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BENEFITS OF DRAINAGE

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DRAINAGE INCREASES THE TILLABLE AREA

The farm drainage records of the Agricultural Experiment Station extend over fifteen years, from 1907 to 1921, inclusive, and embrace eighteen farm drainage systems planned and completely installed under the close personal supervision of the drainage staff. They cover parts of twenty-two gardens and farms in fifteen counties scattered over this state and two in the Red River Valley in eastern North Dakota. They include areas from 3.5 to 500 acres in extent. The variations in soil and surface conditions are almost as great as those in size.

A few of these records are given in detail, and show that the proportion of land on the individual farms useless before drainage and reclaimable for crop production varies from 0.67 to 79.17 per cent, with a true average of 30.14 per cent of the total area of the farm. As a rule the land thus reclaimable is the best on the farm and produces the largest and finest crops. (See Figs. 2 and 3.)

Fig. 1. Seepage Pocket
This condition is easily remedied by tile drainage.

DRAINAGE PAYS BETTER THAN PURCHASE OF NEW LAND

The average market value fo these lands, of which 69.86 per cent was tillable before drainage, was $117.29 per acre. Therefore the resulting average value for the 69.86 per cent tillable without drainage was $167.88 per acre; whereas the average initial cost of reclamation by drainage of the waste spots was but $77.09 per acre, an average saving of $90.79 per acre, or 54.08 per cent over the purchase price of land tillable without drainage.

BENEFITS TO THE INDIVIDUAL FARM

Adds to the best acres on the farm.
Improves quality and increases quantity of crops on existing acres by
- Increasing length of growing season owing to
  - Earlier drying of fields in spring
  - Better aeration of the soil
  - Earlier thawing of ground in spring
  - Warding off frosts in late spring and early fall.
- Checking heaving by frost, and consequent winter-killing
- Increasing the capacity of the root bed.

Insures against drouth by
- Providing larger storage space for reserve moisture
- Inducing better distribution of available soil moisture
- Checking evaporation and consequent baking and cracking of the soil
- Improving the soil structure, thus giving better tilth
- Providing deeper feeding ground.

Improves the chemical condition of the soil by
- Removing excess alkali and acids
- Aiding in decay and nitrification.

Preserves fertilizers; prevents floods.
Squares up the fields and makes the whole farm more easily and cheaply worked.
Improves sanitary conditions, making the farm a better place in which to live.
Improves the appearance of the farm, thus increasing its market value and stimulating the pride and interest of the farmer in his work.

A Few Instances of What Farm Drainage Has Done in Minnesota

Item No.	Date of drainage	County	Total acres in watershed on farm	Acres tillable before drainage	Total acres reclaimed*	Estimated market value of farm per acre before drainage	Resultant value per acre of land tillable before drainage	Cost per acre of reclaimed waste land†	Total cost of drainage
1	1908	Carver	73	63	10	$105	$121.67	$61.50	$615.00
2	1909	Carver	76	62	14	75	91.93	54.14	758.02
3	1910	Itasca	185	85	100	50	108.82	37.11	3,710.99
4	1911	Rice	237	181	56	125	163.67	63.02	3,529.27
5	1916	Clay	300	224	76	125	167.41	98.47	7,483.74
6	1918	Clay	255	180	75	100	141.67	135.59	10,168.93
7	1919	Scott	500	380	120	175	230.26	75.14	9,065.27
8	1921	Stearns	139	104	35	125	167.07	107.13	3,749.50

* Note.—Total acres reclaimed were obtained in each case by reducing land needing only partial reclamation to equivalent acres needing total reclamation. For example, under Item 1 there were 5 acres of wholly waste land and 10 acres tillable half the time, equivalent to 5 acres more of totally waste land, thus making a total of 10 acres reclaimable.

† All drainage cost charged to reclamation.

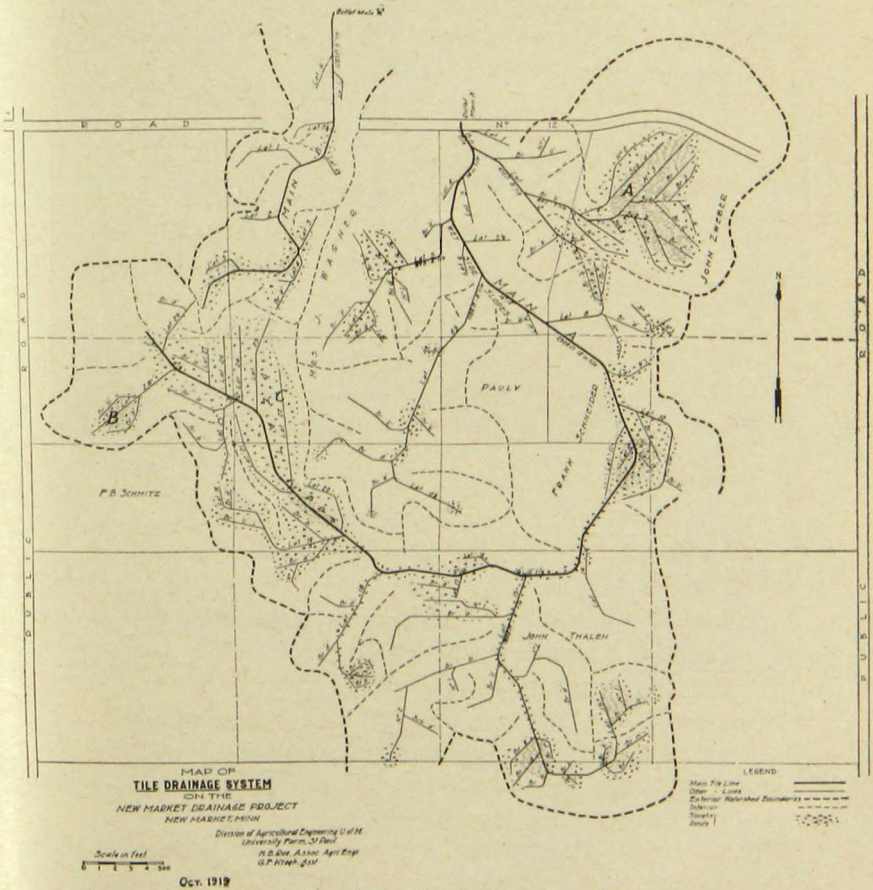


Fig. 2. Cooperative Drainage in Rolling Country Full of Sloughs and Pockets

The farm of Mrs. John Wagner, shown, was six fields and is now one. Mr. Thalen's and Mr. Zweber's fields were more cut up than Mrs. Wagner's, but all these fields are continuous since the drainage was installed in 1919.

Item 1. State Fruit Breeding Farm, Zumbra Heights.—Actual price paid—$7653.45, or $105 per acre. The tillable land therefore cost $121.67 per acre; whereas 10 acres of worthless land were reclaimed at $61.50 per acre and became the best land on the farm. Appearances were improved, fields straightened, and all the land was brought under cultivation. Land in this vicinity recently sold at from $250 to $500 per acre. (See Figs. 4 and 5.)

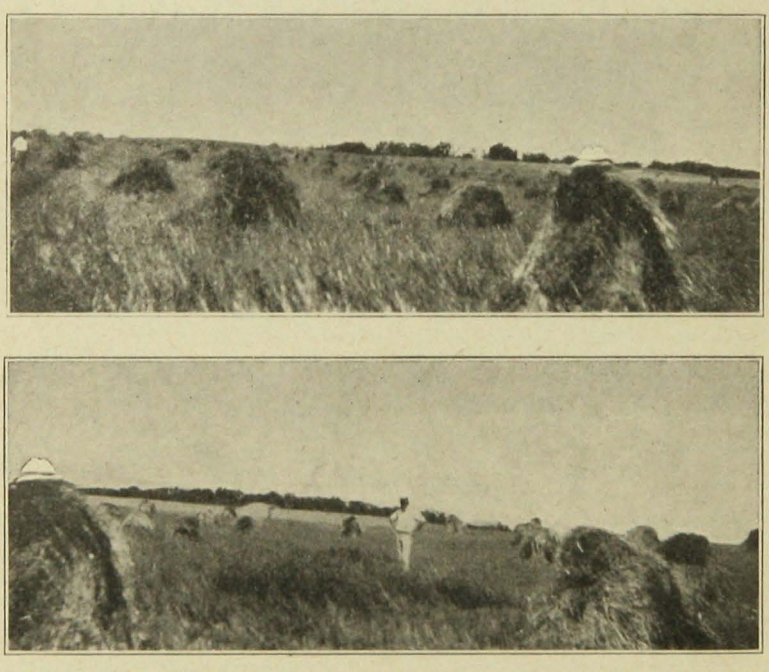


Fig. 3. Succotash on Drained Slough and on Adjacent Upland

Above: Drained slough at junction of Main B and Lateral 4 of Fig. 2.

Below: Adjacent upland to the east. The hat is on the same shock in both pictures (July, 1922). Note how much thicker the shocks stand in the upper picture than in the lower.

Item 2. Farm of Geo. W. Olson, near Belle Plaine.—The total farm was valued at $75 per acre. The tillable land therefore was worth $91.93 per acre; whereas the 14 acres of worthless land were reclaimed for $54.14 per acre. Fields were straightened, the whole farm was brought under cultivation, and the farm income was increased from $994 in 1908 to $2455 in 1912 as a direct result of the drainage. (See Fig. 10.)

Item 3. North Central Experiment Station, Grand Rapids.—The larger part of this farm, located in the given watershed, was a low seepage slope lying below the moraine on which the buildings were set and was all too wet to cultivate successfully. About

a quarter of the farm was covered with slough pockets and a running slough during part of the year. The original speculative value of the land was $25 per acre and it cost about $25 per acre to clear it. The waste upland was reclaimed for $37.11 per acre, and the appearance of the whole farm was greatly improved. Similar land in this vicinity sold recently for $125 per acre.

Item 4. A portion of the land of the Andrews Nursery Company, near Faribault.—The normal value of this farm was $125 per acre, but only 181 out of 237 acres were tillable before drainage, thus making the value of the tillable land $163.67 per acre. Drainage reclaimed the 56 acres of waste land at a cost of $63.02 per acre and made possible the cultivation of the entire tract, which had previously been too wet and cut up for any use except as pasture of rather poor grade.

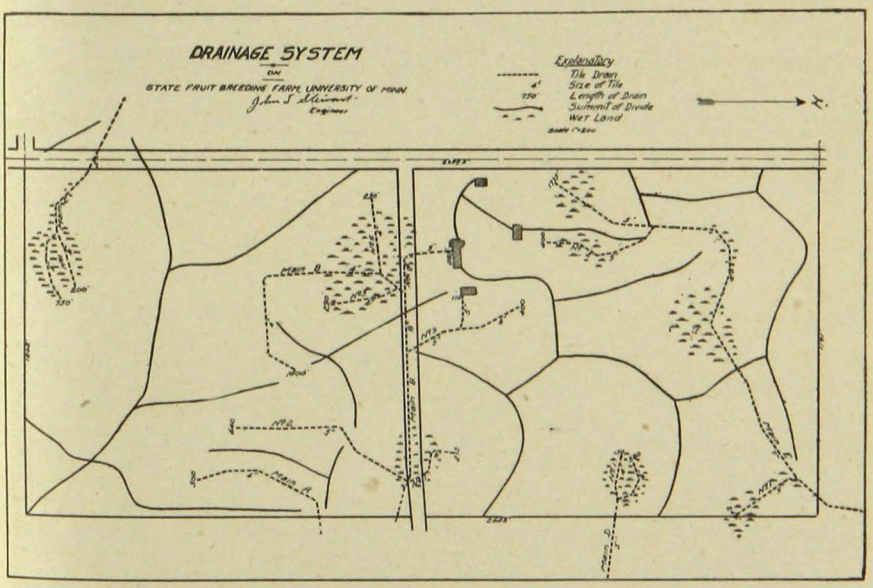


Fig. 4. Comparative Area of Sloughs Reclaimed and General Improvement of Fields Made Possible by Drainage

Item 5. Three hundred acres on the farm of E. C. Schroeder, near Moorhead.—This area was badly pitted with permanent marsh pockets, and about 20 acres at the southeast corner were so low and wet as to be tillable only about half the time. In 1916 this farm was valued at $125 per acre, which would make the value of the 224 tillable acres $167.41 per acre. Drainage reclaimed the 76 acres of permanent marsh at a cost of $98.47 per acre, straightened the fields, and very greatly improved the general appearance of the farm. (See Fig. 9.)

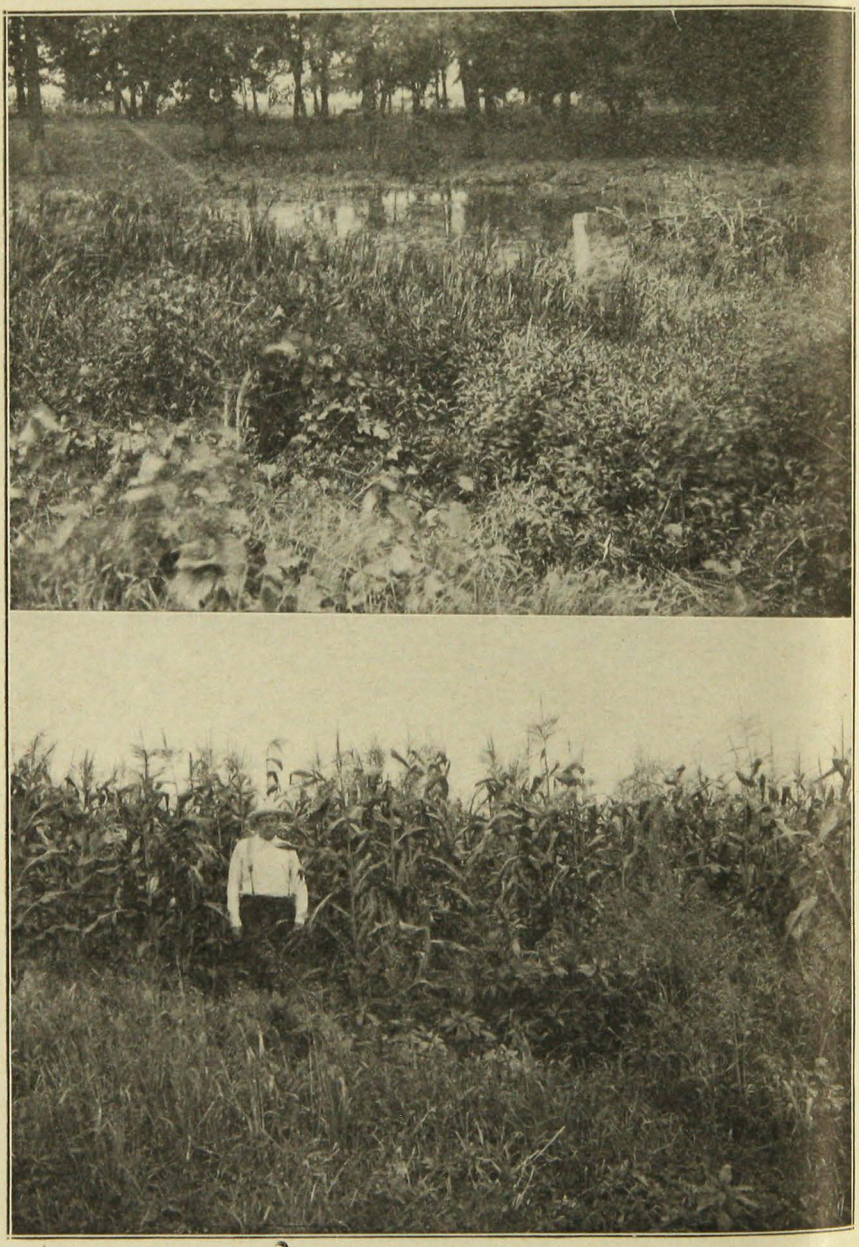


Fig. 5. Before and After Drainage

Above: A pocket on Main D of Fig. 4 in its original condition.
Below: A fine crop of corn on the same ground, after drainage.

Item 6. Two hundred and fifty-five acres of the home farm of E. D. Grant, near Glyndon.—The west half of the tract was badly cut up by permanent marsh pockets, and near the center was a shallow marshy pond about 50 acres in extent. These marshes cut up into six fields, most of which were very irregular, a 400-acre tract that might have been cultivated as a unit. Drainage remedied this condition, reclaiming the waste land at a cost of $135.59 per acre as against a market value of $100 per acre for the whole tract, thus making the value of the tillable portion $141.67 per acre. The 50-acre pond raised a $3000 crop of flax in 1919. In 1922 it bore a good crop of small grain.

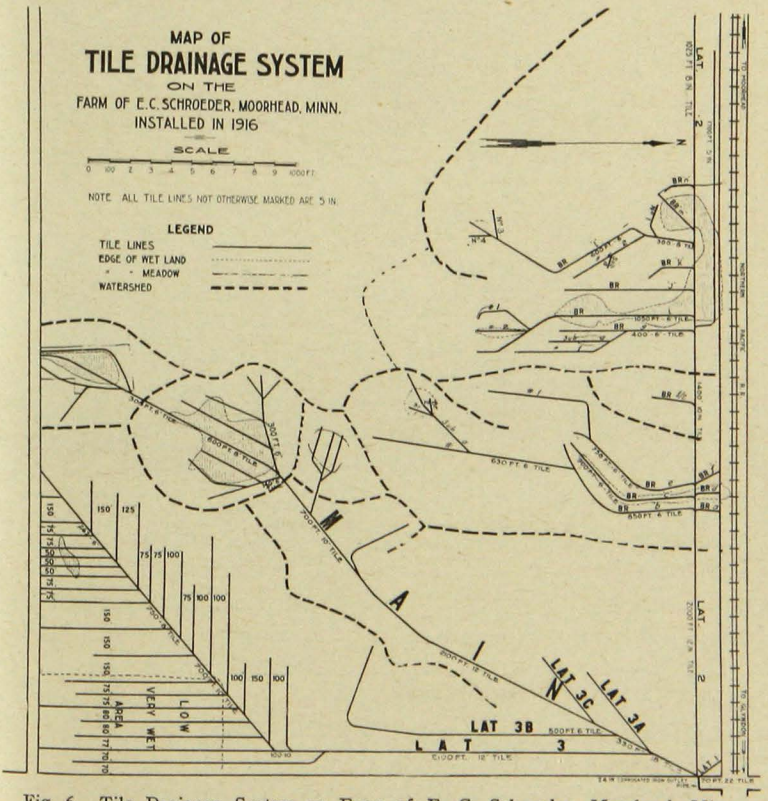


Fig. 6. Tile Drainage System on Farm of E. C. Schroeder, Moorhead, Minn. This shows the great advantage to cultivation in removing the permanent sloughs and ponds as well as the large percentage of waste land reclaimed. In the summer of 1917 the old pond beds on the north side of this farm grew the finest potatoes on the place.

Item 7. Tract of 500 acres near Newmarket—parts of the farms of six owners.—It contained 41 marsh pockets and 5 running sloughs. The land of one owner was in six irregular fields. The market value of these farm lands before drainage was $175

per acre, making the value of the tillable portion $230.26 per acre. The drainage reclaimed the waste land for $75.54 per acre. The old marsh pockets are all drained out and each season since have raised the finest crops of corn, potatoes, and small grain on the entire tract. The many small fields have been replaced by uniform large ones. The owners state that because of the drainage their crops are increased and improved from 30 to 90 per cent and the general value of their farms from 20 to 30 per cent. (See Figs. 2 and 3.)

Fig. 7. Undrained Pocket in Field of Young Grain After a Rain

Item 9. Farm of Mr. G. Heitke, near Paynesville.—This is one of four in the watershed; and the main was put in by all affected owners, coöperating. The drainage was completed on Mr. Heitke's farm only, and the figures shown are for his farm alone. The value of the farm before drainage was $125 per acre, making the value of the tillable portion $167.07 per acre. The waste land was reclaimed at a cost of only $107.13 per acre. A permanent marshy pond, 30 acres in extent, was removed from Mr. Heitke's front yard; and the pond bed grew an $830 crop of flax this year. The public road crossing this pond was so benefited that the county board and the town board both contributed to the cost of the drainage after it was completed. (See Figs 12 and 13.)

DRAINAGE IMPROVES AND INCREASES CROPS ON LAND ALREADY UNDER CULTIVATION

Those who have drained their land almost universally testify that their crops are surer and heavier than before drainage. This increase and improvement amounts to from 15 to 50 per cent. From 20 to 25 per cent is common experience. This great benefit is brought about in the following ways:

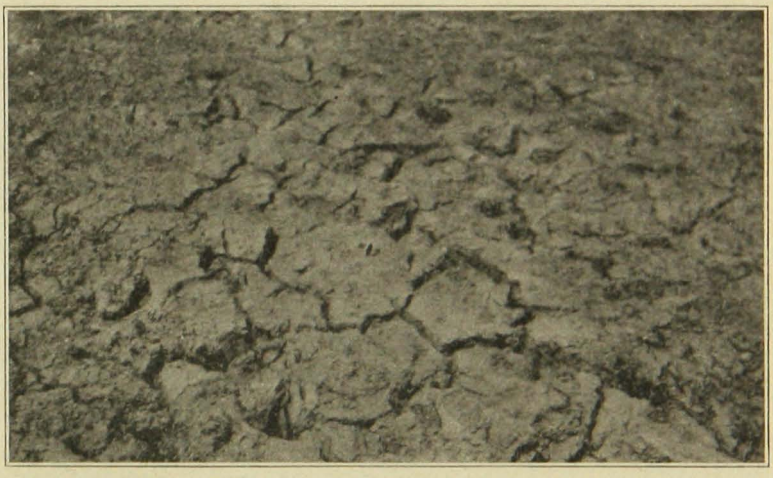


Fig. 8. Cracking of Soil Due to Evaporation of Surface Flood and Baking

DRAINAGE LENGTHENS THE GROWING SEASON

Fields dry earlier in spring.—By drying the fields earlier in spring, drainage allows seeding to be done and germination to take place earlier. A portion of University Farm, St. Paul, was tile drained in 1910. The farm foreman has repeatedly said that he is able to begin spring work from ten days to two weeks earlier on these fields than before they were drained. The director and the agronomist of the North Dakota Agricultural Experiment Station at Fargo have both said that the same is true on their experimental fields. Mr. Wagner, of Newmarket, says that he he can begin seeding fully two weeks earlier in the spring than he could before he drained his farm. Mr. Heitke, of Paynesville, says that he was working his newly drained lake bed last spring fully two weeks before the water was off the surface of his other and older fields.

Soil warmed and frost drawn earlier.—By removing the excess water in the soil, drainage makes the soil more porous. This condition provides for better circulation of air and gases through the

soil, warming it up more quickly and thus materially aiding in thawing out the soil in the spring.

A good illustration of this is the experience at the Peat Experiment Station at Fens, St. Louis County, Minnesota, where tile drainage was installed in the spring of 1919. In the spring of 1920, the frost was all out of the peat on this tract to the full depth of the tiling, by May 25. Just across the tracks of the Duluth, Missabe & Northern Railway is a tract of peat land that has been cultivated for years without being tiled. On this the frost was not out of the surface soil sufficiently to work it until late in June.

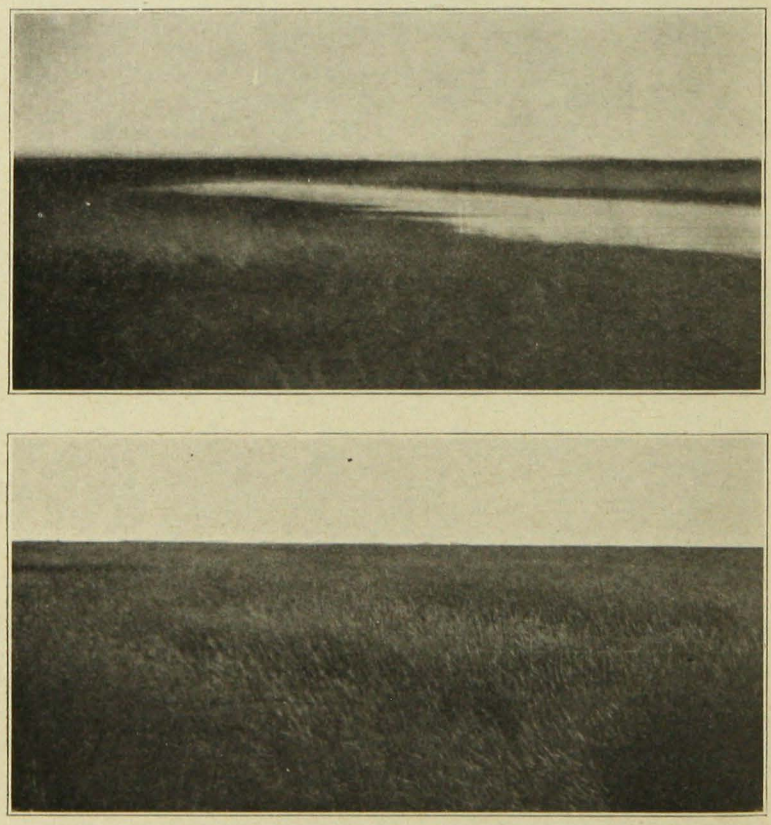


Fig. 9. Views on Grandin Farm, near Halstad

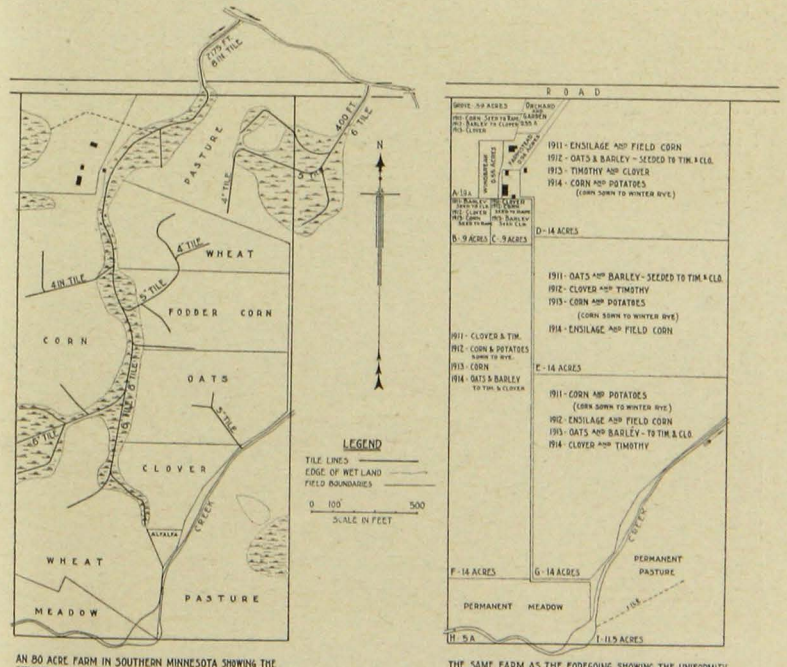
Above: Flooding and drowning out on undrained field (June, 1922).
Below: Rye on tile-drained field adjacent to the one shown above, on the same day.

Evaporation checked, warmth of soil preserved, late spring and early fall frosts warded off.—It is common experience that frost appears much more frequently on low wet areas than it does on

dry well-drained ones. This is because evaporation is much more rapid from a puddled surface than from a dry, well-tilled soil, and the more rapid the evaporation the more rapid the reduction in soil temperature; while, with the passages in the soil broken up and made irregular by the good tilth made possible by drainage, evaporation is checked, and the soil temperature is maintained at a higher point. One of the most marked and direct results of tile drainage, therefore, is the prevention of late spring and early fall frosts.

DRAINAGE PREVENTS HEAVING AND WINTER-KILLING

A well-drained condition of the soil checks heaving by freezing. Consequently winter-killing, which is directly due to breaking of the plant roots and root stalks by freezing and heaving of wet soils, is prevented.



AN 80 ACRE FARM IN SOUTHERN MINNESOTA SHOWING THE SWAMPY IRREGULAR CONDITION OF THE FIELDS BEFORE DRAINAGE AND THE TILE SYSTEM INSTALLED IN 1909.

THE SAME FARM AS THE FOREGOING SHOWING THE UNIFORMITY OF THE FIELDS AS MADE POSSIBLE BY THE DRAINAGE, IN THE FINAL CROPPING PLAN PERFECTED IN 1914.

A TYPICAL TILE DRAINAGE SYSTEM FOR ROLLING LAND.

NOTE: THE INCOME FROM THIS FARM INCREASED PRIMARILY AS A RESULT OF DRAINAGE, FROM $994.00 IN 1908 TO $2455.00 IN 1912.

Fig. 10. Influence of Drainage in Straightening Fields

DRAINAGE IS INSURANCE AGAINST DROUTH

The existence of a long period of severe drouth in an agricultural community should not relegate the subject of farm drainage to the background, for tile drainage especially is a preventive of drouth, and is one of the best means for resisting the effects of drouth.

Evaporation checked, baking and cracking of the soil prevented.—Where there is good tile drainage, there is no puddling or baking of the soil. In time of heavy storm in areas without drainage most of the water which falls runs rapidly into the many depressions and pockets and settles there on the surface, thus puddling the soil and drowning out the plant growth.

Where the only removal of this excess moisture is by evaporation, most of us are familiar with the conditions which result. The surface of the ground becomes baked and usually develops enormous cracks to a depth of several inches. These cracks break up the root stalks and root systems of the plants of many of our most important field crops, thus destroying the growth of these crops and the returns therefrom. (See Fig. 8.) Tile drainage prevents the development of this condition because it puts the soil in better condition for thoro tillage. Good tillage checks evaporation, and the consequent baking and cracking of the soil is thus prevented.

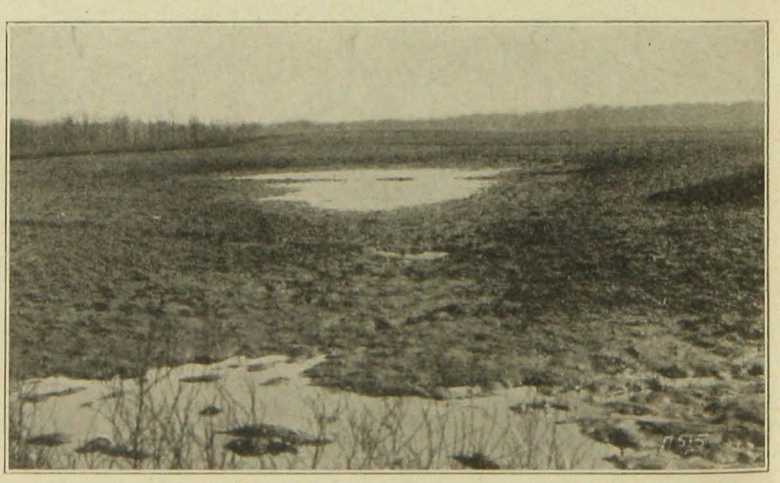


Fig. 11. Undrained Plowed Field After a Heavy Rain

Deeper root bed provided.—Good drainage provides a deeper root bed for plants, thus enabling them to tap the stores of reserve moisture in the deeper layers of the subsoil and by this means to resist drouth.

Drained soil storage space for reserve moisture.—The deeper the drainage, as a rule, the deeper the root growth, the greater the amount of vegetable matter left in the soil, and the more extensive the opening up of the soil to the penetration of moisture, thus developing a larger and deeper storage for reserve moisture.

Available moisture more uniformly distributed.—With the porous condition of the soil thus improved, the available moisture is more uniformly distributed throughout the soil and the upper layers of the subsoil, thus again preventing douth and resulting in more uniform growth of field crops.

DRAINAGE PREVENTS FLOODING

Tile drainage prevents flooding by making of the soil an immense storage reservoir which readily absorbs the flood waters from heavy rainfall that would otherwise rush off over the surface in destructive flood and instead causes them to be carried more slowly to the outlet channels in a more or less steady stream through the agency of the tile drains. Thus not only are seeds and crops saved from destruction, but fertilizer as well, its rich elements being carried into the soil instead of being washed away into the beds of streams and lakes. (See Fig. 9.)

DRAINAGE IMPROVES THE CHEMICAL CONDITION OF THE SOIL

Removal of excess alkali and acid.—By carrying the excess water downward and by preventing impounding in low pockets, tile drainage also prevents the rise or deposit of excess alkali in the soil by washing it down and finally out through the tile drains. This action also removes excess acidity and prevents a return of that condition.

Better decay and nitrification.—Those soil bacteria which aid in decay of vegetable matter and which help to secure from the air the nitrogen required for plant growth demand for their growth and activity the presence of both nitrogen and oxygen. This can be obtained in the soil only if its pores are open, permitting that good circulation of fresh air which drainage makes possible. On the other hand, poorly tilled and water-logged soils are the natural home and workshop of bacteria which rob the soil of nitrogen.

DRAINAGE STRAIGHTENS FIELDS AND LESSENS COST OF FARM OPERATIONS

One of the most important and immediate benefits of drainage is that it makes possible the straightening of field lines; thus encouraging uniformity in size of fields and regular rotations, reducing the distance traveled in farm operations, and making easier the handling of farm implements and machinery in those operations. All these things result in decreased cost of operation and consequent increased profits. The following are a few of the replies received to the question, "How has drainage affected the ease of operations on your fields?"

Mr. Grant, of Glyndon—"About one quarter easier."

Mrs. Wagner, of Newmarket—"Fully one third to one half easier." (See Fig. 2.)

Mr. Heitke, of Paynesville—"Fully one third easier." (See Fig. 12.)

The effect of drainage on farm operations is also well illustrated on the farm of Geo. W. Olson, Carver County, two comparative maps of whose farm, in 1908 and in 1914, are shown in Figure 10.

Surface dry and tillable sooner after rains.—Drainage further greatly decreases the cost and increases the ease of cultivation by drying the surface of the fields more quickly after rains. The director of the North Dakota Experiment Station has observed that the men are able to work on the tile-drained fields from two to four hours earlier after a heavy rain than on the undrained ones. Farmers who have drained their farms have frequently made similar statements.

DRAINAGE IMPROVES SANITARY CONDITIONS

By doing away with sloughs and stagnant water, drainage banishes many foul odors and unsightly places, and destroys the breeding places of flies and mosquitoes and of such larger pests as redwinged blackbirds. (See Fig. 12.)

Tile drains furnish the most satisfactory type of outlet for farm sewage disposal plants.

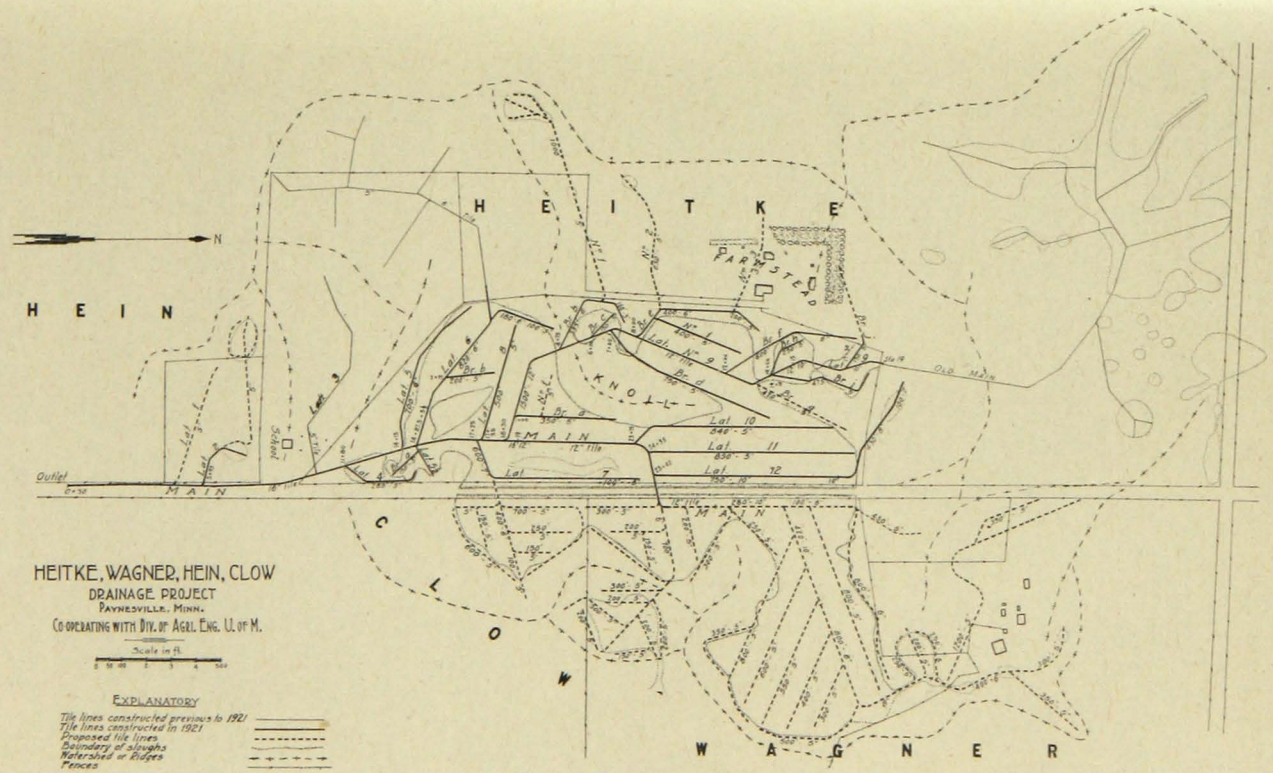


Fig. 12. Drainage System Installed in 1921 on the Farm of G. Heitke, Paynesville, Stearns County, Minn.

Note the large area reclaimed and cleaned up right in his front yard.

DRAINAGE IMPROVES THE APPEARANCE AND CONSEQUENT MARKET VALUE OF THE FARM

Through the avenue of all other benefits drainage greatly enhances the profitableness, convenience, and attractiveness of the farm and so adds materially to its normal market value. The shiftless and poverty-stricken appearance so common on any farm where the owner is continually struggling against the discouragement and degradation of swamps and stagnant water—his equipment, his stock, and himself daubed with mud the greater part of the time—is in strong contrast to the general air of thrift, contentment, and neatness resulting from good drainage. This improvement in general condition and appearance is well evidenced by the series of pictures in Figure 13.

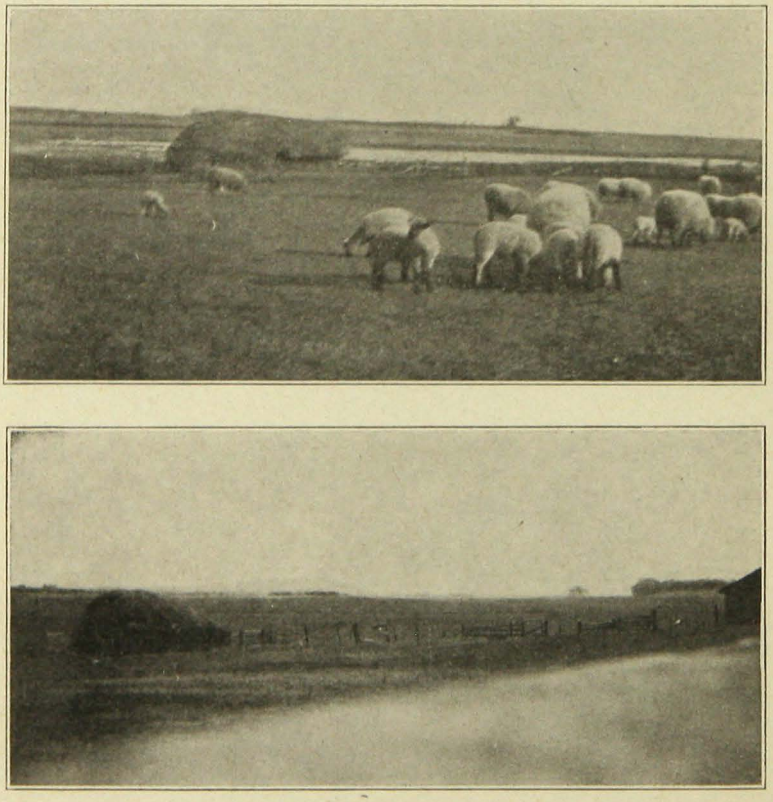


Fig. 13. Evolution of Reclaimed Land on Heitke Farm (see Fig. 16)
Above. Looking southeast from house over slough before drainage in 1919.
Below. Same view after drainage, 1922.

Fig. 13—*Continued*

Above. Breaking on old slough bed after drainage, fall of 1921.
Below. Flax in bloom on old slough bed, July, 1922.
The yield was 415 bushels on 30 acres, bringing $2 per bushel.

TYPES OF MINNESOTA LANDS REQUIRING DRAINAGE

Lands Too Flat for Natural Drainage

Low Lands Separated from Outlet Streams by Higher Impervious Ridges

Bluffs and Slopes Wet Because of Seepage from Higher Water Bearing Levels

Marsh Pockets and Running Sloughs

Overflowed Lands Alkali Lands Eroded Lands

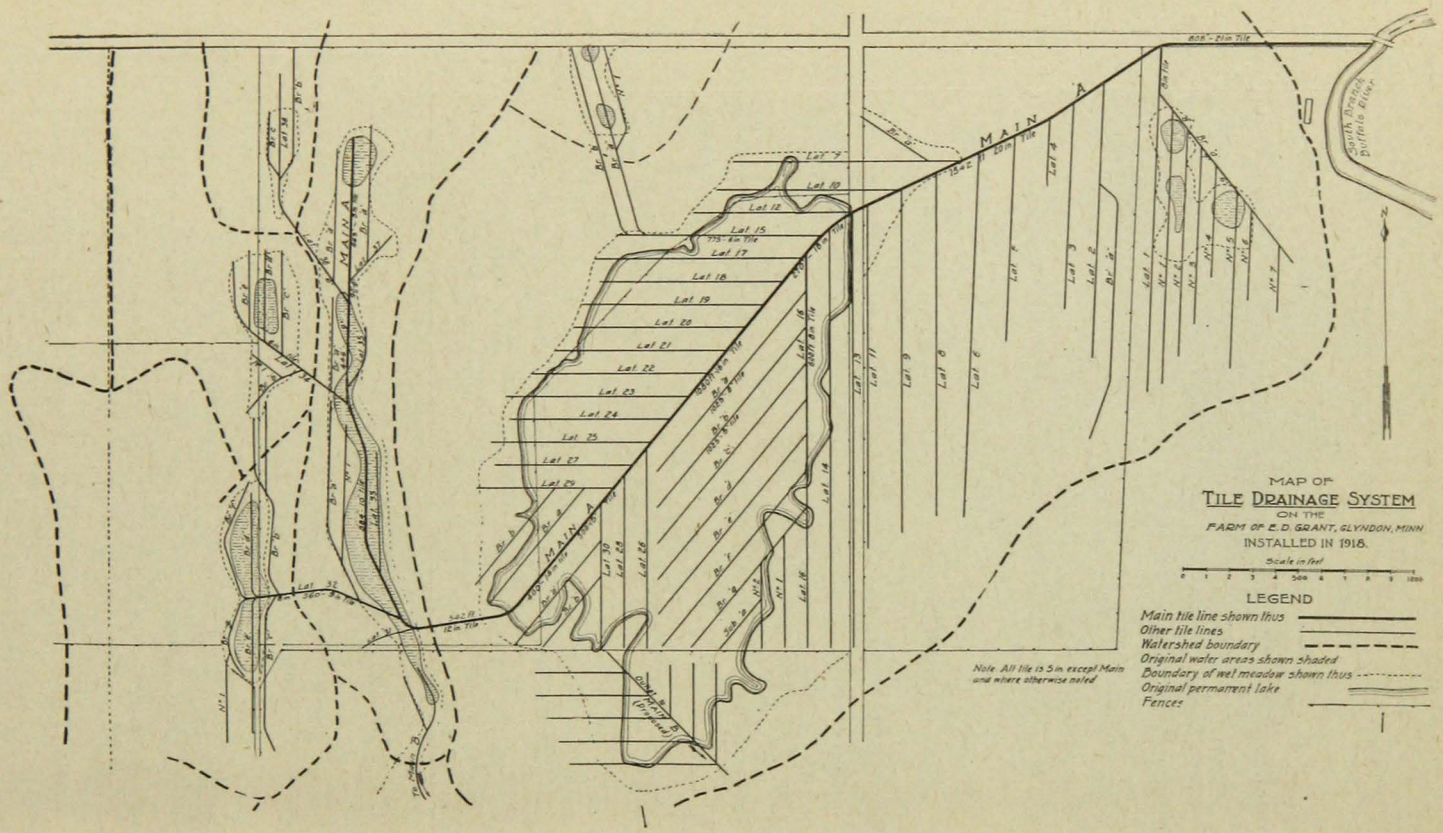


Fig. 14. Drainage of Flat Lands Separated from Streams by a High Impervious Ridge

The old lake bed of about fifty acres, drained in 1918, produced a $3000 crop of flax in 1919. The entire watershed of 255 acres, originally cut up by waste land into six fields, may now be cultivated as one field.

LANDS NEEDING DRAINAGE

The following types of lands in Minnesota need artificial drainage:

Lands too flat for natural drainage, lacking natural outlets of sufficient capacity to carry artificial drainage. (Figure 12 illustrates this type.)

Ridged-in lands, that is, areas which may have sufficient slope in themselves but which are cut off from their outlets by higher impervious ridges. (Figs. 12, 14, and 15 illustrate this type.)

Large areas of our otherwise most productive land in the valleys of the Des Moines, Minnesota, Red, and Roseau rivers and their tributaries are of the first type, while some of these as well as most of our peat bogs and large muck swamps are of the second type.

Bluffs and slopes wet on account of seepage from deep water-bearing strata on higher adacent lands, as in the sand hill and peat bog districts of our eastern counties, along the bluffs of the Minnesota River, and throughout the boiling spring region of northern Wilkin County. (Fig. 1 illustrates this type.)

Marsh pockets and so-called running sloughs bounded on the sides by banks of impervious subsoil and with too flat a slope or too shallow a natural outlet to drain naturally. These two conditions are very common and well known on Minnesota farms practically all over the state. (Figs. 2, 4, and 5 illustrate this type.)

Fig. 15. Low Land Without Sufficient Outlet or Separated from the Outlet by Higher Impervious Ridges

Overflowed lands, as for example low-lying lands along portions of the Minnesota River, flooded practically every spring or during extra heavy rainfall because of the rise of the river over its normal banks. The first step for the redemption of such lands is the construction of dykes along the river banks high enough to reach above the highest floods.

Eroded lands.—Lands having a decided natural slope, or lying near the banks of deep cut prairie streams, with soil of a silty or sandy character easily cut by water running over the surface. The common result is that illustrated by Figure 16.

All types of wet or waste land mentioned can be reclaimed or improved by proper artificial drainage.

Fig. 16. Eroded or Gullied Land in Ramsey County