Peatland Restoration Guide
Spreading Plant Material, Mulch and Fertilizer

François Quinty, Marie-Claire LeBlanc and Line Rochefort

Published jointly by

With the financial assistance of

Canada Economic Development for Quebec Regions

Développement économique Canada pour les régions du Québec

En partenariat avec

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Marie-Claire LeBlanc: Cover image, Fig. 3, Fig. 8, Fig. 9, Fig. 11, back cover;
François Quinty: Fig. 2, Fig. 4, Fig. 10;
Rémy Pouliot: Fig. 5.

This document should be cited as follows

Quinty, F., M.-C. LeBlanc and L. Rochefort. 2020. Peatland Restoration Guide – Spreading Plant Material, Mulch and Fertilizer. PERG, CSPMA and APTHQ. Québec, Québec.

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INTRODUCTION

This booklet in the *Peatland Restoration Guide* series has been prepared to make available new knowledge developed since the 2003 publication of the *Peatland Restoration Guide, Second Edition*.[1] It is intended mainly for the horticultural peat industry, but may also be useful for those interested in restoring peatlands that have been drained and where the surface is largely bare peat. It is an update of the 2003 guide section on spreading plant material, mulch and fertilizer (pp. 46 to 59 of the English version).

This booklet begins with a brief review of the Moss Layer Transfer Technique. It then explains the way to spread plant material, mulch and fertilizer. The time and resources required for each step are also described.

MOSS LAYER TRANSFER TECHNIQUE

The Moss Layer Transfer Technique (MLTT) developed by the Peatland Ecology Research Group (PERG, Université Laval) for the restoration of peatlands (bogs, poor fens and moderate-rich fens) is based on active reintroduction of peatland plant species combined with rewetting through hydrological management. This technique has been used in over one hundred restoration projects in Canada as well as in many other countries. It makes it possible to bring back to the restored site over 80% of the species present in the plant material collected from a donor site, and it limits non-peatland plant species to only 3 to 6%. In addition, long-term monitoring of the vegetation (more than 10 years) shows a progressive decrease in these atypical species as the moss carpet develops. A study by PERG in collaboration with researchers at McGill University demonstrated beyond all doubt that a peatland was once again able to capture and sequester carbon 15 years after restoration.[2]

The success of the Moss Layer Transfer Technique is largely related to how well the restoration work is done, as well as the meteorological and hydrological conditions prevailing while the work is carried out. The MLTT involves the following steps:

- Planning;
- Preparing the sector to be restored;
- Collecting plant material from a donor site;
- Spreading the plant material;
- Spreading mulch;
- Fertilizing;
- Rewetting by blocking the drainage system; and
- Monitoring the restored sectors.

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[1] Quinty, F. and L. Rochefort. 2003. *Peatland Restoration Guide, 2nd edition*. Canadian Sphagnum Peat Moss Association and New Brunswick Department of Natural Resources and Energy. Québec, Québec.

[2] Nugent, K., I.B. Strachan, M. Strack, N.T. Roulet and L. Rochefort. 2018. Multi-year net ecosystem carbon balance of a restored peatland reveals a return to carbon sink. *Global Change Biology* 24(12): 5751-5768.

This booklet focuses on the stages in which plant material, mulch and fertilizer are spread as part of the restoration of *Sphagnum*-dominated peatlands.

SPREADING PLANT MATERIAL

This operation is straightforward, as it simply involves applying a sufficient quantity of plant fragments in an even layer over the peat substrate in order to help the restoration succeed.

Quantity of Plant Material to Spread

It is difficult to determine precisely what quantity of plant fragments to spread over a given surface area because there is a great deal of variation in plant material quality. When planning the work and during plant collection in a donor site, the amount of plant material that will be required should be assessed on the basis of the area of the sectors[3] to be restored. During the spreading stage, the amount of plant material to apply[4] should be assessed visually. Experiments comparing various quantities of plant material have shown that better results are obtained when a thin, even layer is applied (Figure 1 and Table 1). In all cases, the following points are important to remember:

- *Sphagnum* and other mosses have no roots and rely on capillary action and precipitation to get water.
- The plant fragments must be in direct contact with the peat substrate so they can access water.
- Fragments at the top of an overly thick layer of plant material tend to dry out, as they are not in contact with the soil.
- Fragments buried under a too-thick layer of plant material will have limited access to light.
- Plant material must evenly cover 80 to 100% of the ground surface. Outside that range, vegetation does not establish easily, and bare areas will tend to remain so for a long time.

[3] The term "site" refers to a peat production site, i.e., a peat bog. The term "sector" describes a homogeneous area affected by the same drainage network. It is the scale at which restoration is planned. A sector includes a number of peat fields, which are separated by secondary drainage ditches. However, for ease of reading, the terms "site" and "sector" are both used in this document to designate areas undergoing restoration.

[4] Underlined words refer the reader to the boxes.

ASSESSING THE AMOUNT OF PLANT MATERIAL TO APPLY

Since a visual evaluation is needed to assess the quantity of plant material to apply, it can be difficult to estimate how much of the surface is covered, especially if the plant material is the same colour as the peat substrate. The following trick can however help with this estimate: lay a flat piece of light-coloured cardboard, wood or tarp before spreading the plants on a test surface. The plant material cover will be easy to visualise on that surface (Figure 2).

You can set out several flat pieces for a more accurate assessment. They can also be positioned in such a way as to check whether material is being spread evenly over the whole area.

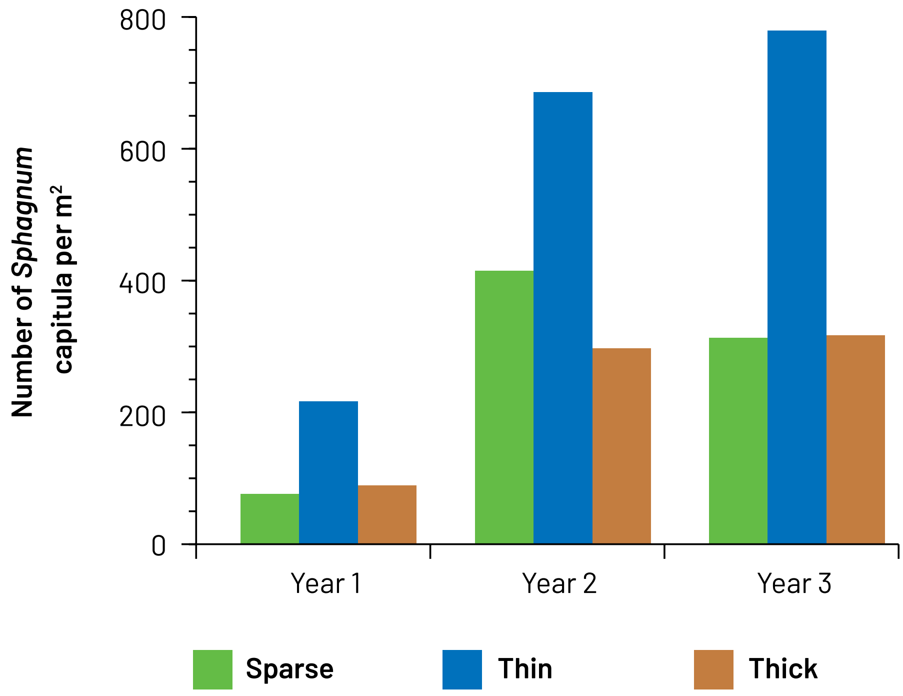

Figure 1. *Sphagnum* establishment (in number of capitula per m^2) in the three years post-restoration, according to the thickness of the plant material originally spread. The results suggest it's better to apply a thin layer than a sparse or a thick one.

Table 1. Description of appropriate and inappropriate amounts of spread plant material.

Assessment	Amount	Description
Inappropriate	Sparse layer	The plant material does not entirely cover the ground. The layer is discontinuous due to uneven application; because too little plant material was used; or because the material included clods, making it difficult to obtain a thin, even application.
Appropriate	**Thin layer**	Between 80 and 100% of the ground is covered with an uncompressed, even and 1 to 2 cm thick layer of plant material (Figure 2). The underlying peat can be seen here and there.
Inappropriate	Thick layer	The peat substrate is completely covered by a layer of plant material over 2 cm thick, and the ground is not visible anywhere. The fragments at the top of the material layer are not in contact with the peat substrate and may dry out.

Figure 2. Plant material cover, as assessed using a wooden panel. The photo shows an appropriate amount of coverage (95%).

As a general rule, the surface of the peat should be visible under the fragments; however, the amount of material can be adjusted according to its quality. When plants are harvested too deep (over 10 cm from the surface), some of the peat without regeneration potential is harvested, which decreases the quality of the plant material. It's also important to consider that, with spring-harvested plant material, it is easy to overestimate the quantity of fragments spread if the material contains ice or snow.

SPRING-HARVESTED PLANT MATERIAL

Plant material harvested in spring may contain snow. It melts slowly, and ice lenses can form in piles, sometimes lasting until summer. Frozen plant material is more difficult to pick up and load into the spreader. Frozen blocks can also damage the beaters that break up the material behind the spreader. The best way to solve this problem is to break up the piles or move them a few metres for a few days prior to spreading, so the snow or ice has time to melt.

Spreading Plant Material

Plant material is spread using conventional manure spreaders (Figure 3). Most spreaders make it possible to apply the plant material in an even layer. The first load is usually used to adjust the amount of plant material spread. This involves having one person standing at a safe distance behind the manure spreader to check the quantity of fragments spread, while the operator varies the spreader's flow and the tractor's speed. This step is also used to determine the spreader's application width (swath width). Once the right combination of speed and flow rate is found, the driver can complete the work alone.

The sequence of spreading operations should avoid having machinery drive over the plant material when the mulch is spread. Driving a tractor or any other machine over the plant material before it is covered with mulch can bury it or mix it in with the peat, which will negatively impact the plants' survival. Since mulchers generally cover a much wider area than the manure spreaders used for the plant material, the most effective strategy is to spread two to three swaths of plant material and then cover it with a side-discharge mulcher, without having to drive over the introduced fragments.

Figure 3. Plant material being spread using a hydraulic push (hydro-push) manure spreader with horizontal beaters.

Figure 4. Apron box manure spreader with vertical beaters.

Figure 5. V-shaped side-discharge spreader.

Various types of spreaders have been used for plant material, including the following:

- Apron box spreaders with horizontal beaters;
- Hydraulic push (hydro-push) spreaders with horizontal beaters (Figure 3);
- Apron box spreaders with vertical beaters (Figure 4);
- V-shaped side-discharge spreaders (Figure 5).

Most of the equipment used will easily yield an acceptable spread, except for V-shaped side-discharge spreaders, whose mechanisms often get blocked by roots and branches.

Plant material is heavy, especially when waterlogged, and a loaded spreader can easily get stuck if the ground is wet. It is better to use a spreader equipped with tires providing good floatation. It is also important to consider the ground conditions: frozen (spring or late fall) or dry ground (late summer, generally) offer the best conditions.

It is not recommended to spread plant material when the ground is too soft, because the machinery can create deep ruts. Field tests have shown that these ruts have a negative impact on plant establishment. The conditions in the depressions are conducive to the establishment of mosses, but the raised areas between them tend to dry out faster, so that the conditions are less favourable overall (see the Site Preparation and Rewetting booklet). Observation has also shown that the mulch on the raised areas between ruts is easily moved by the wind, encouraging frost heaving. The mulch then tends to accumulate in the ruts in a thick layer that hinders plant establishment.

Midsummer is not the best time to spread plant material even if the overall conditions are favourable for working. This is because the plants dry out very quickly, which can compromise their survival and establishment. Midsummer is also the time of year in which peat extraction takes place, meaning that the staff and equipment of peat producers are tied up.

Resources, Time and Costs

The following machinery is needed to spread plant material: a tractor, a manure spreader and equipment to load the plant material into the manure spreader.

Using a large spreader can save time where there is a low risk of the equipment getting stuck. Rental costs vary greatly, but it is generally easy to rent these machines from farmers. A well-equipped team can spread plant material over four or five hectares in one day. However, the amount of time needed varies depending on the team's level of experience, the distance from the donor site, the restoration site's configuration, the ground's bearing capacity, the equipment used and other factors.

Summary

- Spread a thin, even layer of plant material (the surface of the peat should be slightly visible under the fragments).
- Never drive machinery over spread plant material without mulch.
- Not counting the adjustment of the machinery, you can plan for the spreading of plant material to take an average of two hrs/ha, if you coordinate optimally with the mulcher.

SPREADING MULCH

The plant fragments face very difficult conditions when they are spread on bare peat surfaces. Exposure to heat, sun and wind will dry them out, decreasing their chances of surviving and forming a new plant cover. It is therefore essential to improve these conditions to allow the plants to establish.

A number of techniques aimed at improving conditions for the establishment of plant material have been tested: irrigating using sprinklers; pumping water in irrigation canals; using living mulch and windbreaks; and more. In almost all cases, the plant material dried out and died before being able to form a new plant cover. The treatment giving the best results was using a protective cover like mulch.

Functions of Mulch

Mulch has long been used in agriculture to protect the soil and plants against exposure to unfavourable conditions. Research has repeatedly shown that applying mulch is one of three key factors for success in any peatland restoration project using the Moss Layer Transfer Technique. Here are the other two:

1) Reintroducing plants through plant material that contains fragments and diaspores of appropriate plant species; and
2) Adequate rewetting of the restoration site.

Applying mulch is equivalent to placing a sheltering roof over plant fragments. The mulch promotes plant establishment by creating a layer of moister air that stays cooler during the day and warmer at night (Figure 6). The mulch also helps decrease evaporation at the surface of the peat, thereby lowering the risk of desiccation. By reducing temperature fluctuations, mulch also prevents frost heaving, which is caused by freeze-thaw cycles and is harmful to plants.

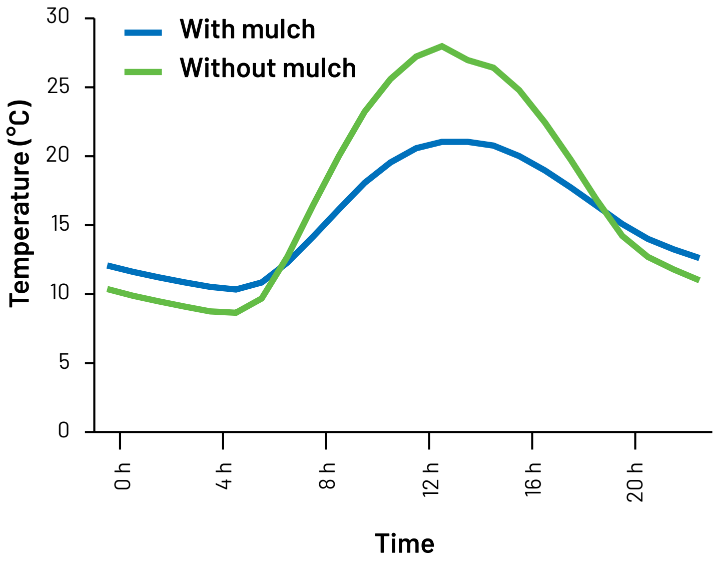

Figure 6. Average temperature at the surface of the soil over the course of a day, with and without the use of mulch (in this case, straw). At midday, the temperature at the surface of the soil is almost 10°C higher when no mulch is used.

Types of Mulch

An important characteristic of mulch is its ability to create a layer of air at the soil surface that stays cool and moist and is relatively insulated from the ambient air. To do this, the mulch must be made up of fairly rigid long stalks that become intertwined during spreading to form a protective layer that traps the ambient air and limits its exchange with air above the mulch. However, care must be taken when using straw that was harvested more than six months beforehand and has been exposed to bad weather: the outer layer of these straw bales is often wet or mouldy, and the straw is not as rigid as fresh straw. It tends to collapse and flatten instead of creating an aerated protective cushion. A similar problem is observed when the straw is chopped up or shredded into shorter pieces. It is therefore important to avoid using shredded straw and to make sure the mulcher being used does not shred the straw.

In experiments carried out during the development of the Moss Layer Transfer Technique, straw from grains (wheat, oatmeal, rye or barley) was compared to commercial mulches, such as *Curlex and Eromat*, and to other types of artificial cover. Straw mulches were found to be more effective than commercial mulches for protecting plant material, primarily because they form a thicker mulch and are easier to apply over large surface areas. They also have the advantage of being available almost everywhere and are relatively inexpensive. Hay bales can also be used, but only when straw is not available. However, hay bales are generally more expensive and create mulch that is not as well structured as straw. Hay can also foster the establishment of undesirable plants because it contains viable seeds of varied species, though this problem is generally short-lived because these species cannot tolerate the acidic conditions of peatlands very long. While straw mulch is used in most restoration projects, it is also possible to use whatever is available locally, such as pea mulch for instance, so long as the plant species chosen creates a mulch with the characteristics described in the previous paragraph.

Wind displacement of mulch is not a frequent problem at most restoration sites. After being exposed to precipitation a few times, the bits of straw adhere to one another and the mulch is able to withstand wind. There are exceptions however: sites that have more wind exposure; and sites that are subject to flooding after rapid spring thaws, which release large quantities of water in short periods of time (often seen in the Prairies). Certain measures can be taken to prevent mulch displacement. During the site preparation stage (see the **Site Preparation and Rewetting** booklet), dikes (sometimes also referred to as berms) can be created to protect the peat surface from erosion and limit the movement of mulch and plant material. In cases where the mulch does get displaced, a second layer of mulch can be applied (manually or mechanically) when the soil is frozen.

Mulch Density

For the following reasons, it is very important to apply the proper amount of mulch:

- A too thick layer can delay or even prevent plant establishment;
- An insufficient amount of straw does not adequately protect the plant material and therefore can limit plant establishment success; and
- Mulch accounts for a significant portion of restoration costs.

Research has shown that 3,000 kg of straw/ha is the minimum amount required to maximize plant establishment (Figure 7). This generally corresponds to approximately 18–20 round bales of a diameter of 5 ft (1.5 m)/ha (Table 2), although it is difficult to compare different weights and volumes of straw due to variations in moisture conditions.

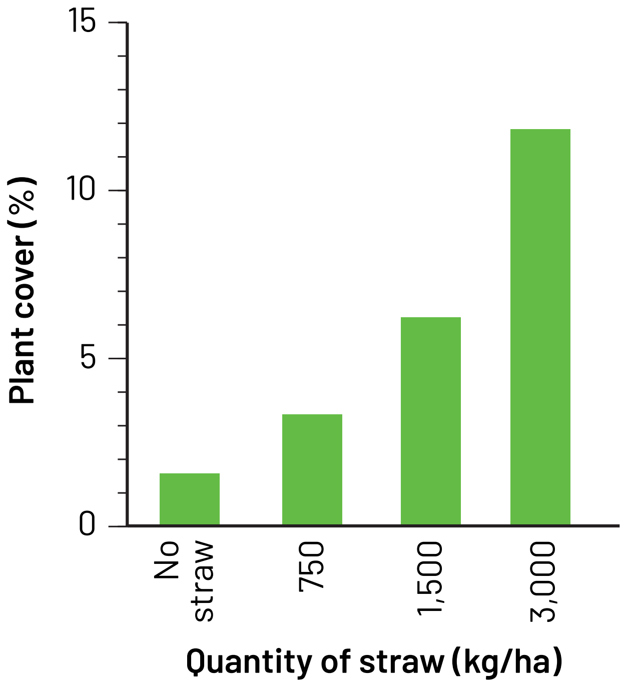

Figure 7. Plant cover (in percentage of coverage) after three years of growth under different quantities of straw mulch. Using no or too little straw significantly reduces plant establishment.

Table 2. Number of straw bales required by unit of surface area.

Bale diameter; width is 5 ft (1.5 m)	Number of bales	
	Per hectare	Per acre
4 ft (1.2 m)	25 to 30	10 to 12
5 ft (1.5 m)	18 to 20	7 to 8
6 ft (2 m)	12 to 14	5 to 6

ROUND BALES

Using larger round bales is considerably more economical than choosing smaller ones. For example, the volume of a round bale with a diameter of 5 ft is approximately 1.5 times that of a bale with a diameter of 4 ft. Handling costs are always high because bales have to be transported by truck, then unloaded and reloaded onto trailers to be taken to the restoration site, and then unloaded and loaded into the mulcher for spreading. It takes only one to two minutes to spread a bale, but many more to load more bales. So, for the same amount of time and effort, 50% more straw is handled when using bales with a diameter of 5 ft, and 125% more using bales with a diameter of 6 ft compared to bales 4 ft in diameter.

Large square bales (3 ft x 3 ft x 5–6 ft) can also be used. Depending on the equipment used, this type of bale is fairly easy to handle. However, square bales are harder to spread because mulchers have a rotary mechanism designed for round bales (Table 3).

The mulch must be thick enough to create a layer of air insulated from the ambient air. It must also allow enough light to reach the introduced plant material. You should be able to see the peat or plant material through the mulch here and there. Research has shown that plant fragments cannot survive when the mulch is too thick and compact, probably due to insufficient light. It is therefore important that any clumps of straw be broken up during spreading.

Spreading Mulch

The mulch and plant material are usually spread at the same time. This reduces the plant fragments' exposure to sun and wind, and avoids having to drive directly over the plant material.

Many types of equipment have been used to spread mulch (Table 3; Figures 8, 9 and 10). Side-discharge round-bale mulchers, which discharge straw from the side, to a width of 10 to 15 metres, are the most commonly used. Here are the main advantages of these machines:

- One operator can do the work because these mulchers are self-loading.
- They can hold two bales of straw.
- They spread one bale in one to two minutes.
- The equipment does not have to circulate over the plant fragments because the straw is spread laterally.

Table 3. Types and efficiency of equipment used in North America to spread plant mulch.

Side-discharge mulcher (Figures 8 and 9)	This equipment is suitable for round bales. It spreads mulch sideways to a width of 10 m to 15 m, is self-loading and can carry two bales.
Vertical mulcher	This equipment uses round bales and spreads straw from the back. This means the tractor has to drive over the plant material on the ground, which may damage it. The mulch is not spread over a large distance.
Rear-loading side-discharge mulcher (Figure 10)	This equipment spreads straw efficiently over a width of 10 m. It can use round bales or large rectangular bales. The bales must be loaded with other equipment (tractor) and loading is difficult because the opening is small and faces upward.

Figure 8. Side-discharge mulcher.

Figure 9. Side-discharge mulcher (rear view).

Figure 10. Rear-loading side-discharge mulcher.

When spreading mulch, the operator should avoid driving over previously spread plant material, as the plant fragments may be crushed, mixed into the peat or buried, all of which can hinder their survival and establishment. Plant material should always be handled with care. A side-discharge mulcher has a spreading range of over 10 m and therefore can cover plant material without having to drive over it.

Spreading mulch on windy days may prove difficult. If the wind is too strong, the task will be almost impossible. On the other hand, if the wind is blowing in the right direction, this can help spread the mulch.

Resources, Time and Costs

The following must be taken into account when planning mulch spreading operations:

- Renting a mulcher;
- Purchasing mulch;
- Transporting the mulch to the site;
- Loading and spreading (with a tractor and mulcher).

The time required for spreading mulch is estimated at six hours per hectare. The required time and staff have been estimated based on one operator using a self-loading side-delivery mulcher. As is the case when spreading plant material, a number of variables can influence the amount of time required. Since transporting the bales of straw is the most time-consuming task, positioning them in strategic spots before starting the work will reduce the reloading time. In addition, since the mulch is spread soon after the plant material, the two operations must be well coordinated to reduce the waiting time between the two steps. It also makes sense to use larger bales and to allocate more staff for spreading the mulch. For example, an operator can be specifically assigned to loading the mulcher. This will reduce costs, as the two operations (spreading and reloading the mulcher) can be done at the same time.

The cost of straw varies by region and from year to year. If the straw cannot be delivered directly to the restoration site due to access issues, additional time must be allocated for transporting the straw on tractor-drawn trailers. Planning ahead and making arrangements with local farmers are the most likely ways of reducing the cost of straw. Mulcher rental costs are negotiated with local farmers.

Summary

- Avoid driving over previously spread plant material.
- Apply an even layer of straw as soon as possible after spreading the plant material.
- Apply the right amount of mulch. If spread too thinly, the plants will not receive adequate protection, reducing their chances of establishment. If mulch is spread too thickly, plants may receive less light, hindering their survival.
- Avoid using equipment that chops or shreds straw into small pieces, as the straw tends to collapse instead of forming a thick mulch, which is needed to create a layer of cool, moist air above the ground. The mulch must look aerated, and the ground or the plant material should be visible here and there.
- Using large bales reduces the application time and restoration cost.
- Fresh straw spreads more easily, and thus less is needed, which reduces the restoration costs.

FERTILIZATION

Fertilization is included in the restoration measures because it significantly increases the chances of success and helps the plant communities establish more quickly. Experiments have shown that applying phosphorus fertilizer increases the germination from spores and implantation of certain pioneer moss species, notably bog haircap moss (*Polytrichum strictum*). In turn, the mosses create conditions that facilitate the establishment and growth of *Sphagnum* fragments. Rapid colonization of the bare peat substrate by bog haircap moss stabilizes the soil, which then helps to reduce or prevent damage from erosion and frost heaves. In addition to fostering the implantation of bog haircap moss, fertilizer helps many vascular plant species characteristic of peatlands to establish. The advantages of phosphorus fertilizer have been widely demonstrated in applications on many sites. It is therefore considered an essential step to the restoration's success.[5]

Phosphorus

Many fertilizers contain phosphorus, but not all are suitable for peatland restoration because most also contain varying quantities of other elements. For instance, nitrogen is not needed for peatland restoration because bare peat surfaces contain a sufficient amount of it to ensure the growth of plants accustomed to nutrient-poor conditions. Fertilizers that are rich in calcium should also be avoided because the high calcium level is detrimental to the growth of *Sphagnum* and may promote the implantation of undesirable species. It is therefore recommended to use fertilizers that mainly contain phosphorus.

Despite the slightly higher cost, it is preferable to use granular rather than powder fertilizer, because the powder's fine particles are easily swept up by even the slightest wind. This reduces the fertilization's effectiveness and can contaminate nearby bodies of water along with neighbouring peat fields still under extraction.

Granular phosphate rock is the recommended fertilizer because it allows good distribution of the phosphorus during application, in addition to being slow-release. The phosphate rock most frequently used in eastern Canada (0-13-0 formula) contains 25% total phosphate (P_2O_5), half of which (13%) is immediately available to plants, and the other half becoming available gradually, especially in acidic environments. Other phosphorus-rich fertilizers, like superphosphate, are not recommended because they are highly concentrated and need to be applied in such small quantities that they are impossible to spread evenly.

[5] Applying fertilizer in a wetland may be subject to regulations. It is important to check before proceeding.

Application Rate

The recommended application rate of 0-13-0 phosphate rock is 150 kg/ha (60 kg per acre). For instance, it takes 180 kilograms of fertilizer to cover a 30 m x 400 m (100 ft x 1,200 ft) surface area. The rate can be adjusted if a fertilizer with a lower or higher phosphorus content is used.

Applying the Fertilizer

Fertilizer is applied after the mulch has been spread, using a simple conical spreader that hooks up to the tractor's power take-off (PTO) shaft (Figure 11). These spreaders are effective given the small quantities of fertilizer needed. There are conical spreaders that can be hooked up to or pulled by an all-terrain vehicle and are activated by an electric motor or the turning of the wheels; however, they do not always provide the desired results. The jolts produced by driving over an uneven surface can cause the drive mechanism to work only intermittently, resulting in the fertilizer not being spread evenly.

It is important to begin by adjusting the spreader to make sure it will apply the right amount of fertilizer. However, it may not be possible to calibrate it precisely. One adjustment method that can be used is to load the spreader with a known quantity of fertilizer to spread over a given surface area (e.g., 180 kilograms for a 1.2 hectare field) and then adjust the spreader's flow and the vehicle's speed in order to cover the surface with that load. The operator can then adjust the flow and speed accordingly for subsequent surface areas. It is also important to determine the spreader's application width (swath width). This is generally easy to do. Have someone stand at a safe distance from the tractor and give a visual estimate of the width. Note that tractor-mounted conical spreaders have a swath width of about 15 metres.

Driving over surfaces where mulch has already been spread causes much less damage than driving directly over plant material. A tractor will have greater floatation on mulch and will leave almost no trace during fertilizer application unless the ground is soft. This is especially true of spreaders hooked up to the PTO of a tractor with dual or triple wheels, because the weight will be distributed over several wheels. On smaller sites (under 1 ha), ARGOs and ATVs can be used, with an electric-drive spreader attached. They offer the advantage of being very lightweight.

Figure 11. Fertilizer being applied with a conical spreader hooked up to the tractor's PTO.

It is recommended that fertilizer be applied when the plants will absorb it and most benefit from it, that is, when they are in full growth, or just before. It is also important to apply fertilizer when it is the least likely to reach nearby bodies of water and adjacent surfaces. It is therefore recommended that fertilizer be applied between late spring (when the meltwater has receded and the soil is dry enough to bear the machinery) and early September. If applied too late, the fertilizer will be of little use to the plants because it runs the risk of getting washed away with the excess water from fall precipitation or snowmelt in the spring.

Finally, avoid spreading fertilizer before heavy precipitation. Check weather forecasts (wind and precipitation) before applying.

Potential Impacts on the Environment

There is little information on the environmental impacts of applying phosphorus fertilizer for peatland restoration, but the risks of impact are low for the following reasons:

- A low dose is applied and only once.
- Phosphate rock is a slow-release fertilizer.
- Phosphorus has low mobility and is retained by the peat.
- Drainage ditches in the restored sectors are blocked, so no water should be able to leave the site.

However, phosphorus can cause significant adverse impacts if it reaches a body of water. It is known that phosphorus promotes the growth of algae and aquatic plants, which contributes to the eutrophication of lakes and streams. As with any other product, safety measures must be taken when applying fertilizer:

- Handle the fertilizer with care. Avoid handling within 30 metres of a body of water and avoid spills.
- Respect the recommended application rate. Adding more fertilizer than needed will not produce better results. Quite the opposite, adding too much phosphorus can harm *Sphagnum* and assist in the spread of undesirable species.
- Be sure to block the drainage ditches before or right after applying fertilizer to keep it from reaching receiving bodies of water.
- Keep all surplus fertilizer in a dry place for future peatland restorations.

UNDESIRABLE SPECIES

A potential drawback of applying fertilizer is that it can encourage the growth of plants not characteristic of peatlands. The species that may take advantage of the fertilizer will vary according to their presence near the sites being restored. In eastern Canada, fireweed (*Chamaenerion angustifolium*) and the species whose seeds are found in straw are the most frequently seen. In the western provinces, invasive species and weeds are catalogued, and their control is often mandatory. Birch and poplar trees are also common. There is little data on the long-term population evolution of these species on restored sites, but a decline is expected due to the environment's acidity, the rise in water level and the increasing competition with peatland species.

Common reed (*Phragmites australis*) is increasingly common. It colonizes several types of habitats and is found in peatlands in production and on some restored sites. Once established, it spreads quickly and is very difficult to eradicate. Common reed produces many seeds, which can make their way into peat products. Its presence can hinder the reestablishment of the peatland species targeted by restoration. This plant also reproduces vegetatively, forming new individuals from rhizome segments. It is best to take prompt action once this plant has been identified on a site, because small colonies can be destroyed via excavation (excavated material should be handled with care and incinerated), while large colonies can quickly grow out of control. Herbicides (glyphosate and imazapyr) are the only means of controlling the largest populations, but there may be restrictions on their use in wetlands. Establishing a plant cover comprised of peatland species may prevent reeds from establishing via seed arrival because they need light to germinate. Once established, common reed propagates through its root system.

Resources, Time and Costs

Applying fertilizer requires little time and few people. An operator equipped with a tractor and a spreader can cover approximately two acres in one hour. Small conical spreaders can be rented from farmers at low cost. While they are rarely used nowadays, many farmers still have them.

Phosphate rock is a natural fertilizer whose availability varies regionally. The nongranular (powder) version is less expensive but is more difficult to handle and to spread evenly, and it can more easily contaminate nearby bodies of water and surrounding areas.

The following should be taken into consideration during planning: purchasing the fertilizer; renting or checking the availability of the required machinery (tractor and fertilizer spreader); and the amount of time needed to apply the fertilizer, which is estimated at 0.5 hours per hectare.

Summary

- The recommended application rate is 150 kg of 0-13-0 phosphate rock per hectare (60 kg/acre) to accelerate the establishment of a carpet of moss.
- Use a granular fertilizer rather than powder.
- Adjust the spreader's flow and the tractor's speed to achieve the right application rate.
- Apply the fertilizer between late spring (after snowmelt) and early September.
- Handle the fertilizer with care to avoid contaminating any nearby bodies of water and the peat in the fields still under extraction.

Published jointly by

gret perg
Groupe de recherche en écologie des tourbières
Peatland Ecology Research Group

Canadian Sphagnum Peat Moss
Tourbe de Sphaigne Canadienne

apthq
association des producteurs de tourbe horticole du québec
québec peat moss producers association

Créneau d'excellence
Tourbe et substrats
Peatmoss & Substrates Cluster

With the financial assistance of

Canada Economic Development for Quebec Regions
Développement économique Canada pour les régions du Québec

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Québec