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Drainage.

Horace Greely, who, some years ago, passed the remark, "Go west, young man," also said that any land worth plowing was worth draining. This, with certain limitations, I believe to be true. The cost of drainage may exceed the value of the land after it is drained, in which case, or in cases approaching this result, the advisability of drainage is donbtful; or the land may be so perfectly drained by nature that, though the land may be benefitted, the additional returns would not justify the expenditure; and it is well to emphasize the fact, that some land which is plowed is not worth plowing and consequently not worth draining. There is no well defined line of demarcation between soils which can with profit be under-drained and those which cannot; under-draining is not a panacea for all ills, not even the effects of bad farming. But in order to know when it can be profitably applied to farm land it is necessary to look a little into the working of nature.

Soil is porous, and like a sponge, retains in its texture by attraction, a certain amount of water. When any in excess of this is added, it sinks to the first impenetrable strata, or stratas through which it passes but slowly, and from then rises higher and higher as more is added until it finds a lateral outlet; just as water poured into a pail will rise higher and higher until it finds an outlet in the side of the pail or until it flows over the top. Thus descending into the ground, we come to a certain point where the water is stagnant. The most common sources of moisture are rain and snow, but there are other causes of an excess of water in soils which would otherwise have a sufficient outlet *e. g.* when water is poured out on the surface by springs or from the high lands.

For the germination of plants, there are three requisites: warmth, air and moisture. An excess of moisture in the soil, besides being in itself hurtful to the plant, excludes the other two and prevents proper cultivation of the soil. If the water rises very close to the surface or is swampy, the seed rots in the ground and only acquatic and other wild plants and grasses will grow.

Under-draining supplies the necessary outlet for this excess of moisture, and at proper depth from the surface. This means, in effect, that the soil is deepened, for the roots will then strike downward and the plant obtains wider feeding ground, stands more firmly in the earth and has a greater depth of earth to protect it from the summer drought. The season is lengthened for growth and cultivation. A strata of ice below the earth's surface melts very slowly in the spring. But when the earth is rendered porous by under-draining, even though the frost may have sunk deeper through the removal of the stagnant water, the melting snow and the warm spring rains quickly pass through the porous earth and it is more quickly warmed and dried for growth or cultivation. That the soil may retain a healthful and proper degree of moisture, it must be pulverized as much as possible, and in order to be pulverized it must be moderately dry when plowed, otherwise it is left in hard lumps. Pulverization of soil, besides rendering it more capable of retaining moisture, enables it to absorb the dew and the moisture from the air during the season of drought. It is the chrystalization of stagnant water, a short distance below the surface which results in winter killing. Drained land is lighter to work, is less injured by cattle in feeding, loads may be hauled on it with less injury, and surface washing is prevented. It permits the rain to pass freely through it with its wealth of ammonia carbonic acid, and other fertilizing vapors absorbed from the air. It permits air to reach the roots from which they may obtain their needed supp'y of oxygen, since an excess of water excludes the air. Drainage also warms the soil as it prevents evaporation and permits the air and warm rain to enter its pores; as heat will not pass downward in water, it removes the excess of water which would retard the condition of the heat downward from the surface of the ground. Under-draining protects the plant from drought as well as from too much moisture.

When and to what extent under-drainage is needed can only be learned by close study of each particular soil and the underlying strata, together with the general geological formation of the district. The depth in our climate where we are subject to severe frosts should not be less than four feet or three feet at the least. Very retentive soil requires a less depth than those which are porous.

Omitting the consideration of frost, the deeper drains are in any case more efficiency, for as will be inferred from our previous remarks on the theory of draining the greater portion of the water enters the tile from the bottom, not from the top as usually supposed. It is good practice in very porous soils to put a roof of clay directly over the tile to prevent it directly receiving the water. Water entering from the top is very apt to carry sand with it, while it has not been sufficiently filtered of its fertilizing substances. The deeper the drain, the fewer drains will be needed. The distance of drains apart must vary with individual circumstances. As has just been said, depth compensates for distance. Some lands need drains ten feet apart, in others six to eight rods is not too great a distance. In this the land owner must be guided by his knowledge of the porosity of the soil, the amount of water to be carried off and the fall which can be given to the drain.

Whatever draining is done, should be carried out in a systematic manner. A plan should be drawn showing the location of every drain, together with the general topography of the land. Stones should be placed at the corner of the fields and measurements referred to them. Drains should as a rule be laid down in the direction of the greatest fall. The greater one's experience in such matters, the more thoroughly he knows the impossibility of correctly judging it by the eye, unless the fall is very great. Nor can tile be evenly laid by the method usually adopted, viz: judging the fall by the water level. If a drain is worth putting down it is worth constructing properly. It adds very little to the business of the engineer to make a survey for a system of tile drains, staking them out and giving the depths from such stakes, but no money can better be expended by the land owner. The capacity of a tile drain is limited by the activity of the bore in its smallest part. If tiles are laid unevenly, hollows act as miniature catch basins for sand and other material, which clogs the pipe, and to that extent diminishes the whole capacity of the drain above. A drain will work satisfactorily with a fall of 3.20 feet to the mile. Six feet per mile is considered a good fall. The less the fall the greater the danger from obstruction, but with a great fall there is more necessity for careful laying, as at the times of a rush of water, the water may force its way through the joints, and washouts are apt to occur. In laying tile care should be taken to make the joints as close as possible. The closest joint that can be made freely admits the water, and large openings allow sand, etc., to enter the pipe. By revolving the tile or perhaps turning end for end, equal contact all around can be secured. In joining one drain with another, some difficulty is experienced. The smaller drains should not meet the main drains at right angles, but should be curved so as to permit the water in it to enter the main drain in the direction of the current. A junction should be made by the use of a branch tile in the shape of a Y, as cutting and fitting tile to one another can rarely be done successfully, the tendency being to cause an obstruction.

Outlets should be as few as possible, and to this end the smaller drains should if practicable, be carried to one large main drain and thence to one common outlet. The outlet is usually a very much neglected portion of the drain. It should, if possible, be constructed of an iron pipe supported by stone masonry. Tile, when exposed, cannot be safe from frost or the treading of cattle and consequent filling up. It should be protected by an iron grating or screen to prevent frogs, mice, and other vermin entering and choking the drain. It is common to see the tile outlet completely submerged in mud, and you need scarcely be told that this is bad