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LAND DRAINAGE AND SOIL CONSERVATION IN RETROSPECT

by

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My work as an extension specialist was largely in fields where faulty technical practices called for correction, and in unexplored areas, in which people unaware of basic considerations were outspoken critics. This provided personal satisfaction of accomplishment, but called for restraint because sound principles are too readily by-passed as unpopular.

SECTION ON LAND DRAINAGE

As a senior student in the College of Agriculture in 1914, one of my elective courses in the spring semester was land drainage; instructer, the late Professor E.R. Jones. One of the field exercises in the course was trenching by hand tools and laying two lines of tile, 200 feet long and spaced about 35 feet apart, on the University marsh, located west of University Bay Drive. The outlet for these tile lines was a pumping plant powered by a gasoline engine, that elevated water from the grade of the tile to above lake level. About a week after the improved drainage became operative, the land between the tile-lines was plowed with a team of horses.

Shallow drainage had been operative on the University marsh for close to 5 years, but inensive use for crops had not been possible. This inadequate drainage system consisted of open ditches about three fett deep and spaced at intervals of 330 feet. The pumping plant had down-draw of about two and a half feet below marsh level. The marsh had been a floating peat bog and the initial settlement had exceeded expectations. The power plant was a windmill, a copy of the much publicized Holland example. Needless to say that the power was inadequate. The obvious conclusion from this early effort was that inadequate drainage can not produce satisfactory results. The need for development of such low lying marsh land that it requires outlet by pumping, will not have wide use in the immediate future.

The fact that tile drainage assured field operations and the knowledge that peat soils such as this University marsh, had the capacity to produce good corn crops, stimulated Dr. H.L. Russell, Dean of the College of Agriculture to action. As director of the experiment station, Dean Russell had supervision of University farm operations. Farm workers were hauling corn to fill silos on the farm campus from the University Hill farms with horses, a time consuming and costly operation. This was before farm mechanization. The potential saving prompted Dean Russell to use the very limited budget surpluses at ends of the next several fiscal years to finance the tiling of the 70 acre University marsh, and improvement of the pumping plant. I will refer to my activity in the development of this project later.

Activities as Extension Specialist

Now for an outline of some of my early activities as an extension worker. The day after completion of requirements for a degree, I went to work as an extension specialist in land drainage under direction of Professor E.R. Jones. My primary function was to design and supervise installation of tile drainage systems on individual farms, to be utilized for demonstrating proper drainage practices and evaluating results. One of the serious problems of the time was getting the hand tilers who dug the trench depths "by guess and by gosh" -- they called it digging "by water" -- to accept the grades and depths established by survey, but most of them become converts after due evaluation of the positive results. Another problem was farmer resistence to use of adequate amounts of mineral plant foods to balance the liberal Nitrogen supplies of the high organic matter soils. These matters are common place practices today, but were very important considerations in work plans in the 2nd and 3rd decades of the century. Now tiling is done exclusively with the special tile trenching machines, operators of which want figures of cuts established by survey. Profits from use of mineral plant foods are effective salesmen.

One important consideration in promotion of drainage during that early period is equally critical today. Many farms have some land dry enough to plow and plant -- probably not at the ideal time -- but too wet to produce profitable crop yields. We placed heavy emphasis on profitableness of tiling such land because it saved labor and insured maximum crops. I vividly recall such a farm owned by Ed Uraas, Larsen. This was larger than the average size farm of the locality, but much of the acreage fell in the above class of land. Tiling the "border land" of that farm nearly doubled income.

A tile drainage project on the C.W. Keyes farm near Fond du Lac, added only a moderate acreage of crop land but promoted convenience of farm operations. A few lines of tile laid in draws that had made fields irregular, provided for better field layout and facilitated operations.

An entirely different set of conditions made drainage very desirable and profitable on the Williams dairy farm at Wales in Waukesha County. Dairy cows had been grazing on a sizeable area of moderately deep peat and tromped it into a very irregular boggy surface. The farm was producing certified milk (pasturization was not prevalent at the time) for the Chicago market. Mr. Williams received complaints of too high bacteria counts at times when the cows used this boggy pasture. The tile system on this troublesome pasture made it possible to eliminate the bogs, produce better pasture, and it reduced complaints from the milk distributer.

Work on University Marsh

During a period of approximately 5 years beginning in 1915, an important incidental duty was designing and supervising the tiling of the University marsh and improving the pumping plant to secure deeper drainage, and with the installation of electric power that provided automatic regulation. Overall plans were made by consultation with Prof. Jones, but I did all the detail and field work and Prof. Jones made administrative contacts. This was completed by 1919. Somewhat over 20 years ago, campus planners started making dual use of the marsh. They needed to dispose of material excavated for basements for University buildings, and provide additional parking area. Result: the filled in marsh is parking area #60.

Role as Deputy of State Chief Engineer

Enactment of our present County Farm Drainage law in 1929 was preceded by an evolutionary period that began about 1909, when the first codified Drainage District Law was enacted. As deficiences, and practices that might be labeled abuses today, became apparent, amendments were enacted. But people involved in drainage activities, such as substantial land owners, operators on drained land, victims of land speculators' practices, surveyors and engineers, and lawyers who had participated in organization of districts, were not satisfied with the amended patchwork. Among them I recall lawyers, F. W. Lucas, Madison; Peter J. Meyers, Racine; B. M. Vaughan, Wisconsin Rapids; who evolved the framework of the County Farm Drainage Law enacted by the 1929 Legislature.

The law provides for a three member County Farm Drainage Board who serve as administrators of all drainages in that county. The board does not promote drainage. Their duties begin only where a majority of land owners, owning over half the land, have petitioned for drainage. All of board findings require approval of the County Court to make them effective. Provisions are for two sets of plans in sequence; first one, preliminary for feasibility and general benefits; the second, on final drainage plan and assessments. At court hearings on these plans and board reports, both proponents and opponents have the right to appear. For safeguards, the State Chief Engineer, who has policing powers, is required to review and approve plans before the construction can take place. Under these requirements, the College of Agriculture became involved. The State Chief Engineer, C. A. Halbert, stated that he did not have staff qualified to evaluate agricultural enterprises. He deputized Professor Jones as State Drainage Engineer and me as Assistant State Drainage Engineer. Upon the passing of Professor Jones in 1937, I was promoted to the higher rank, and served in that capacity until retirement in 1956. During all of my period of service in both capacities beginning in 1929, I made the called for field examinations and reports. From 1928 to 1956, only 1/3 of my time was officially designated for use in the field of land drainage but in the latter part of that period, actually less than that was used because of decreasing demand for drainage and increased pressure for soil conservation.

These drained lands serve to fill needs and help solve problems very well, particularly in many instances on family size farms that are pressed for volume of production. Many such farms contain some wet land, which when and if drained could increase volume of business sufficiently to maintain a family. The high organi matter soils commonly called "muck" by operators are ideally adapted to the productio of vegetables, commonly designated as truck crops, and mint, for which the demand is active. Without that production of "muck" farms prices of those popular foods would be higher. Illustration: James D. Swan, presently state senator, developed an 800 acre truck farm in a drainage district near Elkhorn, by supplementing the outlet ditches with tile systems under our direction. This was done in the late 1930's, in time to help ease food shortages during World War II. A Jefferson County Farm Drainage, that I assisted materially in the organization steps, improved the sizeable area of "muck" on the Febock farm, Cottage Grove, to permit conversion from marsh grass to mint production.

Disastrous Land Speculation

The most trying, discouraging, and frustrating experience of my entire 42 years as an extension worker occurred in the late 1920's. This resulted from a special assignment in the Central Wisconsin sand marsh area located largely in Adams, Juneau, Monroe, Portage, Taylor, Waushara, Wood, and Clark counties. The soils involved in the problem were shallow to moderate depth peats underlaid with sand grading from fine to coarse. Brief review of background serves to outline problems of the area. Land speculators had bought up large tracts of this peat land at very low prices, much of it on tax titles, promoted organization of drainage districts, and constructed ditches with proceeds from bond issues.

Then they advertised land for sale widely, canvassed prairie farmers of Iowa, Illinois, and Indiana, and sold an appreciable number of them peat in these districts on basis of color that resembled prairie soil. Sales were aided by the fact that good crops had been harvested in some scattered areas where peat fires had concentrated mineral plant foods in the ash. Victims of the misrepresentations had sold their moderate size prairie farms and with proceeds bought large tracts of the ditched peat land. They carried prairie farm practices of the corn belt of the time to this northern area, without evaluating the differences in soils, climate, types of agriculture prevalent in the locality, sparse settlement, etc. Crop failures, killing frosts, defaulted drainage bonds were common place. Settlers were discouraged and edgy. My additional assignment for the latter part of the 1920's: Determine fertilizer needs or requirements and convert cornbelt farmers to the type of farming prevalent in the area, but strange to farmers from the corn belt.

My activities or efforts covered only a few years. To determine fertilizer needs, I laid out test plots, with each treatment covering an acre. Single treatments of Potash, Acid Phosphate, combination of the two was quite standard, with agricultural lime added in a few situations. The plots with all the elements added in combinations gave the best results. Potash led in the single treatment plots. As a follow-up, I advertised demonstration meetings and personally invited some farmers. Attendence of farmers at the plot meetings was discouragingly small. Right on the ground where fertilizer results were obvious, general tone of comments, was "we don't need that stuff, this land is black like the prairies. It's got to turn out crops." My obvious conclusion was: methods used for opening peat lands of Central Wisconsin to agriculture were unwarrented, or untimely at best.

With the exception of the Portage County Drainage District, commonly called Buena Vista marsh, which has its east border marked by the terminal moraine of the Wisconsin glacier, the Central Wisconsin ditched marshes have been abandoned by farmers. Work on the Hancock peat experiment station in this district, by refined and extensive fertilizer and crop tests, established sound standard practices for that district. But we must remember or recognize the fact that peat soils are extremely variable.

My one productive contact in the Central Wisconsin marsh area, of this disappointing period, was with Jim Isherwood, a native farmer located near the northeast corner of this district. He evaluated test results and used the materials needed for crop production. However, I have had no contact with that farm since the early 1930's.

Some Pertinent Observations

In the course of activities and duties, I covered many thousands of acres of wet land. A conspicuous feature noted was that springs and spingy zones are prominent at margins of marshes. This is evidence of discharge of water that had infiltrated into the upland, down to the water table. In simple terms, wet lands function primarily as part of the natural drainage system. I cannot reconcile the prevalent sweeping claims of water storage with the extensive observation of water discharge.

The present high cost of land drainage virtually prohibits important activity for material increase of crop acreage. A very limited area is being drained for the production of truck crops. Since peat and muck soils, of which there is a fair supply in south-eastern Wisconsin, when well drained, are ideally adapted to truck, and other rank growing crops, our farmers are entitled to share in that enterprise. Development rate ought not exceed materially the active demand for vegetable products, and corn as a feed grain for self sufficiency. The long term trend of draining land will be determined by population increase, which probably will eventually become a powerful force.

A bill was introduced in the 1971 session of the Legislature, apparently with the object of curtailing drainage by individual farmers, by providing slight financial incentives, and severe penalties. However, the bill also provides that the enforcing agency, the DNR, may drain land for game feed production, when that agency is both an interested party and jury, empowered to curtail farmer activity, on the assumption and assertion that wet land enhances the environment. Draining land for production of feed for game birds may have high priority now, but need for human food will eventually have an inning.

In this connection it is rational to recognize the fact that, except for very limited coastal areas, (only large area Everglades of Florida) marshes are largely confined to a belt along the Great Lakes. But the people in the generally more densely populated parts of the nation outside of this belt, do not appear to be suffering for want of wet land.

SECTION ON CONTROL OF SOIL EROSION

My association with the beginning and development of erosion control work from June 1922 to the end of July 1956, on basis of activities is naturally divided into three periods. (1) During the first 5 years, from 3 to 8 weeks per year, were appropriated from the drainage project, and used in helping farmers with gully control devices, largely in river terrace farms. (2) Following this pioneer effort, K.L. Hatch, Assistant Director of co-operative extension work, after inspecting and appraising the pioneer effort, and obvious problem, elevated the work to project status in 1928. For the next 6 years, the project work under state direction, was supplemented by Federal aids: first year by Lake States Forest Experiment Station, and the balance of the period by CCC camps and CWA make work programs. During the approximate dozen year period, the variety of problems encountered in the field, forced the conclusion that effective control practices need to cover a wide range of practices adapted to specific needs or situations. The 1922 calls for help led to the development of permanent gully control dams. High intensity storms brought farmer calls for help for protecting sloping fields that were loosing top soil as evidenced by rill. I staked and helped construct terraces on moderate slopes and recommended longer rotations and strip cropping on steeper slopes, or conversion to permanent pastures. In answer to farmer calls to protect buildings on bottom land, and obvious threats to highways and bridges by meandering streams, we developed the pile wing deflectors. (3) An act of Congress in 1935 created the SCS and relegated work of the extension specialist to purely educational phases. The SCS seems to limit activities to sheet erosion control practices, with emphasis on strip cropping and contour field operation and assumes that those practices will eliminate run-off and all erosion problems. Their belief in this theory, and perhaps desire for uniformity in national programs appear to by-pass special critical situations such as that inherant in the gully destruction of the level stream terrace soils of south-western Wisconsin, and damage by stream bank meanders.

when those very practices are emphasized, and featured in SCS conservation farm plans, as effective practices for reducing soil losses. Those measures have value, but over all, they can reduce soil loss only moderately. Even with our relatively young agriculture, attrition by erosion has brought us to the stage where erosion is noticeable on land steeper than very moderate slopes, and on land forms, such as stream terraces, gully formation is shocking in severity and extent.

The question that naturally follows; why weren't steps taken to prevent the damage before this stage of the problem was reached. The answer to that is based on tradition; and changes in traditions evolve slowly. Agriculture in this nation is relatively young and farming in Wisconsin has been extensive for less than a century and a half. Also, remember that the origin of our early settlers was the British Iles and western Europe, territory that has oceanic climate, contrasted to our continental type. <u>This fact is very important.</u>

At this point rainfall characteristics of the two types of climate need to be reviewed for contrast. Under the oceanic type total rainfall is generally quite libreal and rather uniformly distributed and falls at such gentle rates that practically all of it infiltrates into the soil and there is little or no excess to go into run-off and carry soil away. By contrast, continental climate is very erratic. Annual rainfall has wide variations. Droughts and excessive precipitation periods are quite common, but time of occurrence is erratic. Fortunately, most of our rain storms are of the gentle character that are almost entirely absorbed by the soil. Farmers call such rains "soakers". But in the continental type climate, occasional storms deliver water at a rate considerably in excess of infiltration capacity of the soil. These are the dynamic cause of our soil erosion problem. When such intense storm is of short duration, soil loss may be quite moderate. But as length of time of the high intensity increases, total precipitation increases, run-off becomes excessive, and damage severe. Farmers call such storms "gully washers". The popular press labels such storms "cloud bursts". Annual rainfall records do not reveal high intensity storms, but actually masks them, because the annual totals contain an overwhelming percentage of gentle storms.

The above facts serve to explain the tardy start and slow progress of soil conservation in the country as a whole, and perhaps specifically in Wisconsin. Examples are necessary to change traditions, and that includes farmers and educaters.

The first soil loss plots in the United States were by the Missouri Experiment Station, and 5 year results were published in Research Bulletin #33 of that station. One of the important conclusions was that 3 to 5 of the more intense storms of a season caused 90 to 95% of the soil loss of that season. This conclusion has been verified by other state stations, and by the Ten Federal state co-operative stations, including the Wisconsin station near La Crosse. Another significant figure was provided by the La Crosse station during one of the latter years of the life of that station when a much longer duration storm of high intensity than those of annual frequency occurred. I do not have the publication in which this storm was recorded, and did not commit the specific figures to memory. However, at the time I saw the figures, I divided the annual 3 tons of soil loss per acre, that the technical staff of the station had determined as tolerable, into the tons per acre lost from this one storm, and obtained the figure that about 70 years would be required to compensate for the loss from this one storm, and that discounts the losses from all intervening storms. Soil loss once sustained cannot be recovered.

This provides one answer to the erratic nature of gully formation. Such a storm or storms obviously hit Buffalo county shortly before I received the "eye opener" in 1922. A storm of similar character, occurred in the North Bend vicinity in 1914, and a similar one was recorded by the Madison station of the U.S. Weather Bureau in 1911.

A review of some features of the storm, and damage caused by it, that residents of Bayfield label the 1942 flood, serves as a specific illustration of the above principles. Guided by local leaders, "Marv" Schweers and I made a rather hurried inspection shortly after the storm had taken place. Run-off from a watershed of about 600 acres, about 75% in brush and trees, concentrates in Ball Park Ravine which continues as a draw through the City of Bayfield. In the city, feeling of security had become so great, that buildings were located in the draw. A conspicuous one was a bakery about 100 feet long and 20 feet wide, with the long dimension astraddle the drainage way. The flood water had passed through the building, carried away the end walls, and all of the equipment from the interior. The side walls were decidedly out of plumb. In brief, this was a complete wreck. Very extensive gully formation was observed in Ball Park ravine above the city.

The damage noted above in part, was caused by run-off from about 5 inches of rain that fell between 11 PM and about 10 AM the next day. The highest intensity period came soon after midnight, with much of the initial portion quite intense and the terminal portion very moderate. No accurate estimate of the run-off is available, but it probably was on the order of 50% of precipitation.

The 5 examples of intense storms of considerable duration, caused conspicuous and extensive gully damage, and the feature of extensive sheet erosion was short of overlooked or ignored because of the spectacular nature of the gullying and associated damage. Now the inclination of many individuals working in the soil conservation field will be to label the 5 illustrations as unusual isolated events. Just because they are so widely distributed, with probably the most severe one located farthest north, compels the following conclusions from the illustrations, and known related facts:

1. No section is immune to that type of destructive storm.
2. Such storms have random distribution.
3. In time the entire landscape will be covered.
4. While center of succeeding storms may not coincide exactly with the antecedent storm centers, the border overlap will result in quite unniform erosion damage.

Geologists paint a gloomy picture, long range. They feel that our civilization cannot survive the ravages of soil erosion. Their conclusion is based on the physical record of erosion, when the entire land surface was in virgin plant cover. In their view, farming encourages erosion of an accelerated rate.

The forecast of ultimate tragedy ought not stop us from emphasizing the immediate need for and advantages in using the rather easily applied control practices, from which farmers receive immediate benefits. On the other hand, we need to avoid placing too great reliance on those methods for slowing down the attrition of erosion to a tolerable extent.

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Erosion is a continuous, destructive force

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Long range research to develop control methods dependent on mechanical principles is essential

This points to the need of research intensive in character and extensive by necessity, to reveal or uncover the most intensive control practice or practices physically possible, and practical for general application as a goal. Application by farmers will probably be at a slow rate, but that assumption ought not delay the time for starting research. Progressive thinkers will establish a desirable trend. The following statement of conditions under which such research obviously must take place ought not be construed as planning the research. They are enumerated as some considerations that a long period of time may be required; a fact that an early start is desirable.

1. The erratic occurance and location of intense storms present uncertainties of time and place.
2. This forces the observation that a liberal number of stations ought to carry on the selected tests.
3. Practices to be tested will probably be the product of some experiment station workers, and each ought to be evaluated by an appreciable number of personnel of different stations for selection of the most promising; modifications may follow.
8. Quantitative measurements of effectiveness in comparison with presently approved practices are essential.
5. Follow-up tests ought to continue for a long enough period of time to establish confidence in the method.
6. A long period of time will be required but the desired information is essential.

Ancient civilizations battled progressive erosion

Two historical examples reveal development of bench terraces, that in all probability originated out of necessity. They are located in widely separated parts of the world, but both have continental type climate. There is no record of when or how these bench terraces were established, but obviously it took place in the distant past as erosion became conspicuous.

One of the situations is China where bench terraces established many centuries ago are now in use. Don't discount this as primitive. It was an effort of an old persistent civilization to neutralize physical forces of their environment.

In Peru we have an illustration of remnants of bench terraces. They are located in the territory originally occupied by the Incas, and apparently a product of their civilization. Presumably some may have been deliberately planned and constructed as benches as indicated by the fact that the faces of some were protected with stones. Others may have been developed by accumulation of sediment above banks of earth on contours. In all probability, the development of these terraces was during the rise of the Inca civilization, that reached its peak abbot 2000 years ago. At that time the civilication ended suddenly, and the cause is unknown but probably was invasion by barbarians.

These illustrations are not offered as a recommendation, but to emphasize the fact that heroic measures eventually evolve, and that it would be wise to uncover measures short of "last ditch stand."