A STUDY OF THE AGRICULTURAL RECLAMATION OF A MUCK AREA IN OCEANA COUNTY, MICHIGAN

Thesis for the Degree of M. S.

Hall Ivan Sippy

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A STUDY OF THE AGRICULTURAL RECLAMATION OF A MUCK AREA IN OCEANA COUNTY, MICHIGAN

A Thesis Submitted in Application for the Degree of Master of Science at Michigan State College

by

Hall Ivan Sippy

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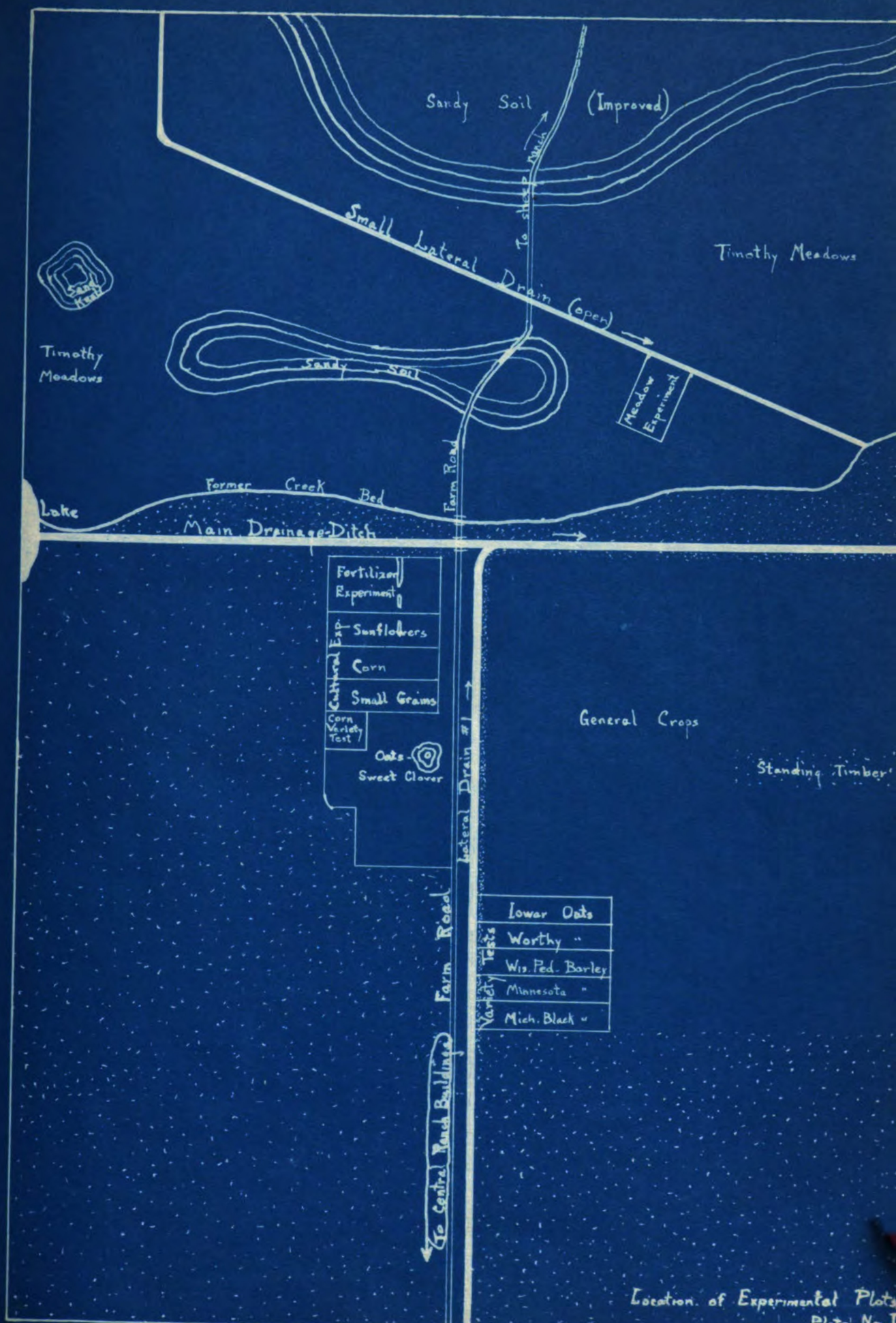
Sandy Soil (Improved)
To sheep ranch
Small Lateral Drain (open)
Timothy Meadows
Sandy Knoll
Timothy Meadows
Sandy Soil
Meadow Experiment
Former Creek Bed
Farm Road
Lake
Main Drainage-Ditch
Fertilizer Experiment
Exp. Sunflowers
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PART I.

INTRODUCTION

INTRODUCTION.

The problems involved in the management of muck soils differ greatly from those encountered in handling mineral, or upland, soils. Even among the various mucks themselves, there are vast differences in their responses to identical methods of treatment. Thus, the muck farmer finds himself entangled in complications totally unlike those which are common on the uplands, and his search for advice which might aid in solving his problems, is often rewarded only by a collection of contradictory information.

It is unlikely that a definite standard of procedure- a manual of rule-of-thumb directions for soil tillage, such as we have for mineral soils- can ever be established for the management of muck lands. The agricultural experiences of every muck farmer, doubtless, will always be essentially different from those of his fellows.

And yet, by exhaustive experiments on typical deposits of muck- experiments which investigate the responses of the soils to different methods of drainage, tillage, and fertilization, and to the use of different crop varieties- it should be possible to arrive at conclusions which may form a dependable guide to the successful management of muck soils.

It is due, again, to the great variation found among mucks, that experimental work in this field must be highly specialized. Each series of investigations must be conducted upon an area which may be considered as representative of a definite type of muck soil, but which has distinctly individual characteristics in physical properties, climatic

conditions, and adaptability to crops.

This manuscript deals with such a series of investigations. It confines itself to a discussion of field work with general crops grown on a tamarack-cedar muck tract, which is in the process of reclamation, and which is located in the west central portion of the lower peninsula of Michigan.

PREVIOUS INVESTIGATIONS.

In a study of muck soils, the search for a background of literature brings a full realization that this work is in a relatively pioneer field. Most of the basic literature is too technical to be applied such practical field experiments as are under discussion here.

There are, however, a few publications which deal with previous experimental work in muck culture, and the results of those investigations are of great value as a check upon, or, perhaps more correctly, as contrasts to the conclusions which suggest themselves from the data secured in this particular series of experiments.

A digest, of such parts of previous reports as have a direct bearing upon the title of this thesis, follows:

* "Of all the general farm crops for peat soils, hay seems by far the most important.-------- Peat lands are excellent for hay, but less suited to the production of grains (although) ----- of the small grains, rye, both winter and spring varieties, oats, barley, and buckwheat have been found most successful, giving as good yields as on mineral soils.

Rolling: "In Europe the use of a very heavy roller on peat lands is now recognized as one of the most useful operations--- all experiments elsewhere have confirmed this on poorly decomposed peats, and only in one case has any unfavorable effect, even upon well decomposed high lime peats, been reported.

Drainage: "On deep peat" (over 4 ft.)"---- one must count on thorough drainage by numerous open ditches or tile lines. In Minnesota in very wet seasons, there may be no lessening in yields due to over-drainage, but the average returns

will probably prove so much higher where the water-level is regulated that provision should be made for such control----"

Chemical Requirements: " The most common initial need of our unproductive peat soils is phosphate. A later requirement of potash is to be expected on all bogs upon which the peat layer is neither exceptionally shallow nor rich in mineral matter from washed-in sediment."

Golden Valley Experiments: " Available phosphate is lacking, and when supplied, good yields of most crops are obtained. Potash has shown no distinctly beneficial effect------this potash sufficiency should not be expected to continue long. Flax, oats, winter rye and field peas are the most promising grains." The danger of summer frosts, the threatened potash exhaustion, and the good growth of grasses and cloves combine to make the production of milk, beef, mutton, and wool the most promising use of these peat lands when properly fertilized Other general conclusions from the two year experiments at Golden Valley are as follows:

> Sweet clover yielded highest and showed the most marked effect of various fertilizer treatments. Rolling plowed land with the heavy roller caused a marked increase in yields of sweet clover, western rye grass, and timothy-clover hay in every case. From general observations it was concluded that grain yields were not increased by rolling, although growth and lodging were increased. Unproductive peat may be made productive by either acid phosphate or stable manure or by burning. Burning is recommended only under very favorable conditions, where the fire can be carefully controlled and a shallow skiming of the top layer of

soil can be effected without bringing the water table too near the resulting surface.

Soil conditions reported for Ontario are for the most part in direct conflict with the usual situation in Michigan mucks, as, for example, in the following Ontario conclusions:

*Muck soils supporting a tamarack or black spruce vegetation will be found unproductive. Muck with a sandy subsoil invariably yields poor results. The greater the depth of the muck, the poorer the soil will be. No attempt to utilize the muck should be made until the water table has been reduced to at least forty inches below the surface.

An Ohio report confirms the prevailing idea that a chemical analysis is not a true index to the crop-producing capacity of muck. Potash, it decides, is the greatest need of most mucks, because of the great tendency of potash salts to leach out of these soils. Unlike the Ontario publication reported just above, the Ohio Bulletin affirms that the character of the substratum is unimportant if the muck is over two or three feet deep. Corn, oats, and hay are said to thrive best on shallow peat where a clay subsoil lies within a foot of the surface. On drainage, the Ohio recommendation is to delay any tiling until open ditches have been functioning for three years, the length of time required for a newly drained muck to settle. A treatise on "The Management of Muck land farms in northern Indiana and southern Michigan",* strongly advocates grain and livestock farming for the muck soils of this locality. As opposed to methodsof

*Ontario Bulletin #178

***U.S. Bulletin # 761 **Ohio Monthly Bulletin May 1919.

intensive truck farming, the use of these lands for the production of general crops and livestock is, according to Smalley, a much safer enterprise, although the returns per acre may be less. He supports this contention by the arguments that the profits for any one of the intensive crops may be destroyed any year by over-production of the crop, and that the greater costs of labor, tillage, marketing, etc, for truck crops more than off set, on the average, the greater returns.

This resume' then, brief as it is, accounts for most of the published literature directly applicable to the line of work with which this thesis concerns itself. It is encouraging, to say the least, that the muck experiments now being conducted throughout the state are so much more extensive, more practical and more accurate, than those of the past, that we may hope to secure, within the near future, a collection of data which will form for further investigations a much more servicable background than present students are able to secure.

PART II.

HISTORY OF THE MUCK TRACT

A. Location and General Description.

The field experiments which form the basis for this report were located in Oceana County, Michigan, in Section twenty-eight, Leavitt Township, on a tract of muck land known as "The A. F. Sippy Ranch"; owned by Dr. A. F. Sippy of Chicago. The ranch lies fourteen miles east and two miles south of the town of Hart, the nearest railway station. Muskegon is approximately forty miles southwest, and Walkerville, the Post Office, is located four miles north of the central ranch buildings.

The soil and topographical conditions of the adjacent farms defy accurate description, due to the amazing variation found. On the whole, however, the soil immediately east and south of the ranch is rather hilly, and from light sand to a good quality of sandy loam. North and east of the ranch the soil is mostly heavier-clay or clay loam- and more level. Stony areas are found here and there; and nearly all of the farms have some muck. A large area of muck land, which was developed by Dr. B. W. Sippy of Chicago, adjoins the A. F. Sippy Ranch at the north-east. The most usual enterprises on the neighboring farms are dairying, rye, bean and potato raising, and fruit growing, although the locality is slightly too far to the east to be included in the great Lake Michigan fruit belt. The farms are, for the most part, small- perhaps averaging eighty acres in area. All kinds and conditions of development are to be found- the prosperous, well managed improved farms rubbing shoulders with abandoned blow sand hills, victims of years of destructive farming methods. There are no large units of muck soil except those mentioned above.

The A. F. Sippy Ranch itself may be most aptly described as a deposit of muck land fringed with a border of sandy soil. Also, a tongue of sandy upland, lieing east and west, divides the muck area included in the western half of the ranch. Variations from this general statement are as follows: An area of clay loam occurs at the north-east border of the ranch; there is no upland along the northern border; the south-western corner of the ranch is sandy upland.

The topographical details are shown more clearly in the accompanying map. (Plate I) As the map shows, the experimental plots are located near the mouth of the eastern lateral north-south drain, known as ditch # 1. They are placed, there rather centrally, in the south-western quarter of the ranch.

Original Swamp
Undergrowth

Floating Dredge

Beginning the Beaver (1913)

B. Drainage.

At the time of its purchase in 1915 by Dr. A. F. Sippy, the lowlands of the ranch were an undrained swamp- part of what were generally known as the "Beaver flats". This name was taken from the name of the creek which wound sluggishly through the swamp, taking away through its shallow basin none of the surplus of water which rendered the land unfit for tillage. The Beaver creek was in reality the outlet of the lake which still remains on the ranch, although it has been greatly reduced in size by drainage. The lake is usually called "East Lake" though the names "Sorter" and "Mud" are also applied to it.

Obviously, the first step in the reclamation of the swamp was to get rid of the water, and this was made possible, in 1916, by the "Beaver Drain"- a drainage project conducted by the County. This drain has its source in the east shore of East Lake, carrying due east for one and one-fourth miles, whence it bears north-east for an equal distance, then turning east again. The drain continues along the same general course as that held by the old Beaver creek; so that at the completion of the dredging the old creek bed winds across and around the ditch in innumerable intersections. Seven miles from its source, the Beaver drain empties into the Beaver River- which pursues in general a northerly course and empties into the Pere Marquette- which flows back west into Lake Michigan.

This particular ditching operation was carried out by means of a floating gasoline dredge, which was assembled and built within a stones throw of the present ditch. Parts for

the dredge were ahuled in with teams to a sandy knoll northeast of the lake, and here the machinery was assembled. The entire working unit of the dredge was installed on a heavy timber frame work, designed to float, and to carry the weight of the machines. The long boom, and scoop extended forward from the floating platform. It is eloquent of the saturated condition of the soil at that time, that immediately with the beginning of excavation, enough water collected to float the dredge readily. The machine dug its way to the shore of the lake and then proceeded down the true right of way of the ditch.

The results obtained from the Beaver Drain were very satisfactory, and were a great encouragement to the owner of the land to continue with his drainage project. Immediately with the completion of the Beaver, the soil along its banks began to dry out, and within one season a strip, of perhaps forty rods in width, along each bank was rendered dry enough for any agricultural operation.

With an outlet now at hand, it became possible to develope a system of lateral drains. These, as a rule, were laid out in a north and south direction, emptying, of course, into the Beaver. Five of them were dug by a Monagan gasoline dredge, owned by Dr. B. W. Sippy, and several small ones were dug by hand labor.

The first of these lateral ditches is the one most important to this discussion- because of the location of the field experiments near its bank. The width and depth of this drain is typical of all of the power-dug laterals. It is about twelve feet from bank to bank at the surface and about six feet across the bottom. The average depth

is about five feet.

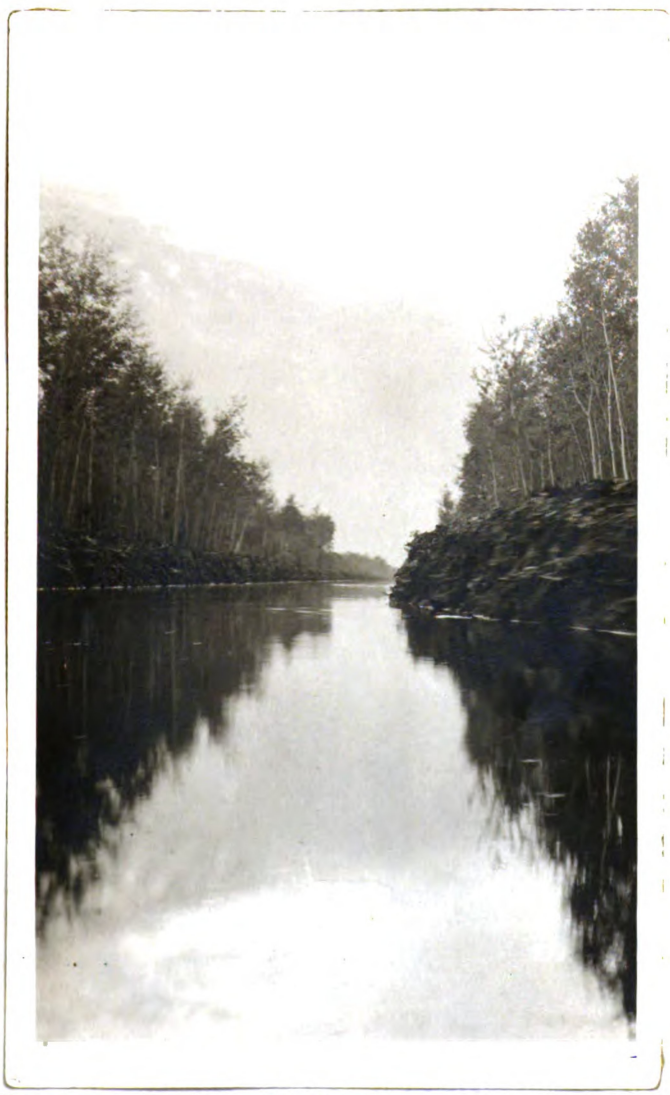
The small hand ditches, which were put in later, were in each case for the purpose of carrying off some localized excess of water, and play little part in the general scheme of drainage. Hand ditch A (in the chart) removes the excess of water from a creek on Section 21 which otherwise would flood the meadows in the spring; B drains an area of unusually low land around its source.

As an outstanding peculiarity of this drainage scheme, the wide separation of the laterals must at once be mentioned. It would be difficult for one unfamiliar with this particular sort of muck soil structure to realize that it is possible to secure ample drainage of the soil between ditches nearly one hundred rods apart- especially in the case of a soil which, previous to draining, was practically under water throughout each entire summer. Nevertheless, satisfactory drainage has been achieved by means of this simple system of open ditches- and there are very few spots within the limits of these drains which can not be worked with a wheel tractor, even in the spring of the year.

Indeed, the problem of over-drainage has become at times nearly as important as that of getting rid of the water. In periods of drought the land near the ditch banks tends to dry out excessively, and at such times the crop yield may be seriously affected. To avoid, in part, such losses, the idea of installing dams in some of the main laterals, has been considered. A concrete dam has already been constructed near the mouth of lateral # 1, but has not yet been put to use. There is little doubt of the practicability of backing up

the water in these drains, however, for a system of dams has long been in use successfully under similar conditions on the neighboring property of Dr. B. W. Sippy.

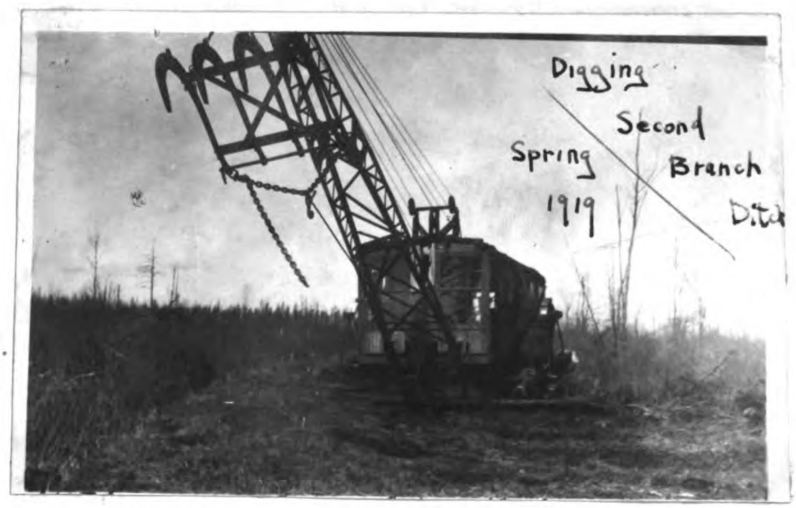
East Lake
Showing Source
of Beaver Drain.



Beaver Drain, before
Completion of Outlet

First Lateral Drain

Right of Way
for Lateral
Drain #3
(1919)



"Walking" Gasoline
Dredge Using
Brush Hooks.
(1919)

Beginning
Hand
Ditch

C. Burning.

The effect of burning off the surface of muck soils is one of the most interesting phases of the subject. Variable and contradictory reports of the results from such burning are available- ranging all the way from absolute ruin of the agricultural value of the burned areas, to such an amazing increase in the fertility of the soil as to influence muck farmers in some localities to burn for the same purpose that their better-informed neighbors fertilize.

Practically all of the muck land now under cultivation on the A. F. Sippy Ranch has been burned over, but, fortunately, its agricultural value has not been lowered by this burning, except in unimportant, isolated cases. Some of this burning has been done deliberately as a first essential step in land clearing- in which event the fires were set during a certain condition of soil moisture and were carefully controlled. But by far the greatest burn-off was in the summer of 1920, when a great fire started from the carelessness of a workman's burning brush during a drought. The drainage program was at this time nearly complete, and the soil had had several seasons in which to dry out thoroughly. Much of the lowland shrubs and trees had died or withered up from lack of their accustomed moisture, and formed thickets of highly inflammable kindling. A dry spell of four weeks duration had added to the fire danger- and so when flames started there was no possibility whatever of controlling them. Practically all of the drained muck on the ranch burned over during this fire- and all within the space of five days. During this time the sky was filled with a reddish brown smoke which was seen from Pentwater,

twenty-five miles away;- the peculiar odor of smoldering muck drifted all over the vicinity; innumerable tamaracks, their roots burned off in the muck, kept crashing to the ground. When the fire finally burned itself out in the undrained swamps there was only an occassional crag of a tree left standing in the area which had been a jungle of tamarack, cedar, and undergrowth only a few days before. Fortunately, the fire had travelled rapidly and there had been moisture enough below the surface so that the soil was burned off evenly to a depth of about one foot only.

Had it been possible to follow in right after the fire with a crew of workmen to pile chunks and stumps, the burn would have been of enormous value in clearing the land. But it was almost impossible to get labor during that season; so the work done by the fire was taken advantage of only over a relatively small area, and much of the tract is now reverting to brush and weeds.

There have been other extensive accidental fires both before and after the one in 1920. On one occassion about twenty-five acres of timothy sod burned off completely, necessitating a complete re-clearing of the roots and chunks from the layer of soil newly exposed. In no case has any injury to the productivity of the soil seemed to result from burning.

D. Clearing.

Most of the land clearing on the ranch has been done on an acre basis- that is, an area of land of relatively uniform difficulty of clearing is selected and measured, and the job "let" to the applicant, at a certain price per acre. The idea has always been to begin operations on strips of land most easily cleared- in fact the earliest reclamation of land was secured at a cost of only eight dollars per acre for the clearing, while the average payments per acre for land cleared have varied from ten to fifteen dollars. The economy of this plan is readily apparent- for by such a program it is possible to make a considerable amount of land productive at a minimum cost; so that returns from these fields may aid in the payment of the more expensive clearing costs for other land. The disadvantages are that the fields thus secured may be too small for the most economical operation and are often located inconveniently to the buildings and roads.

The first step in clearing is invariably to get a "burn" over the area. By this it is not necessarily meant that the soil is burned- in fact the muck itself is seldom intentionally fired. The burning is usually done in the early spring just before growth starts. At this time though brush and weeds are usually somewhat packed down as a result of the winters snow, and, if there has been a comparatively dry period since the melting of the last snow, it is often possible to get a very satisfactory removal of brush, briars, weeds, sticks, etc., by a quick fire, which cannot burn into the wet and frosty ground. Successful burns are seldom secured in the fall and in the summers the muck is too dry to allow the risk of a fire.

As soon as the ashes are cool, the clearer begins to "log off" his piece (i.e. remove the stumps and roots). This is the most wearisome of operation, for there seems to be no end to the number of roots and chunks, which often almost completely cover the ground. Even though the clearing agreement stipulates that only roots on the surface of the ground need be removed, there is always enough of such material to convince the workman that he has earned his money. The first step is usually for men, working in pairs, to start piles of chunks at convenient places in the field using roots etc, which are nearby and can readily be piled by hand. Next the heavy roots, stumps, and logs which cannot be lifted, are snaked to the piles with a team, and flopped on the piles by means of a decking chain. There are very few stumps which are too firmly rooted to be jerked out by a team trained to the work- for the roots are, of course, imbedded only in the surface of the soil, which is so loose as to offer little resistance. Careful men will take considerable pains in starting their piles of this heavy material, for a firm foundation will make it possible for them to build large, tight piles which will burn up almost completely and lessen the work of repiling after the fires.

When the large stumps and logs,have been removed, it is often the practice to cruise about the field with a horse-drawn "toad", or long stone boat, upon which device are loaded such remaining roots as could not be conveniently lifted into a low wagon. This material is drawn to the piles on the toad.

The rest of the logging is most expeditiously done with the aid of a low wagon with a wing-sided hay rack. This wagon

is drawn slowly back and forth across the field, starting at one end of the area, and systematically working toward the other end. A man walks at each side of the wagon, tossing the loose roots and chunks on the rack. As soon as a load is collected one of the men drives to the nearest pile and unloads while the other man goes over the next strip to be picked up, loosening up tight roots with a spade and perhaps throwing some of the chunks into small piles which can be loaded into the wagon more rapidly. In this way the field is finally picked clean of most of the roots, which are now in great piles about the field.

If the field is small and if the intention is to get a crop in the year of the clearing, the piles are often made at the side of the field as a long winrow to be burned the next spring. But in any event, the piles should stand a year to dry out thoroughly before they are fired. If they are dry and closely piled, the roots will burn up very satisfactorily and require little re-chunking. Pieces of logs and stumps which are not entirely consumed are hauled outside of the field and piled.

The method thus described has so far seemed the most practicable means of getting land cleared under the condition. prevailing in the locality. And yet it is so difficult to employ men who are skilled enough at such work to make it profitable for them, that the amount of clearing which can be done in this way is very limited. Most men dislike to take the risk of contracting for a clearing job on an acre basis, and the alternative of hiring men by the day for such

work has not proved very satisfactory. The work is hard, dirty and monotonous, and without the stimulus of receiving payment for amount of land cleared rather than time put in, day laborers are apt to prove unprofitable to their employer.

Many efferts have been made to evolve a system of clearing which would reduce the amount of hand labor required. An enterprising neighbor devised a sort of derrick, or "jammer", operated by a twelve horsepower gasoline engine, which was designed to snatch and pile the stumps. This machine proved entirely impracticable- it was too light to keep from tipping when piling heavy stumps, and too heavy to be skidded about by a team. Another derrick, similar to a hay stacking out-fit, and operated by a horse and a system of pulleys, was used for some time in making large piles of stumps. The machine worked well and built very good piles, but so much time was consumed in taking it down and resetting it for each pile that progress was too slow to be profitable. The gasoline dredge which dug the lateral drains is an excellent machine for this work, but of course its operation is entirely too expensive to allow its use economically for the purpose. The tractor is often used for jerking stumps and stubborn roots, but it is not much more effective for this purpose than horses, because of the difficulty of getting traction in the loose soil when the drawbar is hitched to an unyielding load.

An enormous compound hook, constructed for use on the boom of a gasoline dredge, was given a trial during ditching operations on the ranch. This hook was designed to be dropped into a thicket of brush, which could then be clawed out and piled. The device removed the brush successfully, but took

so much soil along with the roots of the brush that the land thus cleared would be practically unfit for cultivation. The use of the hook for land clearing was abandoned, although it proved to be of value in removing brush before dredging.

Dynamite is frequently used in the land-clearing operations, but chiefly as a means of splitting and loosening large stumps rather than for actually blowing them out. Heavy blasting results in deep pockets in the muck which are miry and cannot be tilled.

In short, none of the attempts to reduce the man power needed for this kind of clearing have been successful. There seems to be no mechanical means of gathering up the innumerable small roots- and that, after all, is the longest and most costly part of the clearing process.

First Disking

Twice over

Third Swamp Field
1919.

Third Disking

E. First Tillage.

Immediately following clearing, the soil is in excellent condition for seed-bed preparation without plowing. The fire has removed all sod, and killed the weed seeds, leaving a loose surface which yields readily to the action of the disk harrow. A Fordson tractor and a set of tandem disks is the combination always used on this farm on new land in this condition. Once over going around the field and once over on opposite diagonals, and the soil is thoroughly worked up to a depth of about six inches, and the ashes are thoroughly mixed in with the muck.

This operation invariably throws out a new crop of roots and chunks, and so, after disking, it is necessary to traverse the field once more with a wagon and pick off these roots. It is not practicable to use either a spring tooth or spike tooth harrow on this new root infested land, nor would it be necessary because the disk harrow gives perfect seed-bed preparation without catching on the roots as does the drag.

Winter rye is looked upon as the ideal first crop for this soil. It is thrifty enough to win out in competition with brush and weeds; it is put in in the fall when there is a longer planting season than in the spring; its tall stiff straw permits the binder table to be set high enough to miss roots and snags; and its yield is good under most conditions. Rye is seeded from a disk grain drill as early as possible in September. It is drilled moderately deeply in the newly disked muck, at the rate of about one and one-half bushels per acre. Immediately after harvest, the stubble is usually thoroughly disked and the roots picked off carefully. At

this stage the soil is ordinarily well subdued, and smooth enough to warrant seeding down, and so another crop of rye may be planted, this time seeded with timothy and alsike for a permanent meadow. In this way the field may be brought into productivity at a minimum expense for tillage operations.

As a first crop, for new ground which is ready in the spring, either sunflowers or corn is excellent, except for the danger of frost. There will be no growth of weeds the first season after burning, and so it is considered unnecessary to cultivate either of these crops when used in this way. Either rye, oats or barley may follow the corn, without the necessity of plowing.

Millet is a successful first crop, but there is again the frost danger. Oats may be used, and in this case it is found advisable to seed with sweet clover, which will make a rank growth the second season to smother out any weeds or brush, and yet which will die out after it is harvested, so that the field can be fitted for another crop by means of the disk, without plowing.

It will be observed that in these tillage operations, plowing is avoided wherever it is at all possible to do so. Plowing in this type of muck so interwoven with roots, is a most difficult and expensive process. But the land must be plowed when there is sod to be turned under, and so it has become necessary to develope a method of plowing which will meet the unusual conditions found in this muck.

For many years the only successful plow tried was the "Marsh Breaker" manufactured by the South Bend Plow Company. This is an extremely light weight, long shared two-horse walking plow, with a narrow landside, and a heavy slab

coulter reaching from point to beam. This seems to be by far the most satisfactory walking plow on the market- its light weight allows it to be disengaged readily from roots and stumps, and lightens the draft on the team. If kept with a razor edge, the slab coulter cuts through small or rotted roots rather satisfactorily; and the plow turns over sod well where it has a reasonable opportunity to work. But at best, plowing under these conditions is slow and tedious, with continual delays for removing roots from the point.

It was not until this last season (1924) that a promising means of plowing up the meadows on the ranch was discovered. A demonstration by the Oliver Plow Company was arranged, in the hope of finding a tractor plow which would overcome the obstaclesto economical plowing of root infested muck. Of the various plows demonstrated, the only one which could do the work satisfactorily was the Marsh and Brush Sulky # 41. This is an implement of special design, and its success is the result of several entirely new departures in construction, which may be enumerated as follows:

1. Style of Coulter:

The feature which does by far the most to enable the plow to operate successfully is the giant rolling coulter which is thirty-six inches in diameter, mounted on roller bearings and so placed that its edge revolves just below and behind the plow-point. When a root is encountered, this coulter will either crush through it (aided by the great weight of the entire implement- about eight hundred and fifty pounds), or, if the root is too large to be cut, the coulter will roll over it, lifting the plow up and over the root so that the plow-point cannot thrust itself into the obstacle. The

wonderful advantage of such a coulter is at once apparent- it practically eliminates the great handicap in muck plowing, of stopping continually to remove roots.

2. Great Clearance:

The plow bottom is carried fully three feet behind the frame, or working parts, of the plow. This remarkably large throat allows the stumps and roots, which inevitably turn out of the ground, to escape readily without making the operator stop to disengage them.

3. Heavy, Rigid, Construction:

A very few rounds in the field with any of the other plows demonstrated revealed that they could not stand up under such punishment as a tractor plow receives from continually driving into roots and stumps. Coulters were bent, points broken, and pins sheared off. But the 41 Sulky made its way through and over all these obstacles without the least damage to its rugged parts.

4. The Furrow Pusher Attachment:

Although the marsh sulky turns a twenty-two inch furrow, like all other plows it throws the edge of one furrow upon the furrow turned just before. The object in plowing muck, is of course, to get as firm an arrangement of the furrow slices as possible, with a minimum of air pockets. The only device which completely accomplishes this object is the furrow pusher attachment, which simply rides along behind the moldboard and pushes the furrow slice, just after it turns, over toward the plowed ground about six inches farther than it would ordinarily fall. This allows the next furrow slice to fall flat in the furrow, where the furrow pusher shoves it up snugly against the edge of the last furrow slice, ultimately

leaving a plowed surface which is very nearly as firm as the meadow was before it was broken and which permits no growth of grass at the furrow edges the next spring.

In spite of its great size and weight, the marsh sulky is easily handled by a Fordson tractor- because muck offers, of course, very little plowing resistance, and the plow can be kept in motion instead of colliding with roots and lodging frequently.

In addition to plowing sod, the marsh sulky has been used with gratifying results on land which has stood for several years since burning, and meanwhile grown over with brambles, small popils and wild cherry trees, and weeds and brush of all kinds. After the loose roots, stumps and logs are removed from a field of this kind, the marsh sulky is put to work, and succeeds beyond the most optomistic expectations warranted by such a hopeless project. Of course it is impossible to secure a fancy job of plowing under such conditions but the sulky will do what no other plow will do- tip over the undergrowth and turn dirt on top of it. Heavy roots and logs are jerked out of the ground so that they can be removed, and poplar trees as tall as ten feet are often uprooted and covered completely by the action of the plow. In this kind of breaking it is advisable to have a skillful man walk along beside the plow, to ride it when a patch of sod is encountered or to help free it from roots, snags, etc and to keep the furrow clean for the next round. It would be out of the question to put in a crop directly on land plowed in this fashion, but such plowing does make it possible to use the disks on the field after the roots are removed and gradually work the brush roots into submission. If the land can be

"plowed"thus in the spring and disked at intervals during the summer it will be roughly in shape for a crop of rye in the fall.

Three views of the Oliver Marsh Sulky, showing the furrow pusher attachment used in plowing a muck sod.

Breaking new muck with the Marsh and Brush Sulky. The 36 inch rolling coulter, which lifts the plow over large roots and blind stumps, is the feature of construction which makes this kind of work practicable.

F. Adaptability of Crops.

Necessarily, the cropping system for this muck land must be closely limited, for there are but few crops and crop varieties which prove adapted to the peculiar nature of the soil, and to the climatic conditions.

Frost may be considered as the chief limiting factor in the choice of crops- to the extent that those which are appreciably susceptible to summer frosts can never be planted without great risk. Corn, beans, potatoes, millet, etc., are hence seldom raised. However, about one season in every four during the farming operations on the ranch, has been successfully passed without frost, and these occassional seasons have yielded remarkably high yields of corn for ensilage. For this reason a field of about fifteen acres is usually planted to corn, as a gambling project. Hay, rye, oats, barley, and sunflowers can be raised with low risk of freezing, although it is true that summer frosts striking any one of these crops at certain periods in their development may cause considerable damage.

Scarcity of labor is another limiting factor in the selection of a crop rotation. Such crops as sugar beets, and special muck crops, which require a great deal of attention during the growing season, are avoided, because of the difficulty of securing even enough labor to care for the ordinary crops grown.

The great distance from market also eliminates the advisability of growing crops which have a large bulky product to be marketed- e.g. beets, potatoes, etc.

Hay is considered by far the most suitable to the prevailing

conditions for the following reasons:

1. It is the safest, surest crop for this soil- a dependable yielder, little affected by climatic conditions.
2. It requires a minimum of labor .
3. It can be sold at a good price on the local market. Fruit farmers around Hart and Shelby buy most of the hay for their horses, and little is grown in their vicinity.
4. Unmarketable hay or hay in excess of what is sold, can be fed out to advantage to the livestock on the ranch.
5. The aftermath can be utilized profitably for summer and fall pasturing.

Timothy hay is, of course, the most easily cured, most cheaply seeded and is in good favor with the buyers, and so most of the hay sold as a cash crop is straight timothy or timothy and alsike.Seedings are made in the fall with rye and the meadows are not plowed up for five or six years. A yield of two ton per acre may be expected on this soil and the decrease in yield after this period of cropping, without fertilization of any kind, has been slight. Hay is made in the usual way- using a side delivery rake and cylinder hay loader. The hay is cured in the winrow, and put up right in the field- either fn stacks or in hay barracks. The hay for sale is baled as soon as it is out of the sweat, and trucked to market. The hay for feeding is left until winter and hauled to the barns on sleighs.

The meadows to be plowed are turned over in the early

fall, and the land is disked and rolled with the heavy concrete roller in the spring. Fields thus fitted are usually planted to sunflowers, or corn, or a mixture of the two, for ensilage. The seed is drilled through an ordinary grain drill in thirty-five inch rows. This crop is given as little cultivation as possible- just enough to keep down weeds and grass-, and is cut for ensilage immediately after the first frost which damages the sunflowers. It is possible to secure yields of from fifteen to twenty tons per acre of sunflower silage in this way.

If the fields growing cultivated crops are to be seeded back to timothy for a cash crop, the seeding is generally made in the fall with rye. Immediately after silo filling, the corn and sunflower stubble is thoroughly disked and rye and timothy seed drilled. Alsike is broadcasted on these fields from a fiddle seeder in the early spring at the rate of about two pounds per acre.

If the hay from the seeding following the cultivated crop is to be used for cattle feeding on the ranch, more clover is desirable in the mixture, and so best results are secured from spring seedings. Such seedings are made with oats or barley, and consist of a mixture of about four pounds of timothy, four pounds of red clover, and two pounds of alsike. The oats or barley is sowed at the rate of from two to two and one-half bushels per acre as soon as the sunflower fields of the preceeding year are thoroughly dried out and disked up- usually shortly after the first of May. Yields of about forty bushels of barley and from fifty to sixty bushels of oats may be expected in a favorable season. The oat straw is of

excellent quality and makes remarkably good roughage for cattle feed.

Alfalfa, despite the prevailing opinion that it is not adapted to low land, is gradually gaining great favor as a hay crop on muck. A small patch of alfalfa on the ranch is now starting its fourth year with an apparently perfect stand- no winter killing or June grass encroachment whatever being noticeable. A larger field is entering its second season with hardly the loss of a plant since seeding. Stands are very readily secured without liming or fertilization by sowing in the spring from ten to fifteen pounds of seed per acre either alone, or with barley, oats, or rye. The hay can be cut only twice yearly, but yields fairly well and makes hay of excellent quality.

Sweet clover has been used with success as a hay crop, although it makes a very rank growth unless cut early. It is somewhat difficult to cure, but when made properly it is eaten readily bu cattle.

Making Timothy-Alsike Hay

Rye

In the Shock

Harvesting Oats

G. Livestock Management:

It is the proper handling of a large amount of livestock which makes it possible to arrive at a satisfactory operation of a ranch consisting of an extensive rough range, a considerable area of muck, growing general crops, and a quantity of light sandy soil.

Cattle can be pastured very economically during the spring and early summer on the cheap, uncleared swamp areas and unbroken high land. Also, ewes can lamb and pasture, on cutover land during the early season while grass is good. By the time that these rough pastures begin to fail, in late July, the aftermath on the muck meadows is ready for grazing. There is, of course, a very luxureant growth of grass on these meadows, and cattle and lambs can be brought to a very good grass finish early in the fall.

At present the ranch program includes the wintering of about one hundred head of cattle (about half of which are breeding cows or heifers), and about two hundred ewes. About fifteen cows are milked and the butterfat sold. The skim milk is fed out to fattening hogs, and to the calves from the milch cows. A few hogs (about twenty) are fattened each year.

The beef herd consists mostly of grade Herefords, and is being developed on the ranch from common native cows, of chiefly Red Polled or Shorthorn foundation, which were gradually brought up in the vicinity. The second Hereford cross is resulting in a very satisfactory degree of uniformity and beef type in the herd. The cows are bred to calve in the late spring and early summers, and the calves

are allowed to run with their dams until fall. Any of the calves which do not promise well as beef type animals are usually sold during the summer as large veal. Cows of four or five years, which have attained their full growth, are dried up in the late summer, and grass-fattened for sale in the fall. Steer calves are wintered twice, and sold as long two-year-olds off grass.

It is very evident that the profits in such an undertaking must be very small per animal unit and so operations must be conducted very economically and on a relatively large scale. The cows are wintered entirely on roughage- a limited amount of silage along with oat straw and rather inferior hay. Calves and yearlings are also wintered on roughage- but with more liberal rations of silage, and better quality hay. The cattle come through the winter in fair flesh, and the cows have a few weeks of grazing in which to get in good condition for calving.

The cattle selected for fattening on the meadow aftermaths include all full-grown and barren cows and all two-year old steers. They make very rapid gains, and are usually in fair condition for sale by late September. Up to the present time, all such cattle have been sold to local butchers at an average return of about five dollars per hundred. It has not been thought advisable to begin shipping to the Chicago markets until carlots of uniform stock become available.

Sheep raising has proved to be a profitable venture on the ranch, and is rapidly increasing in importance. Ewes are wintered solely on alfalfa or clover hay and bean pods with a moderate ration of oats, or oats and bran in the early

spring before lambing time. The wether lambs are shipped to the Detroit market in the fall after two months grazing with their mothers on the muck meadow aftermaths. None of the predicted difficulties from pasturing sheep on low ground (foot rot, colds, etc.,) have been encountered, and the sheep thrive and fatten on the well-drained meadows.

Dairying is conducted only as a sideline, to aid in the economical distribution of the labor on the ranch. Most of the milking is done in the summer and fall while the cows are on pasture, but the tendency now is to increase the number of winter milch cows. Dual purpose cows- Red Polled and dairy Shorthorns- are mostly used, due to the value of their calves to the beef herd, but the intention now is to develop a small herd of Guernsey cows for the future. The cows are also pastured on the muck meadows.

Little purebred livestock business is done outside of the use of purebred sires. A small but select flock of registered Shropshire Sheep is maintained- chiefly to ensure a supply of good rams. A few registered Hereford females are kept in addition to the purebred bulls. The location of the ranch is not favorable to any large-scale purebred breeding of beef cattle or sheep.

Livestock, in addition to the direct returns from their products, are aiding wonderfully in the development of the ranch. The extensive areas of old, tillable sandy soil are becoming amazingly productive as a result of liberal applications of barnyard manure. The fertilization which is, or which may become necessary on the muck can be obtained by means of a commercial fertilizer, probably muriate of potash

and the manure made from the feeding of muck grown crops can be applied to the upland soil which responds so well to the nitrogenous constituents and organic matter of the barnyard manure.

PART III.

EXPERIMENTAL WORK

EXPERIMENTAL WORK.

Experimental studies of muck soil conditions on the ranch have been in progress for three seasons. These investigations may be roughly classified into three divisions.

1. Studies of tillage methods on muck.
2. Studies of the adaptability of crops and crop varieties to this soil.
3. Studies of the fertility needs of the soil.

The third division of the experimental work consists chiefly of an orthodox fertility project, similar to those conducted by the College on muck areas in various parts of the state. The first and second divisions of the work, however, present material which results from a far more unusual field of investigation, and concerning which very few authentic reports are available. It is to be regretted that the results from the extensive cultural and variety tests carried out at the ranch are as incomplete as they are- a succession of summer frosts during two seasons destroyed crops which were nearly ready for report. The sequence of the studies is hence seriously broken, and it is necessary in some instances to present data for one season which is unconfirmed by repetition. Nevertheless, it is true that, in most cases, general observations for the second season appeared to confirm the original data.

Character of the Soil for the Experimental Work.

The area of muck chosen for the first experimental projects, in 1922, was selected with the idea of securing a field which would be representative of the most common soil conditions to be found on the ranch. As the map shows, the area is located at the corner of the Beaver and lateral drain number one. This insures good drainage, although any of the land within forty rods of either the Beaver or one of its laterals is fully as dry. Before it was cleared, this area of land supported a dense growth of tamarack and cedar, with a profusion of undergrowth of great variety.

In 1918 it was burned over during the early summer, at a time when the muck had dried out enough to burn off for the most part, to a uniform depth of a few inches. Some burn-out pockets resulted, but in no case did the muck burn down to a depth of over one foot.

The land was hastily cleared in 1920 and oats broadcasted and disked in. A fair yield resulted. The next year the stubble was disked up and corn planted. That season, an enormous crop of ensilage was cut, with no cultivation of the corn whatever. The burning, in 1918, had evidently destroyed all weed seeds and grass, and there had not as yet been time for a new encroachment of such material.

The first step, after the selection of the experimental tract in the fall of 1921, was to make a thorough survey of the soil over the area, which included about five acres. The average depth of muck undoubtedly exceeds eight feet, except immediately adjacent to the tongue of sand which comes to the surface, as shown on the chart. No plots were put on near this sand, however, so no further mention of that feature of

the field need be made. Other surface variations, such as shallow burn-outs, and such minor irregularities, were infrequent and insignificant enough to be ignored.

The surface soil seemed to be moderately well advanced in decomposition, although it is true that a considerable portion of the surface soil was clumped together in the light, flaky clods characteristic of a sedge deposit of an earlier stage in decomposition. For the most part, however, the surface soil appeared to be well pulverized and decomposed.

Studies of the soil profile were made, at regular intervals throughout the field, to a depth of from four to five feet. As has been suggested above, the appearance of the first six inches of the soil profile suggested a sedge foundation. The probability of sedges as the original vegetation was more markedly evidenced in the lower sections of the profile. With increased depth, the muck became gradually a lighter brown in color, and the layers of slightly decomposed vegetative material in the samples became more distinct. Although the lower sections were found to be very raw and slippery to the touch, they gave no appearance of a colloidal structure. A composite of the surface soil samples was collected and taken to the College for chemical analysis.

It is only in the most general way that this muck can be descriptively classified. In a vague manner, the soil may be listed in the "Swamp group of peat material", sub-classified as "the coniferous forest type of muck."* This means that the soil used in these experiments has supported a chiefly coniferous type of vegetation- but this statement must be qualified by granting that there was an appreciable inter

* Dachnowsky's classification.

In organizing this report of experimental studies it has been thought advisable to group the account into three divisions: i.e. Cultural experiments, variety tests, and fertility experiments. The method of discussion will be to give the history of each crop used in each experimental division, throughout the entire period of experiments with that crop. Results, therefore, will be presented consecutively from 1922, 1923 and in some cases 1924 experiments, for each crop under discussion.

CULTURAL EXPERIMENTS

Cultural Experiment

Spring Rye | Oats | Winter Rye | Sunflowers | Corn.

Check Not Rolled

Rolled once before planting

Rolled 3 times before planting

Rolled once before and once after planting

Rolled once after planting

Not rolled

Spring Disced
Spring Plowed
Spring Disced
Spring Plowed
Fall Plowed
Fall Disced
Fall Plowed

Spring Plowed: Cultivated 3 times; Cultivated twice; Not cultivated

Spring Disced: Not cultivated; Cultivated twice; Cultivated 4 times

Spring Disced: Cultivated 4 times; Cultivated twice; Not Cultivated

Spring Plowed: Not Cultivated; Cultivated twice; Cultivated 4 times

Rolled once before planting

Not rolled

Rolled once before and once after planting

Meadow Experiment.

Rolled Once | Not Rolled | Rolled Twice | Not Rolled | Rolled Once

K 150

Check

P 150

1922 P150 K150

1923 Residual effect

Check

P 150 K 150

Plate No. III.

CULTURAL EXPERIMENTS

The objects of the cultural experiments were as follows:

To compare plowing vs not plowing
To compare spring plowing vs fall plowing
To study the effect of various rolling operations as compared with no rolling
To study the effect of cultivating corn and sunflowers.

In the cultural experimental projects put on during the three years of study at the ranch; corn, sunflowers, timothy, spring rye, fall rye, and oats were the crops used.

In all cases the plots were uncommonly large, and every attempt was made to carry on the work under practical field conditions. All plots were fertilized uniformly at the rate of 300# Acid Phosphate and 250# Muriate of Potash per acre. All cultural treatments, except those which formed the basis of each particular phase of the experiment, were identical.

Plowing was done with a sixteen inch walking marsh breaker, horse drawn. A seven foot set of tandem disks, drawn by a Fordson tractor, were used for the disking. The corn and sunflowers were cultivated with one-horse, spring tooth cultivators, which can be handled advantageously among roots.

The roller used in the cultural experiments demands a somewhat detailed explanation, as it is as yet difficult to obtain a roller, on the market, which meets the requirements of muck soils, and hence a muck roller must be of private construction. Several forms of muck rollers have been devised, and it is likely that some of the rollers, designed since the one used in these experiments, have more desirable features of construction. However, this roller is fully as effective as any in firming the soil, and can be constructed

with very little expense or labor. The details of its construction follow:

Two sheets of boiler-plate, rolled and riveted to form cylinders two feet long and thirty-two inches in diameter, were purchased. The cylinders were placed on end on a plank platform, and a two-foot length of two inch water pipe was set upright in the exact center of each. This pipe was held in place at the bottom by a shallow two inch hole in the platform, and at the top by a wooden framework. The cylinders were then filled with a 2:4:6 concrete mix, which was allowed to set for three weeks. A heavy plank framework of the style shown in the illustrations was constructed meanwhile. This framework was equipped at each side with a six inch bearing, of two inch water pipe, as shown.

When ready, the cylinders were placed in position within the framework, and a one and three-fourths inch steel shaft of proper length was inserted through the entire assembly. The two sections of roller were separated from one another, and from the bearings, by three steel collars on the shaft. Ordinary pipe caps were screwed on the outer ends of the bearings, and the roller was complete.

Nearly all of the material for this roller was purchased at a junk or old iron shop. The actual cost of materials, exclusive of concrete and lumber for the roller described above, was sixteen dollars. After the materials were collected only a little over one day was required for two unskilled men to complete all of the labor of construction.

The finished roller weighs nearly 3500 pounds, thus exerting a pressure of about 850 pounds per foot of length.

This is even a greater firming pressure than that advocated by the Austrian authorities* (1500 kg. per 1.5 meter), or by the Minnesota Station* (1600 lbs. per yard). The roller is handled readily under all conditions by a Fordson tractor. The double cylinder construction is of considerable value in turning corners with the heavy roller, because it is possible for the outer cylinder to rotate faster on the turn than does the inner half of the roller. The axle of the roller is readily lubricated by withdrawing the shaft partly, first at one end and then at the other, and applying grease.

* Minnesota Bulletin #184.

THE HEAVY CONCRETE ROLLER

This Home-made Mack Roller is 4½ feet wide and 32 inches in diameter, and weighs 5500 pounds. The material for its construction cost less than $35.00.

(A) CULTURAL EXPERIMENTS WITH SUNFLOWERS.

As the chart shows, the cultural work with sunflowers for ensilage was undertaken on an entire acre of land, April 20th.,1923, this plot was divided in half longitudinally, and one half was plowed. The other half was disked twice, and the entire plot was harrowed once with a spring-tooth drag. 250# Muriate of Potash and 300# Acid Phosphate were applied broadcast, and dragged in with a spike-tooth harrow.

The plot was not worked again until May 28th., when a thorough spike-tooth dragging was given to the soil just previous to planting the sunflower seed. On May 30th., Russian sunflower seed was drilled longitudinally, in 35 inch rows, from an ordinary grain drill. A good uniform stand was secured.

Rolling treatments, before and after planting, were given as listed in the tables which follow.

By June 30th., the field was becoming rather weedy, and so the cultivating experiments were started. Each half of the plot (one plowed the other disked), was subdivided, longitudinally, into three equal parts. In each case, the central one-sixths received no cultivation, the next pair in sequence were cultivated twice, and two outside one-sixths were cultivated four times during the season. The cultivations were made on June 30th., July 9th., 16th., and 23rd.

From the outset, the sunflowers on the unplowed half were very evidently developing more rapidly and vigorously than those on the plowed area.

Only in one or two cases could any benefit from the rolling

treatments be distinguished by mere general observation.

By the time of the third cultivation, it became apparent that, in spite of the weeds, the uncultivated strips were growing more thriftily than the cultivated plants.

A frost July 4th., which killed corn, damaged the sunflowers only slightly and temporarily.

The sunflowers were harvested late in September, by the following method: Workmen cut off the stalks by hand and stepped upon a platform scale for weighing, after which their own weights were deducted. The total weights for each of the 42 plots harvested were thus secured. After weighing, the sunflowers were ensiloed.

The sunflower cultural experiment for 1923 was put on in exactly the same manner, on the acre of land used for corn in 1922. Very fortunately a killing frost in July, and another in August completely ruined the crop, so that no definite results can be presented. The only significant observation made during the period of growth of the sunflowers in 1923 was that the uncultivated portions in both the plowed and unplowed halves of the field were becoming overpowered by the weed growth, which was far more serious than in 1922. As before, the unplowed half showed by far the better growth of sunflowers, up to the time of the frost.

TABLE I.

Yields per Acre of Sunflowers, Grown on Plowed and Unplowed Muck, which had Received Different Rolling Treatments and Different Cultivations.

Plot	Spring Plowed			Not Plowed			Averages
	4 Cult.	2 Cult.	Not Cult.	Not Cult.	2 Cult.	4 Cult.	
1. Not Rolled	10.6 Tons	8.8 Tons	12.6 Tons	13.7 Tons	12.8 Tons	12.4 Tons	13.4 Tons
2.Rolled once before planting	12.9 "	19. "	15.6 "	15.5 "	15.4 "	14. "	15.4 "
3.Rolled 3 times before planting	13. "	14.8 "	13.5 "	16.3 "	15.8 "	13. "	14.4 "
4.Rolled once before and once after planting	16.6 "	14.7 "	16.7 "	14.9 "	16.8 "	16.1 "	15.9 "
5.Rolled once after planting	16.3 "	17.7 "	18.5 "	15.2 "	14.8 "	18. "	16.7 "
6.Not Rolled	12.7 "	15.6 "	18. "	14.9 "	15.3 "	14.1 "	15.1 "
7. Rolled once before and once after planting	16.5 "	22. "	22.3 "	29.7 "	26.2 "	19.6 "	22.7 "
Averages:Cultivations	13.1 "	16.1 "	16.7 "	17.1 "	16.7 "	15.3 "	

Averages: Plowing vs. not plowing — 15.3 Tons — 16.4 Tons.

Panoramic End View of Sunflowers: Cultural Experiment, 1922.

---------- Not Plowed ---------- ----------Spring Plowed ----------

4 Cultivations 2 Cultivations Not Cultivated Not Cultivated 2 Cultivations 4 Cultivations

The data secured from the 1922 sunflower cultural experiments may be summarized as follows::

Unplowed soil yielded over a ton per acre more than plowed soil.

Rolling invariably resulted in better yields. The best results were secured from rolling once before and once after planting, but rolling once after planting gave nearly as high a yield. The average yield from the rolled plots exceeded the average yield from the unrolled plots by nearly three tons per acre. The benefits from rolling were considerably more evident on the plowed than on the unplowed soil. Three rollings before planting gave a lower yield than one rolling. The only probable explanation of this result is that variations in the soil conditions caused the differences in yield.

The uncultivated sunflowers gave slightly the best yield, but very little more than those cultivated twice. Cultivating four times produced a depression in yield of nearly two tons per acre.

It would be presuming too much to venture any recommendations from the results of this one year of experiment with cultural methods for sunflowers. In a general way, however, it would seem that soil for sunflowers should not be plowed, except when absolutely necessary (e.g., a sod). Rolling with the heavy roller once after planting should prove profitable, and possibly more satisfactory returns would be secured by rolling once before and once after planting.

It might be concluded that cultivating should be practiced only as a measure to prevent weed growth, and should be avoided whenever weeds are not seriously threatening the crop.

Satisfactory results were obtained from the use of the grain drill as a seeding method. The seed was sown rather thickly to avoid a rank, woody growth. The sunflowers were ensiled shortly after flowering. Sunflowers were found to feed into the ensilage cutter best when started heads first.

(B) CULTURAL EXPERIMENTS WITH CORN.

Killing summer frosts, in both 1922 and 1923, destroyed the corn crop so that no results from this work can be presented. The experiment was laid out in every way identically to the cultural sunflower experiment. The same cultural treatments were given throughout. Wisconsin #25 seed was used, planted May 30th., in checked rows, 40 inches apart. The stand secured was excellent.

June 28th., the first cultivation was given. The frost of July 4th., damaged the corn almost fatally and checked its growth for so long a time that weeds took possession of the field.

However, by July 23rd., the growth was thought to be sufficient to warrant continuing the experiment, and so the cultivation treatments were resumed. Of course, it was impossible to get the weeds under control at this stage of their growth.

Early in September the corn received its second severe frost which ended all hope of harvesting the crop for experimental data. It could be observed in a general way, at this time, that the corn on the unplowed half of the field was the better. Most of it had attained a height of from six to eight feet, whereas that on the plowed half averaged about six feet or less. NO other significant differences in the corn could be observed. The entire crop had done amazingly well in competition with the frost and weeds.

The experiment was repeated, identically, in 1923, on the acre of land used for sunflowers in 1922. Killing frosts

were so frequent during the summer of 1923, however, that the corn was destroyed utterly, and the field was taken over by weeds and grass.

(C) CULTURAL EXPERIMENTS WITH SPRING RYE.

The cultural work with spring rye was very unsatisfactory, due to the extremely low yields secured from this crop, and hence was carried on in 1922 only.

The division of the field was exactly the same as for corn and sunflowers, and fertilization and cultural treatments (with the exception of course, of cultivation) were identical.

The one-acre field was drilled on April 29th., at the rate of 3 bushels per acre. The meagre crop was harvested by hand on August 6th., and sent to the College for threshing.

TABLE II.

Yields per Acre of Spring Rye on Plowed and Unplowed Muck which Had Received Different Rolling Treatments.

	Spring Plowed	Disked Only
1. Not rolled	2.6 bu.	6.8 bu.
2. Rolled once ..... . before planting	4.3	5.4
3. Rolled three times before planting	4.7	9.3
4. Rolled once before and once after planting ..	9.8	12.3
5. Rolled once after planting.....	10.	8.2
6. Not rolled	8.7	8.9
7. Rolled once before and once after planting ..	11.2	11.
8. Not rolled	5.7	7.6
9. Rolled once before and once after planting .. and twice during growth	3.5	7.8
Averages	6.7	8.5
Averages, rolled plots.....	7.3	9.
Averages, not rolled.....	5.4	7.5

TABLE I.

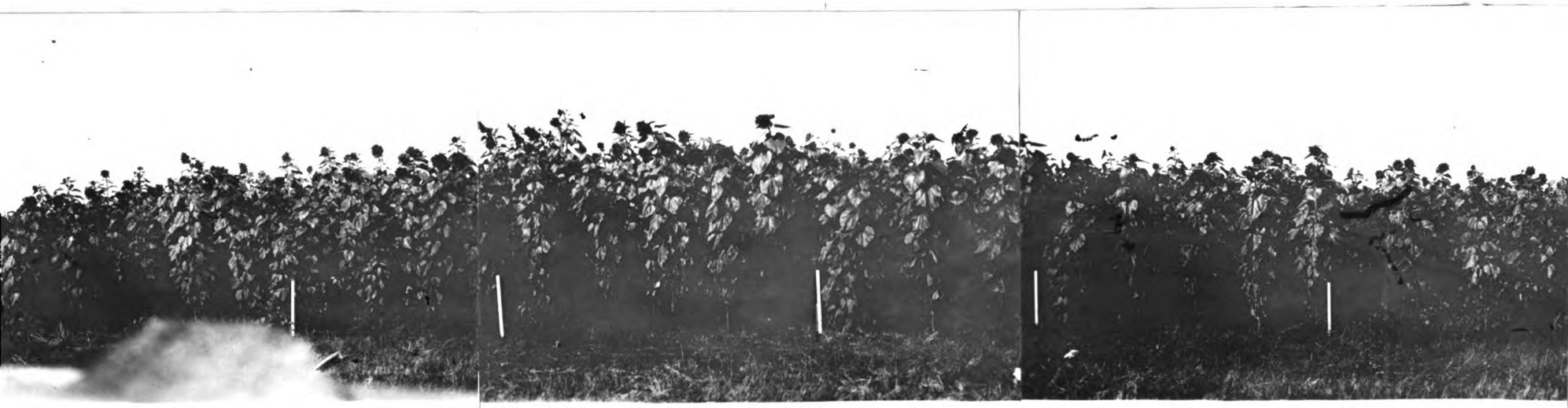
Yields per Acre of Sunflowers, Grown on Plowed and Unplowed Muck, which had Received Different Rolling Treatments and Different Cultivations.

Plot	Spring Plowed			Not Plowed			Averages
	4 Cult.	2 Cult.	Not Cult.	Not Cult.	2 Cult.	4 Cult.	
1. Not Rolled	10.6 Tons	8.8 Tons	12.6 Tons	13.7 Tons	12.8 Tons	12.4 Tons	13.4 Tons
2.Rolled once before planting	12.9 "	19. "	15.6 "	15.5 "	15.4 "	14. "	15.4 "
3.Rolled 3 times before planting	13. "	14.8 "	13.5 "	16.3 "	15.8 "	13. "	14.4 "
4.Rolled once before and once after planting	16.6 "	14.7 "	16.7 "	14.9 "	16.8 "	16.1 "	15.9 "
5.Rolled once after planting	16.3 "	17.7 "	18.5 "	15.2 "	14.8 "	18. "	16.7 "
6.Not Rolled	12.7 "	15.6 "	18. "	14.9 "	15.3 "	14.1 "	15.1 "
7. Rolled once before and once after planting	16.5 "	22. "	22.3 "	29.7 "	26.2 "	19.6 "	22.7 "
Averages:Cultivations	13.1 "	16.1 "	16.7 "	17.1 "	16.7 "	15.3 "	

Averages: Plowing vs. not plowing — 15.3 Tons — 16.4 Tons.

Panoramic End View of Sunflowers: Cultural Experiment, 1922.

---------- Not Plowed ---------- ----------Spring Plowed ----------



4 Cultivations 2 Cultivations Not Cultivated Not Cultivated 2 Cultivations 4 Cultivations

54

It is evident that the data from the individual plots is erratic, and at times contradictory. If any value is to be gleaned from this experiment, it will be from a comparison of averages of yields, rather than from a comparison of yields from individual plots.

The average grain yield from the unplowed area was 26% in excess of that from the plowed soil.

The average of all of the rolled plots showed a yield of 32% higher than the average of the unrolled plots.

The best results were secured from rolling once before and once after planting. Rolling during growth (May 30th) proved detrimental.

(D) CULTURAL EXPERIMENT WITH WINTER RYE.

On October 1st., 1922, a strip of the spring rye stubble was plowed, and another strip of equal width was disked thoroughly. Both strips were dragged and given the usual fertilization, and rolling treatments.

Rosen rye seed was drilled, at the rate of two bushels per acre, on October 3rd., By the middle of October a good stand of rye was present.

One of the crosswise strips, rolled once before and once after planting, was rolled once more on May 2nd.,1923.

Plots were harvested July 30th., and taken to M.A.C. for threshing and weighing.

TABLE III.

Yields per Acre of Winter Rye grown on Fall Plowed and on Unplowed Muck Land which Had Received Different Rolling Treatments.

Plot No.	Fall Plowed	Unplowed
1. Not Rolled	16.3 bu.	22.5 bu
2. Rolled once before planting	17. "	22.1 "
3. Rolled once before and once after planting	21.4 "	22.8 "
4. Rolled once after planting*	11.7 "	16.5 "
5. Not Rolled*	10.2 "	16. "
6. Rolled once before planting	18.5 "	22.7 "
7. Not Rolled	18. "	22.6 "
8. Rolled once before, once after planting, and once in the spring	23.8 "	26.5 "
Average	19.1 "	23.2 "
Average yield from rolled plots	20.1 "	23.5 "
Average Yield from unrolled plots	17.2 "	22.6 "

*These Plots were overgrown by Canada thistles, which undoubtedly caused the depression in yield. They are not included in the averages.

The results from the winter rye experiment furnish, perhaps, the most significant set of cultural data secured from this series of studies. It is to be regretted that the trials were made during the second year and hence, were not repeated.

Unquestionably, the unplowed area furnished the better yields in all cases, exceeding, on the average, the returns from the plowed soil by three bushels per acre.

No benefit worthy of note was received from rolling the unplowed strip, except in the case where the rye was rolled in the spring following its planting. In this case the yield was increased by nearly three bushels per acre.

Rolling invariably proved much more beneficial on the plowed than on the unplowed portion, especially on the plot which was rolled in the spring.

The conclusion may be tentatively drawn that rye should be sown on unplowed muck wherever possible, and rolled once in the early spring.

(E) CULTURAL EXPERIMENT WITH OATS.

Oats were selected as a crop to replace spring rye in the experiments. The experiment was elaborated to the extent that a strip of fall plowed soil was added for comparison with spring plowing and spring disking. This strip was plowed on October 1st., 1922; the spring plowing and disking were done May 3rd., 1923. Rolling treatments were the same as in all of the other cultural experiments.

Worthy oats were the seed used.

This was a very unfortunate choice, as the variety tests of the same year showed Worthys to be a very inferior variety for this muck. The variety is doubtless responsible for the small yields secured from the cultural oats experiment. The oats were drilled, at the rate of, three bushels per acre, on May 5th.

TABLE IV.

Yields per Acre of Oats Grown on Fall Plowed, Spring Plowed and Unplowed Muck which Had Received Different Rolling Treatments.

Plot	Fall Plowed		Not Plowed		Spring Plowed	
	Grain	Straw	Grain	Straw	Grain	Straw
1. Not Rolled	22 bu.	2304#	32.3bu.	2080#	15.5 bu.	1344#
2. Rolled once before planting	22.2	2176	30.5	1984	12.2	1312
3. Rolled once before and once after planting	25.8	2432	29.8	2240	18.4	1472
4. Rolled once after planting	25.4	2464	26.5	2048	19	1536
5. Not Rolled	19.6	1760	31.7	1920	13.3	1280
6. Rolled once before planting	20.5	2016	33.7	2400	15.8	1248
7. Not rolled	20.8	1728	28.4	1728	12	1408
8. Rolled once before and once after planting	28.3	1888	33.4	2048	19.2	1664
Average - all plots	23.1	2096	30.6	2058	15.2	1408
Average - rolled plots	24.4	2195	30.8	2144	16.9	1446
Average -	20.8	1931	30.8	2024	13.6	1344

Again, the data from the cultural oats, experiment argue in favor of disking only, rather than plowing. The yields of grain are appreciably higher where the soil was not plowed., and the yield of straw is about the same for the disked and fall plowed plots. Spring plowing appeared to be very unsatisfactory, both for grain and straw yields.

Rolling produced definite increases in grain yields, but it is doubtful if the returns secured from the operation would pay for its expense. It is fair to presume, however, that in a dry season the percentage increase of yield from rolling would be considerably higher than it was in 1923. Rolling once before and once after planting gave the best results. The rolling benefit was most marked on the spring plowed plots.

Rolling appears to have had no striking affect on the yields of straw.

(F) CULTURAL EXPERIMENT WITH TIMOTHY.

The cultural work with timothy consisted only of rolling treatments, and was undertaken on a timothy sod* which had been cut for hay for five years prior to the experiment project. The experiment was carried on for two seasons: 1922 and 1923.

The area used for this project was staked off adjacent and perpendicular to a hand ditch, as shown on the chart, Plate II. The rolling treatments were given longitudinally, and early in the season (just as growth was starting), both years. No outward indications of any differences in rapidity of growth, or vigor of development, among the plots, could be noticed.

Plots were cut individually with a mowing machine, and raked by hand. The hay was allowed to cure in the cock, until thoroughly dry, before weighing.

* The same area as that used in the fertility experiment with timothy, discussed later.

TABLE V.

Yields per acre of Cured Timothy Hay from an area of Old Muck Meadow which had Received Different Rolling Treatments.

Plot	Treatment	1922	1923	Averages
1.	Not rolled	4660	2900	3780
2.	Rolled twice April 26th, and once May 21st.....	3860	-	-
3.	Rolled once April 26th, and once May 21st.....	4360		
4.	Rolled once	4900	3133	4016
5.	Rolled twice	4800	3167	3984
6.	Not rolled	2400	3033	2717
7.	Rolled once	-	3433	-

The higher yields in 1922 may be accounted for by the fact that that season was much better for hay growing than was 1923. Both seasons, however, supplied more moisture than is often received and perhaps this fact accounts for the very slight benefits resulting from rolling.

It must be granted that the increase in yield resulting from rolling is hardly sufficient in any case to justify the expense of the operation, as far as this experimental evidence shows. Rolling once apparently gave yields fully as high as did two rollings. Rolling during the growth of the hay seemed to lower the yield.

No reasonable explanation of these responses to rolling can be offered. It would be highly desirable to repeat this experiment until data from seasons of less waterfall could be reported.

VARIETY TESTS

VARIETY TESTS.

In accordance with the scheme of all of the experiments undertaken at the A.F.Sippy Ranch, the variety trials were laid out on a large scale, and under practical field conditions. Variety tests with corn were put on in relatively small plots, due to the simplicity of harvesting a small patch of corn readily. For the small grains (barley and oats), however, the one-acre plot idea was evolved. This was merely the use of one measured acre for each variety of seed sown, and was conceived as a means of avoiding the inaccuracy which must inevitably accompany the harvesting of a small patch of grain. Such a patch can not be truly representative of field conditions, because it does not take into account the soil variations found in a field, and because the factor of error in harvesting and threshing a small amount of grain by hand is much greater than that resulting from handling an entire acre. The length acre plots was four or five times as long as the width. Thus inaccuracy, resulting from soil variations, was minimized.

Corn variety tests were tried for three successive seasons, only to be destroyed each time by summer frosts.

The barley trials of the first season gave such a markedly greater yield of one variety that it was thought unnecessary to repeat the acre plots the second year.

Acre-plot tests with oats were carried on for two seasons.

(A) VARIETY TESTS WITH CORN.

The areas used for corn variety tests were prepared each season with the greatest care. Soil of uniformity of surface conditions and of drainage, etc, was selected, and disked thoroughly at intervals during the early part of each season. It was dragged and rolled just before planting. About one-half acre was planted to corn, for variety trials, each year.

The seed was planted in 42 inch checked rows, and dropped by hand to insure the same number of kernels (3) in each hill. Five rows of each variety were planted.

The varieties used were as follows:

1. Flint- a yellow, northern grown flint corn.
2. Northwestern Dent- a very early red dent corn.
3. Garrod-
4. Mentha Muck-
5. Wisconsin #12- "Cold Resistant", a strain selected from Wisconsin #12 parent stock.
6. Wisconsin #25- an early yellow dent corn.
7. Golden Glow- a variety recommended by M.A.C. Crops Department for upland use in this locality.
8. Duncan- a variety recommended by the Farm Crops Department for ensilage in this locality.

Each year the corn was kept free of weeds by cultivating and hoeing. A good stand of all the varieties was secured each time, but only in the first test (1922) did the corn recover enough from summer frosts to attain much size. That season the Wisconsin #25 variety recovered best from the frost and made enough growth before fall to have some

value as ensilage. The other varieties made only a feeble attempt at recovery from the frost, and were decidedly inferior to the Wisconsin #25 plot by corn-cutting time.

(B) VARIETY TESTS WITH BARLEY.

The 1923 tests with barley revealed that crop to be of the most promising of the general crops adapted to this muck. Previous to these trials, barley had never been grown on the A.F.Sippy Ranch nor anywhere else in the neighborhood.

The soil for the barley tests had raised corn the previous year. It was thoroughly disked, dragged, and fertilized at the usual rate, early in the season. On May 6th., one acre of each of the three varieties of seed was drilled at the rate of two and one-fourth bushels per acre, seeded with sweet clover.

The varieties used were:

1. Michigan Black Barbless
2. Wisconsin Pedigree
3. Minnesota #

All three varieties developed excellently and began to ripen in early August. The straw of the Wisconsin Pedigree barley was considerably longer than that of the other two varieties, which were of about the same height. There was no lodging whatever, anywhere in the field.

At first it appeared that the Wisconsin Pedigree would ripen earliest, but the other two varieties hardened up more rapidly at the last, and were cut first.

Plots were harvested individually, with a grain binder, and the bundles allowed to cure, right on the plots, in the shock. The bundles from each plot were then hauled to the threshing machine and threshed, and the yields, as measured by the machine recorded.

TABLE OF YIELDS PER ACRE OF BARLEY VARIETIES.

1. Wisconsin Pedigree.....38 bu.
2. Michigan Black Barbless...28 "
3. Minnesota # .....22 "

Nearly twice as much straw was obtained from the Wisconsin Pedigree as from either of the other barleys.

The grain from the Wisconsin Pedigree plot and the Michigan Black plot threshed much cleaner than did the Minnesota barley, and was heavier and harder.

The sweet clover seedings appeared to be best on the Michigan Black and Minnesota plots, but by the next season all three seedings seemed about the same. All of the seedings were excellent at that time.

Since the season of this experiment was normal in every way, and since the field conditions were kept very uniform, there can be but one interpretation of this test: i.e. that Wisconsin Pedigree Barley is by far the best of the three tried, on this muck.

In 1924, the barley trials were repeated, on a small scale, with the purpose of determining the value of, muck-grown seed vs. upland grown seed. A severe frost, just at the time when the grain was going into the milk stage, ruined the crop, and so only observations of the apparent development of the various plots can be reported. These, however, have considerable value.

The lay out of the project was as follows:

1. Wisconsin Pedigree- certified, upland-grown seed
2. " " - seed grown on the ranch, on muck
3. Michigan Black Barbless- certified, upland grown seed

4. Michigan Black Barbless- seed grown on the ranch, on muck
5. Minnesota "Manchuria Barley"

The plots were only about one-tenth acre each in area, each being the width of the grain drill from which they were sown.

By the time of the frost, plot # 1, had apparently attained by far the highest degree of development, with plot # 3 second, and plot # 5 third. Both of the plots planted with seed of muck origin were decidedly inferior, making a poor stand at the outset, and lacking thrift and vigor of growth. It would seem from this trial that seed barley for muck should be grown on the upland.

(C) VARIETY TESTS WITH OATS.

All variety tests with oats were conducted on one-acre plots. Only two varieties were planted in 1923, due to the late delivery of some of the seed ordered. In 1924, six one-acre plots were laid out for the work. For the experiments of that season, the area chosen was in a field hitherto unused for experimental work. The usual seed bed preparation and fertilization were given for all of the oats variety tests.

Iowar and Worthy were the only two varieties used in 1923. The yields were fairly satisfactory, in response to rather good oat-growing weather, that year.

In 1924, the experimental project was much more extensive. Two plots of Iowar seed were planted, one of muck-grown seed, the other of upland grown seed. The other varieties were: Iowa 103, Minnesota "Gopher", Minnesota "Victory", and Wisconsin #7. This six-acre project was very satisfactory at the outset, with the different plots exhibiting, from the very start, highly individual behavior in their development. Very unfortunately, the frosts, which killed the barley and corn this season, damaged the oats so severely that it was hardly profitable to harvest the crop.

The oats plots for both seasons were harvested with a binder and threshed individually by a custom threshing machine. The Worthy oats of 1923 were lodged rather badly, whereas the Iowars, with their shorter, stiffer straw, stood up well. As would be expected, a better seeding was obtained with the Iowars than with the Worthys.

The muck-grown Iowar seed, used in the 1924 trials, resulted in rather a poor stand on its plot. Germination and growth were appreciably slower than on the upland-grown Iowar plot. Iowar again seemed to be the best variety, although Iowa 103 was a close second. Of course, it is impossible to predict which variety would have yielded best had the oats had time to reach maturity.

TABLE OF

YIELDS PER ACRE OF GRAIN: OATS VARIETY TESTS.

1923 Tests

Iowar	45 bu.
Worthy	32 "

1924 Tests

Iowar, muck-grown	18 bu.
Iowar, upland-grown...	26 "
Iowa # 103.....	22 "
Minnesota "Gopher" ..;	20 "
Minnesota "Victory" ..	15 "
Wisconsin # 7	15 "

FERTILITY EXPERIMENTS

N

	Check	K300	P100 K300	P200 K300	P300 K300	Check	Irregular Sandy Strip Not Treated	Manure- 12 loads	Manure 6 loads	P300 K200	P300 K100	P300	P300 K300	N100 P300 K300	Check	
A							Sunflowers									A
B							Corn									B
C							Potatoes									C
D							Sugar Beets									D
E							Spring Rye (1922) - Fall Rye (1923)									E
F							Oats									F
G							Millet and Soybeans									G
H							Clover and Timothy									H
I							Alfalfa									I
J							Hubam (1922 only)									J
K							Sweet Clover									K
	1	2	3	4	5	6		7	8	9	10	11	12	13	14	

W E

Arrangement of Fertilizer Experiment
Plate No II.

FERTILITY EXPERIMENTS.

As the chart shows, fertility experiments, with eleven crops, and fourteen different fertilizer treatments, were conducted.

The area employed for the fertility experiment was two acres in extent, and was located along the bank of the Beaver drain (Plate I). Its condition at the time the experiments were put on was as described on page

It was thought best to plow this piece of land the first season, in order to get the roots out more thoroughly, and to secure a more level surface. It was plowed as early as possible (April 18th), and worked down thoroughlywith disk and drag, until planting time. For the 1923 project, the soil was merely disked thoroughly, except of course, on those strips which had been seeded in 1922, to a hay crop, for study in 1923. Both seasons the field was rolled twice with the heavy roller, just before the fertilizers were applied

The fertilizer strips were applied crosswise of the longitudinal strips of crops. Each fertilizer plot was thirty feet in width, with an unfertilized alley, three feet wide, separating it from the next strip. The arrangement of the fertilizer plots was as follows:

1. Check- no fertilization
2. K 300- Muriate of Potash at the rate of 300# per acre
3. P 100 K 300- Acid Phosphate " " " " 100# " "
   and Muriate of
   Potash " " " " 300# " "
4. P 200 K 300- Acid Phosphate " " " " 200# " "
   and Muriate of
   Potash " " " " 300# " "

5. P300 K300-	Acid Phosphate and Muriate of Potash	each at the rate of 300# per acre
6. Check		
7. Manure		" " " " 12 loads " "
8. "		" " " " 6 " " "
9. P300 K200-	Acid Phosphate	" " " " 300# " "
	and Muriate of Potash	" " " " 200# " "
10. P300 K100-	Acid Phosphate	" " " " 300# " "
	and Muriate of Potash	" " " " 100# " "
11. P300 -	Acid Phosphate	" " " " 300# " "
12. P300 K300-	Acid Phosphate	" " " " 300# " "
	and Muriate of Potash	" " " " 300# " "
13. N100 P300 K300-		
	Nitrate of Soda	" " " " 100# " "
	Acid Phosphate	" " " " 300# " "
	and Muriate of Potash	" " " " 300# " "

Each of the combinations of fertilizers was thoroughly mixed in a cement box. The plot which was to receive a treatment was then staked out, and a cord stretched from stake to stake. The fertilizer mixture was then applied broadcast, by hand, up to the lines at the edges of the plots. After all of the fertilizer mixtures had been applied, the field was dragged lightly with a spike-tooth harrow.

The Muriate of Potash used in the mixture was a German salt which had been reground.

The Acid Phosphate was a Swift fertilizer of 16% phosphoric

(A) FERTILITY EXPERIMENT WITH SUNFLOWERS.

Fertility results for Sunflowers are available only for 1922, because of the killing frosts of 1923. Even for 1922, only a partial report can be made, because of the damage done to some of the sunflower plots by rabbits, when the plants were young.

The sunflowers were drilled May 30th., in 35 inch rows. A good stand was secured on series 7 to 14, but series 1 to 6 were eaten off by rabbits. These plots were replanted, only to be eaten off again. The remaining sunflowers were cultivated twice, and hoed twice, to keep down weeds. They were harvested Sept. 24th, and weighed green.

The table, which follows, shows no benefit from manure or nitrate. Best yields were secured on the plots which had received potash in the mixture.

TABLE I.

Effect of Different Fertilizer Mixtures and Manure on Yields of Sunflowers Grown on Muck.

Plot No.	Green Sunflowers (entire plants) Yields per acre.
8. M6	14,400 #
9. P300 K200	26,400
10. P300 K100	29,500
11. P300	21,400
12. P300 K300	25,600
13. N P K	18,500
14. Check	14,550

(B) FERTILITY EXPERIMENT WITH CORN.

The corn on the fertility plots seemed to survive the 1922 frosts better than did the cultural or variety corn, possibly because of the proximity of the Beaver drain and its brush-covered bank. Enough soft corn was formed to collect some data. There is, of course, no report for 1923.

Wisconsin #25 seed was hand planted, May 30th., in checked rows. Two cultivations and two hoeings were given.

The plots were cut by hand, September 23rd, and the fodder shocked. The ears were divided into two grades according to maturity, and weighed. The stover was weighed after standing in the shock for a month.

In the table which follows, the bushel yields per acre are computed on the assumption that 74# ear corn = one bushel. The table of mature corn includes everything that was not entirely too soft to harden up for feed.

TABLE II.

Effect of Different Fertilizer Mixtures and Manure on Yields of Corn Grown on Muck.

Plot	Ear Corn: Yields per acre	% Maturity	Dry Stover: Yields per acre
1. Check	13.6 bu	72%	3100 #
2. K300	25.6 "	60%	1900 #
3. P100 K300	30.4 "	70%	2600 #
4. P200 K300	31.2 "	76%	2400 #
5. P300 K300	38. "	70%	2700 #
6. Check	21.1 "	60%	2200 #
7. M 12	26.8 "	60%	
8. M 6	15. "	50%	3300 #
9. P300 K200	14.9 "	54%	3200 #
10. P300 K100	22.4 "	70%	2800 #
11. P300	15.3 "	46%	2400 #
12. P300 K300	11.1 "	80%	3400 #
13. N P K	1.8 "	33%	2100 #
14. Check	4.6 "	90%	1900 #

The yields of corn for fertility series 1 to 7, are very coherent, showing a steady increase for phosphate and a decided improvement with potash. This phosphate benefit is a very interesting feature, because of the fact that this experiment is one of a few in the entire project which shows any definite yield increase from a phosphate carrier.

The remainder of the series does not show as significant results, although there is a decided superiority of all of the fertility plots (except the one including nitrate) over the check. The addition of the nitrate carrier produced a distinct depression in yield of ear corn and in the percentage of mature ears. This depression for the nitrate plot appears in many of the fertility experiments. The only explanation that can be offered is that these plots may be on a strip of less productive soil.

Little is to be learned from the table of maturity, which is erratic and without sequence.

The yields of stover follow no definite course, although it is generally noticeable that the stover yields are high where the grain yields are low.

(C) FERTILITY EXPERIMENT WITH POTATOES.

In the 1922 project, two varieties of potatoes were planted: Petoskeys and Burbanks. The Burbanks failed to yield any potatoes whatever, and so results are offered only for the Petoskey, or Rural Russet, variety.

The potatoes were planted in 36 inch checked rows May 30th. A fine stand was secured, but considerable damage was done by the frost of July 4th. The potatoes were cultivated and hoed twice, and were sprayed twice. Every potato was dug on each of the plots, and the percentage of marketable potatoes determined on a standard basis.

The table which follows shows a decided benefit from fertilization, except in the case of fertilizer series # 13, where complete fertilization, including nitrate of soda, gave a yield markedly lower than the average of the check plots. Benefit seems to be derived from the use of both phosphorus and potassium carriers, although potash is the more decided in its improvement of yield. Manure gave good results better with the smaller application.

The percentage of marketable potatoes is higher on the fertilized plots, especially on those plots including potash.

TABLE III.

Effect of Different Fertilizer Mixtures and Manure on Yields of Potatoes Grown on Muck.

Plot	Total Yields per Acre of Potatoes	% Marketable
1. Check	105 bu.	52%
2. K 300	150 "	76%
3. P100 K300	135 "	78%
4. P200 K300	150 "	80%
5. P 300 K 300	150 "	93%
6. Check	95 "	57%
7. M 12	155 "	74%
8. M 6	170 "	85%
9. P300 K200	170 "	70%
10. P300 K100	145 "	79%
11. P300	155 "	69%
12. P300 K300	180 "	77%
13. N P K	95 "	47%
14. Check	135 "	66%

(D) FERTILITY EXPERIMENT WITH SUGAR BEETS.

No beet drill was available for the planting of sugar beets so it was drilled with an ordinary grain drill in 28 inch rows, May 30th. On the whole, this method of seeding gave a fairly good stand, but there were too many blank spaces in the rows for a detailed experimental study. Therefore, when the beets were thinned, in early July, some of these pulled beets were transplanted into the blank spaces. Many of these replants survived.

Later, the beets were thinned more, and wer hoed, and weeded byhand once. There was not time to give them more than the most ordinary care. Nevertheless the beets flourished, and made a very satisfactory harvest in October.

Samples of beets from most of the plots were taken to M.A.C. for analysis of purity and sugar content.

TABLE IV.

Effect of Different Fertilizer Mixtures and Manure on Yields of Sugar Beets Grown on Muck.

	Yields per Acre	% Purity	% Sugar
1. Check	8,800 #	86.7 %	15.8%
2. K300	14,800 #	88.9 %	16.3%
3. K300 P100	15,100 #	85.7%	16.1%
4. K300 P200	15,600 #	88.6%	17.2%
5. K300 P300	16,200 #		
6. Check	12,100 #	88.6%	16.4%
7. M 12	16,200 #		
8. M 6	13,800#	90.8%	15.7%
9. P300 K200	16,600 #	85.7%	15.1%
10.P300 K100	16,800 #	88.0%	16. %
11. P300	16,400 #		
12. P300 K300	18,800#	86.7%	14.9%
13. N P K	12,600 #	84. %	15.3%
14. Check	8,300 #		

As in the case of the potato experiment, the response of sugar beets to fertilization was good. Potash gave a decided benefit, which was accentuated by the addition of phosphate in the fertilizer (series 2,3,4,). Manure gave good results, this time in accordance with the rate of application. The value of potash is strikingly evidenced in series # 12, where potash gives an increase of over two tons above the yield for phosphate alone in series # 11. The characteristic inferiority of the nitrate plot is present.

No conclusions can be drawn from the table of purity, except that the nitrate plot is inferior and the manure plot best.

The percentage of sugar is fairly definitely increased by fertilization, although some of the data contradicts this statement. The sugar content of the nitrate plot is not far below the average.

(E) FERTILITY EXPERIMENT WITH SPRING RYE.

Yields of spring rye were very poor indeed, and are of value merely to show the relative responses of the fertility series.

The seed was drilled April 29th., at the rate of 3 bushels per acre. On August 6th., the plots were harvested by hand, sacked, and taken to the College for threshing and weighing.

Low as the grain yields are, they do show an interesting reaction to the different fertilizing treatments. The response to potash is definite and invariable. Phosphate apparently gave no benefit whatever. Nitrate did not seem to produce a depression as it usually does.

The yields of straw show no particular favorites among the fertilizers, although they usually do indicate a better growth where fertilizer was applied.

TABLE V.

Effect of Different Fertilizer Mixtures and Manure on Yields of Spring Rye Grown on Muck.

	Grain: Yields per Acre	Straw: Yields per Acre
1. Check	2.3 bu.	575 #
2. K300	5.8 "	750 #
3. K300 P100	5.7 "	775 #
4. K300 P200	5.3 "	700 #
5. K300 P300	4.9 "	825 #
6. Check	3.7 "	875 #
7. M 12	2.7 "	775 #
8. M 6	3.6 "	850 #
9. P300 K200	3.8 "	975 #
10. P300 K100	3.1 "	825 #
11. P300	3.1 "	775 #
12. P300 K300	5.4 "	1025 #
13. N P K	5.1 "	1025 #
14. Check	3.3 "	775 #

(F) FERTILITY EXPERIMENTS WITH OATS.

Complete data for two years fertility study of oats were collected. The chief fault in this project is found in the variety of oats selected. Worthy oats were used, and these proved an unadapted variety in the variety tests conducted later.

An excellent stand was secured both years by drilling the Worthys at the rate of 3 bushels per acre. The plants on the fertilized series showed a more vigorous growth and development in both trials.

Characteristically, for Worthy oats on this muck, an enormous growth of straw, with poorly filled heads, resulted. Even the straw lodged, in many cases, too early to give a high yield.

For 1922, a table of the amount of lodging on each plot, is presented. In 1923, lodging was serious only on series # 7,8,and 13.

TABLE VI.

Effect of Different Fertilizer Mixtures and Manure on Yields of Oats Grown on Muck.

Plot	1922 Yields per Acre			1923 Yields per Acre	
	Grain	Straw	% Lodged	Grain	Straw
1. Check *	3.3 bu.	2000#	%	8.4 bu.	1680#
2. K300	16.7 "	3200#	0 "	23.1 "	1920#
3. K300 P100	14.9 "	3200#	0 "	24. "	1880#
4. K300 P200	18. "	2960#	80 "	22.6 "	1960#
5. K300 P300	18.8 "	3120#	90 "	23.4 "	1840#
6. Check	11.5 "	2400#	10 "	12.5 "	1600#
7. M 12	23. "	2800#	40 "	16. "	1760#
8. M 6	25.4 "	2320#	50 "	17.7 "	1760#
9. P300 K300	26.4 "	2960#	80 "	19.2 "	2000#
10. P300 K100	18. "	2960#	50 "	18. 1 "	2240#
11. P300	16.7 "	2480#	10 "	17.4 "	2160#
12. P300 K300	22. "	3600#	100 "	29.8 "	3200#
13. N P K	9.9 "	3360#	75 "	8.5 "	2600#
14. Check	16.7 "	2560#	50 "	9.6 "	1760#

* Damaged by rabbits

The tables indicate that best results are obtained from the use of potash. There is, however, a benefit from phosphate over the yields given by the check plots. Manure, apparently, was beneficial, especially in the first trial. Application of a commercial nitrogenous fertilizer reduced the yield of grain.

Lodging was greatest on those plots which gave the best yields. No stiffening of straw sufficient to hold up the oats seemed to result from fertilization, but it is fair to presume that the variety of the oats was largely responsible for the excessive lodging.

(G) MILLET-SOYBEANS: FERTILITY EXPERIMENT.

The millet-soybean experiment was included because of its interest as a test applied to a possible emergency hay crop for muck. The experiment was an utter failure both years, however, due to frosts which ruined the crop.

Manchu soybeans were drilled solid from a grain drill, with Hungarian millet broadcasted ahead from the grass seed attachment. The stand of millet was excellent both seasons, and the soybeans made a fair stand.

Some millet survived the frosts in 1922 on series 1,2,3,4, and 5, but there was not enough left to justify harvesting.

(H) CLOVER-TIMOTHY HAY: FERTILITY EXPERIMENT.

The seeding of clover and timothy was made April 29th., 1922, using a mixture of 4# medium red, and 4# timothy per acre. The seed was broadcasted ahead of the drill.

An ideal stand was secured. Of course, no hay was cut in 1922, but the plot was clipped of weeds twice during the season, with a mowing machine with cutter bar tilted high.

In 1923, the fertilizer treatments of 1922 were repeated as usual with the fertilizer mixture merely broadcasted on the various plots in the early spring. The hay was harvested July 11th., by the method used in harvesting all of the experimental hay crops, as follows: The alleys in between the fertilizer series' were cut out with a sickle. The entire hay strip was then mowed longitudinally with the mowing machine. Each entire plot was next raked by hand, and finally allowed to cure for several days in an individual cock. The cock's were weighed in a rack, on a set of platform scales.

TABLE VII.

Effect of Different Fertilizer Mixtures and Manure on Yields of Clover-Timothy Hay Grown on Muck.

Plot	Yields per Acre of Cured Hay.
1. Check	2350#
2. K300	3300#
3. K300 P100	3000#
4. K300 P200	2700#
5. K300 P300	2950#
6. Check	2600#
7. M 12	2750#
8. M 6	
9. P300 K200	2950#
10. P300 K100	2800#
11. P300	2000#
12. P300 K300	2550#
13. N P K	2600#
14. Check	2050#

The results of the clover-timothy experiments are decisively in favor of potash as the fertilizing agent. An average increase of over 600 pounds per acre was secured by the use of the fertilizer mixtures including potash. No benefit was derived from the use of phosphate or nitrate.

1. Alfalfa and Clover-timothy plots from 1922 Fertility experiments. Corn, and other plots appear in the right backgroumd

2. View of corn and sunflower cultural plots immediately after the second killing frost in the summer of 1922. The corn is destroyed, but the sunflowers merely wilted.

3.Oats on the 1923 Fertility project. Check plot on the left, Potash fertilization on the right (Plots # 1 and #2).

(I) ALFALFA: FERTILITY EXPERIMENT.

The alfalfa, sowed in 1922 for this fertility experiment, was the first ever tried on muck on the ranch. A fine seeding was secured by broadcasting 15 pounds per acre of Grimm seed, inoculated by the bottle culture method. Growth was rather slow at first, but the vigor of the plants increased materially during the summer months. Weeds were clipped twice during the season, but they managed to encroach considerably on three of the centrally located fertility series. At the west end of the alfalfa strip, some June grass which had not been sufficiently subdued before seeding, crowded the alfalfa rather seriously. These series were hence omitted from the experimental harvesting in 1923.

Fertilizer applications were repeated in 1923 as usual. Two cuttings of alfalfa were made, one on, July 11th., and the other at the last of August. The alfalfa seemed to be improving continually, the second cutting was much better than the first. The plots were harvested by the usual method.*

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TABLE VIII.

Effect of Different Fertilizer Mixtures and Manure on Yields of Alfalfa Hay Grown on Muck.

Plot	Yields per Acre of Cured Hay	
	First Cutting	Second Cutting
1. *		
2. *		
3. K300 P100	800#	1400#
4. K300 P200	750#	1450#
5. K300 P300	900#	1450#
6. Check	700#	1350#
7. M 12	750#	1300#
8. **		
9. **		
10. **		
11. P300	800#	1200#
12. P300 K300	900#	1350#
13. N P K	850#	1400#
14. Check	550#	1400#

* June Grass

** Weeds

The benefits from fertilization are much more apparent in the yields from the first cutting than from those in the second. In fact, the uniformity in the second cuttings is so pronounced that there may be said to be no appreciable response to fertilization. This may have been due to the development of the deep root systems of the alfalfa to the extent that they were feeding well below the surface.

The chief benefit in the first cuttings was derived from the presence of potash, although there is an undoubted yield increase also where phosphate was used.

It may be mentioned here that present observations (spring 1925) indicate that the alfalfa planted in this experiment is entering upon its best year. The stand has gained rather than lost ground, and is far more thrifty than the newer seedings nearby. No differences in development, are now apparent which might have resulted from the original different fertilizer treatments.

(J) ANNUAL SWEET CLOVER: FERTILITY EXPERIMENT.

In order to get immediate information about sweet clover, the annual white variety ("Hubam") was planted in 1923. The seed was broadcasted ahead of the drill, at the rate of 15# per acre, on May 2nd.

The Hubam made an unpromising start, but by the middle of June it was well under way, with a perfect stand, well advanced in development over the other seedings.

By August 28th, the Hubam had started blossoming, and so it was harvested by the entire plot method. It was necessary to open the winrows to further curing. Some difficulty in making the hay was added by a moderately heavy rain, but the Hubam ultimately put up in fair shape.

The uniformity of yields is amazing. Apparently, no reliable increase whatever was returned from the use of any of the fertilizer combinations.

TABLE IX.

Effect of Different Fertilizer Mixtures and Manure on Yields of Annual Sweet Clover Hay Grown on Muck.

Plot	Yields per Acre of Cured Hay
1. Check	4000#
2. K300	4000#
3. K300 P100	3900#
4. K300 P200	4200#
5. K300 P300	3800#
6. Check	4200#
7. M 12	4000#
8. M 6	4300#
9. P300 K200	×
10. P300 K100	4400#
11. P300	4000#
12. P300 K300	4300#
13. N P K	4400#
14. Check	3800#

× Damaged by rain.

(K) BIENNIAL SWEET CLOVER: FERTILITY EXPERIMENT.

No report of this experiment can be presented, due to an error in seeding. The plot was put on in the usual way, but through some mistake at the seed department, alfalfa seed had been put up instead of sweet clover. The result was a seeding of alfalfa on the sweet clover plot.

(L) TIMOTHY MEADOW: FERTILITY EXPERIMENT.

The timothy meadow used for fertilizer experiment was the same as that described in detail for the cultural experiment.* Fertilizer applications were made crosswise of the rolled strips.

In 1922, this experiment was put on really as an afterthought, and so the arrangement is rather sketchy. The project that year consisted merely of three series- two checks, and one fertilized strip. Acid phosphate and muriate of potash, both at the rate of 150# per acre, were used as a mixture on this strip.

In 1923, the meadow plots were fertilized according to the arrangement shown on the chart on Plate III. The 1922 fertilized strip was left unaltered, as a study of the residual effect of fertilization. The three series of 1922 were repeated, with the addition of a series of potash only and phosphate only.

The fertilizers were applied as a top-dressing, each at the rate of 150# per acre. The hay was made according to the regular method.**

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TABLE X.

Effect of Different Fertilizer Mixtures and Manure on Yields of Timothy Hay Grown on Muck.

Plot	Yields per Acre of Cured Hay	
	1922	1923
1. K150		4100#
2. Check	3930#	2700#
3. P150		2200#
4. Residual P150 K150		3800#
5. Check	3590#	2500#
6. P150 K150	5630#	4400#

The table shows very satisfactory returns from the use of fertilizer on the old timothy meadow.

In 1922, fertilization increased the yield by nearly 50%, almost a ton more of hay. Moreover, this fertilization lasted over into the next year to produce an increase in yield of about 50%, 1200 pounds of hay.

The 1923 results give evidence that potash is the fertilizing element required. Plots where potash had been applied invariably showed a benefit, whereas the yield of the phosphate plot was even lower than that of the checks.

Views Showing Yields of Timothy Hay from Fertilized and Unfertilized Plots which had Received Different Rolling treatments.

Rolled once

Not Rolled

Rolled Twice

PART IV.

PRACTICAL APPLICATION

PRACTICAL APPLICATION.

The experimental results reported in these pages has not been obtained without much labor and expense, both for the Soils Department of the State College, and for the A.F. Sippy Ranch. Has it been of real worth? or must these tables be discarded, like too much of our experimental data, which has been collected merely as background for publications without value?

It must be freely conceded that the material presented above has a very narrow range of usefulness. But the very nature of the study- the extreme variability of different muck soils- has required that the scope of this work be limited to one specific set of conditions. The practical application of the results of these trials, then, can be of benefit only in the management of muck areas which are similar, in soil conditions, climatic influences, and cropping systems, to the muck tract upon which the work reported here was conducted.

The value to the A. F. Sippy Ranch, of this series of experiments, can hardly be measured. In fact, they should form there, the basis for practical field trials to be continued year after year. From this aspect, the one great return from the experimental studies has been the narrowing down of the problems- the elimination of speculation about the value of this or that cultural method, fertilizer treatment, or crop variety. In this way, it has become possible to concentrate attention upon enterprises which are apt to prove worth while, and to strive to find ways of improving still further upon these practices.

But the applications of experimental conclusions, on the Beaver Flats, can be listed in a much more specific manner. From nearly every cultural method tested, every crop variety compared, and from the responses of each crop treated with fertilizers, there have been obtained experimental results which are continually regulating the management of this muck soil.

From the cultural experiments, the following field applications have been made at the ranch.

Plowing is considered a necessary evil, to be replaced by disking wherever it is possible to work up a seed bed by this means. Fall plowing is the invariable rule.

Rolling with the heavy concrete roller is a standard operation. If possible, the seed bed is rolled once before and once after planting (in accordance with most of the experimental findings). If the season is crowding and only one rolling can be given, it is given directly after planting. Winter rye is rolled in the early spring. Despite the failure of the experimental rolling of meadows to show an important increase in yield, such rolling is in good favor at the Ranch especially on new seedings. It is the belief that, in a dry season, there would be a profitable increase in yield from rolling meadows in the early spring. Moreover, there is a certain benefit resulting from the smoothing action of the heavy roller- the pressing down of sticks etc., and the crushing in of expansion cracks in the soil.

Cultivating is regarded as an operation of value merely in the control of weeds and grass. Crops arenever cultivated with the idea that their yields will be increased by the

The results from the variety tests of crops have been of the greatest value. The cost of growing adapted varieties is no greater than the expense of raising inferior yielders, and the right kinds of seeds yield far better. At present, Wisconsin Pedigree barley, Iowar oats, or Swedish Select (original stock for Iowars) and Wisconsin # 25 corn, are adapted varieties in use on this muck, as a result of experimental discoveries. Seed for these varieties is grown on the upland for planting on muck.

The application of the results of the fertilizer trials is a problem more for the future than for the present. Although the experimental investigations detected a beginning potash hunger for most crops growing on relatively old soil, there is little of the muck on the Ranch which has been cropped long enough to have, as yet, a great need of fertilization, for general crops. An imminent necessity, however, is the application of a potash carrier upon some of the older timothy meadows, and it is the preliminary experimental work which will make the intelligent selection and use of this fertilizer possible.

A number of benefits which were more or less incidental, have resulted from the period of experimental study. Alfalfa sunflowers, and barley were used for the first time as a muck crop on the ranch in the experimental projects. These three crops now bid fair to become very important additions to the cropping system. Beter rates of seeding for oats and rye have been worked out during the experimental trials.

In short, the Ranch is undoubtedly deriving great benefit

from a practical application of the findings of these experimental studies. At present, further variety tests of barley, oats and corn are in progress. A keen outlook is always kept for anyunusual responses to different seeding methods or cultural practices on muck for the experimental idea has established itself upon the Beaver, and is there to stay.

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