competitive if its procession is based on local substances and performed close to the sales market.

In regard to social-related issues, (Mathis et al., 2015) conclude, that there are no social risks from the compost production (in Switzerland), whereas peat bears low potential in regard to working conditions1 and due to health risks for worker and local communities through the creation of dustduring the extraction and procession phase . However, Boldrin et al. (2010) found out, that compost carries a higher ‘human toxicity’ related to water and soil than peat, because of higher heavy metal contents. Moreover, compost might have a higher impact on ground water resulting from leachate.

In conclusion, compost can be perceived as a reasonable substitute for peat in agriculture and gardening. Not only has it valuable advantages in regard to its high nutrition value and thus as a natural fertilizer, but also does it allow for significant emission savings compared to peat or mineral fertilizers. Nevertheless, it does lead to more uncertainties due to its structural features and variable nutrient composition.

Ecological, economic & social disadvantages of compost Kilian

Many hobby gardeners are often confronted with the same problem: They have too less of their own compost and they would need more valuable and fertile soil for their vegetable beds. Basically, if they don’t want to make use of chemical fertilizers, they know have two options to raise their future yields: Mixing soil up with peat or buying compost. Assuming, we will choose the latter, there are some pros and cons connected with compost. In this section we will have a look on rather negative aspects compared to peat. Compost can be the perfect fertilizer for everyone’s garden, especially when it is produced in small scale from our own organic waste. But what do we have to consider when buying industrial compost? What are the general disadvantages?

Compost from local composting plants are cheap, with costs of 17-20€ per ton. But when looking in a more detailed way, we will soon realize, that we haven’t purchased only compost. Small pieces of plastic have become an integral part of compost. In Germany, the “Bundesgütegemeinschaft Kompost” has introduced a limit for plastic parts in compost: Per litre of compost, a maximum of 15 square centimetres is allowed (MDR Garten, 2019). 1 litre is equivalent to 1000 square centimetres. Therefore 1,5% of the compost can be plastic. Assuming we will buy 200kg of compost, what will be a realistic amount, we can have up to 3kg of plastic in it! That’s actually an incredible amount. Added to this we have to consider that the parts are sized from small, visible parts to micro plastic, that’s hardly visible. Scientific research has shown that micro plastic in terms of poly ethylene and others have effects on the soil and micro-organisms in there. How far this can be problematic for our food and garden has to be analysed in future studies in more detail (MDR Garten, 2019).

We now mentioned a rather “new” problem of plastic in our compost. Are there differences in the processes of composting or even negative aspects? According to the Styrian State, different methods are available when it comes to dealing with biogenic waste and sewage sludge. when we talk about composting, we have to differ between “open systems” and “closed systems”. Open systems represent everyone’s composting areas in the gardens and also agricultural and industrial composting. This system has capacity limits, only small quantities can be handled. These composting plants must be at an acceptable distance to residential areas and the area must be suitable due to the occurring emissions. The open windrow composting is the most common form of composting. However, the windrow composting is restrained in the height of the so called “windrows” which shouldn’t be higher than 1,5 – 2m. When windrows are higher, larger methane emissions occur and they have to be turned over every three days (Angelika Stüger-Hopfgartner, o. J.).

In the presence of the quantity over 3.000 tonnes/year a closed system has to be preferred. Materials not suitable for the open composting process and very smelly substances have to be treated in this way. A disadvantage that occurs is, that due to economic and technical reasons, a minimum throughput is needed to operate this composting plant, since machine equipment can’t be downsized (Angelika Stüger-Hopfgartner, o. J.).

The “Hessisches Landesamt für Naturschutz“ mentions five main disadvantages of smaller, decentralized open composting plants (Hessisches Landesamt für Naturschutz, o. J.):

* -  There is a difference in the quality of the compost
* -  These composting plants are low tech companies
* -  Operating costs are much higher for these plants
* -  It requires a relatively large land use
* -  High implementation and monitoring costs have to be expected

A difference in the quality of compost is quite an interesting aspect and this can lead to a disadvantage compared to peat. Peat is quite standardized per definition and it gets cut out of the ground. We have an idea of the advantages we get when we buy peat. In the case of compost, it depends on the fact, if it was composted in the right way and also the starting materials.

Another aspect which often comes along when talking about composting in general are the hygienic matters. This is especially important for private composting at home. During the process of composting, different types of bacteria and mould are involved. The Bayerisches Landesamt für Umwelt (2013) clearly stated, that microorganisms that are breaking down our kitchen waste are harmless, when some basic rules are taken into account: Persons allergic to moulds and with a weak immune system should not store kitchen waste for a long time and completely give up composting in the garden. For the process itself it is important to keep in mind the following five points: Material, temperature, humidity, pH value, time span.

When putting the wrong materials in the compost, health risks can occur due to pathogenic bacteria (in the case of meat waste). Temperature is one of the most important aspects. Only with high temperature, pathogenic bacteria, fungi, parasites and viruses can be inactivated. However, achieving such temperatures is often not possible in hobby-composting, hence the input materials are even more important. For humidity an optimal level has to be achieved, covering the compost prevents too much water from coming in and keeps the heat stored. Even though the pH-value needs not much attention, it is important to mind a minimum time period of one year before using the compost.

Farrell & Jones (2010) analysed food waste composting and the possibilities to use it as a peat replacement. In the discussion they concluded, that the peat-free compost gave the poorest results in the case of absolute height of sunflowers. Over 12 weeks, sunflowers treated with peat-based compost have grown significantly higher. They pointed out, that the physical characteristics may be the key factors for plant growth rates. Moisture content and organic matter can be understood as such factors and are quite important. What was quite interesting in their findings was, that indeed peat-based compost led to higher sunflowers, whereas compost from garden and food waste led to an increase in the head-diameter, seed biomass and even the total biomass of the plant. This result is quite paradoxical. For horticultural use it would be most important to have quite a large seed mass and head size of the sunflower. They measured three macro-nutrients, and two of them, potassium and ammonium-N, were present in significantly larger concentrations in compost. However, considering these indicators as important, compost would even have a reasonable advantage in comparison with peat.

Andersen et al. (2010) concluded that many compost users did not know about the arguments for using compost instead of peat, manure and fertilizers. As a result, they did not change the use of these products even when applying compost. Summing up their results, the estimated substitution of peat in hobby gardens was about 50%, which means that there is still room for further improvements. Even when compost is not substituting peat or anything else, it still contributes to a better soil structure, nicer garden and a better economy and better growth.

Peat renaturation of Kirchseefilz Pauline

In 2014 the state of Bavaria in Germany decided to implement an environmental protection program for 2050. One of the main focuses lays on natural CO2-storages that can be found for example in peatlands. They have one goal they already want to achieve by 2020: To bring back soil wetness into 50 moors in the state of Bavaria. Since 2008 about nine million Euro were invested into the rehabilitation of 10 peatland areas. So far there has been a positive effect on saving an annual amount of 25,000 tons CO2 (Bayerisches Staatsministerium für Umwelt und Verbraucherschutz 2017).

*1. Problems with peat in the past*

The functional principle of peatland is to capture carbon. Without any disruption from outside, it is the only ecosystem that can capture a significant amount of carbon continuously. Due to climate warming and manmade drainage, those carbon pools can be released into the atmosphere. That’s about 4.5% of all fossil emissions. (Drösler 2009, p. 60). But it does not only capture carbon, also nutritive and toxic substances that flow as subterranean or surface water through the moor are getting captured by the peat (Tiemeyer et all. 2017, p. 22).

Over centuries, people cut peat out of peatlands to use it as a cheap burning material. Later it was discovered that white peat also brings health benefits and today it is mainly part of garden mold (Bayerisches Landesamt für Umwelt 2017).

**Graph 1:** Peat gets cut and dried to get burning material (Bayerisches Landesamt für Umwelt 2017)

A fully functional moor can be compared with a sponge: filled with water. To cut peat, the area has to be dry. The dried parts absorb air, which makes it possible for bacteria and fungus to decompose the peat. The boggy soil is decreasing and sinks. If there has been for example constant agricultural cultivation for a longer period the surface might even sink a few meters (Bayerisches Landesamt für Umwelt 2017, p. 3f.).

*2. Renaturation*

The so called Kirchseefilze in the municipality Sachsenkam in Upper Bavaria are part of the 800 ha nature reserve Ellbach- and Kirchseemoor. In 2012 a renaturation was started in the area of a former peat cutting plant. This was already the third project within the peatland area - after Königsdorfer Weidfilz in 2005 and Auer Filz in 2007. 376,000€ were invested through the climate program Bavaria 2020 by the state of Bavaria (Landratsamt Bad Tölz-Wolfratshausen 2019).

One of the main barriers was the ownership of the peatlands. About 37 ha had to be sold or let to be rent by the administrative district. To recover the peatland’s own water balance and the naturally occurring flows, in an area of about 23 ha 378 drainages were closed. Fosses in the shape of slots, that once were used to dry the peat, got closed and bigger fosses and the actual area were peat got harvested was flooded with water (Landratsamt Bad Tölz-Wolfratshausen 2019).

**Graph 2:** Power shovel closes drainages (right) & renatured peatlands (left) (Landratsamt Bad Tölz- Wolfratshausen 2019)

From those measurements not only the climate is benefiting from but also flora and fauna in the Kirchseefilz: Endangered wildlife can reclaim itself. Also floods and droughts around the peatlands are now less of a concern as the natural water cycle is steadier again. But as already mentioned the main goal was to capture carbon again: Right after flooding the whole area, about 36 t of C02 got trapped into the sink. On top of that 345 t of CO2 emissions are now prevented every year that got emitted just by the peat composting itself in previous years (Landratsamt Bad Tölz-Wolfratshausen 2019).

Peat-free Potting Soil: Regional realisations and problems Annechien

Peat is a finite and raw material that is often extracted in the Baltic states, Scandinavia and Ireland, where it is excavated from wetland areas. Peat contains organic matter, which in contact with oxygen, forms CO2 that enters the air (Wechem, 2017). According to the United Nations Environment Program, the destruction of peat soils accounts for ten percent of carbon dioxide emissions worldwide and thereby contributes to climate change (UNEP, 2011). Furthermore, transport to the Netherlands also produces CO2 emissions (Mila & Vamil, 2017). Moreover, peatlands have a great natural value and are important for filtrating water contaminants and buffering water level height (Dede & Ozdemir, 2018). As a result, it is important to preserve natural peatlands. Recently, this has been recognised and legislation has become more restrictive, especially in European countries. As a result, the price of peat has risen rapidly, which led to a continuous search for substitutes (Zulfiqar, Allaire, Akram, Méndez, Younis, Peerzada & Wright, 2019).

Nevertheless, the use of peat-free potting soil is lagging behind in the Netherlands, certainly in comparison with other countries (Stuivenberg, 2016). Dahlin et al. (2019), undertook research in the preferences of commercial users such as cultivators in horticulture and arboriculture and non- commercial users such as private gardeners regarding peat-free potting ground. They found that the most important attribute was the price, after which costumers preferred the soil to come from ‘renewable sources’; hence without peat. However, when this was presented as ‘peat-free’ it had little effect. Furthermore, private gardeners prefer the water holding capacity of peat and give this preference higher value in comparison to the environmental impact of its harvesting (Dahlin, Beuthner, Halbherr, Kurz, Nelles & Herbes, 2019). Another problem arises as the definition of organic potting soil is ambiguous. Peat-free potting soil is often described as organic as it complies with the EU standard for organic farming fertilizers, soil improvers and nutrients. However, there is no legal basis for labelling this as ‘organic’ as there is no definition for what is or is not organic for non-food products. As a result, other organic potting soils that do contain peat are confused with peat-less variants. Nevertheless, there are quality marks that ensure the disturbance of the wetland landscape is minimised. The European Ecolabel does not allow peat in potting soil. It has the highest environmental rating of all potting soil quality marks. Additionally, in the Netherlands, the quality mark Regulations for Trading Potting Soils (RHP) and the Environmental Program for Floriculture (MPS) set requirements for this. This is a joint venture between peat farms, scientists and nature organisations that want to make peat extraction sustainable. With MPS, potting soil for a maximum of three quarters may consist of peat, the extraction of which may not result in environmental disadvantages for the environment.

The rest of the raw materials must be renewable. Sustainability requirements are also imposed on these raw materials, such as sand, clay, coconut, compost, bark, lava, wood fibre and rice chaff. Bark and wood fibre, for example, preferably come from sustainably managed forests. The wood fibres come from sustainably managed forests in the Netherlands and Germany, says Scheer. The composted beech leaf and the compost from green waste come from Dutch residual flows. The rice husk comes from northern Italy (Wechem, 2017). Rice chaff is also added in the newer versions of the product. Rice chaff contains silicon, which makes cell walls of plants stronger and therefore less sensitive to fungi and vermin. The potting soil also becomes lighter (Blok, 2016).

For a potting ground to have good functionalities a few soil properties are of importance. These include dry bulk density, nutrient content, organic matter content and water holding capacity. Important properties that influence the growth of the roots are pH, EC, water retention, water uptake rate, porosity, stability, shrinkage and nitrogen fixation. Peat has a good capacity to retain moisture and is airy at the same time, in order for oxygen to be in the soil. However, peat is not yet potting soil, it has to be mixed with other materials such as tree bark, compost, rice chaff, sand, lime and other fertilizers (Stuivenberg, 2016). These materials need to be added because peat doesn’t contain mineral nutrients. These mineral nutrients are necessary for a plant as it used it to grow nitrogen, phosphate and potassium (Blok, 2016). For this reason, compost has been brought forward as a suitable substitute. Compost consists of vegetable remains such as collected vegetables, fruit peels, grass clippings, leaves and prunings that have been almost broken into humus by microorganisms. These micro-organisms convert the organic material into a mineral form that plants can absorb (Stuivenberg, 2016).

Stuivenberg (2019), undertook research into the use of peat-free at a Dutch arboriculture farm. The research showed that some plants thrive better in the peat-free mixture. These mixtures consist of, among other things, compost, bark and coconut. They found that the peat-free soil came to the root faster and that there was more carrot in the pot. Furthermore, they saw an improvement in soil life. Chemical analyses were also performed, in which they found a higher pH value in the peat-free potting soil. In some crops, the pH was much higher than the target value, but fortunately this had no adverse growth effect. The electro conductivity value was lower with the peat-free soil. Without peat, the soil has less buffering, so that the water is less well retained, and the growth is shorter, although it has never stood still. Therefore, it is important to properly adjust the fertilization based on the monitoring of the soil (Stuivenberg, 2016).

Waste processing company Attero has succeeded in making a new raw material for potting soil from vegetable, fruit and garden waste, so that the proportion of peat can be reduced. Attero is the market leader in the Netherlands for processing waste from the VGF container. Every year no less than 600,000 tons of source-separated organic waste find its way into compost. Cultivation tests have shown that this so-called substrate compost is very useful for potting soil. The results are excellent, according to research conducted by Attero with potting soil producers and Wageningen University & Research. The substrate compost is perfectly suited to replace part of the peat in the potting soil that consumers can buy in the garden center. The replacement of part of the peat in potting soil results in a considerable environmental benefit. This gives the VGF a more high-quality destination, which means that less peat has to be imported from abroad. The processing of organic waste into substrate compost results in a CO2 saving of more than 250 kilos of CO2 per ton of organic waste. With a more conventional VGT processing this is 40 kilos of CO2 per tonne (Mila & Vamil, 2017).