First Prize Essay.

ON THE BEST METHOD OF UNDERDRAINING THE DIFFERENT SOILS OF ONTARIO, THE COST AND THE PRACTICAL BENEFITS RESULTING THEREFROM.

(By the Editor.)

(Continued from May Journal.)

Silt is the deposit of soil held in solution by running water. It is sure to be deposited in slack water, which may be caused by a break in the fall or by unevenness in the grade of the drain, amongst others, a strong argument in favor of a drain of perfectly even grade from the outlet to the head, where it can be obtained—and where it cannot, the sections which have not a common grade should have one that is uniform throughout each section. Silt may be caught in a basin beneath the drain, which may consist of a single large tile set on end, into which the water flows, deposits the sediment, and then flows on. For large drains, or where the waters of several drains are collected, the basin may consist of a chamber built of stones, or better still, bricks; it should be covered with a flat stone "well packed around the sides with clay, and the place marked that it may be occasionally cleaned out." The drainers of Ontario do not, we fear, give the attention to the item of silt which its importance demands, and hence the tendency to use tiles so large. Although silt basins have till recently been thought indispensable in an efficient system of drainage, the recent improvements made by the New Jersey tile-makers in the construction of junction tiles, etc., have almost entirely obviated the necessity for their use. The curved tiles, made by this firm of various degrees of curvation, greatly assist in abruptly changing the direction of drains. The use of these tiles has not extended to our Province, so far as we are aware, nor have they been manufactured here; why, we cannot say, as clay in the hands of the potter is very plastic.

Obstructions other than silt should be guarded against. Roots of trees often obstruct drains, especially willows. Deep-rooting trees and under-drains cannot peacefully occupy the same ground. Mr. Wm. Rennie directed our attention to a piece of spring wheat growing on his "Seed Farm" considerably injured in consequence of the stoppage of the flow in a three foot drain, as he supposes by the fibres of a mangold, which had penetrated the joints and had then become washed downward by an accelerated flow of the water in the drain, thus forming an effectual dam. This points in the direction of deeper drainage. For some time after the construction of the drains occasional *flushing* will be advantageous. This is done by simply preventing the flow for a little and then suddenly removing what has kept it in check.

The *details* of procedure in construction are far from unimportant. When the ground is mapped and the land staked, the *tiles* should be laid down, as material in constructing a fence, and here the fruits of forethought will be sweet, if anywhere. It is cheering to witness intense energy in action, but not to the extent of two stalwart brother farmers humiliating themselves by heaping passionate abuse the one on the other as they snatch for tile in a yard, while the benignant face of an eastern sun is creating the smiles of the morning. The county of Oxford can tell the humiliating details which we have left untold, but the grave of oblivious silence is their fitting resting-place. A Von Moltke is quite as useful in planning a campaign of drainage as in planning a Franco-Prussian war.

The *tools* should be on hand. Those of elaborate construction have been manufactured, but great difficulty has been found in getting men to use them, which after all is the true test of the value of a tool. In Canadian practice the chief tools used in digging are the ordinary spade or shovel, a ditching spade, longer and narrower, of polished steel, a second ditching spade longer and narrower and stronger than the first, a snipe-bill scoop, a finishing spade, and a pick, are the principal tools used in cutting the ditches. The ditching spade may be twenty inches long, six inches wide at the top and four inches at the bottom, and in ground not too hard can be sunk the whole depth by the operator using an iron shank screwed upon the sole of his boot. The digger always works backwards, clearing out the earth with the scoop every two or three feet. These implements, till recently brought from England, are now kept by advanced hardware-men. The best implement, however, that we have yet heard of, may be had of Mr. Wm. Rennie, of Toronto, at a cost of $275. It is his recently invented "Elevator Ditching Machine," which is guaranteed to cut from one hundred to two hundred rods of three feet ditch in a day in ordinary subsoil, of which we shall say more further on. It is therefore extremely probable that this labor-saving invention will soon leave the ditching-spade in its place in the tool-house, keeping company with the scythe and the cradle swung by a dying generation.

In *cutting* the drains the plough is frequently used; four furrows usually are ploughed and the earth shoveled back. A subsoil plough is sometimes used with a strong horse walking in the furrow, then draining spades No. 1 and 2 come into use till the required depth is reached. Sometimes the sides may be so loose that the earth excavated must be thrown well back and then supported by boards, braced by strips of wood.

Grading the bottoms requires great care, otherwise, if the grade is uneven, silt will accumulate in the depressions, underlying water will so soften the ground as in some instances to displace the soil, and even decompose the tile itself. The scientific method is to use a measuring staff with arm at intervals, to get the exact depth at these places, boning rods for sighting planted where the measuring rod stood, and the line and plummet. In grading these spaces three men are required, one to sight, one to hold the plum-rod, and one to do the grading with the finishing spade, and scoop or pick, as the case may be. The method discovered and practiced by Mr. F. Malcolm, of Innerkip, and since it has been made known, adopted by many others, is simpler, quite as effective for ordinary purposes, and therefore more scientific. We quote his own words: It simply amounts to this! "The erection of a line five feet above where the bottom is intended to be, so that the eye may be used in making it horizontally straight. Drive stakes in pairs, one each side of the drain, and nail a strip of board between them, the upper edge to be straight and five feet from the intended bottom. If the drain is to be three feet and a half deep, the upper edge of this board will be one and a half feet from the surface of the ground. The distance between those sights will depend on the length of the drain, that is on a straight line. The finisher of the drain should always have some two of the sights before him, and with a rod similar to the half of a carpenter's ten foot pole, try the bottom by setting it on end at every two or three feet, and sighting over the top, which (when the proper depth is reached) should always correspond with some two of these horizontal sights. The trouble of erecting these sights may be largely dispensed with by simply driving board stakes (the upper end being a few inches wide) at such points as will not interfere with the digging beyond the point to be dug at either end of the drain. But the upper end must always correspond with the line five feet above the intended bottom. I say five feet, but any height may be used that is most convenient to the digger. If his sights are six feet above the bottom, then his rod must be six feet long in order to correspond." The prime importance grading occupies in cutting drains will justify the length of the quotation.

Canadian practice oftener grades by means of the water in the ditches at the time of digging, but this is objectionable when it can be avoided, owing to the softening of the foundation by the action of the water. It is common practice to place the foot on each side as it is laid to ensure the firmness of position, when the bottom of the drain has been thus softened it is difficult to make even joints.

The *width* of the ditch should be considered, which will vary with the depth and the nature of the soil. The wise rule is to avoid all unnecessary handling of earth. Ditches four feet deep do not require a width of more than twenty inches at the top, when three feet deep, fifteen to eighteen inches will suffice.

Brooks carrying the water from springs should be "jumped" until the tiles are ready to receive the water, lest it undermine the banks of the newly cut drains and keep the bottom too soft for efficient work. If need be the water may be conveyed temporarily in a different channel for a time, where this does not entail too much labor and where the nature of the ground admits it.

Tiles may be placed in *position* by an instrument made for the purpose, but Canadian practice usually places them in front of the operator standing in the drain and making the joints as close as possible where necessary, by means of the tile-pick. A close joint is very desirable, especially when collars are not used. The difficulty is not in securing the means of ingress for the water, but in having the joints sufficiently close to keep out silt. Round tiles may be laid on any side which lessens the labor of jointing, the large ones being kept in position by lumps of earth and stones between them and the sides of the ditch, while great care is necessary in laying the tiles properly, it may be in a decreasing ratio, as the workman ascends the drain. In ditches when there is running water the laying of the tiles should follow close upon the grading.

Practice differs as to whether the drain should be laid open from end to end and the tile-placing commence at the beginning or the terminus of the drain, or whether it should be done by commencing at the lower end, working upwards and finishing piece by piece. The condition of the soil and the extent of the fall should decide the course of action here. When the soil is wet and soft and the fall is slight, the former course should be adopted, as it is not wise to allow such muddy water to run through the tubes, but when there is little or no water it is preferable to commence at the outlet and work upwards, in which case but little is hazarded from the fall of heavy rains.

In *filling* the trench, some first chip down the sides of the drain, trampling the earth thus dislodged with the feet firmly around and above the tiles. Where this is not done the firmest of the earth, free from stones, should be thrown in, gently at first, and when filled to the depth of fifteen to eighteen inches, trampled by the feet of the workman, and some say that it will be labor well spent to ram down the earth occasionally with a maul for the purpose, with a view to hinder the too free filtration of water from the surface, which carries silt with it. Surface water should reach the drains laterally or, better still, from beneath, which is usually the case.

Our countrymen, however, do not usually take this