ABSTRACT

Drainage in the Forest District of Bjursfors

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Bulletin of the Royal School of Forestry, Stockholm, Sweden.
No. 8. 1952.

AROUND the turn of the century, and coinciding with the general growth of interest among foresters in the possibilities of drainage of boglands or waterlogged forest soils, a very comprehensive scheme of drainage operations was initiated in the forest experimental district of Bjursfors, which lies in the counties of Vastmanland and Kopperberg in mid Sweden.

These experiments in drainage were due to the initiative of the Director of the Forestry Institute, Professor C. G. Holmerz, who was responsible for the administration of the area. Trials were carried out on every type of bog in the belief, which was then current, that every form of peat was suitable for forestry purposes, irrespective of the intrinsic quality of the peat, if only it were thoroughly drained. Bog drainage technique at that time was in the experimental stage and was mainly based on the principles applied to the drainage of tillage land. This led in general to a great deal of unnecessary or useless ditching. Further, the cultural methods applied to the crops following their establishment on the drained area produced very variable results, both negative and positive.

These drainage trials provided in the ensuing years very valuable subject material for studying, on the one hand, the relative forest values of the different peat types and, on the other, the effectiveness of the drainage systems and cultural operations applied.

Professor Gustav Lundberg, who is the author of this Bulletin, has been in touch with the work since 1902, *i.e.*, over a period of 50 years, and during that time he has seen the crops develop and has measured the yields on the representative sample plots, which have been regularly recorded since 1923. He gives in this Bulletin the results of the experiences gained by himself and other workers, notably Professor Carl Malmstrom, in Bjursfors and other areas. The Bulletin deals with the basic objects of peat drainage for forestry purposes, discusses the worth of the various peat types for timber production, and finally explains the technique of water regulation and the handling or cultivation of the drained bogs.

Developments on the experimental areas up to 1923, together with details of the ecological changes and sample plot assessments were written up by Eric Lundh in 1925.

The present Bulletin deals with the subsequent developments and includes tables of yields and increments from the various sample plots.

Among the most valuable conclusions arrived at so far, the following are worth reording :

Drainage Technique

In comparison to the thoroughgoing preparation prerequisite in the reclamation of peat bog for agriculture, where one must consider not alone the need to provide conditions suitable for tillage implements but that in addition most tillage crops are very sensitive to a high water table, drainage for forestry purposes is much simpler.

On bogs suitable for reclamation, *i.e.*, bogs of the type which after drainage make good forest soil, there is no need to worry about the water actually in the bog, so long as conditions allow for a drying out sufficient to encourage establishment and development of the crop. This drying out is brought about by evaporation and later by the trees themselves which become powerful factors in the drainage of water through their transpiration systems. Therefore, all that is necessary is to trap, by a system of strategically placed ditches, all water that flows on to the reclamation area from outside in such quantities or under such conditions as to promote the growth of bog forming plants.

These trap drains must, of course, be linked up in a suitable lead-off drainage system to ensure that the water be led off from the area into streams or watercourses. Special precautions must be taken to prevent the system from becoming ineffective due to the sinking by shrinkage of the drained bog below the level of the trap and run-off drains.

As the growth of bog forming vegetation is dependent on a constant, all the year round, water supply (this however does not necessarily apply to high bog or blanket bog), occasional waterlogging or flooding after rain is of no great importance. The usual sources of trouble are associated with the occurrence of impervious layers which cause springs to break out in the drainage area, or when there is a constant inflow from higher lying boglands or neighbouring peat covered uplands.

The frictional resistance of peat to the lateral movement of water is so great that it can only be overcome on very steep slopes. This type of water movement, lateral seepage, can be practically ignored. The depth of the drains is not, therefore, of major importance. The main thing is to have the drains deep enough to allow for the fall of ground, the shrinkage of the peat and the quantity of water that they may be called on to carry.

The fall in the drains themselves is of major importance, particularly in regard to their maintenance and efficiency, a fall of 1 in 150 to 200 is desired in the trap drains and 1 in 300 to 1 in 400 for the lead-off drains.

Where the fall is too little the drains are liable to block up, due to an accumulation of growth, or a collection of leaves and rubbish. Where the fall is too great undercutting and erosion of the bed may result in the banks caving in and blocking the drains.

The Bjursfors technique of drainage can be put briefly as follows :

1. Trap by means of contour drains (laggdiken) all water flowing

from higher levels, particularly water from poor peats or sterile soils.
2. Catch all water breaking out as springs or flushes by means of forked drains (fonggaffeldiken).
3. Carry the water from 1 and 2 as required, by means of lead-off drains (tegdiken) to the natural watercourses or main drains.

Where mains have to be dug great care is taken to insure that the site of the main is at the lowest point of the basin floor ; this applies only to basin bogs, of course.

Readings are taken of the surface levels on a series of transects, the depth of the peat is sounded, this providing a series of bog profiles, the lowest points are connected up to give the lie of the main or sub-main drains. The reason for this is to avoid the risk of the drain becoming useless due to bog shrinkage. If the drains are at the very lowest point they can be deepened to keep pace with the sinking bog surface. Otherwise the time may come when they may lie above the lowest point, when they may cease to function, fill up and the whole process be put into reverse.

Forest Growth on Reclaimed Bog

Except on very deep bogs, the main factor which influences the growth of trees on reclaimed bog is the composition of the peat itself, especially with regard to its content of the main essential nutrients for tree growth, lime, potash and phosphate.

The supply of nitrogen will be usually forthcoming from the products of decomposition of the plant remains in the peat. The rate of decomposition will be speeded up if the supply of mineral nutrients is present in quantity and the process tends to accelerate as time goes on.

The mineral content of peat varies enormously, and depends entirely on the nature of the plants from which the bog was formed and on their demands on and content of the minerals in question. The quality of turf for reclamation may, therefore, be said to depend on :

1. The hydrological conditions under which the bog grows, that is, the quality of the water on which the peat forming plant communities depend for their growth.
2. The geological structure of the district.
3. The climatic conditions.

The so-called ombrogenous bogs, which are characterised by a more or less convex development of the bog surface, are dependent on climate. Their water supply comes almost entirely from precipitation as snow, rain or dew. They are, therefore, questionable subjects for forest reclamation because of the poor mineral content of the turf.

The so-called soligenous bogs which are flushed with water from the surrounding, higher mineral soils are very suitable for reclamation. The quality class of these soligenous bogs varies enormously and can be related directly to the quality and nature of the flushing water. The richness of the flushing water supply is bound up with the local geology ; soils or rocks rich in bases give rich (hard) water, siliceous or acid soils or rocks give poor water. Soligenous bogs of large extent are less attractive than those of limited size. Extensive bogs of any origin in

regions of high humidity are unattractive subjects. The soligenous bogs in Bjursfors have all given excellent results after drainage with mean annual increments from 100-200 cubic feet or, in other words, yields which are on the average twice as high as on the best mineral soil in this area. In other areas, however, especially in extensive soligenous bogs in Norrland, results have not been so good.

The so-called topogenous bogs, *i.e.*, basin bogs can develop into either soligenous or ombrogenous type bogs depending on the richness in plant food of the water supply and on the general climatic conditions.

In the classification of bogs other systems are in use in addition to the water source method. These include a study of the plant ecology, the degree of humification and other methods, all of which have proved useful.

Afforestation and Silviculture on Drained Bog

Due to climatic conditions the only trees available are Scots pine, Norway spruce and birch. Of these the spruce is away ahead as a timber producer. The pine establishes itself more quickly than the spruce but in time the spruce overtakes the pine or birch in mixed stands and greatly excels both in final yields.

The only drawback to the spruce is its susceptibility to damage by late spring or early summer frosts, which do no damage to pine or birch. It has been found impossible to establish spruce on bare reclaimed bog except by using advanced nurses of pine or birch. Spruce has shown, however, amazing powers of recovery from repeated frostings, and crippled bushes have invariably made good trees as conditions improved. In addition it has the power to throw off the effects of shading and suppression, no matter how long or intensely it has suffered as soon as the suppression elements are removed it comes away in normal fashion. These factors combine to give the spruce a unique value for bog planting. In addition it is observed that spruce grown on peat rarely suffers from butt rot.

The afforestation of reclaimed bog in Bjursfors is mainly by natural seeding from the surrounding forest. It is important to preserve any scrub pine or birch which may be present to provide protection against frost. Since drainage depends to a great extent on the action of the tree roots and the transpiration from the crowns, thinning is delayed until the draining process is well advanced. Spruce continues to develop under a birch canopy, better in fact than when the birch is removed. Too heavy thinning of birch often results in a check of the spruce, and may if excessive, result in the death of the young spruce. The explanation given is that the spruce which develops in shade has a particularly sensitive foliage, weak in palisade tissue and easily damaged by frost or bright sunlight.

With regard to cultivation and the use of nurse plants it is observed that spruce should preferably be planted under the shade of nurses. Turf planting is recommended and, better still, the more recently (in Sweden) developed technique of ploughed strips.