COMMUNICATIONS

ON

DRAINAGE

AND OTHER CONNECTED

AGRICULTURAL SUBJECTS,

FROM THE TRANSACTIONS OF THE

VIRGINIA STATE AGRICULTURAL SOCIETY, FOR 1857.

THE DRAINAGE OF MARLBOURNE FARM.

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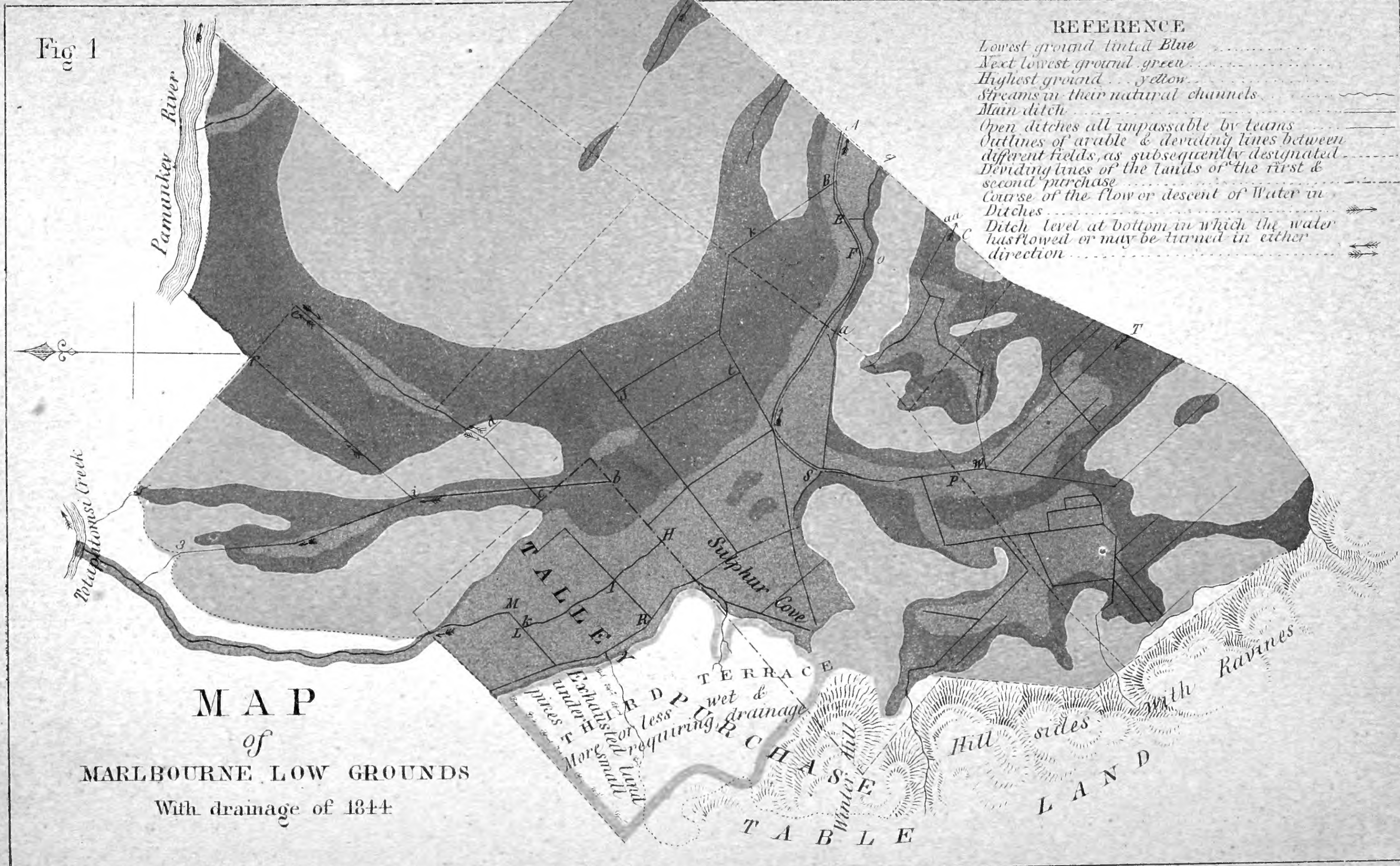
The low-grounds of Marlbourne farm, on the Pamunkey River, have remarkable and important conditions in regard to the supply of injurious water, and its being diverted by proper drainage. These conditions, when first noticed by me, and also for years afterwards, while they demanded my investigation, and more and more directed my draining labors, were also supposed to be peculiar features of this farm, or, of its neighborhood, as none such had been then observed elsewhere. But it is more probable that the like remarkable characters of land and water, and the like requirements and difficulties of drainage, belong also to many other and remote localities of bottom-lands bordering on this and other rivers. Further—from recent and extended personal observations, made long after the writing of this report was begun, I have learned that the like remarkable and important character of land, and conditions of injurious water, extend generally throughout the low and level lands of south-eastern Virginia, and the much broader surfaces of similar lands in North and South Carolina. And I now infer, that throughout all this great region, the natural conditions of the supply of excessive and injurious water, and the great and general difficulty of draining, are similar to those which I have had to contend with—and which conditions have scarcely any where been understood, or the difficulties properly treated in practical operations. Yet, these very conditions which, while neglected or unknown, have heretofore operated as insuperable difficulties to the effective drainage of such lands, when understood, and made to direct the plan and labors of draining, will be the best means for both reducing their cost, and greatly increasing their efficiency.

When first occupying this farm, all my previous labors and experience in draining had been on lands of entirely different character. The general principles and laws of draining are indeed uniform. But my former practice, and errors, and failures, and also the successful operations on the small spaces of narrow and sandy alluvial low-grounds of the high and hilly lands of Prince George county—bordering on small and rapid streams, sometimes hastily and enormously swollen by heavy rain-floods pouring down from the hills—afforded no precedents, or instruction, for my later occupied farm, where almost all the conditions were reversed. In some cases, my previous experience served to mislead the later efforts, made under circumstances so different. A total stranger to my new locality, and to all that was required for its proper drainage, I found no existing practices, or even opinions, of other persons, from which I could gain any useful lessons for my instruction. Few, if any, of the numerous farms bordering on the Pamunkey needed draining labors of such difficulty and magnitude as did mine. But every such farm needed more or less of additional draining; and everywhere, within my limited range of observation, there was great deficiency of proper views to direct such labors, and consequently of profitable results from the actual and also very laborious operations.

The extent of land of this farm when first bought and occupied (Jan. 1844,) and then or since made arable, (exclusive of some 22 acres of high table land around the mansion, now included in the permanent pasture,) was 730 acres. All this is of low-lying land, except some 10 acres of Winter Hill, which is a high and narrow spur stretching out from the main body of table land. (See Map, Figure I.) The later purchase, in 1850, of the adjoining Talley tract, of 300 acres in all, gave the additional surface for tillage, after all the forest part had been subsequently cleared and drained, of about 49 acres of low land, besides some 52 acres of the higher terrace, or "third low-ground," principally. Thus the two tracts which now make Marlbourne farm, together contain (730—10=720+49=) 769 acres of "second low-ground" or of the middle terrace. Of "first lowground" or the lowest terrace, subject to inundation by even the highest freshes of the river, there is not an acre of the farm—nor any other ground except along the face of the steep bank of the river. Neither is any part of the soil of the farm formed by river alluvium, or the deposition of sediment from the river floods. In the present condition of the river, and of its highest floods for thousands of past years, it may be safely asserted that the river has not covered, and could not have affected, any other than lands of the lowest terrace, or "first low-grounds," which constitute considerable proportions of many other Pamunkey farms. But even these lowest lands (of other properties,) whether rarely or often submerged, have gained but little either of accretion or of fertility of soil, from the scant and poor sediment of the river floods—and in some cases, these lands have lost much soil, and even sub-soil, by the recent washing and denuding action of the strong currents of the high freshes. These facts are mentioned to prevent the common and entirely erroneous inference of strangers, that the low-grounds of this river, below the head of tide, are of alluvial formation—except, (and this but partially,) the lowest lands, still subject to inundation, and in some cases also to denudation. The highest and the middle (or third and second) low-grounds entirely, and also the lowest for its sub-soil, have been formed mainly by the reverse or denuding operation of the great flood, which at a very remote (but the latest) geological epoch, rushed, from the north-west, over this whole region, and washed and scooped out and shaped the now valleys and bottom lands, and the present channels of the tide rivers—after the same flood had previously deposited its drifted and suspended materials over the whole surface, and of which entire deposit the present high table-lands and all their lower beds are formed, as the present bottoms were by the earlier deposited earth. The great deposition of drift, or suspended materials, and that mostly of barren earth, which is general over the higher surfaces in our tide-water region, also served to add something in material and more in fertility and value, to the bottom-lands of this farm, as of all other bottom-lands, or high flats, bordering on rivers. For though one part of the great action of the deep and violent and long-passing flood was to wash off and remove the previously accumulated deposits—first down to the surface of the now highest terrace, next, by the more contracted current, to the middle terrace, and still later to the lowest, and finally to the present narrow channel or bed of the river—still, in the diminution of volume, and fluctuations of velocity of the current, there were also some new and superficial and partial deposits of sediment left on the before denuded terraces. These deposits occurred successively on each terrace, when the still covering but then subsiding waters were comparatively tranquil, and so the finer and richer suspended earths were then let fall, to form the surface soils of the bottom lands. This manner of action has served to vary the form of the surface and the composition of the soils, as may be seen by any careful observer on the ground, and in facts which will be adverted to in the following account. The course of the great flood was in the direction of the general course and descent of the broad bottom through which the very crooked and narrow Pamunkey river now meanders, forming the low-grounds mostly in different peninsulas or "necks," usually of several miles width. Hereabout, the whole bottom varies from 4 to 5 miles across, from one foot to the other of the high table land on both sides. The latest action of the ancient flood has left the surface of this farm in many long, low, and irregular flat ridges, stretching in the general direction of the great flood, but also in some cases varying, as might be inferred from the different modes of action, and the different courses of particular smaller currents. And the ridges also show soils and sub-soils of all textures, from the closest and most intractible clay to the lightest and loosest sand—and of which soils there were, in their original state, all grades of quality between poverty and great richness. The irregular depressions, or basins, left between the different low ridges, or knolls, for the greater part, had no sufficient fall, or lower outlets, and therefore they had mostly remained under ponds of shallow water, when the land elsewhere had been left dry, or bare of water. Into and through these former ponds, flowed the small streams from springs in the ravines of the high table land. And in the course of ages, the sediment brought down and deposited by the turbid rain-floods which swelled these streams, had served to raise the bottoms of these ponds from 2 to 6 feet, with a very close clay, and also in most cases had added, latest, a deep, black, and extremely rich clay soil. Such, it seems to me, were the producing causes of the remarkable variety and frequent changes of both the different levels of the surface, and of the different textures and degrees of fertility, of the soils of this farm. Reference to the Map, Fig. I. and the explanations thereof, will serve best to show the variations of the levels of the surface—and also the many and great difficulties thereby opposed to the drainage of the farm by even the best system of surface and open ditches—and which difficulties would be still more obvious to an observer of the land itself. This Map (Fig. I.) also presents the numerous ditches, all of them open and impassable by teams, as they were before my own better system was begun. And besides all the ditches that I found, there will appear there some others which I, at first, deemed necessary and therefore dug, while I still trusted to, and aimed to make more perfect, the former plan of mere surface-draining. For the greater convenience of reference, and for comparison with the present condition of things, in this map (for 1844) there is also included the low-ground of the Talley tract, which was not occupied until in 1850. Also there are there designated the divisions of the farm according to my subsequent six-field rotation, which was not established, or devised, until in 1848, and which had not been extended regularly to the later purchased Talley tract, when (in 1856,) I transferred the whole property to my children, and when the rotation, and its division of fields, were changed for a different scheme.

The whole body of low-land, of both properties, had long been cleared and cultivated, except about 26 acres of both tracts, and which space is within the letters *R*, *I*, *c*, *b*, *H*, in Fig. I. This land, mostly of rich, low and wet swamp, which I found under its original heavy forest growth, was cleared and brought under tillage at different times from 1845 to 1855.

Fig 1



MAP
of
MARLBOURNE LOW GROUNDS
With drainage of 1844

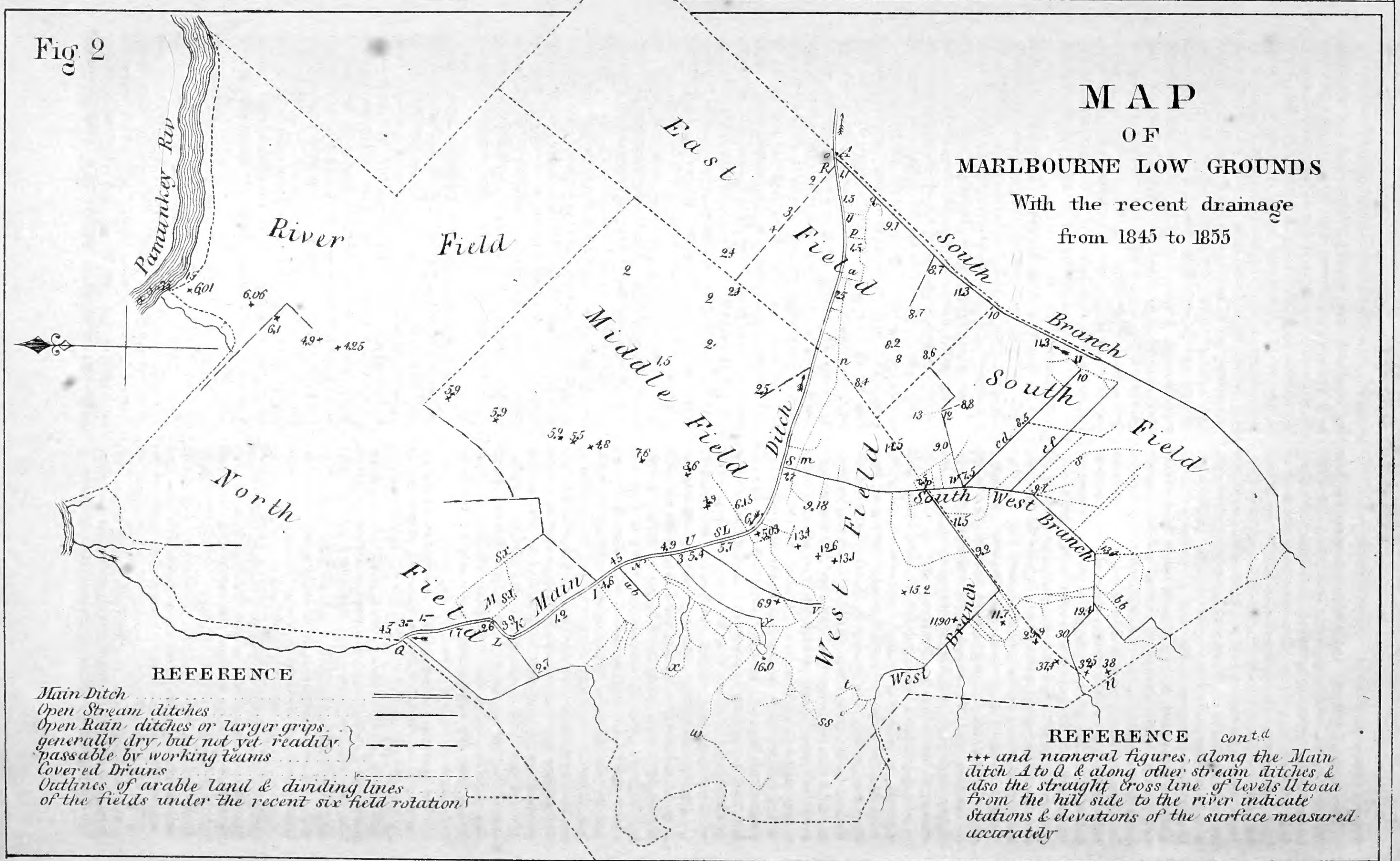


Fig. 2
MAP
OF
MARLBOURNE LOW GROUNDS
With the recent drainage
from 1845 to 1855
Pamunkey Riv
River Field
North Field
East Field
Middle Field
West Field
South Field
South Branch
South West Branch
West Branch
Main Ditch
REFERENCE
Main Ditch
Open Stream ditches
Open Rain ditches or larger grips generally dry, but not yet readily passable by working teams
Covered Drains
Outlines of arable land & dividing lines of the fields under the recent six field rotation
REFERENCE cont.d
+++ and numeral figures, along the Main ditch A to Q & along other stream ditches & also the straight cross line of levels U to aa from the hill side to the river indicate Stations & elevations of the surface measured accurately

The map (I.) shows the numerous open ditches which had been dug, and were designed to be kept open to their first depth, and all of which were then deemed indispensable. Yet not one of them operated properly, or sufficiently for its designed purpose. When properly located, and if deepened and well-shaped, the larger ditches might have been made to serve well as stream-carriers, and to receive the surface-water only. But of all the ditches designed to tap and collect spring or under-water, none of them could have been made effective, by any care or labor, because it was impossible for any ditches to be kept open deep enough for that purpose, even if any had been dug deep enough at first. Therefore, while all of these numerous ditches, as here marked, were impassable by teams, and therefore all constituted great impediments to tillage—and every one, as serving to remove some water, was necessary to be kept open, not one of them served its purpose fully or effectually; and all the land that had required draining at first, was still suffering, more or less, by excess of water—and would have so suffered even if every ditch had been kept as deep, and in as good order, as had been designed at first.*

The positions of streams and of the larger wet ditches, as shown on Fig. I, generally indicate, with sufficient distinctness, the lower levels of surface compared with stretches of other ground on one or both sides. But there are sundry exceptions to this rule, especially on the higher grounds; and some others may be seen on the maps, in cases where ditches, to connect detached basins, or to drain basins, have to discharge through rims, or ridges, of higher surface. Besides the indications of lower levels presented in the positions of ditches, and the courses of the streams, the grounds of the lower and lowest levels are distinguished by suitable markings, and by different colors on Fig. I. and further, by the marked levelling of different lines and points, stated in numeral figures, on Fig. II. But it should be observed that the three different levels indicated by different colors, are only relative to adjacent surfaces, or bordering grounds. Absolute differences, or grades of elevation, will be indicated according to the actual measurements, and all in reference to the lowest original surface of the low-ground of the earlier purchase, which is the point designed by the numeral 0, near *A*, the eastern outlet of the present main ditch, (Fig. II.) It may be stated, generally, that the differences of elevation of adjoining surfaces are mostly slight, and the changes very gradual. The few exceptions to this rule occur where the lowest of the three marked grades of surface adjoins the highest, and when the latter is also of the sandy dry knolls or ridges. These only, where highest, rise to heights from 8 to 12 feet above the lowest grade, and which extreme elevations are in some cases near together. Omitting a small extent of such highest knolls of the second terrace, and the whole of the higher third terrace, the whole low-land of the farm would seem to the first glance of an observer as very nearly level. And when viewed from the edge of the nearest high table land, not only this, but the like low-grounds of several adjacent farms in sight, for miles both in length and breadth, would seem, to the eye of a stranger, to be of one uniform level surface.

The textures and degrees of fertility of soil vary greatly, and within very close distances. The most clayey and the most sandy—richest and poorest—the higher and lower levels of surface—or the wettest ground (naturally,) and the dryest of the farm—severally are, in many places, within a few yards of other ground of the most opposite conditions. These many and great variations of character add greatly to the difficulties of drainage. The land of lowest surface (tinted blue on Fig I.) is nearly all of stiff clay. Most of this land is supposed to have been formerly covered by ponds of greater or less depth. Those which were deepest at first, and surrounded by higher rims of enclosing ground, are still of lowest relative surface, and the sites have been covered by rich sediment, forming a black stiff soil. And most of such land continued to be rich, because too lately or imperfectly drained to have been exhausted by tillage. But some parts of such ground, and also the lowest, as the parts near to both the out-lets of the present main ditch (*A* and Q, Fig. II.,) were mostly as poor as any land could be found under tillage. These impoverished portions, though less formed of recent sedimentary deposit, still must have been formerly very rich. But as this land had never been half-drained, at best, and probably had always been ploughed wet, and often tilled when wet, this treatment, much more than the exhausting course of cropping, was the cause of the remarkable condition of poverty produced—and probably brought about before a single good crop had ever been raised on this formerly rich land.

In and among, or bordering on, this lowest land, there lie the next and but slightly higher grounds, (colored green on Fig. I.) These portions are in some cases sandy, but mostly are of very stiff yellowish gray clay, with stiff deep and poor subsoil, of like texture. All these surfaces seem to have been of but a moderate degree of fertility at first—and generally had been reduced to extreme poverty before I began to improve or cultivate them. All this land, as well as the still lower levels before mentioned, suffered much from the effects of wetness, and all needed to be drained much more effectually than ever had been done in any case.

Most of the remainder of the land, (entirely tinted yellow,) is of the different higher levels of the "second low-grounds." In general, where both high and sandy, as is usual, the ground of this class needed no draining. It has, generally, a pervious and dry sub-soil, and the like under-beds, and thus the soil is naturally and effectually under-drained. This land might have been ploughed

* The engraver of the maps has not correctly copied the drawing in the dotted or broken lines, and which defect, to prevent mistakes of the reader, will require this additional explanation. The dotted and broken lines in Fig. I. do not in any case represent *drains* or *ditches*—but only imaginary *boundary* and *dividing* lines of different fields or properties. Therefore when these same lines appear in Fig. II. of course they represent the same imaginary demarkations—and therefore need not be mistaken for (even when too much resembling,) the other dotted or broken lines introduced in Fig. II., one of which (- - - - - -) represents rain-ditches, and the other (..............................) represents covered drains.

The marks of levelled stations, stretching across from the foot of the hill in South Field *l l*, Fig. II., to *a a*, at the river, should have been arranged in a straight line—but which is made crooked by incorrect drawing. The numerals at these (and also sundry other stations,) show the elevation of the surface, (in feet and tenths,) counting from the station 0, near *A* (Fig. II.) the lowest arable surface of the orignal tract. All the numerals indicate heights above the station 0, except the three most northern marks along the main ditch (near *Q*) and two others next to and at the river. These are *minus* quantities—or so much *below* 0. The height of the surface of the water-bearing stratum (gypseous earth) out-cropping on the river bank, is 15 feet below the level of 0, and the river, at low water, is about 35 feet below 0.

and tilled flush, (or without ridges and alleys, or water-furrows,) except that the spaces were so small, or so irregularly intermingled with those of lower and wet ground, that different modes of tillage would have been inconvenient. The land of this class, when of clay soil, or medium loam on clay sub-soil, (as generally in East, Middle, River, and North Fields,) needed to be cultivated in beds, with good deep alleys, and cross-grips through all lateral depressions. It will be shown that these formerly indispensable surface-drains for even high surfaces, are now much less needed. In the other two fields, lying between the present main ditch (*A* to *Q*, Fig. II.,) and the hill-sides next to the table-land, there are many parts of this higher land, and even far up the slopes of the third terrace, (white with yellow out-line, Fig. I.) and also on the higher slopes of the table-land itself, that were oozy, and entirely too wet for tillage—and if tilled, to yield any profitable product. The old plan of drainage attempted for such land, by shallow open ditches, had been entirely insufficient, and generally of no useful effect. It was some time after my earliest and also improper labors for draining on this farm, that I first learned the following remarkable fact: While there were numerous small springs and oozes in the higher grounds of the land south and west of the main belt of lowest land, through which the present main ditch extends, and spring water could be readily reached by digging ditches in many parts of the higher grounds of South and West Fields, there was not a spring, nor had any vein of water been reached by the deepest ditches, in all the other four fields east and north of the line of the present main ditch. Springs were found only, (and these were numerous, and abundant in water,) bursting out low down on the face of the river bank, or on the sides of as low ravines, emptying into the river. The cause of this strange non-appearance of spring, or under-water, and that too in land which, for the greater part suffered greatly for want of drainage, will be shown hereafter.

It should be observed that the different nearest levels and grades of land generally pass from one to another so gradually as to be almost imperceptible. It is only where the highest borders on the lowest, (yellow touching blue, on Fig. I.,) that a considerable difference of level and appearance may be inferred to exist. In the much greater number of cases, where different elevations of ground are indicated by blue and green tints in contact, or yellow and green, it should be understood that the actual dividing lines are uncertain, and that the land is very far from showing the distinct outlines of levels which are necessary, for illustration, to be presented on the map.

When I first took possession of this farm, (January, 1844,) all proper care of the previous plan of drainage, such as it was, had been so much and so generally neglected, that I could not at first see or understand the operation of the numerous existing ditches—so much were they choked in many places, and their former action prevented. Numerous as were the ditches, and nearly all of them then holding water, and passing it off continually, to some extent, over more or less of obstructions, all the lower land was everywhere extremely wet—and but little, if any except the highest and sandy knolls, seemed then dry enough for tillage. The obstructions, caused by the washing down of sand in the upper parts of the stream-ditches, and of mud in the lower parts, the caving in of the sides, the rooting of hogs, and the long-trodden crossing-ways of cattle, made almost every ditch, (where not quite filled,) a miry pool of water; which, whether derived partly from springs, (as I at first erroneously inferred to be general,) or immediately and only from rains, the supplies of water seemed to have permanent or long-continuing sources. Indeed, in winter and spring, water was always passing off slowly from every such obstructed ditch. Having heard that the farm had formerly been under the charge of some good managers and drainers, I too hastily thence inferred that the existing ditches had been properly planned and placed for the experienced wants of the land; and that, if cleaned out, and still more, if enlarged and deepened where obviously insufficient, they would at least serve to keep the fields dry. It was midwinter when my operations were begun; and the ditches and the land were then in the wettest condition. It was essential to remove the injurious water as soon as possible, from at least enough land for the next corn crop. The then main ditch, descending from *P* to *A*, Fig. I. and the receiver from nearly all the other ditches, though the most needing deepening, could not then be helped, because of the strong current, and the margins, everywhere raised by banks, being too high, and the sides too steep, to permit laborers, standing on the banks, to clean out and open the ditch, with hoes. But in this imperfect and tedious mode, (to prevent the laborers standing in water,) most of the old and shallow ditches were then cleaned out; and subsequently, in warmer weather, the main ditch, and also the long and (as then supposed) important ditches of North and Middle Fields were not only cleaned out to their first depth, but still more deepened by the spade. It was not until after much of such deepening had been done, that I found that a large proportion of it was worse than useless; and that narrow grips, or, at most, shallow rain-ditches would suffice, where I had deepened old ditches, and dug some new ones, to reach and draw off under-water where none could be found. Much of this old ditching, after this deepening, and also most of my early new work in aid, had to be filled up, at different later times, after being substituted, or rendered entirely useless, by the making other and effective drains in other places.

Deeming it proper and necessary in a report of this character that the soil and surface of the land in question, and especially the relations to wetness, should be described clearly, the foregoing description has been made as full as seemed to be required for the object. But for the remainder, and in reference to all the actual proper subsequent operations, a much more concise method will be adopted—omitting all details of practice, and, for the greater part, stating only general operations and results, and the general changes already produced, and others deemed certainly in progress, and which will occur hereafter, from labors already completed, or others still in progress.

The great and all-important cause of the general wetness of this land, (the confined under-water,) was not even suspected, until after I had begun to construct covered drains, deeper, indeed, but still much too shallow at first, in substitution of the previous general system of shallow open ditches. And it was some years still later, before I knew certainly that this cause of wetness was generally existing beneath the low-grounds. And even then, after learning that the pervading and general source of wetness was under-lying and confined and upward-pressing water—and thence correctly inferring the proper remedy—still I could not adopt the proper and then obvious means for relief, because not then able to command, for deepening, the proper out-lets for the water. Omitting all details, both of my wrong and proper procedure, I will proceed to describe the natural conditions of the under-beds of the land, and the under-water, and to state, in general terms, the several different plans of drainage successively attempted.

Under the whole body of low-ground, there lies a bed of wet and generally pure sand, or other permeable earth, of unknown thickness. The upper surface of this sand bed approaches to being horizontal, but has a slight general dip, in the direction of its course from beneath the high table-land towards the river, in the bank of which this bed crops out. The dip is not uniform or regular, and the height of the surface of the sand-bed has many variations. Under all the lowest land, it is rarely so near the surface as 4 feet, and is more generally 6 or 7 feet below the surface of the soil. Under the high sandy knolls or ridges, the sand-bed rises higher, and intermixes insensibly (as to texture) with the higher and dry sandy sub-soil. The annexed conjectural profile of the strata will serve for better explanation.

In the entire profile or cross-section of the strata, (embracing Fig. III. and IV.,) the perpendicular distances, and also the dip of the strata, are much exaggerated, so as to be made plain to the eye; but the principle of the operation of the water, and of the remedy, is not thereby affected.

Suppose the wet sand-bed, *e*, Fig. III., to extend, from under the higher land, descending very gradually and slightly towards the river, passing first under the high sandy soil *a*, Fig. III., and next under the black alluvial clay of the lowest level, *b*, *c*, *k*, Fig. III. and IV. (tinted blue in Fig. I.)—next under the slightly higher clay soil *k* to *l* (tinted green in Fig. I.) and its like impervious sub-soil and under-bed of clay—to the river bank, where the water of the sand-bed first found discharge in a line of numerous and copious springs, which burst out over the top of the impervious bed below. This lower bed here is of gypseous earth—which elsewhere is replaced by marl, or by clay. Here formerly was the first continuous or considerable out-flowing of the water, after its long and slow passage, by lateral percolation, under the low-grounds, for some two miles of distance from under the table-land.

It may be inferred that the same sand-bed extends, in the opposite and ascending direction for miles under the high table-land, and the covering clay stratum, and gradually rising to "crop out," and to form the expanded general soil at some remote locality.* There the rain sinks through the surface soil into the lower sand, and to the next lower and impervious bed—and thence the water percolates laterally along the dip of the beds, to supply and to surcharge the continuation of the sand-bed under the low-grounds, and thence to the river. In the earlier portion of this long under-ground passage of the water, and where it had the highest elevation, it is probable that the sand-bed was never quite filled by water—and therefore, while oozing through, and glutting the lower sand, for a long distance, the upper layer of the sand-bed might still keep dry. But as the rate of the

* In this neighborhood this sand-bed probably reaches the surface and forms the general soil and sub-soil of the level sandy ridge between the Pamunkey and Chickahominy rivers.

Fig. III. *Profile of Strata—South of Main Ditch.*

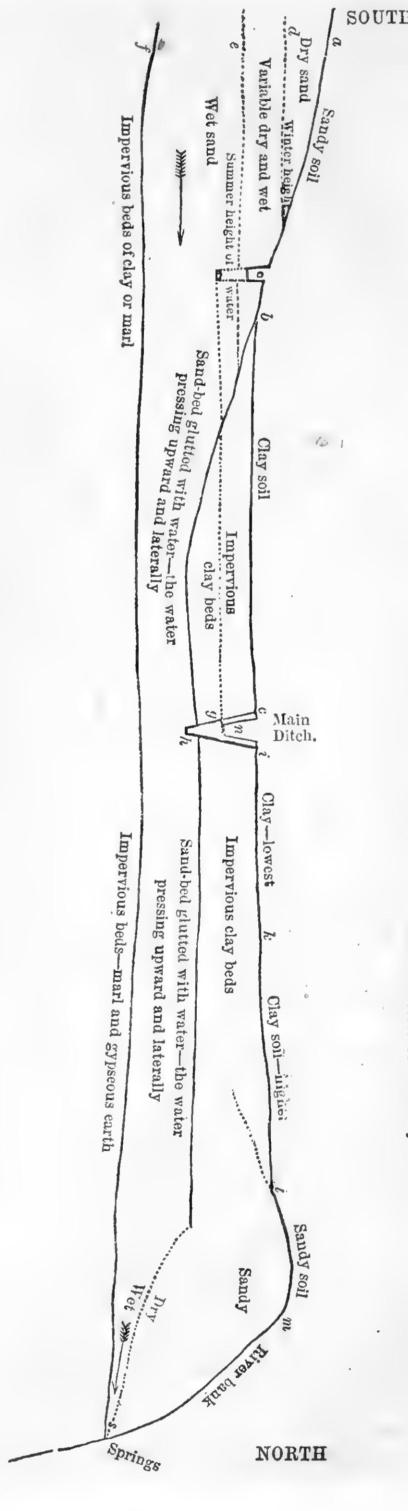


Fig. IV. *Profile of Strata produced. North of Main Ditch to River.*

lateral progress of the water, and of its final discharge, was much slower than the average supply to the upper sources (and elsewhere) by rain, the obstructed water would necessarily fill the sand-bed at some lower place, (as under *b*, Fig. III.) up to the impervious clay above; and still farther on, and lower, the water would press upward, in proportion to the measure of the higher level of the distant water, and the pressure of its weight on the water confined below. According to a well-known law of hydrostatics, water, so confined between two inclined and impervious beds, and pressed on by the weight of all the remote water standing at a higher level, would rise perpendicularly, if a vertical passage were afforded by a well, or an auger-hole, to a height equal to that of the distant and higher standing water, pressing thereupon.

Therefore, if the sand-bed was surcharged, and its water pressing upward with sufficient force under *b*, (Fig. III.) where the glutted bed approaches nearest to the surface, a spring, or ooze, might there be formed, either permanent, or otherwise flowing or oozing out only when the sand-bed was fullest of water. Or, even without showing any separate water, the soil there might generally be too damp and cold for healthy production.

The longer the lateral course and passage of the confined water, and the lower its forced depression, by the superincumbent impervious bed, the greater would be its tendency to rise, by filtration. Under these circumstances, wherever the surcharged sand-bed passed under clay, there would rise injurious dampness by means of upward pressure and filtration, or still higher by the operation of capillary attraction of the upper earth. And this injury from wetness might occur even where no water was ever found in the digging of ditches, or was seen separate, except such as had fallen in rain on the surface, and which could not sink and escape by percolation, because the lower bed was already full of moisture, and could receive no more.

But in the case of a partial discharge of water at *b* (Fig. III.) or not, either the greater portion, or the whole, of the under-water, still surcharging the sand-bed, would continue to press onward in the direction of the dip of the bed and its impervious cover, to beneath *g*, and thence to beneath *k* and *l*, the clay soil of higher elevation—and thence, under the still higher and also dry sandy land near the river, to *s*, the out-let in springs bursting out on the surface of the lower impervious bed.

Before any drainage had been attempted, and also, and to great extent, after the former shallow and insufficient ditching, the constant upward pressure of the confined under-water served to keep the lower parts of the incumbent beds always damp, and very unfavorable to tillage, and to the production of the soil above, even though no water might be seen to rise, or to stand; and none was so seen in the low-grounds, except in some very few feeble and temporary springs, and none of these north of the line of the present main ditch. With these inconsiderable exceptions, the only water seen was that of the several streams which passed through the farm, and the rain-water which, when in excess, stood for more or less time on every low depression—and also wherever the land generally suffered from moisture, without showing any other than rain-water. Accordingly, the only aim of the earlier attempts to drain, (i. e. on the *first plan*,) was to collect the rain-water from the surface, and to conduct it off with the streams and their temporary rain-floods—which objects were but imperfectly attained. The general opinion then was, (and perhaps is now,) that draining was only required for land where water, either standing or flowing, was visible on the surface, or could be readily reached by shallow ditches.

This *first method* of draining, in former use on this farm, was to make open ditches to carry off the permanent streams, to the lowest and then only outlet on the farm, (which was at *A*., Fig. I.) These ditches, being too narrow and shallow, very slowly carried off the rain-floods also—which then, from every heavy rain, rose above the margins of all the principal ditches, and overflowed the bordering low-grounds, and sometimes the distant basins, filled by refluent water from the swollen main stream. Numerous smaller, and also open ditches, were cut wherever there appeared oozing water, or wherever rain-water collected in basins. These operated very partially and imperfectly. The best possible operation of these small ditches, and when in their best condition, could only be to take off the surface rain, or other water, which was too much in excess to be absorbed by the earth, or retained on its surface. Such shallow ditches nowhere reached the glutted sand-bed—did not draw off any of its confined water—and could not lessen the upward pressure, and the great and general cause of wetness of the land. Yet every such ditch, at some times, served to gather and carry off a little of the injurious water, which after being drawn up from below, by insensible filtration, saturated the upper soil in many places; and therefore every ditch, seeming to be of some use, was supposed to be indispensable—while all of them together produced but very little benefit, and no complete drainage anywhere. Reference to Fig. I. will show all these numerous open ditches, which formerly were dug, and were designed to be kept open. They were dug no deeper than they were, because the need of deep draining was not then even suspected. And if the necessity had been then understood, it would have been impossible to keep ditches open to the sufficient draining depth.

Before the next, or the *second method* was begun, (my first improvements by covered drains,) I was aware of the importance, (as the very foundation of any system of general drainage,) of deepening the out-let, and deepening and widening the stream-ditches leading to it. And this work was soon begun—including the substitution, by new ditches, of some of the old courses that were obviously and entirely wrong in their position. But it was not until in 1851, after the purchase of the adjoining Talley tract, that I was enabled to make the additional northern and lower out-let, (at Q, Fig. II.,) and thereby was permitted to begin properly the *third method*, and the only proper plan of drainage for this land, by deepening the principal ditches into the sand-bed, and thereby tapping and discharging its before confined water. But this reference is in advance of the actual procedure.

The *second method* of draining attempted was by means of covered drains. These, taken from the then lowest places of discharge, at the bottoms of the nearest open stream ditches, (as at *g*, Fig. III.,) were extended to every wettest spot (as *b* and *o*) and along every oozing line and slope. These drains, designed to be covered as soon as completed, were dug as deep as their out-lets permitted, so as for them to have a slight descent—and they usually reached the glutted sand-bed, or its water forcing a way upward, at the upper end of the digging, where the sand-bed rose higher. Thus every such ditch received some of the water forced up by hydrostatic pressure, and of course every one did some good in lessening the surcharge of water, and reducing the general and pervading evil of the confined water. While much of this work was in progress, and while finding many evidences of particular cases of upward pressure of under-water, still I had not recognized the general existence of this pressure of water from below. If knowing it in many places where no water, or only a little by slow filtration, was found, and which could not be reached by the spade, it might have been tapped by an auger-hole, and drawn up vertically into the ditch and so conducted away. It was much later that good use was made of this aid. With all their defects of both plan and construction, and especially that of all the early diggings being too shallow, the covered drains generally served their designed purposes, at least as long as they continued to operate. But, for want of sufficient depth (that being prevented by the then shallow out-lets, and principal open ditches,) and for other errors of construction, which experience enabled me to correct in later operations, many of these early-made covered drains failed partially, and in some cases entirely, and were repaired, or substituted by deeper and effective drains. In Fig. II., where all the covered drains are marked, wherever two or more are very near to, or cross each other, it indicates that the first had failed, and had been substituted by another.

As the deepening of the old lower part of the main ditch, and the deep digging of the new part, were in gradual progress from 1844 to 1855, and the principal tributary stream-ditches were deepened in proportion, every covered drain, made in later times, could have a deeper out-let, and therefore could be sunk deeper than the older ones, and was so much the more operative, and will be so much the more durable in its operation.

Reference to Fig. III. will better explain the early use and operation of the covered drains. In wet and oozy spots, as near *b*, shallow open side ditches, *o*, had formerly served merely to take off such part of the surplus of under-water as there rose to the surface in winter and spring, or when the under-water stood higher than that level. These ditches did not reach the surface of the summer height of the water in the sand-bed, and therefore, in summer they were useless for their designed purpose. Afterwards, when a covered drain was extended from the then bottom of the old main ditch (*n*) at *g*, along the dotted line from *g* to the old side-ditch at *o*, and that side-ditch also deepened and covered, then the new digging being sunk below the summer height of the water in the sand-bed, operated to draw off water at all times—though still to but small depth, and with no aid from upward pressure of the water, as there was no confinement of the water there.

Later, when the main ditch, at *h*, was sunk, (first by the auger and afterwards by the spade,) low enough to tap the confined water in the sand-bed, the water, under the hydrostatic pressure, would rise with force into the ditch, and its level would be lowered in proportion in the sand-bed, and by this lower and more effectual draining of the sand-bed, all the neighboring covered drains, as shallow as the one here represented, would be left dry, and become useless for their designed object of draining the under-water of the sand-bed.

All the covered drains which reached water in the sand-bed were dug on the south side of the present main ditch (Fig. II.) A few which were made on the north side, (as *SL*, *xy*, and at *R*, Fig. II.) though deep and well constructed, reached no water, even with boring extended into the sand-bed. The reason for this will be seen hereafter.

As soon as each field, or separate large portion of land, was provided with covered drains, the older open ditches were mostly rendered superfluous and useless, and were filled with earth. The three principal streams only, (South, South-west, and West Branches,) which brought in much surface-water and rain-floods (and also much sand,) from high land outside of this farm, were left in open and deepened ditches; and a few other smaller ditches were left open for full trial, which are designed to be soon converted to covered drains. These are the ditches *VU*, *x*, and *ab*, (Fig. II.) in West Field, and *cd*, or *ef*, or perhaps both, in South Field. The covered-drains are invisible at the surface of the earth, and of course no impediment to tillage. The stream-ditches which will remain open will be almost the only impediments, and even these obstructions will be much lessened in importance, by the sloping of their sides, and lowering of their margins. A comparison of the number of ditches formerly open, and all of which then obstructions to the passage of teams, as shown on Fig. I., and the few now open, and the still fewer to continue open, will display the great advantage gained in the mere removal of impassable obstructions to teams, and preventions to ploughing and tillage.

After all the covered drains which were at first deemed essential had been constructed, on the land first occupied, I obtained, by purchase, the adjacent land, Talley's, (shown in Fig. I.) which first enabled me to give another and lower place of discharge to the waters of half of the whole farm—and also put in my possession the head sources (on the third terrace,) of sundry springs and under-ground veins, which before I could not command, nor their issues into my former property. These new and important facilities I proceeded to put to use, as soon as my other labors permitted, by extending the main ditch, enlarged and deepened, entirely through the central low-grounds, and making the new out-let (at *Q*, Fig. II.,) as deep as the neighboring property would permit—and the whole ditch (1900 yards) as deep as could then be safely kept open. To obtain greater draining depth than could be done at first by the spade, the auger was used to bore through the impervious clay bottom (of the earlier excavations,) and into the glutted sand-bed, by which much of the under-water was drained upward, in advance of the later and still deeper, and much more effectual excavation by the spade. All of the glutted sand-bed, when first exposed, or tapped, is quick-sand. And even if the first digging could have been sunk deep enough everywhere to penetrate the quick-sand, it would not have been safe to do so at first. If then attempted to be dug into, the fluid quick-sand would flow in from the sides like water—and thus leaving the solid upper clay without support, it would fall in, and nearly fill the ditch. To prevent this evil, it was necessary at first barely to reach the quick-sand, if it could be reached by digging—and then leave it to discharge the before confined water through the new out-let thus afforded, until the general cleaning out of the ditches in the next spring season. Then the upper sand, previously opened, and before quick or fluid, would, by being drained, have become firm; and then a layer (of 7 or 8 inches thick,) could be dug out, before again reaching and having again to stop at the sand still quick. In this manner, and in successive years from 1850 to 1855, I gradually enlarged the whole main ditch, and deepened it to 6 feet generally, and to 7 at one point—reaching the quick-sand for two-thirds of the whole length of 1900 yards, and excavating the bottom into what had been quick-sand full two feet in some parts. Also the quick-sand has been reached by deepening with the spade, for some 1000 yards length of the lower parts of the several larger tributary streams, and of the upper part of the main stream, which is formed by their confluence, (at *p*, Fig. II.) Only at and near the old out-let of the main ditch, *A* (Fig. II.,) the depth is still less than 4 feet, and the quick-sand is not approached—because of my not being allowed to lower the discharge through the adjoining and lower land. This deep ditching into the under-bed of glutted sand was the *third method* used for draining this land, and the only correct principle of procedure. The object had before been but partially effected by the previous and numerous covered drains, most of which derived their supplies of water from the sand-bed below—and in most cases of the earlier works, when the sand had not been exposed to the eye, or its presence and close neighborhood then known. And as the constructing, of covered drains and the later deep digging of the principal open ditches were in progress together, for some years of the same time, and as both plans were, and still are, in operation together, their separate effects cannot be estimated with any opproach to accuracy.

The actual and the necessary operation of this penetrating, for such long extent of diggings, the before confined water of the sand-bed, is to draw in as much water therefrom as can find a lower or more ready discharge by this new and lower out-let than existed before. And in proportion to this measure of relief, or the reducing the previous glut of the sand-bed, so much will be lessened the former upward pressure of the confined water, and its universal though slow discharge to the surface by insensible filtration. The lateral passage of the under-water, through the sand-bed, from beneath the hills to the nearest new out-let into the deep ditches, is still from 600 to 1100 yards of distance—through which, the water has to force its way through fine sand, and with very slight descent. Of course, such passing of the under-water must be extremely slow. But, gradually, the small veins in the loose sand must be washed out larger at and near their out-lets, and these openings will extend higher and higher into the body of the sand-bed, and the water will then flow out faster. The facility for percolation, and the consequent better draining operation, may be expected to increase for years to come. But already, the progress of the operation, though slow, is manifest, both in the greater general dryness and good tilth of the soil, and also in the laying dry of some covered drains, and the lessening the flow of water from many others. These latter effects can only result from lower discharges having been given for the water of the sand-bed. Should the deepening of the main ditches into the sand-bed serve to keep permanently free from water 6 inches depth only of the upper layer of the sand, that would be enough to cut off the previous permanent supply of under-water to every older covered drain—and would prevent all the former upward pressure of water, and its former effect of keeping all the earth above too damp. Further—by the removal of the glut of water from the few upper inches depth of the sand, so much of the sand-bed would thereby be changed from being a continual source and supply of wetness, to a sure means of dryness to all the over-lying earth and soil. For then, there being no wet earth above the sand to constitute an impervious bed, (as all wet earth is impervious to more water,) the excess of rain-water, instead of remaining in pools in every slight depression of the surface, will sink into and filtrate through the then pervious under-earth (even if it be clay,) to the then drained sand below, to be therein absorbed, carried down to the lower glut, and with the other water pass off to the nearest lower out-let. A layer of dry (or well drained) sand, at from 5 to 7 feet below the surface of level land, will as certainly keep the surface soil drained, as the same sand, if always surcharged with confined water, will surely make the surface-soil wet—and will render all efforts to drain the soil of but slight benefit, until the surcharge of water, and its upward pressure, shall have been removed.

So far, nothing has been said of the draining of the larger portion of the land, lying north of the present main ditch, (Fig. II. and IV.) And almost nothing had been done especially for that object, except to keep open rain-ditches through all the lowest depressions of surface, and grips through the slightest depressions, and to have all this land, as elsewhere, kept in beds and alleys, (or "ridge and furrow" culture,) so as to lead off, as quickly as could be, the surface-water derived directly from rains. To these imperfect drainage operations, always formerly in use, I could devise no means of improvement, other than more perfect execution of that plan. Much of the soil was of the stiff clay of medium elevation, (*h* to *l*, Fig. IV. and of green tint in Fig. I.,) all of which suffered from wetness, and yet in which no practicable depth of ditching could find under-water. The causes of both these facts may be seen in the profile of strata exhibited in Fig. III. and IV. The water in the sand-bed, below this higher clay surface, *k* to *l*, had pressed upward in the same way as elsewhere, and as has already been described. And though the over-lying earth was there so much thicker, that thickness did not prevent the earth being injuriously affected, and up to its surface, by the upward pressure of the water confined below. The rain falling in excess on the surface, could not sink into the under-beds, except in dry seasons—(for undrained soil is the dryest of all and very dry and hard in dry seasons—) and of course a small portion of the injurious excess of rain-water could only be drawn off, by means of alleys, grips and rain-ditches, and slowly and imperfectly, because of the almost perfectly level surface of this clay soil.

The removing or lessening of the general surcharge of water, by the later tapping the sand-bed along the main ditch and elsewhere, has reduced the upward pressure, and consequent wetness of soil, on the north side as much as on the south, though in a different mode. And the draining effect of the main-ditch on the north side is the more manifest, because nothing more has there been done than had always before operated. Indeed much less is now done than formerly. For some of the former wet and impassable ditches are now but shallow and usually dry grips; and many former grips are no longer opened. A large space of this land (in River Field,) for which beds and alleys, and also sundry grips, had been heretofore deemed indispensable, has been tilled in corn this unusually wet year (1857) with flush ploughing, and without a grip or water-furrow—or there appearing any indication of the want of either—the crop being the best ever grown on the land. By cutting off, at the main ditch, so much of the former supply of under-water, probably all the former upward pressure of water has been now removed from this land—and the upper layer of the sand-bed may already serve to drain from, instead of supplying water to, the surface soil. This manifest change, and draining effect has been produced generally on land of this description lying as much as half a mile from the nearest part of the main ditch, the deepening of which is the only known cause. This condition of things will serve to explain why the covered drains dug north of the main ditch have not operated to draw any under-water.

If my views and deductions are correct, the draining effects of tapping the quick-sand bed, and reducing its surcharge of water, will increase for a long time to come. And as soon as the effect extends so as to drain the whole upper layer of the sand-bed, then all the covered drains should cease to flow—and serve only (and for that would still serve well,) in aid of surface draining, to draw and to speedily discharge, any excess of rain that may fall on the bordering land, and which will quickly find its way into any neighboring covered drains.

Besides in the greater depth of draining, there has been effected, in connection with the ditches, much improvement, which it will be enough here to slightly mention. The great depth of an open stream ditch can only be maintained by well and broadly sloping the sides—having the width of the top not less than thrice the perpendicular depth of the ditch, and the bottom as narrow as can convey the ordinary stream. To this shape most of the open ditches have been made to approach, through greater or less portions of their courses—and the work will be persevered in until all that are designed to be kept open shall have been brought to the shape and proportions named. When this widening of the top and sloping of the sides shall have been completed for the central and higher portion of the main ditch, then that portion of the bottom may be sunk a foot lower, so as to penetrate to the quick-sand throughout. Already, by thus lowering the margins, and sloping the sides of the rain-ditches, (of which the bottoms usually are dry, except immediately after the fall of rain,) —and of which work, much is effected by the plough, and when ploughing to prepare for tillage—most of the length, of the rain-ditches, even now, are no longer obstructions to the passage of teams, or the running of ploughs, carts, or even the working of reaping machines. In the last harvest, (of 1857,) the reaping machine safely and effectually cut across one of these completed and properly shaped rain-ditches, along which good wheat stood within a few inches of the middle of the firm bottom. Yet this ditch formerly was a standing puddle of mire and water, 3 feet deep from the top of its then raised banks, and served to obstruct tillage and prevent the growing of crops for full 12 feet of width, besides the damage to the tilled crops by the teams turning on both sides of the ditch. Yet the bottoms of these ditches, are now deeper than in their best original state, and are far more effective for draining than any depth could cause, if without the present lowered and sloped margins. By extending this additional improvement to all the open ditches—and mainly by ploughing, (when preparing the field for corn,) so as always to throw every furrow-slice in the direction from the ditches and grips—all the rain-ditches will hereafter be nearly obliterated, as impediments to tillage; and the obstruction of the larger stream-ditches will be very much lessened. Where parts of the rain-ditches are already so shaped as no longer to impede tillage (or ploughing across, if dsired,) so much of the marks for such ditches are omitted on Fig. II. But after a few more years, and of ploughings from these ditches, scarcely any of these present impediments to tillage will remain—and the now obstructing rain-ditches, though then as deep and as operative as ever, will be much less noticeable in the fields, than the marks for them now appear on the maps.

The higher land, or third terrace, throughout, (Fig. I., white with yellow outlines,) which had no ditches prior to my occupancy, nevertheless required, and has received, much under-draining. The injurious under-water, there, was derived from higher sources than the general sand-bed. Therefore these covered drains will not be laid dry by the deepening of the main ditch, or any other now open ditches.

An important improvement has latterly been made, of different character; not operating directly to drain, but indirectly, by diverting or dividing the great rain-floods which came down the bed of South Branch from high and hilly lands outside of the low-grounds and the farm. This stream formerly pursued the very circuitous course shown in Fig. I. (from *T* by *P* and *S* to *A*.) Since, by cutting a ditch along the boundary line of the farm, and the straightest course permissible, to the eastern out-let *A*, Fig. II., about half the length of the previous passage of the water has been saved; and much injury prevented, in reducing the height of the floods of the before confluent streams. From this cause, added to the more important general deepening and enlarging of the main stream ditch, and its having the additional out-let at Q, in latter years it has rarely occurred that any rain-flood has overflowed a few of the lowest spots of tillage land.

The changes, and the beneficial effects of the whole under-draining, both by the numerous covered drains, and the few later deep open ditches, though certainly very great, and also highly profitable, cannot be estimated otherwise than generally, and much on supposition. The actual and known increased production of the farm, which occurred during and since these operations, is no correct measure of the benefit of draining. For—besides extensions of cultivated surface by the later purchase of very poor land, (as was all the old tilled part of Talley's,) and the gradual bringing under culture 26 acres of new cleared and rich forest swamp land—there were in progress other improvements, and especially that of early and general marling. How much of the subsequent and general improvement of fertility, and actual increase of crops, may be due to marling, or to better tillage, and a better rotation, including the introduction of the pea-crop for manuring—and how much is due to draining, or might have been obtained by draining alone—I cannot know, and will not hazard a conjectural estimate. But high as I place the fertilizing effects of marling, these could not have been obtained, (nor the proper benefits of any other manures,) if on other than drained or dry soils. And except on the higher and naturally dry ground, my marling would have been of but little effect, without the aid of draining.

Neither did the draining, even when most effectual, convert the before unproductive ground at once to a productive condition. All the naturally wet land, that had not been too wet for the ordinary mechanical operation of ploughing, had been regularly tilled, and had been reduced by cropping and wet ploughing to extreme sterility. This was the case with nearly all the higher wet land, (marked green on Fig. I.,) and on parts of the lowest land also. After such land had been well drained, it still was so poor as to be worthless in its then condition; and even after marl had been applied, it was still very poor, and only then rendered capable of being well and profitably improved and enriched, by the further use of putrescent or alimentary manures, aided by proper tillage, and manuring crops.

Further, the addition of more surface for crops, by the bringing in the extremely poor land later bought—and also the poorest parts of the older purchase, (at first omitted from tillage because of their extreme barrenness,)--while adding something more to the general or gross products of the farm, served to lessen, and to keep down, and still keeps down even to this time, the general or average rate of production to the acre—which is the much surer indication of the measure of improvement, or of its increase. For these reasons, the statement of former and recent crops would be delusive, and lead to incorrect conclusions—in some cases making the improvement appear greater than the truth, and in others, much less. It is then with the claim for allowances for all these grounds for incorrect deductions, that the following statement of the principal grain crops will be submitted.

It should be premised that the crops for the first two or three years were made on the then dryest portions of the land, and where the want of draining was then least felt. Also very early in my occupancy, the old ditches were all well cleaned out, (and some of them also deepened,) and the former plan of draining (by the first method,) was in its best operation. No wheat had been sown for 1844; and my first crop, in 1845, was grown on detached pieces of the dryest and richest land that the farm offered, without regard to the order of culture, or any plan of rotation. Also I had previously marled part of the ground for this first crop of wheat. All these circumstances made that crop much larger than a fair average field or portion of the farm would then have yielded. It is understood that previous to my occupancy, the land (including the subsequent Talley purchase) had never yielded as much as 1000 bushels of wheat in any one year, and rarely reached to near that quantity. In my occupancy, as well as before, no guano, or other bought or transported manure, (other than marl,) has ever been applied to this land. Neither has any hired or additional labor been employed for the drainage or other improvements, more than the always insufficient supply of hand and team-labor, used for the tillage, cropping, and general management of the farm.

CROPS OF WHEAT AND CORN MADE ON MARLBOURNE FARM.

Years.	WHEAT.			CORN.			REMARKS.
	Acres.	Crop. Bushels.	Average to acre.	Acres.	Crop Bushels.	Average to acre.	
1844				156	2830	18.14	After 1844, all the land cultivated in corn had been marled,—and all of the wheat, after 1845.
1845	134	1977	14.75	112	1600*	14.28	Since 1848 (inclusive) when my six-field rotation was begun, one entire field has always been under broadcast peas, of which all the vines, and most of the grain, were ploughed under as manure for wheat.
1846	201	2432*	11.42	120	3600	30.	
1847	235	3511	15.32	175	4500	25.71	
1848	256	5127	20.02	106	3080	28.12	
1849	263	3375*	12.83	137	5431	39.64	
1850	238	4595	19.73	124	3500	28.	
1851	267	6072	22.74	148	4027	27.21	
1852	259	5332	20.60	124	5438	43.85	
1853	255	4790	18.8	143	5097	33.11	
1854	287	5830	20.31	144	5000	34.62	
1855	333	8004	24.	158	6175	39.81	
1856	327	5647*	17.37	138	3321*	24.06	* These crops very short, owing to remarkably bad seasons.
1857	351	8410	23.96	250	10,000†	40.	† This by estimate, as the crop is not yet gathered.

Then, if putting aside the progressive rates of production as a measure of the improvement by draining, there is nothing to adduce for proof, but the former and present condition of the land as to moisture and dryness, intractability and cloddiness, or pulverization and now usual better tilth and ease of ploughing and tillage. The differences in these respects, and whether with or without the knowledge of the former and recent rates of production, to any observer well acquainted with the farm both in former and the present times, would be sufficient proofs of the benefit and profit of the latter drainage, and the comparative inefficiency of the first-used plan. But to strangers, and by writing, I cannot offer any positive or satisfactory evidence, other than the assertion that, in all of the above recited conditions, very great improvement has been produced by the two better methods of under-draining—by covered drains, and by still deeper and more operative open main ditches. All the ground of the two lower levels, (severally marked blue and green, Fig. I.) and some other also of the much higher and oozy ground, formerly was always much too wet for at least half the year, and yet, most of which, in long droughts, was extremely dry and hard, and very difficult to plough, and when ploughed, was generally left in hard clods. Now, (with some small exceptions,) this land is as dry as any very flat and stiff land well can be; and where longest and best drained, the soil is easily and well pulverized by ploughing, and put in beautiful condition of tilth. It is true that in some limited spaces the draining has not yet been completely effectual. Further, even where most operative, more perfect drainage might be obtained by super-adding the English system of "frequent" or "thorough draining," to remove surface water—if that very costly improvement could be afforded on our low-priced lands. But with these exceptions—and speaking according to common opinion and understanding in regard to land and draining—every observer of this farm would now pronounce that it is *well drained* nearly throughout. And further—a new observer, if entirely unacquainted with the former condition of the land, would probably suppose that the lowest land had always been generally as dry—and had needed, for perfect drainage, only the few open stream-ditches now visible. Even these, where completely shaped, have their sides so sloped and lowered, and their bottoms so narrow, and altogether they present so little impediment to passage, that the actual depth and capacity of the open ditches would be much under-rated. And if the great number and extent of the concealed under-drains were made known to such new observer, he could scarcely believe that there had ever existed any necessity for their construction.

But successful and profitable as has been the latter drainage, taken altogether, I have to confess that half of my labors were so injudiciously and improperly applied, as to be (to that amount,) nearly thrown away. If the proper labors could have been given in the proper order—and beginning with the best and most important means, instead of these being the latest employed—the actual effects and benefits might have been obtained in half the time, as well as with half the cost of labor that has been incurred. Much of this loss was unavoidable, because of the want, at first, of the property or the control of other land, necessary for the proper plan of drainage, which has latterly been adopted. But the greater errors and losses were owing to my own want of knowledge in the beginning, both of the true causes of the then existing evils, and of the proper course and means for remedy, even if these means had been then available.

A NEW PLAN FOR PLOUGHING FLAT LAND, IN AID OF DRAINAGE.

BY EDMUND RUFFIN.

On the borders of the Atlantic tide-water rivers, and for more extended spaces near the mouths of these rivers, there are many and large bodies of low-land and of surfaces nearly level, or but slightly undulating. All such lands, naturally, are more or less wet and require drainage for their good tillage and production. And whether drained effectively, or ever so imperfectly, such lands, under culture, usually require, and have, a number of open ditches, to collect and carry off the streams, and the excess of rain and surface water. In former publications, I have offered my views at length in regard to the proper modes of draining, and the subsequent tillage (in very wide beds,) of lands of this class—and therefore these important and main branches of the general subject need not be here discussed. Nor will either be mentioned, except incidentally, and as necessary for explanation of the later and auxiliary improvement by the manner of ploughing, which I design now to set forth, and to recommend.

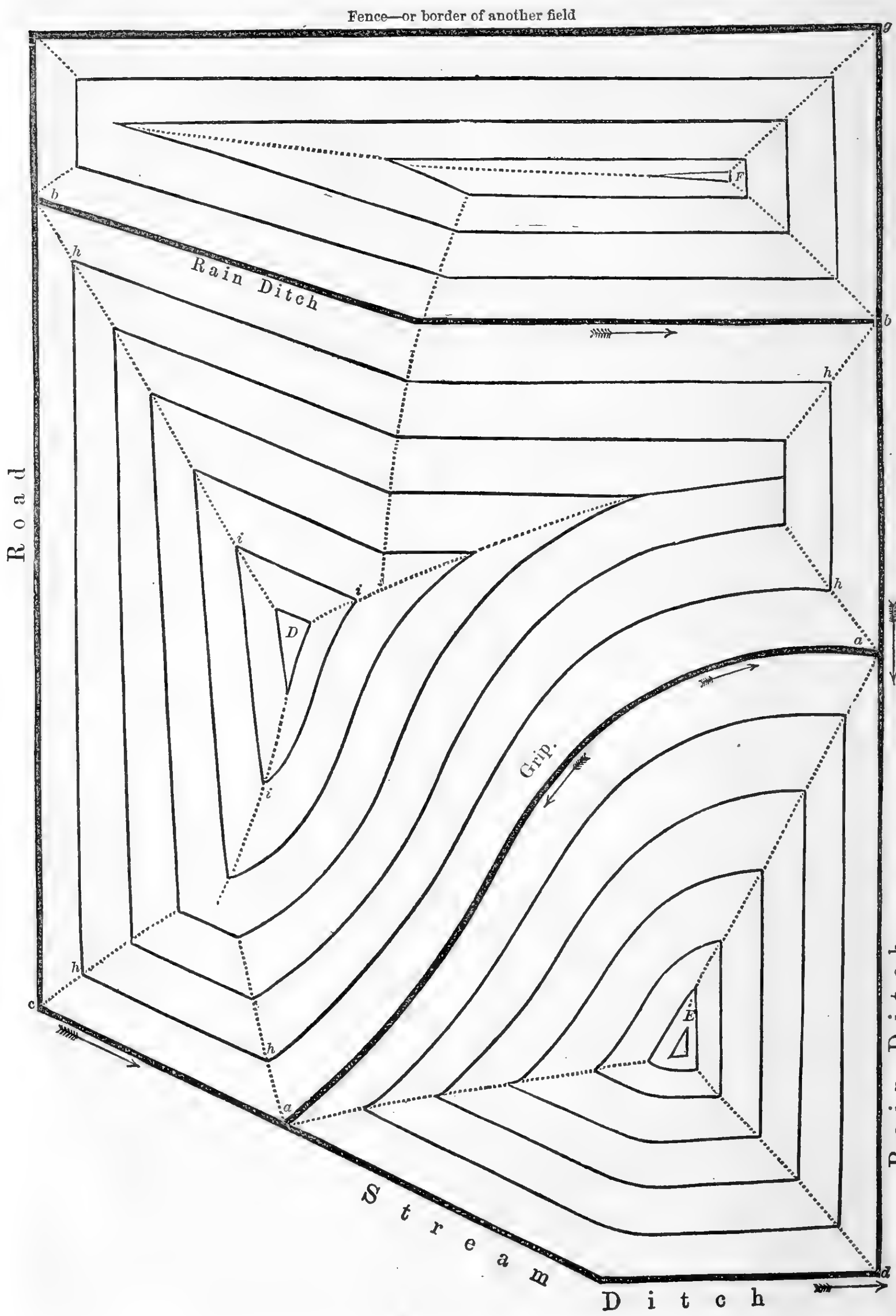
Whether any field, or farm, of the flat surface in view, is drained properly or improperly, there will be many ditches running in different directions. Where the lands are most level (as in large spaces of interior lands of lower Virginia and North and South Carolina,) the ditches may be placed almost anywhere, and in any direction, to operate as designed. But more generally, and especially on the borders of rivers, the surface has so many and frequent though it may be but slight undulations, that the open drains, for rain or surface water, must be placed precisely in the lowest depressions, and directed in the courses of these depressions. As these latter circumstances are the most usual, and are the most difficult, I will suppose them to exist, when making the following remarks. Then, in a field of this kind, we may suppose there to be many slight and mostly narrow depressions, running in various directions, between the somewhat higher and very much broader intervals of dryer land, but still not dry enough for draining to be dispensed with. Through all these depressions, (even where there are no springs to collect, or permanent stream to vent,) there pass open rain-ditches, which are impassable by ploughs and teams—or smaller grips, which perhaps are ploughed across, and therefore require cleaning out, and almost renewing, after every ploughing of the ground. In either case, these open surface-drains, of whatever sizes, are great sources of trouble, and great impediments to tillage.

Further—as the depressions are usually but very little below the level of the near adjacent ground—and the line of the ditch is not at all lower than its borders—it follows that the earth thrown out in the first digging must raise the margins—perhaps to be raised still higher by every subsequent cleaning out of the ditch. These banks, even if spread as far as to be thrown by shovels, still raise the margins—and even if but two or three inches higher than the ground farther off from the ditch, this slight elevation seriously impairs the proper draining effect of the ditch. Further—when the ploughs have to stop and turn at the sides of the ditches, they always bring there and leave some earth on the margins—and this serves still more to counteract drainage, and to cause future labor.

Such would be existing evils, even when great and unusual care is used to remove the first-raised banks of ditches, and to prevent subsequent accumulations of earth there. But it is much more common, and far worse, to let the ditch banks remain to raise the margins—and further, to add to them by the subsequent ploughing, (if flush,) being so ordered that every furrow-slice, cut near to the ditch, is turned towards its banks.

Within the last two years, I have introduced a new manner of flush ploughing, which serves from the beginning to moderate the evils in question; and which, in the course of time, will have the best effects, in adding to the draining operation and effects of open ditches, of all kinds and sizes, and also in lessening the future labors for maintaining their proper operation.

NOTE.—In this report of a particular drainage operation, it has been the design and effort of the writer to make it as concise as could be, so as to exhibit, generally, the causes of wetness, the means used for remedy, and the results produced. If any reader should desire more extended information on the general subject, either in reasoning as to causes, or instruction and directions for the practical labors of draining, and in various circumstances, such particular information may be found in two other of my previous writings, viz: the article "On Draining," in my published "Essays and Notes on Agriculture" (1855) and a report on the "Agricultural Features of Lower Virginia and North Carolina," first and recently published in De Bow's "Southern and Western Review," and since communicated, with additions, to the Virginia State Agricultural Society.


Fence—or border of another field
g
F
b
h
Rain Ditch
b
h
i
i
D
h
a
i
Road
Grip.
h
c
E
h
a
Stream
d
Ditch
Rain Ditch

The annexed figure, or diagram, will enable me to explain more clearly the manner of ploughing. The whole space represents a field, or part of a field, which is divided by two long depressions into three irregularly shaped "cuts" or divisions, D, E and F. Along the middle of the larger interior depression, there had been kept open a narrow rain ditch, of the usual shape, *b*, *b*, say 2 feet deep, and 3 wide, (and which depth was necessary,) at which the plough and teams had to turn, because of the impassable obstruction. The other and smaller depression had a grip (*a*, *a*) say 15 inches wide and 10 deep, across which the ploughs passed, and which was filled and required cleaning out after every ploughing. A permanent stream ditch, *c*, *d*, is one of the boundaries, bordered on both sides by the lowest ground of the field. A rain-ditch *g*, *b*, *d*, makes another boundary, a farm road another, and on the fourth side is a fence along side of the adjacent farm—or another field of the same farm.

It is desired to plough each of these cuts in such manner as to throw every furrow-slice from the outsides, and towards the centre. It is supposed that the ditch *b*, *b*, and the grip *a*, *a*, are in the best locations—that is, combining as much as possible the requisites of having the shortest courses that can be obtained in the lowest ground. If any defect of location exists, it should be corrected, and the ditch or grip be made correct in position. This being done, the next thing is to mark off the ground for ploughing. The field is supposed to have been left, after the last previous tillage, either in broad beds (25 feet or more,) high enough and well-sloped—or in low and narrow beds, previously designed to be ploughed flush, and to be again bedded in the progress of tilling the corn-crop. The farmer, or a careful and intelligent man, and a boy, having each one end of a strong but light cord (of strong hemp twine) about 75 feet long, will direct the ploughman where to mark. Taking one cut, (as D,) the man walks along the outside lines, or as close thereto as the near horse of a plough-team can easily and safely walk. The boy carries the string stretched, and keeps it at right-angles to the outside line on which the man walks. The ploughman, with a small one-horse plough, or coulter, follows the track of the boy, and barely scratches the ground, so as to make a perceptible mark. If a larger furrow were opened, it would be an inconvenience to the main work. Thus, if beginning on the cut D, the first line laid off, will be *h*, *h*, *h*, *h*, *h*, parallel to, and the length of the line distant from the surrounding boundary line of the cut D. At each angle, the plough should mark a little beyond its supposed full distance, and then be lifted back to the proper place indicated by the length of the string, when stretched from the next side. The intersection of the furrows will mark the exact place for the angle. Thus each successive marking will be made, parallel to and equidistant from the preceding, until the work reaches nearly to the centre. If the last circuit made (*i*, *i*, *i*,) does not permit the line to be again used at its full length, it should be shortened, to any less length (say 30 or 40 feet), and another and the smallest interior space (D) marked around.* Next, the plough should mark a line from each of the angles of the inner space through the corresponding angles to the outer boundary, as the dotted lines are placed. The cut is now ready to be ploughed. The plough is first run around the small interior space (D) turning the slices towards the centre. And as the furrows in the beginning are very short, it will be best (to save much trouble in the frequent turning,) not then to use a team of more than two horses. But as soon as the furrows are of sufficient length, this temporary expedient should be laid aside, and the larger plough and team suitable for the land be used. After a few furrows are cut around the inside marked circuit, so as to well designate the outline, then the small interior space D should be ploughed outward; or any way will serve. The plough then resumes its previous place and course, and continues to go around, and to turn the slices inward. The ploughman, in running every furrow should let the plough cut straight and fully up to and turn at the dotted lines. This will keep the work right at the angles, in which places it would otherwise be sure to get out of order. But with this care, and with cutting all the furrows as straight and as equal as every ploughman should do, the ploughing will go on as correctly as in any other mode—and with less loss of labor, and with more thorough execution. More thorough, because there will be no unbroken strips left, and only covered, as in all ridge or bed-ploughing—and no unnecessary and barren water-furrows made, where of no use, as in the closing of "lands" in all flush-ploughing. Further—as the ploughman approaches within a few yards of the next marked line, and still more when nearer, he has in that a test and gauge of his previous work, and a sure guide for the next succeeding. Wherever his last cut furrows obviously vary from being parallel to, or of equal distance from, the surrounding and nearest mark, he has but to make the width of his subsequently cut slices to suit and remedy the defects. The differences of texture or condition of the soil, or of the cover of vegetable matter, will cause the plough to gain more in width in some places than in others, if no care is used to prevent. But with the guidance of the parallel lines marking the widths, and the cross-lines indicating the proper points for the angles of the furrows, it will be easy for the ploughman, (or for any number of ploughs following each other on the same cut,) to make even and equal work, and to close at the outside lines, with but little loss of labor in broken furrows. It is obvious that the outside boundaries, whether made by ditches, fences, or growing crops on adjacent fields, can be ploughed more nearly to, in this mode, than in any other whatever.

The ploughs, and the depth of ploughing, may be of any description suitable to the soil. But, for the convenience of reference to effects, I will suppose the operation and conditions to be like my own. In that, the ploughs for breaking up, whether in winter, to prepare rough or grass land for corn, or in summer, to prepare clover (or weed) land for wheat, are drawn by four mules, and usually in easy ground, cut and turn slices 7 to 8 inches deep, and 12 to 14 inches wide.

First, let us consider the operation of the ploughing, in reference to its great and usually sole object, that of thoroughly breaking, loosening, subverting, and giving tilth to the soil, for sufficient depth, and also burying and covering the vegetable matter which stood on the previous surface.

The land is supposed (like mine) to have been left (at the previous tillage,) in straight and well-

* The engraver of the diagram has made it very incorrect in not having the marked lines parallel to each other throughout each of the several cuts—as is described above, and as the drawing also required.—E. R.

shaped broad and high beds—say 25 or 27½ feet wide, and about 16 inches of difference of perpendicular height between the centre or crown of the bed, and the bottom of the alley. The new ploughing will necessarily cross the former ploughing, and the beds and alleys, in every variety of direction. In part, the furrows will run in precisely the same direction with the beds and alleys—in part, they will cross at right-angles—and elsewhere, they will cross diagonally, at angles of every different size. Before trial, I feared great difficulties, and especially in ploughing across the beds at right-angles. But, in practice, the difficulties were much less than expected—and, on the whole, less than belong to any other and usual mode of ploughing. When ploughing directly across the beds, it is true that the new furrow is of very unequal depths—perhaps 10 inches at the middle of the bed, and barely 1 to 2 inches when crossing the bottom of the deep and narrow alley. But these very different depths, if something more laborious to the team, are more suitable to the requirements of the soil in the extremes of thickness, made artificially by the former bedding. The deeper ploughing under the crown of the bed is still the more beneficial, because that place had been broken but imperfectly, or not at all, by the previous ploughings, which raised the bed, and lapped the soil, without breaking it below, at the crowns of the beds. In the alleys, where the new ploughing barely scraped, the sub-soil had generally been previously reached, in deepening the alleys; and no greater depth of ploughing was needed, inasmuch as the beds are to remain as they were before. When the new ploughing is immediately across the old beds (or at right-angles,) the beds necessarily there retain precisely their former position, and, immediately after the new ploughing, appear even higher than before. In the alleys there was so little cutting, and so little of other earth thrown in, that there will be but little earth to clean out, to leave these beds in better shape, as well as in better tilth, than after any former ploughing.

The advantages of more easily and throughly breaking the ground, and the disadvantages of throwing more of the ploughed soil into the alleys, both increase as the direction is changed to be diagonal—and from diagonal to coinciding with the direction of the alleys. There could be nothing of this disadvantage (worth consideration) of throwing more earth into the alleys, if every furrow was of equal depth, whether in the highest or lowest places—or at the crowns of the beds and in the alleys. In that case, wherever any part of a furrow was opened, it would be filled by the next cut furrow-slice, of precisely equal size. But in practice, the furrow-slices are not of equal thickness whether cut at the crown, or the side of the bed, and in the alley, (—and they ought not to be equal—) and therefore the new flush ploughing does operate slightly, to change for the worse, the previous relative positions of the beds. But this change, and damage, is less than is usually made by the careless ploughing of beds, in the same direction, and whether with the design of raising and preserving the same beds, or cleaving and reversing them. After the flush ploughing described, and in every direction, the former alleys are plainly to be distinguished. And, at a proper time and condition of the land, the running of a two-horse plough up and down in each alley, will sweep out cleanly all the loosened earth that would absorb rain-water, and obstruct its discharge, and leave each bed and alley in the best designed shape and condition for surface drainage. But this opening of the alleys cannot be well done immediately after the ploughing of each cut, nor until rain shall have fallen, and dried off, so that the loose and turfy earth has been somewhat consolidated. In the interval between the ploughing and the subsequent opening of the former alleys, the only evil and danger of the plan may occur, in the fall of so much rain that it will be long before the then water-glutted alleys will be fit for the plough; and when, consequently, great damage will be caused by this long water-soaking of the earth in the alleys. Every care should be used to prevent this evil.

This manner of ploughing should be used certainly for every winter ploughing, (to prepare for corn,) and it may be for any other time when the farmer is sure of being able to complete any one cut, before being stopped in any part of it by hardness of the soil caused by drought. On this account, it may be too hazardous to resort to this kind of ploughing, in summer, when "fallowing," or ploughing grass land to prepare for wheat. Except for this danger of being stopped by drought, summer would be the best time for the operation, as there would be then no danger of damage to the land from the occurrence of saturating and injurious rains, while the alleys were still partially choked by loose earth.

So much in regard to the effects of this mode of ploughing or tilth, and as affecting the preservation of the former bedding. Next I will describe the much more important effects and the main object, in aid of surface-drainage. While the ploughing will be as cheap, and more effectual, as ploughing merely, it will at the same time, and with no more expense, greatly aid the other and proper labors for the most effectual surface drainage.

In general terms, the effect of every such ploughing is to remove the entire surface-soil, to the depth ploughed, from the out-side towards the centre, as much as the width of the furrow-slices. The amount of earth thus removed is enormous. It is dug and removed by the cheapest possible implement and process—and even this labor costs nothing for draining, in as much as it is required for and compensated as necessary tillage. As each furrow-slice removed is replaced by another, there will be but very little (and unappreciable) effect in altering the general level of each cut. But the effect will be considerable, at the outside furrow, even at the first operation—and still more and more at every subsequent ploughing, so long as it may be expedient to continue the same manner of ploughing, for furthering the same object.

If the furrows were cut equal, with perfect accuracy, the results might be exhibited to the eye and understanding with geometrical exactness and force. And this can still be done, with due allowances for the imperfection of practical operations compared to theory. But to some extent, practice in this case may even surpass the theory stated. For, while the latter supposes equal dimensions of furrow-slices throughout each cut, in practice, it will be quite easy to cut the few outside slices of greater than the general depth, and so the more to lower the outside margin. There is another thing which will be here mentioned, which should be understood hereafter in every named operation. When a boundary line of a cut is a ditch (of the usual steep and irregular sides,) the team cannot safely walk so close to the edge as to plough and turn away all the margin earth. There must be from 3 feet to 1 foot left everywhere uncut (according to the depth or irregularity of the side of the ditch) which earth will require to be dug and pulled back by hand-hoes, which thus perform what the plough cannot do at first. This hoe-work, being always understood, and always required in aid of any manner of ploughing, (and much less in this than any other,) need not again be referred to. And the cutting to the edge of the ditch will be supposed to be effected by the plough, though always (for the earlier work) requiring to be finished by hand-hoes.

Then the effect of the first ploughing on this plan, by a four-horse plough, will be to remove the whole surface-soil, for 8 inches deep, a furrow's width, (say 14 inches) in the directions from the outside to the centre. And the outside furrow-slice, or earth of the dimensions stated, will be removed entirely and permanently from its former position—and its equivalent quantity distributed over the interior or central space of the cut. This operation will lower the margin of the boundary ditches or grips, 8 inches deep, and for a width of 14 inches. When the like ploughing has been done on the adjoining cut, (E) and to the other side of the grip *a*, *a*, the furrow-slices would thus be removed from both sides of the old grip, and nearly as deep. A furrow then run along its course, and back in the same track, would deepen the grip, partly fill and slope the borders, and thus, while the grip would be made deeper and better for drainage, it could be less an impediment to tillage, and less liable to be entirely filled with earth by being ploughed across. When the like ploughing is subsequently repeated, another furrow-slice is removed from the outsides of the cuts, and so much a more gentle slope is given to the grip. Then, and thereafter, the plough will be sufficient to clean the loose earth out of the grips. If more depth is desired, it can be given in closing the ordinary ploughing. And even if made of double the former depth, so wide and so gentle will be the slope of the margins, that the grip will present no serious obstacle to the crossing of ploughs, in any direction, of carts, or even of the passage, at work, of reaping machines.

The same operation of lowering and sloping off the margins of the deeper rain-ditches would be proceeding in the like manner, and would only require longer time to approach or perhaps reach, the same good results. Even the deepest stream ditches would be much improved, in their surface-drainage operation; and their obstruction to tillage and to other team labors be greatly diminished.

AGRICULTURAL FEATURES OF LOWER VIRGINIA AND NORTH CAROLINA.

BY EDMUND RUFFIN.

I. *General remarks. The public but slightly informed of the region in question, and especially with lower North Carolina in general.*

The eastern portion of North Carolina presents a large region, of remarkable features, topographical, geological, and agricultural. The enclosed broad sounds, and other waters, are not less interesting, for their recent and great changes; and, besides, they have been the scenes of some of the minor but romantic and interesting incidents of history. Into Roanoke Sound, by the then broad open passage from the ocean, which is now dyked across by dry land, Sir Walter Raleigh's ships entered, and on Roanoke Island they planted the first, though but ineffectual, settlement of British colonists in America. In another portion of these now almost land-locked waters, there occurred many of the acts of Teache, or Blackbeard, the celebrated pirate, and finally, the naval engagement in which he was defeated and killed. If the lands of this region were even worthless, for agricultural and economical uses, they would deserve and reward the investigations of the exploring and laborious geologist; and if destitute of all scientific interest, they would deserve far more attention than ever has been bestowed on them, for their peculiarities of agricultural character, and capabilities for high improvement and profit. Yet, there is no equal space of territory in all the States of the American Union that has been so little visited or seen by other than its residents, and of which the character and values have been so little noticed or known. It is rare that any stranger enters this *terra incognita*. And even of the residents of other parts of North Carolina, of the class inclined and accustomed to travel for business or pleasure, where one such has seen this portion of their own country, one hundred have visited the remote States of the North or South, or West.

The region here referred to, except as to the line of sea-shore, has no exact geographical limits—or at least there is no present information upon which to designate the extreme southern and the whole western boundary. I would include all of the low-lying and very level land, which is the universal character of all the coast lands, of North Carolina, and for a breadth of two to five or more counties westward. As soon as the surface begins to lose its apparent almost perfect level, and to swell perceptibly into rising slopes, there should be placed the western or upper boundary of the low and flat region which is here referred to generally. The same character of country extends northward to the Chesapeake bay and its lowest western affluent rivers; and how far south of North Carolina I am not sufficiently informed to say. In addition to the one universal feature of low and level surface of the highest and firmest lands, it is much intersected by narrow strips of lower and swampy but also firm ground; and, also, immense spaces are occupied by large and boggy swamps, which were impassable, and almost impenetrable by man, until his improvements and labors had produced artificial passage-ways.

This great region affords sundry somewhat connected, but yet substantive subjects, for separate treatment. Such are the now cultivated land and its agricultural condition, and the improvements most needed—description of the great swamps, and such agricultural improvements as have been there made—the geological origin and structure of the different great classes of lands—notices of the ocean sand-beach, and the enclosed sounds, and other navigable waters, and the changes that have occurred in both, &c. Some others, or perhaps all, of these several divisions of the whole great subject may be hereafter discussed. For the present, I will confine myself to sketch the agricultural features, condition, wants, (and errors of culture,) and capabilities of the particular and peculiar agricultural region which lies between the Chesapeake bay and Hampton roads and Nansemond river, on the north, the ocean on the east, and Albemarle sound on the south. On the west, the outline would include all the Dismal Swamp. But all the great space, and the circumstances of that swamp proper, will be passed over now, to be resumed and considered in another and substantive article. The further extension of the western boundary would include the lower Chowan, and the basin of the lower Roanoke. The area designated includes some of the oldest agricultural settlements and oldest towns, and (on the Roanoke especially) some of the richest lands on our Atlantic border. It is also intersected by sundry lines of public travel, and some of which (the land and water steam-lines to Norfolk) have long been used by numerous passengers. Still, all these circumstances do not make this particular agricultural district an exception to the general rule or condition of all the great low-land region, of being unseen, unknown, and little appreciated by strangers. Of the many thousands of travellers who visit, or pass through, Norfolk or Portsmouth, on the great routes, scarcely one ever treads the soil, except in the towns—or ever sees any of the lands of the country, except in the rapidly changing glimpses afforded from a steam-car, or the more distant and uncertain views from a steam-vessel. Princess Anne county, which reaches within three miles of Norfolk, and Norfolk county, lie wholly in the designated section; and these counties, out of the towns, are as little known to the residents of all other parts of Virginia, as any counties west of the Alleghany mountains. Yet, within the heart of one of these counties, and within a few miles of the other, are the important towns of Norfolk and Portsmouth, and the noblest harbor, and one of the most important Government dock-yards and naval stations, of the United States. And the country has been as little appreciated as it was little known; and even by its residents, until recently, and by those who knew it best, as well as by strangers, who had only heard it spoken of and described in the most contemptuous epithets. And, though recent improvements of prices of lands, and in fewer and more remarkable cases, of products and profits, and still more, and longer, in some of the North Carolina counties, indicate much actual improvement and higher appreciation, still very few, even of the most intelligent proprietors, are yet fully aware of the true and great wants of their lands, and their great capability for improvement. Proper drainage alone would double the productive value and the profits of the whole great area of what is usually considered the *now dry* land, and of the firm and partially drained swamps. In addition to the peculiar grounds for agricultural improvement and profit in the land itself, no known region possesses such great facilities for navigation, and for choice of markets. And, in every respect, no where is there a region where agricultural improvement is more needed, and is more available, and offers more prospective profit; and no where have the great advantages offered by Nature been more neglected, or seem to be less known.

For the present, my remarks on this region will be applied especially and particularly to the portion lying east of Perquimons river. My personal observations did not, at first, extend farther west; and much of whatever may be here said of the country extending beyond Perquimons, and including the lower Roanoke valley, will be on report deemed entirely reliable.

II. *Peculiar characters of the low-lands, in surface and qualities of soil.*

The most striking feature of this firm low-land region, is its very low and level surface. Large bodies, say of 1,000 acres or more together, are more uniformly level than any as large spaces of alluvial, or other bottom land, on any of the great rivers of Virginia Such bottom-land as borders the Pamunkey river, for example, might be called undulating, compared to the general greater flatness of the whole great region under consideration. The numerous smaller swamps, interspersed, (which receive and conduct off the overflowing surface water,) are, usually, not much lower than the adjacent highest ground. So far as the eye would indicate, changes of level of even so much as a foot of difference, can rarely be perceived, except in the swamps and depressions which convey the rivers and smaller streams, or temporary rain-floods. But changes of level which are barely perceptible to the eye, are usually made abundantly distinct by the gathering of water on the slightly depressed surfaces, which serve to make the numerous swamps of *firm soil.* A stranger, if travelling through the country in any and different directions, might suppose that the surface of the land was nowhere higher than ten feet above ordinary high tide, or the usual height of the navigable and level waters; but the real heights are greater than would thus appear to the eye. In the interior of Princess Anne county, at Level Green, (the farm of Edward H. Herbert, Esq.,) where the surface seems to the eye as low as any—the elevation, as determined by levelling instruments, is about twenty-one feet above tide. Still, the variations of surface-level are so gradual, (except as to the beds of water-courses,) that it is often difficult, if not impossible, to reach any outlet for drainage of a few feet of fall, without conveying the water by a ditch of some miles in length, and through as high, or higher ground. This feature of the surface presents the greatest impediment to the drainage of the interior lands, and especially upon the ordinary method of mere surface drainage, by open and shallow ditches.

But with all the slight undulations of surface levels, there is nothing to obstruct the view, except the standing crops and fences on the farms, and the trees on swamp or other forest lands. Except for these obstructions, any object of the size of a man, or horse, could be seen over miles of intervening space and distance. In all the great area now under consideration, there is not (native to the locality) a stone, or even a small pebble; and, in few cases, but a little of small gravel.* The soils vary, in different places, between open and light sandy loam, and very close compact gray clay (so-called;) or, perhaps, more correctly, extremely close and compact soil and subsoil, composed mostly of the minutest particles of sand, and which, therefore, are stiffer, closer, and more intractable under cultivation than the finest or true clay elsewhere. Of such red and yellow clays as make many of the best soils and subsoils of the upper country, (above the falls, or among the mountains,) none are seen here.

* There may be, and probably are exceptions, as higher in the tide-water region, in some coarse and imperfect sandstone, recently formed, by ferruginous spring-water filtrating through coarse sand, and, in the course of time, cementing with a deposit of iron the before separate and loose grains of sand. There are many such recent formations of this stone.

III. *Peculiar characters of the rivers, and the many fit for navigation.*

The water-courses are numerous, and many of them are deep enough to be navigated by sea-vessels. In some of the smaller rivers, in parts too narrow and crooked for the ordinary small vessels to turn about or to pass each other when meeting, there is enough depth of water to float a ship. A glance at this section on a large map of North Carolina will show the great number and close neighborhood of these rivers which flow, nearly parallel to each other, into the northern side of Albemarle Sound. The lower parts of these rivers, where of widths, severally, from one to five miles, are more properly estuaries or large creeks, (in the proper sense of that word, and not as usually misapplied,) kept full by the refluent water of Albemarle Sound—just as they would be, and to nearly equal height, if there was no other supply of water from head-springs or rain-floods. But even as ascending these rivers, and after they are contracted to very narrow widths, and, as appearing on the map, the upper channels might be inferred to be merely shallow and insignificant streams, they are, in fact, deep, though narrow rivers, of level and slow-moving water, and continuing deep almost to their visible head-sources; and offer good facilities for navigation to such extent, in number and in length of rivers and their sundry branches, that one-half of them are superfluous, and, therefore, are not put to use. If any obstructions exist, they are made merely by trees fallen across, and are easily removed. The whole country, and especially from Perquimons county to Currituck Sound, is pervaded by broad and deep estuaries near to the sound; and their head-waters, extending near or into the Dismal Swamp, make, with their many branches, a net-work of natural still-water canals, narrow and crooked, indeed, but as deep, as smooth, and as sluggish as artificial canals, and free from the changes of levels and the obstruction of lock-gates, which accompany the benefits of canal navigation. Most of these rivers receive their head waters from the Dismal Swamp or other swamps. The water of all is black as seen in the rivers, and the color of brandy or Madeira wine as seen in a glass, being thus deeply colored, as are all the swamp waters, by the vegetable extractive matters in and on the boggy swamp soils. This discoloration is not entirely lost in the salt tide-water of Elizabeth river, at Norfolk, nor in Currituck Sound; where nine miles wide, below the former (and now closed) Currituck inlet, which, not many years ago admitted deep sea-vessels.

In travelling along the public road from Elizabeth City, North Carolina, to Currituck Court-House, within the distance of seven miles, we passed four navigable water-courses, including the Pasquotank and two of its branches. Three of these had draw-bridges for the passage of masted sea-vessels. The fourth stream had no draw-bridge, because it was not needed in such close vicinity to others; and, also, because, though this branch had abundant depth and an open channel for sea-vessels, it was so narrow and crooked that the banks and trees standing on the borders would entirely obstruct the masts and yards. Such great and numerous natural facilities for navigation, as in the many rivers of this region, are unequalled; and they are exceeded by the aid of art, only in the canal navigation of the Dutch Netherlands.

IV. *General want of drainage and of proper views on the subject.*

Level as is the general surface, and slight the variations of height, in adjacent spaces of all the peninsula between the waters of the Chesapeake and Albemarle, still there are frequent slight changes; and these, more than great changes elsewhere, are marked by consequent differences of character. Every farm of a few hundred acres has some of its surface of swamp, and usually undrained. What is called high or dry land is, indeed, the highest and dryest, but mostly still and always suffering more or less for want of sufficient drainage. The parts which may be only from two to three feet lower than the neighboring highest surfaces, are, because of the depression only, swamps of wet though firm ground. These swamps are very generally of firm soil, and the boggy swamps are of entirely different materials and formation. In all this flat country there are very few springs showing at the surface, and but rarely any springy or oozy places. The water and the wetness of the numerous smaller swamps are due entirely to rains. On the higher spots, or larger high spaces, the early settlements were all made, and tillage has there been continued, with but little respite, to this time. The intermixed lower lands, or smaller swamps, were deemed worthless, and their culture was rarely attempted until within recent times. Yet, even with the imperfect superficial drainage which only is in use, these swamp lands are found to be best, and of fertility rarely exceeded anywhere. Some of this firm swamp, in Perquimons, of which Mr. J. T. Granberry's estate in part is composed, and which but lately has been drained or brought under cultivation, he bought lately, at $55 the acre, unreclaimed. A highly intelligent neighbor told me that he remembered when the same land could not have been sold for 75 cents the acre, and was deemed of no value whatever for tillage.

The soils and also the subsoils vary in texture from moderately light to extremely stiff, close, impervious (now) to the descent of water, and remarkably intractable under tillage, and almost always either too wet or too dry for good ploughing, even under good farmers. Under the worst cultivators such soils are sometimes mud or mire, and sometimes of clods almost as hard as brick-bats. These soils are general or common in Perquimons only. Yet, on good farms, of this very difficult soil, there are seen the best (and excellent) crops of wheat, and other best crops, of all the counties on the sound. The greatest drainage labors and most of the best farmers and best cultivation are also in that county; yet even there, and though many of the ditches are of great size and the drainage labors are remarkable for their extent and cost, still, almost every where, the tilled land is but partially and insufficiently drained. On much the larger portion, perhaps nineteen-twentieths of all the cultivated and even highest surface of the whole region, the drainage is much worse and still more insufficient.

V. *The true principle of drainage for this region and the geological facts on which the principle is founded.*

The great error of the method of drainage, general in all this region, is that the drains or ditches are designed, and only operate, to draw the superfluous and, therefore, injurious rain-water from and over the surface. The principle I would propose to substitute, is to draw off (and keep drawn off) the water which is in excess some feet below and up to the surface, and by thus removing the before constant saturation or glut of the lower earth, to permit the excess of falling rain to sink into the lower earth, and thence pass off below instead of being kept on and near the surface, as now and heretofore, until it either can flow off on the surface to ditches, or is evaporated. Both the existing error and the evil effects and also the benefit of the proposed substituted plan are dependent on the geological structure of the land, and especially of its inferior beds. But, in advance of all description and reasoning as to the causes of the supposed existing phenomena and of tracing the effects in reference to draining, I will simply assume the truth of the great and all-important fact on which my plan and reasoning are founded. This fact is, that the whole of this low and flat country, at some few feet below the surface, (within the extreme limits of from 2 to 8 feet, and more generally from 3 to 5 feet,) has underlying it a bed of pure sand which, at least in all wet seasons, is glutted with water from its bottom to its top. This fact is unquestionable, and may be tested easily by every proprietor. But I have to infer, from the geological structure of the region and on reasoning, which would require too much space to state here, the further fact, that this underlying bed of water-glutted sand is nearly horizontal, but, like the overlying earth and its surface, has a gentle and general dip or declination toward the seacoast, or in a southeasterly direction.

As to the general presence of the sand-bed, it is proved by every well that is dug, and not only here, but in much higher localities of the tide-water region. In the higher country, and at higher levels of surface, the sand-bed lies deeper; and also, there, generally, its upper part is dry, (or without water,) though, by digging deeper, the lower sand, there also, is always found filled (but not surcharged) with water. A like bed of sand underlies most, or all of the bottom or low land, along the rivers in the higher tide-water counties in Virginia; and, as I infer from but limited personal observations, such sand, with much more regularity of position and operation, underlies the whole superficial layers of the great low-land region here under consideration. But in these lowlands, the sand-bed is naturally always glutted with water, which water is a source supplying moisture to the overlying earth, and also, by being already as full of water as it can be; the glutted sand-bed is an effectual barrier to the descent of more rain-water from the surface of the land. This sand-bed is, therefore, the great cause of the existing wetness of the upper beds, and surface soil, and the reason why the usual surface-draining is so imperfect in operation. And the same feature offers the manner and means for effectual drainage.

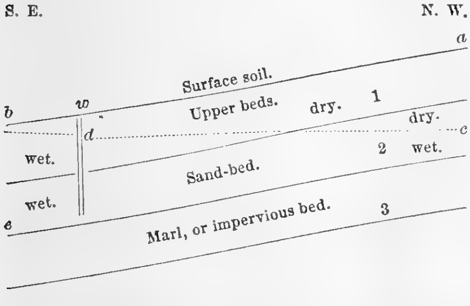
Of course, very few particular facts, and in narrow spaces, have been learned from my own personal observations in this low country. But I had previously discovered the underlying and also water glutted sand-bed, (concealed from all previous knowledge, as a general fact,) below the broad bottom lands of my own farm on the Pamunkey river, (in Hanover county, Virginia,) and had long studied its effects; and in reference to it, had devised, and conducted successfully, extensive draining labors. At first, I had supposed this remarkable and then newly discovered feature to be peculiar to the particular locality of my own farm; but in the progress of my draining operations, and the necessary study of the whole subject, and the true principles of drainage, I came to infer, that the same feature, of an underlying sand-bed, belongs to the whole of the lands of our great tide-water region, and that this sand-bed, where dipping lowest, and glutted with water, was the great cause of the evil of excessive wetness of the lowlying soils above. I felt so confident of the correctness of my deductions, that it induced me at the first time of leisure, to visit the region in question, to seek and to find the facts to confirm and to sustain my theoretical views. And before my first visit to this country, I offered to a friend, residing therein, advice for the proper drainage of his farm (by seeking for and tapping the glutted sand-bed,) which he acted upon to some extent, and found therein the precise effects and all the benefit that could have been expected from his limited first operations on this new principle.

To obtain numerous evidences of the very general existence and position of the sand-bed, it was not required for me to dig or bore into the under beds, or even to see the surface of every locality. Every farm house is supplied with water by one or more wells, and these numerous, previously, and long used wells, go far to supply all the facts required. Whether the sand-bed exists, and near enough to the surface to effect its natural drainage, may be learned usually from inquiries about the wells, their depths, and the causes of the varying quantities of their supply of water. From even but a few such examples, and applying thereto my general views derived from practice and experience of draining in far distant localities, I was confirmed in the general opinions previously formed, in advance of all personal observation. The conclusions thus reached, and for which I will proceed to argue for the conviction of others, may be thus stated; that nearly all the higher and firm, as well as the lower lands, lying between the Chesapeake and Albemarle Sound, are rendered and kept too wet, not (as universally alleged,) because the soils or their under beds are of too close texture to permit the superfluous rain-water to sink, and so be discharged by percolation; but because the underlying sand-bed is already surcharged with water, and by its supplying moisture upward, renders the moist earth incapable of drinking up more water from above.

In the upper and middle ranges of the tide-water counties of Virginia, the reaching the sand-bed, and its being dry when reached, are essential conditions to the construction of a good ice-house—the dry sand bottom serving immediately to absorb, and convey away, by downward filtration, all the water formed by the melting of the ice. This is the operation of the principle of drainage of the higher beds, by the agency of a dry (or drained) upper layer of the sand-bed below. It is also essential to the utility of every well, that it should be sunk through the upper and dry layer (if there be such) of the sand-bed, and into the water-glutted lower part, for the purpose of its furnishing a permanent supply of water. And if, as generally in the flat low country, the sand-bed is full of water to its top, (unless after long droughts,) and is so surcharged that the water is pressed upward, then, in wells there dug, not only would water be obtained as soon as the sand-bed was reached, but the water would rise still higher, and even near to the surface of the land in very wet seasons. Thus, every well in this low country may afford evidence of the existence, height, and character of the sand-bed at its top, and also the height to which water will rise therefrom, and how near the surface of the land the upper bed must be injuriously affected by the water glut below, and whether permanently, or but for the times of wettest seasons. Hence, it follows, that little as has heretofore been noticed, or thought of, in regard to these important facts, and the more important deductions from them, and few as are the residents who have thought at all on these particular points, it is only necessary for farmers and thinking men to reflect upon, and apply the facts they already know, to be assured of the true principle and method of drainage for their land, which will now be more fully explained and argued.

VI. *The underlying sand-bed and its opposite operations in regard to draining.*

Whether the underlying sand is of one continuous bed connected throughout, or broken, or separated, is not important. It is enough that it is general, and nowhere known to be wanting. Neither is its general thickness known, nor is its bottom but rarely accessible or known. But it is certain that this sand-bed lies upon some lower bed, impenetrable to water from above; and which bed, in many known cases, is marl. But whatever may be the lower bed or its texture, the sand-bed itself, however open and loose in texture, if already glutted with water, is incapable of receiving more. Therefore, there is no layer of earth so impenetrable by water, as any earth, and even sand, already full of water; and, in less degree, all dampness or moisture of the underlying bed of earth is so much impediment to the reception of rain-water from above. The following rough figure will serve to exhibit a profile or section of the supposed strata of the lowlands; but to render the differences of level apparent to the eye, it is necessary greatly to increase the thickness of the strata, and the rate of their dip, in the figure, exceeding the natural and actual conditions.



Suppose this figure to represent the surface soil, (*a b*,) and also the inferior beds, all dipping very gradually, (and very much less than in the figure,) from northwest to southeast, or in the direction from the falls of the rivers towards the ocean. The finely dotted line, *c d*, indicates the horizontal level. The upper bed, next below the surface soil (1,) let us first suppose here to be clayey, or of close texture, and not readily permeable by water. The next below is the sand-bed, which is wholly glutted with water, or partly dry (at top,) according to its level, or dip, or the variable supply of water, and its manner of discharge. The next bed, (3,) is of marl, or other impermeable earth, or otherwise, from its constant wetness, incapable of receiving more water from above.

Now, of all the excess of rain-water that falls on the whole surface of the tide-water region, (as everywhere else,) part flows off over the surface of the land, and of that which remains, part is sooner or later evaporated, and part sinks as low as it can be admitted into, or absorbed by the lower earth. The greater discharge of rain-water by its flowing off will be on hilly surfaces, and soils of close and compact texture. The greater discharge by downward percolation, or filtration, will be on the most sandy or porous earth, (if dry before and to enough depth, and the more so if on level surfaces. Whatever water is not taken off by these two modes, can be removed only by evaporation, and until so removed, the remaining excess of water must saturate the soil, if not cover it in part, in stagnant pools, and, for the time, destroy its productive power, and prevent all proper tillage labors. Every transient occurrence of such wet condition must be injurious to tillage lands, and the frequent occurrence of such conditions, even if each one be transient, is enough to render even rich arable land of very little value.

Of the rain-water that falls on the higher lands (at and above *a*,) and that sinks into the earth below, and which is too much to be held absorbed by the next beds, (1,) the excess must sink still lower, and go to supply or to surcharge the sand-bed (2,) below. And all the water in that bed, whether filling it wholly, or only its lower portion, would be slowly but continually pressing laterally in the direction of the dip, (towards *e*,) to seek (and find, ultimately,) a long delayed discharge in the lower channels of rivers. Although the beds of earth may be nearly horizontal, the slightest degree of their general dipping must induce the operation stated. Thus, the supply of water to glut the sand-bed is not only increased by rain-water fallen immediately above, and over porous upper beds, (at 1,) but also another and continuous supply is pressing on laterally, derived from higher levels of the sand-bed (2,) and from rains that fell many miles distant, on the higher country. And therefore, while the upper layer of the sand-bed in the higher country, (or temporarily in the lower country,) may be left dry, (as represented above the level of the dotted line at *c*,) at the lower level of the same sand-bed, and at the same time, it will be necessarily surcharged with water, which, not finding sufficient discharge in its gradual and slow descent along the dip of the bed, presses with all the weight of its higher-lying water in every direction, and not only downward and laterally, but also upward. This is evident even to the eye. For if the water received partly on a higher and distant surface, (near to and also far north westward of *a*,) serves to keep the water in the sand-bed no higher (at any one time) than the horizontal line at *c*, it will still fill the whole depth of the sand-bed as descending farther eastward. As the sand-bed dips, the water confined therein (by the higher bed being but lightly permeable,) would be pressed by the weight of the higher and remote water (rising to *c*,) and, by a well known law of hydrostatics, would rise as high as the line *c*, if having an upward vent. And precisely such a vent is afforded by a well, sunk at *w*, in which the water reached in the sand-bed (2) will rise to the level of *d c*, or as high as may there be the then height of the supply of water near to *c*. Thus, in nearly every well in this low-land region, the water usually rises above the sand-bed which yielded the water; and after great falls of rain, or long continued wetness of the earth, the water supplied by percolation only, and mainly from a distance, rises much higher than usual, and, in some cases, to within one or two feet of the surface of the land.

So far, for more clear explanation, it has been supposed that the higher bed, (1.) was more or less impervious, and so served to confine in the lower sand-bed its water, and greatly to resist and impede its escape by upward discharge. But if, as is more general, the higher bed (1) is of texture permeable to water, that difference does not materially vary the circumstances as to the need and manner of draining. A pervious upper bed will absorb more freely and speedily all the water that hydrostatic pressure would force upward, so as to leave much less visible results of such pressure in particular places, as in wells and deep ditches. But in either case there would be the same general evil to the upper earth and surface soil, of moisture derived from below; and the same remedy required, of discharging the injurious supply of water, by tapping its reservoir below.

To whatever height the water (proceeding from the sand-bed) can rise in the unobstructed passage afforded by a well, (or an auger hole, bored for trial,) to the same height must there exist the force to raise the water, though more slowly, by filtration, but by the same hydrostatic pressure in all the neighboring ground. The bed of earth lying over the glutted sand may be so close (in its moist condition) as to be impervious to the descent of rain-water, from the surface, which would act only by the pressure of gravity. But scarcely any earth is close enough to prevent the absorption of water, pressed upward by the much stronger force acting on the water confined below. Therefore, even when the sand-bed may be as low as six or eight feet below the surface, and a bed of unusually close texture between, the confined water may be so strongly pressed upward as to reach within two feet of the surface. In such cases injurious moisture will rise still higher, by capillary attraction, and more evidently over sandy than a close sub-soil or under-bed. It is owing to this condition of things, that many spaces, without showing any standing or flowing, or even the slightest oozing water, either at the surface or in shallow ditches, are always damp and cold, produce only aquatic grasses or weeds, and exhibit every indication of wetness except the actual and usual presence of water. But after every rain, and even light rains, water will stand in puddles on such places, if level, even though the soil and sub-soil are sandy and open. For moist sand is soon filled by water to repletion, and wet sand will hold water on its surface like a dish.

Thus, I infer that the whole of this low land is underlaid by a sand-bed, glutted with water to its top, and which sand-bed is generally so near the surface soil as to affect it injuriously by water from below. But even if this confined water lay too low to affect the surface earth directly, it would do it indirectly, by preventing the rain-water from sinking, and its excess being discharged by downward percolation. If the sand-bed below were dry, or always free from water for its upper twelve inches only, (as near c,) that upper layer of dry sand would serve as natural under-draining for all the upper earth. Such is the condition of things under the excellent and dry low grounds of Brandon, on James river; and such is inferred to be the case with all the similar low lands, which, though level and of stiff soil, require but little draining labors, and can dispense with all under-draining. The upper layer of the universal sand-bed, being there dry, is always ready to receive and to discharge below all water sinking from above. Thus these fine lands are under-drained by nature. And the only reason why that general under-drainage is not perfect in operation, and ample for all wants of the land, is that this dry sand is many feet (10 to 14) below the surface of the land, and the intervening beds are of clayey and compact texture. Even these impediments would not prevent the surface being generally and perfectly dry, if without any artificial drainage. But the natural draining process is too slow, and therefore the aid of some surface ditches are there needed to pass off more quickly the temporary rain-floods.

But when, instead of the upper sand being dry, and so serving to drain the upper beds, the whole sand-bed is full of water, and that water is pressed upward, then all the upper beds are kept more or less wet or moist, and are thereby rendered unable to receive any more rain-water from above by filtration or percolation. The stiffest and closest clay, when dry, is full of minute fissures; if no moister than usual at some feet below a dry surface, such clay will absorb water from above, and slowly pass, any excess, by percolation to an absorbent or receiving bed below. But earth made wet or moist by water forced upward from below, whether it be close clay or loose and coarse sand, can receive no more from above, and all excess of rain-water left there in pools must remain until evaporated.

We may best estimate the enormity of this evil, of the wet earth below preventing the rain-water from sinking, by the condition of the level woodland still remaining in a state of nature and without any aid from ditches. On such land, in wet seasons and usually in every winter and spring, the excess of rain-water remains and covers most of the surface, and in many cases for weeks or months together. This is universally ascribed by the proprietors and neighbors to the soil or its under-earth being too stiff and close to permit the descent of water; and this is held even where the upper bed is open and light enough for any purpose. Now let us proceed to examine the actual remedy or the drainage plan in general use, and its effects, and next the different principle of drainage and method which I propose.

VII. *The usual and general plan of draining and its radical defects.*

The actual plan or system of draining which is in general and approved use in this region is very uniform in the general principle and features, and also very simple. It consists in digging numerous ditches, mostly shallow and small, merely for the purpose of collecting therein and conveying from the field so much of the excess of rain-water as will flow over the surface. These ditches are at various distances, according to the greater or less excess of wetness of the land, and they are of various degrees of imperfect effect, according to their number and depth. But on no farm is this mode of ditching effectual for drainage, and on a few only has it ever approached that desired end, where the ditches were much deeper than usual and great labor has been bestowed, though on an erroneous system.

The numerous swamps, so-called, or spaces, either broad or narrow, a little more depressed or level than the adjacent ground, serve to afford ground for outlets in deep and large ditches acting as main water-carriers through these swamps to some one of the numerous rivers or deep creeks with which the whole country is intersected. Some of these deep and main discharging ditches may severally receive the waters from two or three different farms and properties, and extend for miles before reaching the final outlet. Still, by combined effort for the common benefit, these longest ditches may be made cheaply enough for their object, and may be made deep enough to suit for any system of drainage.

Supposing that a proper outlet has been secured through which to discharge the water into the river, then each farmer next proceeds to dig the receiving smaller ditches to collect the excess of rain-water from the field. In most cases the farms are so level that the ditches may be laid off in almost any direction, and usually they are made to coincide with the cardinal points of the compass, or otherwise made parallel with, or perpendicular to some road or other straight and long outline of the field. As the most laborious, and also the most perfect draining on this plan, and on the stiffest soil, is seen in Perquimons county, the operations there will be held especially in view in the following description:

In beginning a large drainage operation, or in renewing and substituting a former irregular and imperfect laying off, the main ditch of the field or farm is first dug to discharge into some common main water-carrier, or other deep outlet. But so uniform is the general level and shape of surface, that the required main ditch can usually be made straight, and to agree, in the preferred manner, with the other smaller ditches, and with the direction of the ploughing. Into the "main" and deepest ditch, (usually 3 to 4 feet deep,) and at right-angles to it, and 1,000 feet apart, the parallel "leading" ditches enter, which are 2 to 3 feet deep. Then crossing the last, and parallel to the main ditch, and 150 feet apart, (on some farms, only 125 feet,) are dug narrow "tap-ditches," 18 or 20 inches deep, and which empty, at both ends, into the "leading ditches." The land is tilled in five feet beds, laid off parallel with the smallest or tap ditches. Still, all these ditches, with the narrow beds and their alleys, (on water-furrows,) are deemed insufficient to carry off the excess of rain-water, without the further aid of "hoe-furrows," which are opened first by a plough, and afterwards cleaned out by hand-hoes after every ploughing of the field, because every ploughing (or horse-tillage) fills them. These "hoe-furrows" are made across the narrow beds, at irregular distances of from 18 to 25 yards and empty into the tap ditches. A "hoe-furrow" is made to pass through every slightest cross-depression, and wherever else deemed most necessary. Thus the alleys of the five feet beds first receive the surplus and overflowing rain-water; and so much thereof as can flow off over a level, or nearly level surface, passes out of the open ends of the alleys (from both ends) into the leading ditches, or across the beds along the hoe-furrows into the tap-ditches, and thence to the leading ditches. From the latter the water passes into the broader, and deeper, main ditch, and from it to the common outlet of the farm. The hoe-furrows (or grips) are a little deeper than the alleys of the five feet beds. The alleys may be 6 or 7 inches below the crowns of the beds. This plan is, on some farms varied by the leading ditches running parallel to the main ditches; but the number of ditches and furrows, and the spaces between, are not varied.

The object of this plan, and the only possible operation of it, is to draw off the excess of rain-water mainly *over the surface;* and even with all these numerous ditches and furrows, on perfectly level land, no water can flow off until it has saturated the soil, or stands above it in numerous little shallow pools; and if the field is under tillage, and has been deeply ploughed, all the ploughed layer will suck up as much rain-water as it can retain, before any surplus will begin to flow off over the surface, or, by lateral and horizontal percolation, to ooze out from the soft soil into the lower furrows and ditches. Such draining at best only begins to remove the injurious excess of water from the soil, after it has effected all the damage it can do for the time. It is true that every hour of the continuance of the water would greatly increase the first damage of the saturated soil, and that continuance the numerous drains serve to cut short and reduce, in time and in evil effect.

Some of the main ditches in Perquimons are of much greater depth and of unnecessary width at the bottom, (which should always be narrow, no matter how wide at top and how deep a ditch may be.) Mr. J. T. Granberry's main ditch is 7 to 8 feet deep; and, though without its being so designed, this ditch reached the sand-bed and tapped its glut of waier. This great depth had been sought only for the different purpose of having a sufficient vent for the great quantity of surface water to be discharged from the field.

This system cuts up every field, by spade-dug ditches, into separate spaces of little more than three and a half acres each. Then bridges are required at suitable crossing places over every main and leading ditch, and also over every tap-ditch when they are crossed by a farm road or a temporary track for hauling in a crop. As many other rough wooden structures are required to give passage to water and to exclude hogs where ever a fence crosses the tap or other ditches. The labor necessary to dig and keep open all these ditches, with all the other accompaniments and the increased labor of tillage, &c., among these open ditches, must be enormous. It would not be much more costly, and would return much more nett profit, to adopt, instead, the modern English system of deep and covered underdraining—which system, after all, is but the drainage of surface-water, derived from rains, by downward filtration, and as soon as may be effected after the rain has fallen on the surface in excess.

This plan of draining by numerous ditches separating and surrounding small rectangular spaces was first used on the low (embanked marsh) rice-lands of South Carolina, where it was not inconvenient for tillage, inasmuch as no ploughing or other team-labor was practicable on the soft and miry soil. Thence the same system was transferred to much of the high and firm land under cotton culture, but which needed some attention to drainage. Such ditching was practiced as late as 1843, on much land in Charleston district which scarcely needed a ditch (dug by the spade) any where. But there, while these frequent ditches were deemed indispensable by many planters, they were also deemed so great an impediment to the plough that that implement was excluded therefrom, and these fields were cultivated by hand-labor entirely. In Perquimons, full use is made of the plough despite of the many obstructing ditches. And it has not been very long since cross-ploughing also was in use among these many ditches—the corn rows being laid off and ploughed across as well as lengthwise of the long and narrow rectangles. Of course the culture then must have been flat or without beds and intervening alleys, preserved throughout the year's tillage, as since and now.

VIII. *Evidences or illustrations of the existing inju-*

ries from superfluous water, and of the proper means for relief.

The plan or principle on which I would propose to drain the lands of this low country is very different from what has heretofore been unusually aimed at, and, but partially effected. Instead of removing the excess of water by passing it off *over the surface* through numerous shallow and open tap-ditches, I would, by a few deep and mostly covered drains, tap the glutted sand-bed below, and thus, as much as practicable, lessen or entirely abate the previous upward pressure and direction of the confined water, and thereby relieving the upper bed of earth of its present supply of moisture from below, make it dry and permeable, and so permit, for the future, the excess of rain-water to sink into the drained upper bed, and be thus drawn off by percolation to the still lower sand-bed, (then empty enough at top to receive such temporary additions,) and thence the water to pass along the dip of the sand-bed, and far beneath the surface of the land, to the nearest deep stream or other place of discharge.

It is admitted that, except as to my own limited operations and experience, on a single farm, (Marlbourne,) there is almost no such practical proof of the effects here anticipated in regard to this great low-land region, of which so little is well known to me. But recent, and few, and limited as have been my means for personal examination and investigation in this region, there can be little doubt of the general existence of the one important natural feature on which my plan and reasoning rest, viz: the under-lying and water-glutted sand-bed, having a general, very slight, continuous dip. If this is the general and natural condition of the land, and if it is a sufficient cause for its present wetness, then it follows that the true principle of drainage, which sound theory would direct, is to draw the water from the *bottom*, and not from the *top*, as is the only function of shallow ditches. It may be, in some few localities, that the glutted sand-bed lies too low to be reached by ditches without too great labor and expense. But even such objections to the practical operations will not invalidate the correctness of the theory. And such good objections to practice probably exist in but few cases of limited localities.

It is manifest, to the least consideration, that the usual and universally approved plan and procedure cannot drain this land. As to the moisture infiltrating from the glut below, or driven upward by hydrostatic pressure, or drawn still higher and diffused as mere dampness by capillary attraction, it is obvious that this moisture cannot be lessened by any number of ditches in the upper earth. As to the excess of rain-water, when remaining separate on the surface, some of it will flow off in shallow ditches. But none will so pass off, from a level surface until the excess of water stands in small pools. Nor can any of the surplus water escape by filtrating laterally through the soil until the soil or upper earth has drunk up more rain-water than it can retain. These conditions of extremely wet earth, (and the more if of recently and deeply ploughed land,) must exist before the present system of drainage can even begin to act, and must still remain in force after the ditches have ceased to draw from the land that portion of the water which cannot be held absorbed. All the still remaining water, (and enough for the time to convert tilled soil to mire,) will be removed only by evaporation, as none can sink into the earth below in its present and usual wet state caused by the glut of water in the sand-bed, and the moisture always rising therefrom.

The best farmers seeing the imperfect operation of this plan of draining, have sought the desired improvement in digging all their ditches deeper than usual. But, unless such deepening reached and tapped the sand-bed, the deeper ditches could not gather any water from below, and could convey no more from the surface of the land than would be done by shallower ditches in somewhat longer time.

IX. *The upper beds always permeable if drained.*

But even if it be conceded to my argument that the sand-bed could be tapped, and the previous upper layer of its water be drawn off and kept permanently lowered, it wonld still be denied by most of the farmers that the rain-water can then sink through the earth. This denial would be founded on the supposed impervious texture of the intervening bed of earth. This belief of the under earth being impermeable to water is not only general in Perquimons, (and with much color of truth there,) where the upper earth is extremely close and stiff, and in some places eight feet or more in thickness, but also in Princess Anne and Norfolk counties, where the soil and under earth are abundantly porous, and not generally more than four feet thick.

Further, the immense quantity of rain-water which remains long, and covers much of the surface on the forest land in its natural condition, and which water passes off where ditches have been dug, makes it seem incredible that even half of all this water could sink through the earth below. It is also a prevailing belief that there is more rain in this region than general. I presume that no more rain falls from the clouds; but as very little of the excess of rain-water sinks into the earth, (because of its wetness below,) there is far more of the surplus rain-water to be removed and discharged by ditches than in other localities. In some of the nearly as level but higher lands of parts of Southampton and Surry, in Virginia, scarcely a ditch is required, and there is no evil of rain-water remaining on the surface. There, in furnishing a pervious soil and sub-soil and dry underbeds, nature has effectually under-drained such lands, and in so doing has enabled most of the surplus rain-water to disappear by downward filtration. The great quantity of rain-water in the low-lands which passes off in the ditches is owing to the small absorbing power of the always wet lower earth, and, in less degree, of the upper also.

X. *Examples of the effects of the true principle of drainage, in both artificial and natural operations.*

Though there has been very little practice in this region on the plan of tapping and drawing off the confined water of the inferior sand-bed, and almost none by design, there still have been some such operations, and with marked beneficial results. Mr. J. T. Granberry, in Perquimons, and Mr. E. H. Herbert, in Princess Anne, tapped the water of the sand-bed when they anticipated nothing of the important effect, and merely designed to make unusually large and deep ditches. Mr. W. Sayre, then of Norfolk county, acting on my general views and advice, given to him before I had seen his land, or even any part of the region in question, sought for and found the wet sand-bed at four to five feet deep, and to which no ditch on his farm, or near to it, had before penetrated. He deepened the greater length of his general outside ditch to the sand, and found great increased draining benefit therefrom in the single year which he afterwards continued to own and reside on the farm. One of the effects could scarcely be mistaken. In the summer after the first opening of this deep encircling ditch to the sand-bed, the well, half a mile distant from the ditch, ceased to supply water, and continued thus nearly dry until in the following winter. This well, (or another very close by,) had always before, and as far back as known, yielded water abundantly, and through the dryest seasons. The subsequent and long failure must have been caused by the cutting off, by the deep outside ditch, the supply to the well of water from the sand-bed. It is difficult to appreciate such slow and gradual effects, or to know always to what particular causes to ascribe them. Such effects from this mode of drainage may be slowly increasing for years before reaching their maximum of beneficial operation.

But on this principle there are many other and great drainage operations which nature has executed, and which show the beneficial results that are here promised. Every river or smaller deep water channel in this low-land is, in effect, a deep drain cut into the glutted sand-bed, and which cut or tapping has been operating to draw off the neighboring confined water, and to prevent its upward pressure so far as circumstances permitted. Along the sides of every river and deep branch, the bordering lands, for half a mile or more in breadth, are much drier than any other adjacent lands of equal elevation and like surface. This is the case in Durant's Neck, where the land is very level, and also lower thàn is usual for the firmest soil. This is the long peninsula of good land lying petween Perquimons and Little river, and extending to Albemarle Sound.

The depressed shore of a river does not serve the better to drain bordering land because the river is a mile or more in width. A covered drain, having but a four-inch pipe or passage for water, if serving to reduce and convey away all the excess of under-water, and to prevent its previous upward pressure, and so leave the upper layer of the sand-bed dry, would, for draining effect, serve all the purposes of the widest river of no greater draining depth. If the natural depression for the river's passage serves to drain by lateral percolation half a mile width of the bordering land, a deep artificial drain sunk a foot or two into the sand-bed, and whether open or covered, may be expected to do as much. And if so, deep parallel drains a mile apart perhaps might drain the intermediate land. And such drains, even if ten feet deep and covered, would still be made and kept at less cost than the never-ceasing trouble of the numerous shallow and open ditches in Perquimons. But in most other places, as Princess Anne and Norfolk counties, the glutted sand-bed is not usually more than four feet below the surface, and drains sunk into the sand, and if four or even eight of them to the mile of width or cross-distance, would not be very costly, and could scarcely fail of their object.

XI. *Draining vertically by bore-holes.*

Where the water is closely confined in the sand-bed by the compact texture of the wet overlying earth, and the upward pressure of the confined water is considerable, (because of the quantity, or height, or weight of the water at the higher sources,) a portion of the water may be drawn higher than the top of the sand-bed by the use of the auger. As in most of the wells the water rises to more or less height above the top of the sand, so it would rise as high in holes bored by an inch-auger. And if the main or discharging ditches were sunk but a few inches lower, then the water could be thus drawn up in holes bored in such ditch, the water rising through the boring would continue to flow off along the bottom of the ditch. In such cases, the holes, if found operative, should be bored every thirty to fifty yards in a new ditch, as some will not act at all. Each such bore, when acting to bring up a continued stream, is an artificial "boiling spring." And if there is sufficient quantity and force of the water thus rising, there is no more reason why the artificial boiling spring shall be obstructed and its flow stopped than a natural one.

XII. *The presence of quick-sand both as an impediment or an aid to effectual draining.*

It was by such borings (commenced for a very different object) that I first discovered the general existence and the properties of the water-glutted sand-bed on my own farm, and by them drew up and passed off water in considerable quantity before my main ditch had been sunk within two feet of the sand-bed. But if it is practicable and safe to go deeper with the spade, this vertical draining, in open ditches, should be but a temporary expedient, as it was in my own case. If the water will rise, say two feet in such bore-holes, to the then bottom of an open ditch, it will operate partially to reduce the glut of water below and prevent so much of its upward pressure. But the reduction will not be of any water that cannot force its passage so high. The greatest value of the fact of thus draining up water by boring, is the sure indication it affords of the still greater success of a future deeper digging of the ditch. If water thus rises to the height of two feet, it will rise with much more force and longer continuance if the ditch is sunk deeper and the water has so much less height to rise. If by still later and deeper digging the ditch is sunk into the sand, then there will no longer be vertical or boiling springs, but, instead, water oozing or flowing in laterally from the upper sand and along the whole line of such digging. Of course, and the more if the sand is very fine, such continuous opening is better than any number of auger-holes, even if the bores should always continue open and discharging.

The inability to execute, at once, so extensive and costly an operation, compelled me to deepen my main ditch at different times and in several successive years. But there is another reason for such gradual deepening, which will probably be found to operate in all diggings into the sand-bed in this low country. It is most likely that this water-glutted bed is everywhere a "quick-sand," almost semi-fluid, and which, as soon as dug into, will flow in from the sides and fill with sand the deeper excavation. And if the digging is persisted in it will cause caving or falling in of the solid and dry upper margins of the ditch, so that any effectual or permanent deepening at that time will be impracticable. If quick-sand is the greatest impediment to continued and successful deepening of the digging, its presence is also the surest proof of the necessity for the work and the best surety for its final and complete success. Quick-sand is nothing but a very pure and loose sand of which all the interstices are glutted with water. There is no coherence of the different particles of such sand, and the water contained therein is nearly as much in bulk as the solid matter of the sand itself, and when drained and passing off the water is continually renewed by lateral supply from more or less remote and higher sources. Hence quick-sand is semi-fluid, and flows in almost as freely as water, fills every lower cavity of an open ditch, and is like to enter every crevice of the filling material of a covered drain, and finally to choke the narrow conduit. Nothing can be worse than quick-sand to oppose the immediate and complete excavation of a ditch, whether to be covered or left open. But delay and time afford the remedy. When quick-sand is reached the digging should at first go no deeper than its surface, or no deeper into the sand than may be without causing damage. Then the before confined water, which rendered the sand "quick" or semi-fluid, will find a discharge into the ditch. The previous upward pressure will be removed. Later, the water will subside, leaving free the upper sand, thus drained into the ditch, and as low as the level of the discharge. In a year after the first operation, the then bottom of the ditch will no longer be of quick-sand, as at first, but will have become firm, and may then be deepened some six or eight inches more, before reaching what is still quick-sand below. Thus so much deeper and fuller discharge is given to the water, and so much more of the quantity removed, that thereby another layer of the then highest quick-sand is gradually converted to dryer and firm sand, and which may also be subsequently taken out safely by the spade. In this manner, and easily, and with best effects, I have, in three successive years, gained two feet of depth below the original surface of a bad quick-sand, in which at first I could not keep open the shallowest permanent passage. If all the glutted sand-bed of the low country (as inferred) is also of quick-sand, in like manner it may at first be barely tapped by ditching, and afterwards, and gradually, be dug into deeper, until all the injurious excess of under-water has been reduced and removed.

XIII. *Tests by which to judge, in advance, of the expediency or success of desired draining operations, and illustrations of effects.*

Such is my view of the cause of the general wetness of this low-land region, and such the proposed remedy. If the principle is sound, and the deductions true, it is enough for my argument, and also for very extensive applications of the theory in practice. But it is not for me, slightly informed of particular facts and localities as I am by personal observation, to offer particular directions for practical operations, or to state the natural and various conditions of different localities, which may either invite or discourage and forbid efforts to drain by means of reaching the deep-seated sources of the injurious waters. In many or most localities of this great low-land region the proposed means may be used both cheaply and profitably. In others, owing to the greater depth of digging necessary, the operation, though equally sure of success, might be of more cost than profit. Every judicious farmer acquainted with the local details can best determine as to the applicability of my general plan to his own farm and vicinity. But there are certain indications and preliminary tests of the need for and probable success of such undertakings, which each farmer should consult in advance. These will now be mentioned.

The shallow wells on every farm will have shown whether a sand-bed has been reached, whether its being tapped brought up water, and at what height above the sand, if any, the water stands permanently, and how much higher after winter, or the wettest seasons. These facts would serve to show how high the water may be drawn up by borings, and how much below that height it may be sunk by deep ditching. Thus, any depth of ditching below the highest temporary rising of the water, in wells or bore-holes, would do *some* good in draining off or reducing the glut below, and its upward pressure, though such benefit might be but for the wettest seasons. But the deeper the digging the greater would be the reduction of the hurtful excess of water. And the remedy would not be complete, until the main ditches were sunk into the sand-bed, so as to take off from the adjacent ground, all the former upward pressure of the under-water, and also render the upper layer of the sand-bed dry, and therefore capable of freely imbibing new supplies of rain-water infiltrated from above.

Next, as to the assumed permeability to water of the upper bed of earth. It has been admitted that the upper beds, even if of the most sandy and loose texture, if full of water below, are impermeable to more water standing on the surface. But if such wet earth be deprived of all superfluous moisture, (as by any proper draining,) then, what was impervious before, may become as pervious as desirable. Every one has observed such change in clay, when dug into, and the sides and bottom of the excavation left exposed to a drying atmosphere. Of course, such extent of drying, and the consequent great opening of fissures, is not to be looked for under the covering earth. But in long droughts, earth not affected by under-water, will become as dry as dust for four feet or more below the surface. This is often seen in the digging of graves in summer; while in that dry condition there must be formed innumerable small pores and fissures, caused by contraction, in the most compact earth, through which water would freely sink, and in great quantity, and as low as the earth had thus dried, and fissures been formed. And these fissures could not be again entirely closed by wetness and expansion of the earth, so as to exclude all percolation of water. It is not for me to assert that there will be enough of these fissures, and reaching to sufficient depth, to serve to carry down by percolation *all* the excess of rain-water, even when gradually falling on the earth. But there can be no question that water will be so absorbed, and conveyed away in great quantity, in a soil with under-beds thus drained, when the same earth, before being drained, would have been incapable of absorbing any water below the quickly saturated surface soil.

For the good effect and success of the plan of draining the earth from below, it is not necessary that all or even a large proportion of the water in the sand-bed shall be so drained off. It may be that the bed is twenty feet thick. However thick the bed, its being full of water and surcharged, (proved by the water pressing upward,) shows that the supply of water from the higher parts of the country is greater than the sand-bed has openings for its lateral discharge. Thus, suppose the whole natural discharge of the sand-bed, into rivers and other outlets, and by evaporation, to be in volume, as 19, and the supply of water from rains, and from the more elevated and distant parts of the bed, to be as 20, then it is seen that the excess of supply of 1 part can only be removed by being forced upward through the earth. This is the water that operates injuriously, directly, by causing wetness to the under-earth, and indirectly, by preventing the excess of rain-water from being discharged by sinking. Then, if by tapping the sand-bed, this twentieth part of the water only is removed, the whole upward pressure, and the surcharge is prevented. But further, if by deeper draining the still full (but not then overgorged) sand-bed has its water drawn off and lowered only one foot of its 20 or more of supposed depth, that upper foot of sand, thus made dry, will serve as under-draining (or absorbent) material for all the upper earth, and may receive and continually pass off all the surplus rain-water that may thereafter fall on the surface. Such is the fortunate natural condition of the best low-ground farms on the lower James river before adverted to—best, not so much for their great natural fertility, and good constitution, valuable as these are, as because they are thus under-drained by nature. The upper layer of the sand-bed under these lands, is always dry for some feet down. This dry layer, though some twelve feet or more below earth of clayey texture, is the true cause of the usual dry condition of those soils. And although the wells reach water in abundance at a few feet lower in the sand, that water has no upward pressure, and cannot damage the higher beds of earth and soil. In these cases the natural means for the lateral discharge of water from the sand-bed, (in its high level,) are greater than needed for the quantity supplied. Therefore, the higher layer of the sand-bed is kept free from water, and always ready to receive, and convey still lower, any new and temporary supply from the upper beds and soil. If, on the contrary, the average supply of water had ever so little exceeded the means for average discharge; this upper layer of sand would have been always over-gorged with water, and the surface would suffer with wetness, as do the low-lands on the Pamunkey river, and all this great low-land region here under consideration.

Though wet earth is perfectly impervious to the entrance and passage by percolation of more water from the surface, (pressing downward, and by its own weight only,) I doubt whether any earth in the tide-water region is impervious. If previously drained, at least, none such has occurred in my extensive draining labors and experience. Much soil is made more impervious by having been ploughed or tilled when wet. This operation approaches, in effect, to what is called "puddling," or kneading wet clay, or loam, which is done for the purpose of closing all the pores, and making the earth impervious to water. Such, in the greatest perfection, is the working of clay for pottery, and in less degree, for making tiles and bricks. Hence it is that deep and proper ploughing, introduced on land before often ploughed wet, and always shallow, has well-known draining effect, because the "puddled" and impervious pan is broken up, and the rain-water then permitted to sink through the natural fissures of the lower earth.

NOTE.

It was after the whole of this article had been written that I saw (May, 1857) in the city of Charleston, South Carolina, the best exemplification, and practical proof, of the soundness of the views expressed above. Under the city, and also, (as inferred from a superficial and hasty glance,) under all the higher ground of the whole neighboring country, there lies the bed of sand as described above. The top of the sand is generally within three feet of the surface of the higher and firm ground on which the city is built. As deep in this sand as to the level of 20 inches above low tide mark, excavations were then in progress, in which were to be constructed large culverts, designed to carry away, with the drained water, the filth of the city. These deep culverts were in and across the higher parts of the site of Charleston, and extending on a level from the tide-water of one river to the other. The greatest depth was 14 feet—and more than 10 feet in some places in the sand-bed, and rarely less than 7 feet. The sand was wet to its top; and a little below, it was quick, and becoming more and more fluid, and yielding more and more water as opened, to the bottom of the excavation. Water was usually reached at the depth of three feet below the surface of the street. In the street fire-wells, the water usually stood still higher. I saw one, just before it was drawn off, and laid dry by the new and deeper digging for the culvert, in which the water stood within 18 inches of the surface of the ground. No digging for agricultural draining could have been afforded of one-fourth this depth into the quick-sand—nor could any works for agricultural objects and profits, only, have been completed speedily, and at such great expense of labor and other appliances. Therefore, no mere agricultural drainage operations could have offered such full and satisfactory evidences of the correctness of my theoretical views, as did then, and will still more hereafter, this great city work, of which drainage was but a secondary object, and a mean sought to be used, (in the collected spring-water, held back, for a time, by flood gates,) to wash and float off to the rivers, the soluble and other putrescent filth of the city The ditch, opened to lay the culvert in, was 10 feet wide, with perpendicular sides As soon as the excavation reached the upper quick-sand, a narrow trench only was then dug along the middle, and kept deepest by the strong force of as many laborers as could have room to work. This central and narrow trench served to drain the sand which was then left on the sides—and by being thus made dry, it became almost immediately firm—and in a few hours this former quick-sand could be easily removed by shovels. But before entirely removing this layer of sand to the outer limit of the designed excavation, the farther caving in, (from without the limits) was prevented by driving down a close shield of thick boards, placed vertically, and with their lower edges sharpened. These boards were supported, and kept in their designed direction, by a strong framework of timbers, stretching across the entire width of the ditch. These sharpened boards were driven downward as the excavation was lowered, and were always kept a little below the still fluid surface of the sand, and which would cave in, if not at first held up by this strong and continuous barrier. After thus securing the sides, and removing the sand through a course of some two feet thick, then another like narrow trench would be dug, and by its aid, another layer of quick-sand would be first drained, and then thrown out. In this manner, the designed level for the bottom would be reached, and therefore the culvert (of arched and well cemented brick-work, laid on a floor of plank,) was constructed, and, for each portion, completed very soon after the excavation had been begun. Thus, by great expense of labor, and of mechanical supports and other appliances, this work, for each short distance, might be completed, and made secure, in a day, which, if for agricultural draining, might have required, (in the necessary intermissions of labor,) years for completion, and to be sunk only one-third as much depth into quick-sand.

But though the depth of this great work, for the draining and cleansing of a city, can never be imitated, or even approached in depth, in the country, or for agricultural profits, it is not therefore the less in proof of the correctness of my previous views of the natural features which cause the general wetness of the low country, and the proper and efficient means for, and the true principle of drainage for such lands. And, in advance of the completion of this work, and of all manifest draining results thereof, I will venture to predict that these results will be such as must be inferred from my reasoning stated above, and that these results will be evident for all the ground within half a mile, or perhaps much more, from the lines of the draining culverts.

XIV. *Some of the farming practices of the low-lands—Defects and proposed improvements—Rotations of crops—Pea-fallow, and narrow, and broad-bed tillage.*

In my hasty journeys through this country, though diligently engaged in taking general and superficial views, I had but little opportunity to observe extensively, or to examine the details of farming. Therefore, nothing like minute description will be attempted, and only general remarks offered on some of the most striking advantages and capabilities of the lands, and defects of their culture.

The early settlements were made on the dryest places, and on most of these, tillage has been continued almost incessantly, from the first settlement to recent, or to the present time. Under such treatment, and with the necessary, or at least certain and frequent wet ploughing of land, always too wet in winter and spring, it is surprising that fields so abused have not become poorer than they are. I saw none that were so unproductive as the poorest fields of the higher tide-water counties in Virginia, which have not been marled or limed, or as all such most exhausted lands were before marling and liming were begun; and wherever the formerly most reduced lands have latterly been occupied by good farmers, they have been greatly and rapidly improved. Sundry such cases are to be seen, and especially in Perquimons county. The oldest tilled lands are here referred to. The greatest recent improvements have been the bringing under culture the extensive firm swamp lands which have lost little or nothing of their original and great fertility.

On the farms of Messrs. Francis Nixon and J. T. Granberry, I saw the manner in which these swamp lands are brought under cultivation. The large trees, not needed for timber or fuel are belted and so killed. The heavy forest growth is mostly of gum, poplar, oak, and large swamp pine, (used for naval timber,) some of the latter of great size. The smaller growth is cut down more than once, and mostly dies. The land is used for grazing, until the roots are enough rotted to permit ditching and ploughing. This will be in about five years after the belting of the trees. Then the principal ditches are dug on the plan before described, and as they are to remain, except that when encountering a very large tree in the route, the ditch is there curved around the tree. The next spring, (or before) the smaller ditches are also cut, and the land ploughed and planted in corn.

There is no marl in this region, except at a few exposures of small extent—or rather, the marl lies too deep to be accessible. Some marl has been excavated and used in Princess Anne. There are extensive Indian banks of mussel-shells on the borders of the Chowan river; and in Currituck, an Indian bank of oyster-shells stretches almost continuously for forty miles along the eastern margin of the sound. There are also in shallow waters of the sounds immense beds of oyster-shells, in the places where the animals lived, before being killed by the water becoming fresh. So there is no want of material for calcareous manuring, independent of the supplies of lime and of shells, available from the waters of the Chesapeake. Some of the Indian bank shells have been used, and more lime, and to good effect, as reported, and better than ought to be expected on land not well drained. Next after supplying the first necessity, draining, liming would be especially beneficial to all the lands of this region. Besides other reasons, and benefits to be gained, lime applied on the new and rich lands would serve the better to preserve their fertility; and, on the poorest lands, it will enable the most speedy and complete acquiring of fertility. But the best effects from lime can be counted on only on land previously well drained, or, otherwise, not needing draining.

The great crop of the North Carolina counties is corn. Next to this, and especially in Perquimons, is wheat. These two are the only great crops for market. The lands generally, if not suffering much from wetness, produce corn well. On the new clearings of firm swamp lands, ditched well on the ordinary plan, fifty bushels to the acre may be made. I saw a small field of wheat in Princess Anne, (where that crop is rarely attempted, and never on large spaces,) and several large fields in Perquimons, that in growth equalled what I had just before seen on some of the best lands on James river. There is no better land for the growth of wheat than the soils of close and medium texture here. But the imperfect draining of the fields must prevent the product and quality of the grain being in proportion to the growth of straw; and, moreover, the humid air of the whole region, (caused mainly by the general want of draining, and the consequent great evaporation from the earth,) makes the wheat crops more liable to be diseased with rust.

It was with much surprise, some years ago, that I heard that the best and largest crops of wheat in Perquimons, and in some other parts of this region, were still reaped by the sickle, or reap-hook. This primitive mode of harvesting, which is older than the days of the patriarch Jacob, and which formerly was general in the United States, as it still is in Europe, I had supposed had everywhere, in this country, been substituted by the more expeditious scythe and cradle, if not by the still more modern reaping machine. And when first informed of the ancient usage remaining here, I had erroneously inferred that it indicated very slow progress in agricultural knowledge and improvement. But, when on my visit, while finding this practice far more extended than my previous idea of it, I also heard reasons in its defence, which seem to maintain its good economy. Neither is this practice confined to small crops. The best farmers and largest wheat growers, who sometimes make crops of more than five thousand bushels, reap them with the sickle. I knew that, by this mode, there may be avoided much of the great waste of wheat that is usually made by cradling; but had supposed that the slower operation of the sickle, and the high prices of harvest labor, and the scarcity of laborers at any price, had caused this implement to be abandoned everywhere in the United States, except for spots of rank and tangled wheat, or on steep hill-sides. Even for these latter circumstances, in which the proper use of the sickle would always be preferable, I have not been able to resort to it, because none of our laborers are now accustomed to it, and they would make awkward and very slow work. But in this district, the regular use of the sickle has never been abandoned, or suspended, and, therefore, the laborers are expert; and in a heavy growth of wheat, a good hand, with the sickle, can reap more wheat than he could, on the same ground, with the cradle, besides saving much more of what is cut down. The difference of waste will more than pay the difference of amount of labor and greater expense through a crop. Further, by using the sickle, and cutting as high as can be to save the wheat, most of the tall straw is left standing as stubble in the field, which is the cheapest, and as good a disposition as can be made of it for manuring the land, and makes a vast saving of labor in the hauling, threshing, and stacking, compared to the handling of all the greater length of straw, as usually cut by the scythe and cradle, or by a reaping machine. But, if admitting that the reaping of a heavy growth of wheat by the sickle is preferable, still, in a merely agricultural country it could not be done, for want of the additional force of hands which this process certainly requires. But in the peculiar condition of this district, this objection does not apply. There is so great a number of laborers employed in cutting timber, and in the fisheries, that there are enough, for the higher wages of harvest, to supply the then extraordinary demand for labor on every wheat farm.

Light growths of wheat are often reaped by cradling; and where both modes are thus in use together, the more extensive use of the sickle is, in itself, good evidence of the heavy crops of wheat raised here by good farmers, and on good land. Perquimons has generally stiff soil, and is much the best wheat producing part of this region, (not including the Roanoke bottom.) In Pasquotank the lands are also good, but lighter, and better for corn. Those of Camden and Currituck are inferior in value of soil and agricultural products, and also as to improved farming. Currituck, especially, is so intersected by navigable waters, and bounded by the sound and the ocean, that the labors or pursuits of the residents are all more or less connected with the water and its products.

Except corn and wheat, there is scarcely a crop of large culture raised for market in the North Carolina counties. Cotton, which is so universally and extensively cultivated in the nearest higher counties of North Carolina, and even to some extent in those of Virginia, is not attempted here, as a crop, for market. The general prevalence of wet soil is a sufficient cause for the absence of this crop. Oats, and especially hay, would be good crops for this humid climate and soil. But neither is raised for market, and hay scarcely at all, the fodder and shucks of corn serving in the place of hay, as everywhere in our corn-growing country. Yet vessel loads of coarse and mean hay, from the northern States, are continually brought here for the use of the towns, and for the teams of the lumberers working in the swamp forests. There is no better country for grass east of the mountains. On the farm of Edward H. Herbert, Esq., Princess Anne, on a large space, and elsewhere in Norfolk county, in small lots, I saw dry meadows of orchard grass and clover that would have been deemed good for the best grass districts, and which well attested both the fertility and good drainage of the fields on which these crops grew.

In the counties in Virginia, where near to Norfolk, and with easy access by the regular steamers to the great northern cities, "truck" farming, or cultivating green vegetables and fruit for sale, is the sole business on sundry of the most valuable farms, and it enters more or less into the culture of many others. This business is carried on exclusively, largely, and successfully in Norfolk county, on river farms only, and within a few miles of the wharves. The limitation to these localities is compelled, first, because of the necessary ready access to the steam-vessels, and also because it is only in close neighborhood to a considerable town that numerous laborers can be hired whenever wanted for gathering vegetables and fruits, which requires, rarely, many hands, and for short and uncertain lengths of time. This kind of farming is the most perfect in all its operations, the most costly in money and labor, and the most productive, not only in the gross returns, but in nett profit, and, as reported, it is the only kind of farming in the county that is well conducted. It is not long since this "truck farming" has been established on any thing like its present important position; and in that time. the lands near Norfolk and Portsmouth, suitable for this business, and so used, have increased, in market value and price, from 500 to 1,000 per cent.

This market gardening, or "truck-farming," in these large operations, is a peculiar and remarkable branch of agriculture, which well deserves thorough examination, and more full report, than this slight notice. It is an important and admirable kind of what in England is called "high farming," requiring great expenses, but returning so much the larger profits. Compared to nearly all other farming of the surrounding and neighboring lands, the "truck" farms appear like an oasis in a desert. The quantity and the cost of manures applied on these farms, and the magnitude of other expenses, and still more the great returns of products and profits would be astonishing, if not appear incredible, to a stranger. Still, this business is the most laborious employment of a proprietor, exacting unceasing attention, care, and anxiety, for every hour. Nothing short of untiring industry, care, and also good judgment, can attain success and its great rewards; and even all these will not always prevent heavy losses. The business is precarious, and subject to great changes and hazards, and losses, which no industry or care can guard against. A single severe frost, at an unusual time, may destroy a valuable crop, for which all the expenses have been incurred, except for the gathering and shipping; and which loss may reduce the nett receipts expected by thousands of dollars.

In the Virginia counties, the required drainage and culture are of much easier execution than in Perquimons, and yet both are more negligently performed. No where does there seem to be any regular system of rotation of crops. This essential part of good farming is neglected everywhere by poor and bad farmers. The most energetic and successful cultivators and improvers here have been so much occupied in the heavy labors of clearing and draining their new and rich swamp lands, that they had no opportunity to use any regular rotation of crops. This is a sufficient reason as to the newly cleared lands, for which, for some years, regular rotation would not be required, and would even be improper. But this circumstance and the continued additions of new surface to the tilled land should not prevent the older and poorer land being kept under a proper rotation, or at least under a proper succession of crops. And the neglect is the more reprehensible and strange, inasmuch as the farmers of this region possess peculiar facilities for rotations, in the pea-crop, and a climate admirably adapted to its growth. The limited territory on which both the pea and the wheat crop can grow well, (the one suiting so well to prepare for and aid the growth of the other,) I deem the most favored of all agricultural regions. Still more strange appeared to me the general neglect of peas as a manuring crop in this region, from some of the best farmers of which I obtained most of my early practical instruction as to this particular value of the pea-crop. Yet this great means for improvement, on most farms, seems to be but little used or appreciated. It is true, that peas are planted, as a secondary crop, in every field of corn, and the returns are highly valued. But this pea-crop, except so much as is gathered for seed or for sale, is generally eaten on the ground by the hogs designed for slaughter, (greatly indeed for benefit in that respect,) so that very little of the crop, except the roots and stems, go to manure the land. I heard of no separate crops of broad-cast peas, (or "pea-fallow,") to prepare and manure for a succeeding wheat crop, the most valuable use to which the pea-crop can be applied. It is a frequent practice here for the land in corn (and secondary peas) not to be sown in wheat the autumn of the same year, (as is usual in Virginia,) but for the field to remain until the autumn of the following year, and then to be sown in wheat.

This practice leaves the field idle and useless all the spring and summer, when in that time it might be sown in peas, and bring a manuring and cleansing crop to precede the wheat, without any loss of time or of land. This is a regular part of my own established rotation, and, as supposed, its best feature, though my more northern position and shorter warm season render the pea-crop much less productive and beneficial than in this more favored region. Still more than this omission, another is common and as reprehensible. Wheat, in some cases, is made to follow wheat in two successive years. If, in such cases, there was merely interposed between these two crops a broad-cast crop of peas, (for which there is plenty of growing time,) that addition only would serve to substitute a cleansing, enriching, and judicious succession of crops, for one that is inexcusable and abominable. Clover is made on most of the good farms of Perquimons, and used as a preparing (or fallow) crop for wheat. With the superior facilities for the best growth of peas, if I were farming in this region, I should much prefer pea-fallow to clover-fallow to precede wheat.

The reason offered for the total omission of pea-fallow is the great and engrossing tillage labors required for the great crops of corn, and also for the wheat harvest, both of which occur with and include the very time in which the land for broad-cast peas should be ploughed and sown. This is true, and a sufficient reason, if it is necessary to plant in corn as much land as the laboring force can cultivate. But it would be much better to secure the great benefit of a manuring pea-crop to precede wheat, by the (temporary) sacrifice of omitting to plant as much corn as would release enough labor for the additional pea-crop. This sacrifice was a necessary incident of my own change (in 1848) of the five-shift rotation, without pea-fallow, to the six-shift, with one entire field under broad-cast peas. The fields of both corn and wheat, by this change, were reduced, severally, to five-sixths of their previous size. Yet the wheat crops have continued since to increase, on the general average, and to exceed more and more the previous entire product, and so have the corn-crops, except in the first year only of the reduced extent of cultivation. Yet the advantages of manuring by the pea-crop in my locality and climate are very inferior to those of this region of North Carolina.

While the many firm swamps remained generally under forest, these lands afforded excellent "range" for live-stock, or a great quantity of food, especially for cattle and hogs. But this benefit, (if it was one,) has almost ceased in the best cultivated parts of the counties on the sound. Such is Durant's Neck, the narrow and level and very low peninsula which stretches for twelve miles between Perquimons and Little river to Albemarle sound. This land, being but a few miles wide anywhere, and bounded nearly around by these deep waters, is in consequence better drained, naturally, than the interior lands, and is very productive. Nearly all this "neck" is enclosed, and an unusually large proportion of the whole is under tillage, and there is scarcely any unenclosed forest or waste land for ranging live stock, and none that affords any grazing profit. I know no place where it would be so profitable to dispense with fences, as is done by mutual agreement, by the proprietors of three several neighborhoods in Prince George county, Virginia, each including from 4,000 to 8,000 acres, and making from 10 to 15 farms and separate properties. If the cultivators of Durant's Neck would do the like they would only have to make one short and straight fence to enclose all their fine farms, and save all the cost of their present useless fences. Yet every farm and field is now separately fenced in, and some of the proprietors have no materials for fencing, and buy, and transport from a distance, all their rails. This locality, more strongly than any other, shows the absurdity of our fence laws, and also the strength and long vitality of old habits and opinions, when the former good reasons for them have long ceased to exist. If the live-stock were reduced in numbers to one-fourth, and these were well kept, by being herded within the farms, one cow would yield as much profit as four do now. And when the grazing stocks were so lessened in number there would be much surplus grass left to manure the pasture or other land. While three-fourths of all the present fencing might be dispensed with, the other fourth would serve to make a sufficient pasture enclosure for every farm. For nothing in geometry, is more clearly demonstrable than the proposition that it will require greatly less length of enclosure to fence in the cattle of any well cleared and settled section of country, than to fence in all the fields and crops to protect them from the cattle if left at large. One-fourth of the present fencing in Durant's Neck would suffice not only to make on every farm a proper pasture enclosure, but also the general and joint barrier fence against all other people's stock. Most of the farmers in Prince George, who have joined in these arrangements, if not situated on the border, have no fence except the pens in which to confine the animals at night. But this extreme course is not true economy.

In Princess Anne, there still remains so much uncleared and swamp land, that the leaving cattle to range at large is deemed very profitable to the owners, and perhaps, in general, it is there, more an offset to the expenses of fences, under our fence law, than in any other county of lower Virginia. The open swamps bear reeds in great quantity, which afford abundant and excellent food for cattle through winter and summer. There are herds of cattle that have become wild, and are made use of when wanted for beef, only by being hunted and shot. These wild cattle would be very profitable to their owners, as they require neither food nor attention, except that they are as much at the disposal of every other person who may be inclined to shoot and steal them.

It becomes a slight observer of a newly seen agricultural district of novel and peculiar character, to be diffident of his own opinions thereon, and more especially, when they are in opposition to those of the judicious and experienced resident farmers. One of such subjects I will mention, though without any view of urging the superior value of my opinions and practice, in this respect on my friends in this region, who unanimously and strongly protested against them, at least for their lands. Their experience of facts, in contradiction, certainly deserves more to be respected than my theoretical views as to this region, even though they have been sustained by the results of my own practice and experience elsewhere.

As stated before, the tillage generally, and on the best managed farms, is in narrow beds (five feet,) for corn, and the same size is preserved for wheat. The beds are reversed for every crop, both of corn and wheat. I will not here repeat my objections to this narrow bed tillage, nor my reasons for preferring (where any are necessary) beds of twenty-five or more feet in width. These views have been stated and argued at length in different former publications. (The latest and fullest articles on tillage in broad beds, and also on draining in general, are in "Essays and Notes on Agriculture," 1855.) I will only say here, that all the reasons for preparing wide beds for low and flat lands generally, apply with greater force to the lands of this region, and especially in Perquimons, because they are of more regular level, and with fewer alternations of slight depressions and elevations, than any other low-lands within my knowledge. The best farmers here, with whom I have argued this question, object on various grounds to my broad-beds, but especially, because their frequent cross "hoe-furrows" are deemed indispensable, and if the broad and higher beds, and their deeper alleys were in use, the "hoe-furrows" would have to be made still deeper, and require more labor to dig, and to renew after every ploughing or horse-tillage, and be even inconvenient for the ploughs to cross. This objection would be valid, if indeed it would be necessary (with the broad-beds, and deeper alleys) to retain the hoe-furrows; but this necessity I doubt. For with so much higher beds and deeper alleys between them, on land scarcely varying from a level, or from a regular and gentle slope, I think that the deeper alleys would substitute the hoe-furrows, and render them superfluous, except where a cross depression of surface required a particular cross grip. In my own practice, on the Pamunkey flats, the surface is much more irregular, yet there are no grips kept across the beds, except along the cross depressions. If the inequalities of surface level were as rare as on the Perquimons lands, my cross grips would be fewer and less necessary than they are.

But if my plan of broad-beds would suit this region, there might still be added thereto another improvement, which I commenced using in 1855, and which has been continued since on the Marlbourne farm, with increasing confidence and approval. Without taking time here to describe and recommend the operation in general on the different circumstances of my own farm and practice, I will merely apply the plan to the present existing divisions and ditches of the Perquimons lands.* We will suppose that these present ditches are all necessary and proper to be retained—though such is not my opinion, if a different system of drainage were in use. Then suppose merely the change that each of the rectangular enclosed spaces of 150 feet wide, instead of being, as now, in thirty beds of five feet wide, was ploughed into six beds, each of twenty-five feet width. After two or three years ploughing, and tillage, and gathering of these wide beds separately, they would be as high, and their intermediate alleys as deep as desirable. Then, instead of continuing to plough each bed separately, the first furrow should be cut alongside of the central alley, and turning the slice into it. This furrow should begin and end at 75 or 80 feet distance from the ends of the rectangular "slip," or at (or something less than) the same distance of the central alley from the sides of the slip. Turning the plough at that distance, another furrow should be cut alongside, and throwing the slice to the first, thus making, a "list" in the former central alley. So the ploughing would proceed around this first list, cutting across the ends as well as along the sides, and throwing every furrow-slice towards the centre of the ploughing. This ploughing, though flush, and cutting across the ends as well as along the beds, and with no regard paid to the alleys, would scarcely alter the outline of the previous surface, and would not lessen the height of the crowns of the beds or the depth of the alleys, except the central alley, which would in time be filled, and would not then be needed. The outside furrows would just reach the encircling ditches of the "slip," turning the depth and width of a furrow-slice from each at every repetition of such ploughing. One or two furrows run along each of the old alleys, after the flush ploughing, would clean them out and put the broad-beds in their original shape, and they would be more thoroughly broken by this mode of ploughing. Every successive ploughing of the land to prepare for any crop should be done in like manner. The tendency and operation would be to raise the central part of each rectangular division so ploughed around, and to lower and slope the sides and ends, or margins, next to the surrounding ditches. After a few such ploughings the shallow tap-ditches would be, to the eye, almost obliterated, or changed to mere ploughed alleys or grips. Yet, in fact, they might be deeper than before, and would certainly be more operative for surface drainage than before. The preserving and cleaning out of these "tap-ditches," instead of requiring spades and shovels, would thereafter be as well done by the last finishing furrows of the plough. These ditches would no longer present any obstruction to the crossing of ploughs, or partly loaded carts If desired, (and it might be even desirable in future time,) the corn-rows and their ploughing, in narrow beds, might be directed across the beds and tap-ditches. Further, the end margins of the "slip" being equally depressed, and sloped to the edges of the larger leading ditches, these would be much more easily crossed by teams, and fewer and smaller bridges would be required. Thus, in the course of time, each separate "slip" would be converted to one broad bed of 150 feet wide, and gently rounding surface, and 1,000 feet long, (the present dimensions of the separate divisions,) with sloped margins and ditches between deeper than before, yet presenting either little obstruction, or none, to the crossing of ploughs and teams.

POSTSCRIPT.

Lands on the Chowan and Roanoke.

A later excursion to a portion of Chowan county, and to some of the best farms on the Roanoke river enables me to add something to the foregoing notes of this generally uniform region, and especially in remarkable exceptions, on the Roanoke, to this general uniformity of agricultural character.

In Chowan county, my view extended only over the lands within 12 miles of Edenton, and from 3 to 4 miles back from the Chowan river and Albemarle Sound. The general elevation of the surface is from 11 to 14 feet above the level of the Sound—and the land is more uniform in level

* When I first began this manner of flush ploughing of low and bedded land, and with considerable apprehension as to its complete success, it was not known to me that any other farmer had either used or thought of the same method. But, subsequently, when recommending it to the trial of E. H. Herbert, Esq., of Princess Anne, as an important aid to his usual efficacious practice of draining, he informed me that he had already introduced and used this plan of flush ploughing on his land earlier than my first trial of it, and had found the results entirely satisfactory.

than any other that I had before seen. The soils are moderately stiff, and of good texture for producing wheat. Before being cleared of the forest growth, and ditched, most of the surface of the land was subject to be covered by the water left by heavy rains. The system of drainage in general use is similar to that of Perquimons. But the small parallel (or "tap") ditches are wider apart—usually 180 feet. According to this system, the details of draining were well executed, and effective; and the lands best drained, (especially those of Dr. Thomas Warren,) were very fertile and productive. These, where seen in their natural state, seemed to the eye, and by their growth and wetness, to be swamp. But in fact, they are of the highest level of the neighborhood, and among the dryest, after being drained and cultivated. The natural forest growth was principally of black gum, ash, maple, with some oak and pine—and with these, a general under-growth of reeds. For miles, no change of level of the surface was visible; and the slight general descent of surface could be known only by the direction of the flow of water in the larger ditches. The farms bordering on the Sound, only, have some narrow depressions, of a few feet only in depth, which serve as exceptions to the otherwise general level of the surface. The water in the wells of Edenton and the neighboring country is generally about 13 feet below the surface of the land. This would indicate that the water-glutted sand-bed here lies too low to produce the damage elsewhere usual to land, by keeping water on the surface—or to afford a facility for draining operations, by tapping the sand-bed by deep drains, or by boring. On these points, my hasty and limited observations, aided by inquiry, afford no information better than conjecture.

The broad Chowan is the only river of all this low-land region, east of the Roanoke, which receives any considerable supply of water from higher and distant sources, or is filled by any other than the refluent water of Albemarle Sound. And even as to the Chowan, all the water brought by its upper tributaries, the Meherrin, Nottoway, and Blackwater rivers, if alone, would not usually fill the twentieth part of the broad and deep bed of the Chowan. So that even this greatest of these neighboring rivers is but a partial and limited exception to their general character of having almost no head-springs, or supplies from remote sources.

But the Roanoke is remarkably different in these respects. Its very distant sources are in the Alleghany Mountains, and they make large streams, at all times, even at the base of these mountains. Its bed, throughout its long course to Albemarle Sound, is very narrow for the great quantity of water flowing therein, and which ordinary supply is enormously increased by the transient rain-floods coming from the upper country. These rise to great heights, and cause great injury to the very rich and extensive bottom lands bordering on this river. But for the rare and terrible disasters to the crops, caused by these high freshes, they would be of great improving benefit to the fertility of lands they overflow, in the abundant deposit of richest alluvium which the water leaves. This deposit has made, and maintains, the Roanoke lands the richest on the Atlantic slope; and they would be more valuable than the bottom lands of any of the rivers of that slope, but for their greater liability to be overflowed, which is owing to the remarkable narrowness of the whole bed and course of the river, compared to its length, and to the volume of water which it conveys. The bed of the river, and even to its outlet into the Sound, is too narrow to discharge its floods; and hence they overflow the bordering low grounds, of the second terrace as well as the first or lowest, to their great damage. Thus these rich alluvial low grounds of the Roanoke are greatly subject to disaster from being overflowed by floods, from which danger the low borders of the other rivers of Albemarle Sound are almost entirely exempt.

That the low lands of the Roanoke are so different from all of the neighboring rivers, is owing but in part to the great length of its course, from its distant mountain head-springs. This indeed causes the great volume of the floods, as well as their great burden of rich alluvium. But there is still an additional cause for the obstructed discharge, in the different geological character of the land over which the lower course of this river passes. The lower channels of the other neighboring rivers, on both sides, together with their bordering lands, seem all to have subsided, at some far remote time, below their former levels. But the bed of the Roanoke seems to have preserved its original elevation, if indeed it has not been actually up-heaved still higher. The primitive rock shows in ledges under the channel of the Roanoke far below the foot of the great falls; and even high above the present height of water in the bank at Halifax ferry. The river is very uniform in breadth, and not varying much from about 120 yards, from the falls to Albemarle Sound.

The "first low ground" or lowest terrace, gives the richest soil—which however is not black, or dark-colored, but of reddish yellow, or hazel loam. The "second low ground" is worse in quality, but still is good land. The "third" is still worse; and there is in some cases still a fourth terrace, nearly as high as, though evidently lower than, and different from, the highest table or ridge land, which is usually sandy and naturally poor.

Corn is the great crop of the Roanoke lands. Though fine crops of wheat are raised by the Messrs. Burgwyn, in Northampton, North Carolina, and J. C. Johnston in Halifax, giving evidence of the fitness of the low-ground soils for that crop. Cotton is the next greatest crop to corn; and this culture is sufficient evidence that the lands on which it succeeds do not naturally suffer damage from under or spring-water. The farmers have not much to do for drainage, except to exclude, by deep and broad ditches and their banks, and to vent by culverts, the streams and rain-floods coming in from the high lands, and, by dykes, to keep off the high floods of the river. Both these great objects are well effected only on the properties of a few of the planters—at enormous expense, but at far less cost than the alternative of losing the growing crops usually once in 7 to 10 years, on an average.

The land nearest to the river, whether of the first or second terrace, is always higher than the exterior of the same terrace farther back from the river. This shape of the surface offers the highest foundation for the dykes next to the river, where they are required to be placed. There are great differences and frequent changes in the elevation of ground bordering on the river, and consequently as much difference in the required heights of the embankments. The home plantation of Th. P. Devereux, Esq., Connucanara, in Halifax county, North Carolina, is protected by an embankment rising to the height of 26 feet throughout above the low-water level of the river. The highest fresh yet known, before the embankment was made, rose 22 feet, and covered the whole plantation except a few acres Much of the dyke, being on margin of the highest elevation, is only 4 feet high. But one part, which seemed about half a mile long, it is 14 feet high. To every foot of perpendicular height, there is given 5 feet width of base. On Polenta in Northampton, another of Mr. Devereux's several plantations, (all of which are thus secured by embankments,) the dyke, for 200 to 250 yards of its length is 17 feet high, and more than 100 feet broad at the base. And these high embankments are not the only heavy expense. For it is through their highest parts (these being over the lowest surface of the land,) that it is necessary to keep open large culverts to discharge the waters of land-streams and rain-floods, and from which, by valves, to exclude the river-floods when these are higher than the interior water. On this and four other adjacent farms there are 7 of the large-sized culverts, which cost about $2000 each—and three of these are on one only of the farms. These culverts are constructed of wood, and of course cannot be very durable. Still, great as is the expense, for embankment and culverts, for each plantation, it is cheaply paid for in the safety of a single crop, which would otherwise be lost, if without this means for security from inundation. Such is the correct reasoning of each individual proprietor, and improver in this mode. And thus each one, of the few who have yet so improved, may secure his own possessions from the floods of the river. But it is obvious that every such embankment, operating as an obstruction, must serve to raise the floods somewhat higher on the lands still subject to be submerged. And should every proprietor exercise his equal right to embank all his own lands, and thus the general operation shall strive to confine the river within the limits of its shores, the attempt must fail, and the floods, rising higher in proportion to their lateral confinement, will overtop any dykes which can be made by separate individuals, each working on his own separate plan. It would be very far better, and the only means by which general success can possibly be attained, if the State were to require such works to be constructed on one uniform and the best general plan, for the benefit of all the lands and their proprietors. If such general plan confined the water to its present channel, that confinement would cause much increased velocity and power of abrasion, and thereby a deepening of the bed of the river, if the bottom is soft enough to be so deepened by washing. And if this effect would be prevented by only a few narrow ledges of rocks too hard to be lowered by abrasion, it might be well worth the expense of deeper passages being opened through such narrow and harder obstructions. All the additional and general depth that could be so gained, would serve for the improvement of navigation of the river, as well as to aid the operation of the embankments to protect the lands from the river-floods.

Tug,