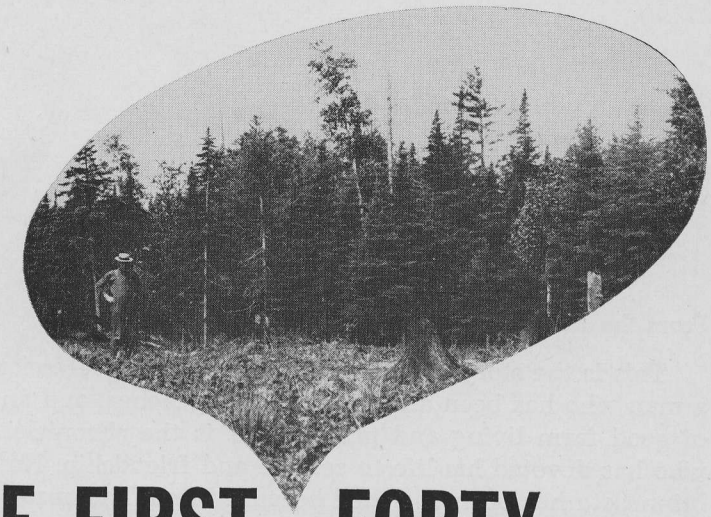
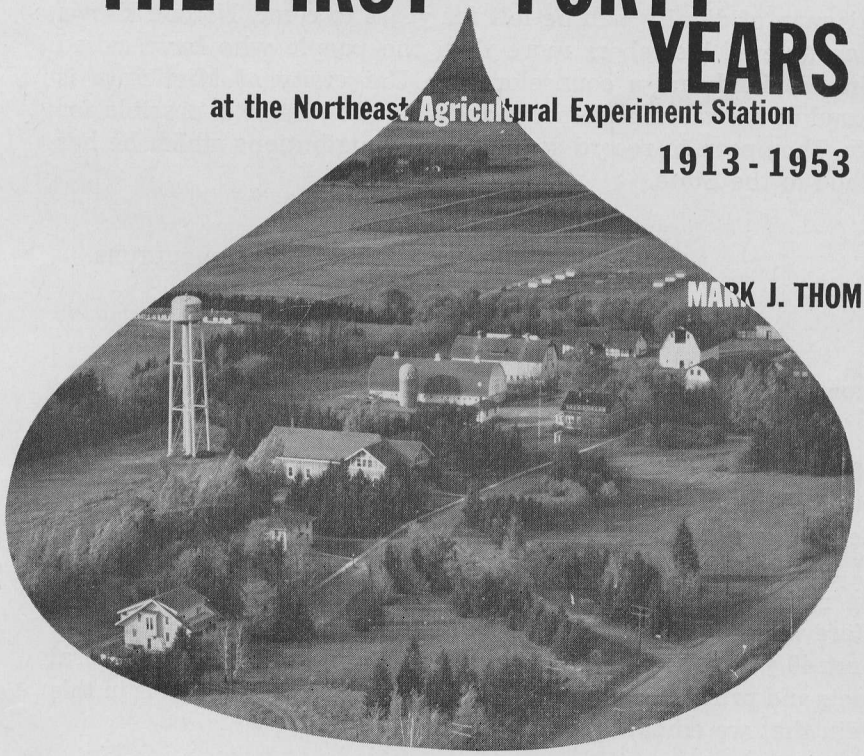
June 1954



THE FIRST FORTY YEARS

at the Northeast Agricultural Experiment Station

1913-1953



MARK J. THOMPSON

Northeast Agricultural Experiment Station

DULUTH, MINNESOTA

Institute of Agriculture

UNIVERSITY OF MINNESOTA

FOREWORD

From the Dean—

This is the story of two score years of the professional life of a man who has been an investigator, a teacher, and an advocate of good farm living and practices. It is the chronicle of a man who has devoted his life to service and friendship. Northeastern Minnesota has been enriched because Mark Thompson has lived and worked there. The wisdom, the enthusiasm, and the charm of this man of dignity will be felt for years to come. No one knows the value of his labors more than the people who have called him a friend and a counselor. The University of Minnesota is proud of his accomplishments and is glad to make it possible for Mr. Thompson to record some of the contributions which he has made to the State.

H. Macy
Dean, Institute of Agriculture

From the Author—

In 1938 we published a bulletin dealing with the University of Minnesota's Northeast Agricultural Experiment Station. Our purpose was "To make a permanent record of facts and pictures dealing with the early history of the institution; to tell the story of its transition from forest to farm; to sketch its contribution to its rural population in the first quarter century of operation." Here we deal entirely with investigations and findings during the first 40 years. We will emphasize the years 1913-53 and general facts and principles rather than statistical comparisons. It is in this vein that we embark on this summary.

Mark J. Thompson

CONTENTS

The great fire accelerated land clearing; a postfire view taken April 30, 1919.

Farmers and businessmen break ground for the administration building, October 1938.

THE FIRST FORTY YEARS

at the

Northeast Agricultural Experiment Station, 1913-1953

Mark J. Thompson

WHAT are the functions of a branch agricultural experiment station? In 1938, they were stated in this way (44)[1]:

"The investigational work at Duluth has been built upon the following interpretation of the function of a branch station:

"1. To test, regionally, the new creations, such as grain and fruit varieties, of the Minnesota Agricultural Experiment Station at St. Paul.

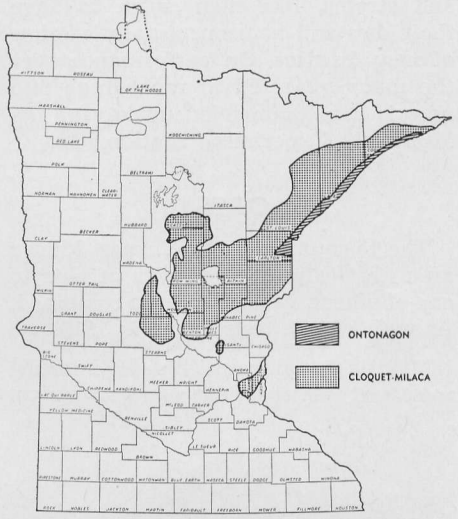
"2. To serve as headquarters for investigations in the culture of certain crops that thrive better at the branch than at the central station at St. Paul. Examples are potatoes, rutabagas, and alsike clover.

"3. To study purely regional crops and problems such as land clearing, stoning, soil fertility, and the mechanics of drainage in the prevailing soil type; crop practices as modified by local conditions; improvement of local plant forms such as blueberries, wild pea, wild vetch, and meadow foxtail grass."

Now we can add item 4.

4. To maintain a herd of ruminant animals to consume the forage crops grown and to provide revenue and fertilizer. This herd, too, is the basis for area livestock studies.

As far as soil types are concerned the Northeast Station is located inside the Cloquet-Milaca type area and also serves the adjacent Ontonagon red clay district, a strip along Lake Superior. The total for both types is over 6 million acres. The soil map as it affects this area is reproduced here.



Combined acreage for the Cloquet-Milaca and Ontonagon soil types is more than 6 million acres.

This report is divided into sections on small grains, hay crops, tilled crops, vegetables, and fruits. Additional sections deal with soil fertility, livestock, and farm engineering.

[1] Numbers in parentheses refer to Publications, page 31.

Small Grains

WHEAT

One-fourth of the harvested acreage in Minnesota's 15 northeastern counties is in small grains or flax. Although wheat is of minor importance in the area, the acreage exceeds that of barley.

The figures in table 1 are not the results of standard varietal tests of small grains over a comparable period as usually evaluated. Rather they provide a historical performance record of each variety grown through its entire (and varying) test period. Many varieties are now obsolete. Grain varieties and strains, like men, seem to have their day and pass on, usually victims of new diseases. On performance over the many years Rival ranks high and now is a recommended variety of the Minnesota Experiment Station.

Table 1. Yield of Major Wheat Varieties, Northeast Agricultural Experiment Station, 1919-52*

Variety	Number of crops	Period	Range in yield	Average yield
Pilot	7	1942-50	5.2-46.0	24.5
Rival	13	1940-52	11.7-41.5	23.8
Mida	12	1941-52	9.9-42.3	21.6
Henry	9	1944-52	14.5-36.3	21.2
Regent	6	1940-45	10.0-33.8	20.8
Java	5	1923-27	11.5-27.7	20.0
Hope	11	1931-41	9.9-39.3	19.9
Progress	17	1925-41	8.4-32.4	18.8
Ceres	12	1925-37	7.1-38.8	18.8
Marquillo	10	1924-33	11.8-26.9	18.8
Mindo	15	1919-37	4.3-41.3	18.4
Marquis	18	1919-42	5.0-37.3	18.0
Thatcher	17	1931-47	4.5-37.5	17.9
Koda	6	1921-27	10.4-18.5	14.9

* Varieties grown four years or less excluded.

OATS

The 15 counties in the Cloquet-Milaca area grow almost five acres of oats to one of wheat, barley, and rye combined. As with wheat, tests began in 1919.

Minn. No. 281, sown April 30, 1913, was the first oats grown at this Station. During World War I, Swedish Select was most popular through the entire north, but its performance record for the few years grown was submarginal. Victory enjoyed a long tenure following it. Anthony was well liked and deservedly so. These, too, have gone. Vic-

First crop of oats on virgin land, 1913.

Table 2. Yield of Major Oat Varieties, Northeast Agricultural Experiment Station, 1919-52*

Variety	Number of crops	Period	Range in yield	Average yield
Ajax	8	1945-52	60.2- 95.0	77.2
Tama	6	1941-46	40.4-120.7	73.9
Clinton	8	1945-52	50.1- 87.2	70.3
Andrew	9	1944-52	54.8- 84.4	68.4
Shelby	5	1948-52	54.7- 80.5	68.4
Zephyr	8	1944-51	40.7- 91.8	67.9
Vicland	12	1941-52	36.7-116.6	67.6
Mindo	8	1943-50	45.1- 86.1	66.8
Bonda	10	1943-52	40.3- 83.5	63.9
Rusota	17	1928-44	20.6-128.7	59.4
Rainbow	7	1928-34	30.5- 80.6	58.8
Iogold	14	1929-42	18.6-116.3	58.6
Anthony	21	1924-44	17.4-126.6	58.4
Minota	12	1919-30	47.0- 71.1	56.6
Gopher	30	1923-52	14.7-116.3	56.5
Silver Mine	4	1919-23	45.7- 74.0	56.1
Minn. 281	7	1919-25	41.3- 78.7	56.0
Minrus	18	1926-44	23.9-129.0	55.9

* Varieties grown three years or less excluded.

Table 3. Yield of Major Barley Varieties, Northeast Agricultural Experiment Station, 1919-52*

Variety	Number of crops	Period	Range in yield	Average yield
			bushels	bushels
Moore	5	1947-52	35.5-63.4	56.6
Vantage	4	1948-52	43.1-60.9	51.9
Feebar	5	1947-52	36.7-63.6	51.0
Montcalm	5	1947-52	28.5-58.2	47.5
Plains	4	1948-52	37.4-44.0	41.7
Kindred	6	1945-52	27.1-52.1	41.2
Trebi	24	1922-52	20.5-77.5	40.7
Mars	8	1943-52	21.5-61.4	39.6
Barbless, Wisc. 38	21	1931-52	10.3-73.4	38.4
Tregal	9	1943-52	22.8-57.0	37.9
Minn. 457	10	1926-35	21.6-58.0	36.5
Minn. 462	9	1927-35	16.3-64.0	36.1
Peatland	24	1927-52	16.1-57.6	35.7
Svansota	17	1919-35	20.9-54.7	34.4
Velvet	21	1922-42	8.9-60.2	32.8
Manchuria 184	24	1919-42	11.4-55.7	32.1
Glabron	18	1922-39	12.9-55.9	32.0
Minsturdi	7	1919-25	21.2-42.6	31.3
Odessa	5	1933-37	17.4-54.5	31.0
Colsess	6	1927-32	19.5-45.8	30.4
Oderbrucker	5	1934-38	7.4-38.8	20.0

* Varieties grown three years or less excluded.

tory was crossed with White Russian to produce Anthony. Anthony, in turn, was crossed with Bond to give Bonda, a popular recommended variety today.

BARLEY

As with wheat, most varieties are no longer used. While the newer varieties of limited test exceed them, Peatland, now in its 25th year, and Barbless, Wisconsin 38, still rank high and are on the recommended list. Manchuria 184 was standard for many years. Trebi, with 23 years of test achieved the all-time high in barley yields. Svansota, the two-row type, was very satisfactory.

OTHER SMALL GRAINS AND FIELD CROPS

Both winter and spring rye have been grown through the years. The rye acreage in this region is not quite half that of barley.

Since both flax and field peas are minor cash crops in the territory adjacent to the Station, variety tests were suspended in 1942. Wartime labor was very scarce.

Field pea acreage could be much larger. Peas and oats make an excellent hay crop. Thus far peas cost less than soybeans and adapt themselves better.

Flax is a risk crop unless sown early here. Moreover, there is little excess plowable acreage over and above feed crop needs on most of the prevailing small farms.

Soybeans that ripen here include Bato, Kabott, Manitoba, Brown, Pagoda,

Table 4. Yields of Miscellaneous Field Crops, Northeast Agricultural Experiment Station, 1919-52

Crop	Number of crops	Average yield
Spring rye	13	18.9
Winter rye	17	20.2
Field peas	11	22.0
Flax	11	14.0

and Flambeau. All had 90 per cent or better germination for the 1952 crop.

CROPPING PRACTICES

Earliest sowing date for wheat came in 1925; oats, 1930; barley, 1931 and 1952. Latest planting dates were in 1944 and 1950. Earliest harvest dates came in 1921 for all grains, latest in 1950.

Experience and observations indicate these sowing practices were successful.

Sow fall rye by September 1 or before, oats before mid-May if possible and barley preferably up to June 1, not later.

Sowing more than 2 bushels oats or barley per acre brought slight gains.

Oats responded to shallow seeding, barley to deep.

Fall plowing seems better for oats and barley, but spring tillage brought excellent crops of oats and rye.

In 10-year averages, oats and barley produced almost identical poundage per acre, with barley producing slightly more total digestible nutrients.

Table 5. Miscellaneous Cropping Practices for Small Grains, Northeast Agricultural Experiment Station, 1920-52

Sowing and harvest dates, 1920-52

Crop	Planting range	Median date	Harvest range	Median date	Days to maturity
Wheat	Apr. 3-May 22	Apr. 26	July 27-Sept. 10	Aug. 16	110
Oats	Apr. 11-May 23	Apr. 28	July 27-Sept. 26	Aug. 10	104
Barley	Apr. 29-May 8	Apr. 28	July 28-Sept. 3	Aug. 13	97

Yields at different dates of sowing: oats, barley, and rye

Crop	Years tested	Date of sowing					
		May 1	May 16	June 1	Sept. 1	Sept. 20	Oct. 10
		yield in bushels					
Oats	7	58.4	42.5	40.1			
Barley	8-9	25.9	26.4	22.1			
Rye	4				25.1	20.5	8.5

Yields at different rates of sowing: oats and barley

Crop	Years tested	Rate of sowing in bushels		
		2	2½	3
		yield in bushels		
Oats	7	48.80	49.5	53.65
Barley	7	24.75	28.0	28.20

Yields at different depths of sowing: oats and barley

Crop	Years tested	Depth sown in inches		
		1	1½	2
		yield in bushels		
Oats	5	44.2	41.55	39.70
Barley	5	20.1	23.50	23.67

Yields with different seedbed preparation methods

Crop	Years tested	Fall plowing	Spring plowing	Spring tillage
		yield in bushels		
Oats	6-9	54.6	47.2	53.4
Barley	5-6	32.2	23.9	26.9
Rye	4-5	18.4	16.8	26.9

Deep tillage did not increase yields over average.

In crop succession tests, the best oats and barley crops followed root crops in 5-year tests, the next best followed potatoes. But rye did better following potatoes than root crops.

Fertilizers

Two and one-half tons of manure per acre per year has not only sustained but also slightly increased original grain yields (1918-21).

Commercial fertilizer nutrients either alone or in combination, up to 360 pounds per acre applied once in four-year rotation thus far have failed to sustain the original yields on virgin soil (1929-31).

As far as lime is concerned, in a five-year test, using 1 to 3 tons per acre, lime had little if any effect on yields of barley, oats, and rye.

Hay Crops

The 1950 census reports that 70 per cent of the harvested acreage in the 15-county area was in hay crop in 1949. So hay crop studies properly dominate field crop investigations at Duluth. The emphasis is on soil fertility. The problem is not to get a stand but to make it grow. Fertility levels are low.

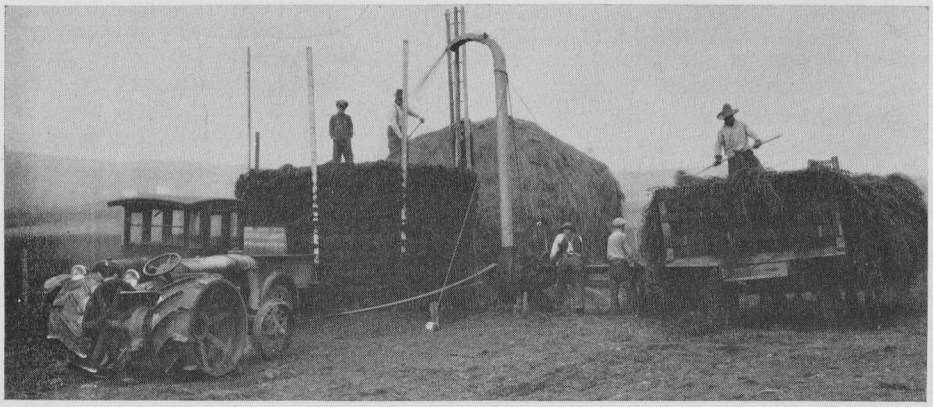
LEGUMES

Figures on dates of seeding alsike and sweetclover are incomplete. Additional tests to complete five years are needed. To date it would seem that seeding legumes after July is risky unless the fall is wet. Seeding by or before July 1 is preferable.

Increase in yields of alsike clover by increasing the rate of seeding is bought cheaply up to 10 pounds of seed per acre. At 12 pounds the increase in yield of 120 pounds per acre barely covers the seed figured at 55 cents per pound.

Of the alfalfa varieties tested, Ladak has an advantage in yield but its test period is much shorter.

Alfalfa seeded alone on the prevailing heavy soil is very subject to winter kill. At the station it is seeded only in combination with other legumes and grasses.



Grass silage is not new. This picture was taken in August 1927.

Table 6. Effects of Different Dates of Seeding, Rates of Seeding, and Varieties Used on Yields of Legumes, Northeast Agricultural Experiment Station, 1930-32

Dates of seeding alsike and sweetclover

Crop	Years tested	April	May	June	July	Aug.
		yield in tons				
Alsike	2-3	1.72	2.02	1.77	1.82	1.37
Sweetclover	2-3	3.64*	3.23	3.11	3.51	1.65*

Rates of seeding alsike clover

Rate per acre	Years tested	Average yields
pounds		tons
4	3	2.03
6	3	2.22
8	3	2.37
10	3	2.61
12	3	2.67

Alfalfa variety tests

Kind	Years tested	Average yield
		tons
Ladak	5	3.79
Grimm	8	3.25
Variegated	3	2.89
Cossack	8	2.74

* One year only.

White sweetclover in a five-year test averaged 2.68 tons, and yellow sweetclover in a two-year test yielded 1.92 tons. The station uses yellow sweetclover exclusively in its mixtures since it is less coarse.

MISCELLANEOUS GRASSES

Slender wheat in tests here gave considerable promise through the second year and then declined.

Crested wheat was poorer.

Orchard grass does not survive well here, even though the first winter.

Bromegrass seeded alone without nurse crop, and with alfalfa made wonderful starts, well in advance of timothy. But by the third year timothy looked better. Perhaps brome requires a warmer, drier soil than found in this area.

Meadow foxtail, a grass resembling timothy but easily three weeks earlier, thrives in most of this area. It usually heads out by Memorial Day, making it the earliest grass. It will make hay by mid-June and aftermath pasture by July 1. However, it grows in clumps and yields are below timothy. Both meadow foxtail and timothy make good feed if cut early enough.

Timothy is the most widely grown grass at the Northeast Station. However, it has at times lost public favor when it has been misused by cutting too late in the season or through deficient fertilization. When these conditions are corrected, no competitive grass has: (1) become more readily established on the prevailing heavy soil type, (2) maintained a stand longer, or (3) produced a greater total tonnage over a period of years for a given seeding.

Reed canarygrass thrives on low-lying meadows of northeast Minnesota. At Duluth it has been used in permanent meadow mixtures for low-lying land in combination with meadow foxtail. Alsike clover has been included in the mixture when drainage was good.

SMALL GRAIN HAY AND SILAGE

Northern farmers often cut oats for hay. They lack equipment to bind and thresh or combine. Making oat hay is logical. Through seven seasons oats, barley, and rye have been sown May 1 and 16, June 1, and July 1. The crop was cut in soft dough stage for hay. May 1 seedings averaged 1.66 tons for rye, 1.48 tons for oats, and 1.45 tons

Table 7. Yield of Small Grains for Silage, Northeast Agricultural Experiment Station, 1950-52

Crop	Silage yield	Dry matter	Dry matter yield	Protein
	pounds	per cent	pounds	per cent
Oats	6,060	40.67	2,464	10.17
Rye	6,057	42.50	2,574	8.21
Barley	7,156	39.00	2,791	8.35

for barley. Oats is preferred to the other two.

At the station five farm fields, each 10 acres or more, were operated under a five-year rotation plan—one year each of grain and tilled crops and three years of hay. Three of these fields are flat and cold, excellent for grain and hay but poor for corn. So a three-year test, substituting small grains, sudangrass, and millet was begun in 1950 and ended in 1952. Reports are for oats, barley, and rye only. Sudan and millet ranged from failure in 1952 to an immature crop, low in tonnage, in 1950. The season seems too short and cool for millet and sudangrass to thrive. Small grains were cut in late dough stage.

ROTATION MEADOWS

The station hay crop is mostly grown in four- or five-year rotations with 2 to 3 years in hay. By dropping tilled crops in the five-year rotation, the fourth year hay crop came into production for the first time in 1953. Fertilization is limited in all cases to 2½ tons manure per acre per year not supplemented by commercial fertilizer. Lime is applied freely.

The rotations date back to the drouthy 1930's when legume failures were common and severe. At that time the so-called "Duluth mixture," now widely used through the north, was adopted. It consists of 2 pounds each of yellow sweetclover (for first year protein), alfalfa, and alsike and 3 pounds each of timothy and redtop. Many substitute bromegrass for redtop, but the latter thrives on the Station's level, heavy soils. By 1940 the project was broadened to include not only acre yields but also botanical composition studies of the crop with its botanical content of grasses and legumes and protein content.

It is commonly believed that yields drop after first year crop on rotation meadows. Note in table 8 how well they were sustained through three years. Indeed, in late seasons the second year crop often exceeds the first. The legume content drops the second year when the alsike and alfalfa are unready to take over from sweetclover, the protein supplier. Observe the increase the third year. With fourth year crop harvests now regular, the vigor of alfalfa in mixed seedings and its tendency to both survive and expand may be carefully measured.

Table 8. Botanical Composition, Protein Content, and Average Yield of Duluth Mixture Rotation Meadows, Northeast Agricultural Experiment Station, 1940-52

Age	Years tested	Botanical composition		Protein content	Average yield
		Grasses	Legumes		
		per cent			tons
First year	12	43.8	56.2	11.0	2.01
Second year	12	21.5	78.5	9.5	1.94
Third year	12	23.0	77.0	9.2	1.91
Fourth year	1	44.0		10.3	

PERMANENT MEADOWS

With expansion of part-time farming and farmer employment in industry, the tendency is to get the farm into sod and leave it there. Rotation meadows become permanent. Perhaps one-half or more of all meadow acreage is in this classification.

Date of Cutting Hay

There is a decided yield gain in delaying the harvest date of hay. It is

Table 9. Effect of Date of Cutting on Yields and Protein Content of Permanent Meadows, Northeast Agricultural Experiment Station, 1937-52

Date cut	Years tested	Average yield	Protein content	
			Per cent	Pounds per acre
		pounds		
June 30	15	1,800	10.92	196.16
July 10	15	2,060	9.60	197.16
July 20	15	2,220	8.65	200.68

Table 10. Effects of Nitrogen on Yield and Protein Content of Permanent Meadows, Northeast Agricultural Experiment Station, 1937-52

Management	Years tested	Yield per acre	Protein content	
			Per cent	Pounds per acre
		pounds		
Check	15	1,500	9.8	147.1
100 pounds of ammonium sulfate per acre	15	2,124	9.5	201.8
150 pounds of ammonium sulfate per acre	15	2,510	9.4	236.2

most pronounced in late spring when the crop really does not get going well until June. But the early cut crop does carry a larger percentage of protein. However, protein yields per acre do seem to balance out. There are advantages in early mowing. The hay is more tender and palatable and the second crop gets an earlier start.

Temporary and Permanent Meadow Management

On an annual basis, the yearly distribution of nitrogen unquestionably steps up the crop on neglected permanent meadow. There is no residual gain. This then is temporary management to support yield. The 100-pound application of sulfate of ammonia brings a larger gain per pound than the 150-pound rate. The 218 pounds hay gained by using the extra 50 pounds and selling at $1.00 per hundredweight will return only a small gain over fertilizer cost.

Using nitrogen fertilizer definitely did not increase the protein content per ton of these crops but did increase the protein content per acre.

An older generation said of land plaster (gypsum), "It made the fathers richer and the sons poorer." The same principle applies to the continuous use of nitrogens alone on permanent meadows. Any gain in yield is made at the cost of the residual supply of phosphate and potash in the soil. Recognizing this fact led to the initiation of a project to stabilize production on permanent meadows.

Permanent Meadow Project

Ammonium sulfate has 20 pounds nitrogen per hundredweight and a ton of manure has 10 pounds.

To work out permanent meadow fertilizer management procedures, two duplicate series were laid out. One-third of each was check; one-third fertilized with ammonium sulfate at 100 pounds per acre; and one-third fertilized with manure at two tons per acre.

It took 10 years to complete the cycle. At the end of the 10-year period, 30 one-year-old meadow records were available—10 for check plots, 10 for ammonium sulfate plots, and 10 for manured plots. One plot had been in sod continuously for 10 years.

At the end of 10 years and the first cycle, management for the second cycle

Table 11. Effects of Application of Ammonium Sulfate and Manure on Yield under Permanent Meadow Management, Northeast Agricultural Experiment Station, 1941-52

Age in years	Number of crops	Yield by type of application		
		Check	100 pounds ammonium sulfate per acre	2 tons manure per acre
		tons	tons	tons
10	3	.91	1.10	1.47
9	4	.95	1.16	1.39
8	5	.87	1.00	1.18
7	6	.85	1.07	1.17
6	7	.90	1.20	1.21
5	8	.97	1.24	1.30
4	9	1.03	1.36	1.39
3	10	1.26	1.46	1.47
2	10	1.37	1.55	1.63
1*	.....	1.36	1.58	1.66

* First crop on second cycle after completing 10 in the first cycle.

was changed as follows: The ammonium sulfate and manure blocks were limed at 3 tons per acre and were given 500 pounds per acre of 0-20-20. During the first 10 years the fertility level declined with each crop harvested in spite of the nitrogen added in either ammonium sulfate or manure. The end sought in the second 10-year cycle is to sustain yield by adding lime, phosphorus, and potash to the previous treatment.

Observe these facts:

1. After the fourth year, all check yields fall below one ton per acre.

2. After the sixth year the ammonium sulfate plots also break.

3. With the eighth crop, the cumulative effects of the manure given is showing up in stabilized and slightly increasing yields.

4. In the second cycle, due to reinforcement, a balance between intake and outgo can be anticipated.

FERTILIZERS FOR HAY CROPS

Lime vs. slag. Records cover five years of hay crops (mostly grass, not over 25 per cent legumes) first year, four years of second year cuttings, and three years of third year cuttings (12 crops in all). Irrespective of age, the slag and lime outyielded the check.

Lime was somewhat more effective than slag. The over-all, all-crop averages were: check, 1.66 tons; slag, 1.82 tons; lime, 1.86 tons.

Commercial fertilizers, in any combination without manure support, have sustained and moderately increased hay yields over a quarter century.

Manure. Even five tons of manure in rotation (1¼ tons per acre per year) has sustained hay yields compared to 1919-21 provided it was spread on grain stubble before first crop. Ten tons, in all cases, both sustained and increased hay yields. It could be applied at any time in rotation, before or after hay.

Tilled Crops

POTATOES

Work at Duluth is limited to the farm management studies for two reasons. First, the prevailing soil type is heavy, tight clay, lying rather flat. It is comparable to the Washburn loam of Aroostook County, Maine, and, like it, it is unsuited for potato culture due to physical factors. Second, there are occasional farms and areas with lighter soils where potatoes thrive. These might be called "tuber oases."

Generally speaking, potato growing is a declining industry throughout the Cloquet-Milaca and Ontonagon soil provinces the Station serves. The crop has moved northwest. Urban centers import their needs. Farm production is mostly limited to subsistence needs and probably runs about a quarter acre, or less, per farm. Potato work at Duluth has been organized under four heads: variety testing, cultural practises, fertilizers, and weather and yields.

Variety Testing

Variety testing began in 1918 and has continued through 35 years. Over 30 varieties have been under test, but this report covers only those in the project for 10 years or more. This is not the standard varietal test report for a period where all varieties run simultaneously. As with grains it is rather a historical performance record of each variety grown through its entire (and varying) test period.

Some of these varieties are obsolete. Green Mountain has built up an envi-

Table 12. Yields of Potato Varieties at the Northeast Agricultural Experiment Station, 1918-52

Variety	Years tested	Range in yield	Average yield per acre
		bushels	
Burbank	14	99.25-385.00	209.30
Pontiac	10	97.20-236.00	196.00
Green Mountain	33	87.10-396.00	188.30
Sequoia	12	99.00-293.00	183.70
Russet Rural	16	67.80-247.45	181.50
King	18	60.50-385.90	179.85
Russet	21	40.30-296.70	171.20
Rural New Yorker	23	58.66-311.60	162.14
Irish Cobbler	32	49.30-298.30	149.40
Chippewa	20	27.50-311.60	141.10
Katahdin	20	47.66-316.30	137.60
Ohio	32	56.80-265.00	135.60
Sebago	13	73.00-264.00	135.20
Triumph	23	38.50-311.60	128.20

able record. Though in test for a third of a century it still stands third from the top. It has been known as McKinley and Carmen No. 1 in the past. But it is going out now because of its susceptibility to blight attack.

Some new promising varieties, in test less than four years, are omitted.

At this date, Cherokee (averaging 178.5 bushels) and Kennebec (161.5 bushels), both on six-year averages, are the most disease-free and promising varieties.

Essex, very blight resistant and in test four years, established the all-time high production record, 632.7 bushels per acre, here in 1949. Ontario is also promising.

The late potatoes outyield early kinds here and Irish Cobbler is still the heaviest early producer. Warba and Waseca, both early potatoes, trail.

Cultural Practices

1. **Rotation.** How often can you raise potatoes on the same land? Growing one year each in a three-, four-, and five-year rotation, the rest periods between potato crops are respectively two, three, and four years. Thirty-four years of test indicate that the length of rotation itself does not affect yield.

2. **Crop succession.** The largest potato crop was grown on sod following hay. Potato yields following other crops declined in this order: barley, sunflowers, oats, potatoes, rye, and roots. This five-year evidence supports the farmers' custom of planting potatoes following sod when possible. Rye and roots seem to have depleted fertility more than other crops.

3. **Deep tillage.** From the six years' evidence, deep (12-inch) tillage for potatoes does not affect yields on these tight, red soils. The extra plowing cost seems wasted money.

4. **Dates of planting.** In a four-year test, one acre planted in mid-May (with acreage yields of 267.86 bushels) was worth almost three acres planted July 1 (with yields averaging 91.7 bushels). Intermediate planting dates and yields were June 1, 229 bushels, and June 15, 169.4 bushels.

5. **Spacing of rows.** Space rows more closely and you dig more potatoes. Five-year records show 30-inch spacing between rows gave yields of 221 bushels; 36-inch spacing, 200 bushels; and 42-inch spacing, 165 bushels.

6. **Disease control.** Here there are three approaches:

a. **Spray vs. check** (both 4-4-50 in 16-year test). Spraying gave 17 more bushels of early stock and 25 more of late stock. Gains were moderate. In fact, four early sprayed crops and two late ones out of the 16 were no better than check.

b. **Spray vs. dust** (both 4-4-50 in six-year test). Dust was more effective on early potatoes increasing yields 11.5 bushels but poorer by 2.4 bushels on late potatoes. You can dust before the dew leaves the foliage when you can not make hay; but you must spray when the foliage is dry at the same time you can make hay. Dusting thus

eases the critical labor load in midsummer.

c. **4-4-50 vs. 4-1-50 and other formulations.** The old standard homemade Bordeaux was more effective on both early and late stock than commercial Bordeaux, 4-1-50, Red River Mix, or Copper King.

7. **Dates of harvest.** Early potatoes averaged only 20 bushels gain and late ones, 40 bushels by delaying harvest through September in a five-year test. Some years these figures were doubled. In 1937, Cobbler made daily gains of 2.73 bushels per day of delay. Late potatoes with longer growing season and later foliage make the best daily gain when the early strains are ripe in autumn.

Fertilization

1. **Response to 5, 10, and 20 tons manure once in a four-year rotation.** Three lessons are apparent here: (a) The largest return per ton of manure used came with a 5-ton allotment (1¼ tons per acre per year). (b) The largest gross yield came with 20 tons allotment (5 tons per acre per year). But even this heavy application was not enough to sustain primary yields. Commercial supplement must be provided. Beginning with 1917, 36 crops have been grown.

2. **Effect of time of application in rotation.** When two hay crops intervened between spread of manure (on grain stubble) and the potato crop, the gain was 14 bushels per ton in plots with 5-ton applications. When the manure was spread the fall before with no crop between, the gain was 16 bushels per ton in the application of 5-ton lots. The dairy farmer would follow the first plan; the cash (tilled) crop farmer would prefer the second.

3. **Effect of time of application in season.** Manure was spread on half of the plots before plowing and on the other half after plowing. Then it was disked in. A five-year test indicated an advantage of about 10 bushels for first practice.

4. **Manure vs. sewage sludge.** When sewage sludge and manure were both spread at the rate of 5 tons per acre on hay, the potatoes the year after showed a margin of 11 to 15 bushels in favor of sludge. This was residual effect. The cost of sludge prohibits its use on field crops.

5. **Relative yields following pasture sod, hay sod, and green manure.** Grass crops can be used by grazing, plowing under, or harvesting the crop. In this project, which was started in 1917, three conclusions were reached: (a) Plowing under grazed sod plus droppings was most effective. (b) Turning under green manure rated next (but green manure values have not been proved here in a third of a century). (c) Turning under bare sod after removing hay was followed by smallest tilled crop.

6. **Effect of lime.** Potatoes were grown for five years on land that had been given 1, 2, and 3 tons of ground limestone per acre. Yields were in reverse of tonnage supplied—the less lime, the more potatoes. The margins of difference were negligible, 5 to 6 bushels per acre. There was some scab on the lime plot also.

7. **Effect of various combinations of fertilizers used exclusively (without manure) on land in a four-year rotation, started on virgin soil.** This project began with potatoes in 1928 so 25 crops have been harvested. It has taught three distinct lessons: (a) The increase in crop has been substantial wherever potash was used, and there seemed to be greater resistance to frosts in the fall. Potash plots remained green longest. (b) The influence of nitrogen was negligible. (c) Lowest yields came from phosphate plots, sometimes below check. These plots also ripened earliest.

8. **Economical use of fertilizers.** Rates used through five years include 220,

440, and 660 pounds per acre of a complete fertilizer heavy in potash. The 660-pound plot yield was almost identical with that taken from the 440-pound plots. The 440-pound application is the maximum to use, at least until there is more organic matter in the soil.

9. **Effect of raw rock and acid phosphate and manure.** In seven-year tests the following yields were obtained: check, 118.7 bushels; manure alone, 140.7 bushels; manure and acid phosphate, 151.55 bushels; manure and rock phosphate, 160.8 bushels; and acid phosphate alone, 117.7 bushels. This work terminated in 1923, 30 years ago. Superphosphates, acid form, are used almost exclusively now.

10. **Effect of no fertilizer, commercial or organic, in three-year rotation.** How long will potatoes perform, grown in rotation on native soil without further additions? Average yields follow: first five years, 127.91 bushels; second five, 87.43 bushels; third five, 49.8 bushels. The crop continued to fade away the sixteenth through twenty-second year. During the final year, 1938, yield was down to 13.4 bushels per acre.

Weather and Yields

Observations on crop reactions to rainfall and temperature of growing seasons were recorded through many years. Previous publications indicated:

1. Distribution of rainfall and temperature is more important than the total of the rainfall and the mean of the temperature.

2. Dry Augusts are bad for potatoes here. The three dry Augusts were followed by three lowest yields.

3. Wet Septembers may improve crops but do not make the largest ones.

4. A dry spring (4 inches of rain or less in April and May) is more important than seasonal total. In 1927 there were copious rains (18.25 inches, May-September) and light yields, 74.13 bushels. The 1934 rainfall was light, 11.18 inches (May through September), and good yields followed, 170.26 bushels. Temperature seems a secondary factor.

CORN

The census of 1950 reports 10½ acres of corn to one of potatoes in the northeast counties.

Silage and Fodder

In addition to those listed in table 13, two other excellent fodders were Evergreen Sweet and Elephant. Many of the flints are now off the market. In the regular four-year rotation, 2½ tons manure per acre per year and no supplement, the 10-year average yield of silage was 7.48 per acre. The variety average above, 7.41 tons, is almost identical. Supplementary fertilization would "up" it. A good yield is 1.6 tons hay per acre. It would require 3 acres of hay to offset 2 acres of fodder corn yielding 2.4 tons per acre. Since it can be planted up to July 1, fodder corn has emergency values in a dry summer.

Sunflowers for silage were grown here for many years. Extensive cultural and fertilizer tests were made. The Arrowhead sunflower, originated by

Table 13. Yields of Different Varieties of Corn for Silage and Fodder, Northeast Agricultural Experiment Station, 1939-44

Kind	Years tested	Yields per acre	
		Silage	Fodder
		tons	
Red cob fodder	4	10.20	3.54
4X fodder	5	9.63	3.36
Kingscrest	5	9.57	3.70
Northwestern dent	5	7.84	2.65
Smutnose flint	5	7.48	1.99
Longfellow flint	4	7.47	2.73
North Dakota Pearl flint	5	7.35	1.43
Acme fodder	5	7.01	2.34
North Dakota White flint	5	4.14	1.31
Gehu	4	3.39	1.07
Average		7.41	2.41

selection at this Station, is now being grown for seed in Red River Valley tests with favorable results.

Ripe Corn

Heat units are too deficient in many seasons to ripen anything but sweet corn in the Duluth area. However, areas west and northwest have hot summers and ripen corn nearly every year. Many varieties ripened during the warm summers of 1938, 1939, 1946, and 1949. The reverse happened in 1950, 1951, and 1952.

It seems wise to restrict corn production to silage and fodder in the cool summers of the Superior Basin, excepting sweet corn for home use. The varieties which have ripened through several seasons, grown from station seed, are listed. These varieties adjusted themselves to the short supply of heat. These are mostly open-pollinated flints with a few hybrids. Wisconsin 1600, not yet released, was the surest, earliest hybrid, with Wisconsin 1602, 240, and 255 close behind. Nodak 203 was one of the earliest hybrids from the west. Nodak 201 and 301 were also good. Fort Kent Golden was the earliest flint, followed by 55-Day, Swedish, Chippewa, Russian Early, Siberian Early, and Pride of the Plains.

A full ton plus per acre of ripe corn was the minimum harvest. Shelled, this would exceed a 50-bushel crop of oats. Of the semidents, Minnesota 23 rated first followed by Square Deal (North Dakota). A selected strain of Early Cornell (New York) also grew ripe, 6-inch ears.

Sweet Corn

Refer to the vegetable section for statistics. The sweet corn harvest is heaviest in September with cool seasons. But the experience of 20 years has established it as a dependable crop, annually, though sometimes late. For the usual sweet corn season such early hybrids as Golden Midget and Orchard Baby fill domestic needs.

Root Crops

Though rutabagas is a minor Minnesota crop, 72 per cent of this vegetable is grown in one Minnesota county, Pine. Since it is a regional cash crop, it has an important place in Station investigations. Also reported are stock turnips and stock carrots.

VARIETY TESTS

The Station trials extend through 26 years. More than 40 varieties have been included. However, for some years local growers have concentrated on Laurentian because of its small foliage, sustained yield, and excellent type and quality.

The all-time high rutabaga yields were: for roots, Kangaroo, 21.77 tons, 1952; and for tops, Our Ideal, 7.62 tons, 1952.

The largest root crop ever harvested here was produced by Improved Green Globe turnip, yielding 37.32 tons per acre, in 1925. Turnips will usually exceed rutabagas in gross tonnage.

Table 14. Yields of Root Crops, Northeast Agricultural Experiment Station, 1923-52

Variety	Years tested	Average yield	
		Roots	Tops
		tons	
All rutabaga varieties	26	12.35	3.72
Laurentian	10*	12.30	3.14
Stock turnips	4-5	13.84	.....
Stock carrots	4	12.86	.....

* Used last 10 years.

Laurentian always grows a small top crop, usually quite flat. Root yields are normal but excel in quality.

CROPPING PRACTICES

1. **Does deep tillage help?** From evidence of six crop years, deep tillage (12 inches) is harmful, if anything, for roots. The check plots were higher in yield by .61 tons.

2. **Which is better for roots, fall or spring plowing?** Spring plowing which brought yields of 9.02 tons in four-year test, was slightly better than fall plowing, 8.69 tons.

3. **Does length of rotation or rest period between crops have any effect?** The short rotation seemed better. The three-year cycle, 2 rest years, gave three-year average of 11.92 tons. With its five-year cycle and four rest years, the three-year average fell to 8.79 tons.

4. **After what crop does the rutabaga thrive best?** In four- and 5-year tests, roots did best on sod land. They did next best following barley, then roots themselves, potatoes, sunflowers, and oats. Many years' work indicates that if rutabagas follow sod, the crop does best if the grass has been grazed. It does next best when the crop was plowed under and poorest where the crop had been removed as hay.

5. **What is the ideal spacing within the row?** Yields are almost identical with spacings of 6, 8, and 10 inches—over 11 tons in a six-year test. Yields fall off with 12 inches and 14 inches thinning. Rows were spaced at 30, 36, and 42 inches. There was a slight gain of .42 ton, using the 30-inch spacing between rows and .18 ton when 36-inch spacing was used instead of 42-inch spacing.

6. **Is there a best seeding date?** In a seven-year test, the best yield was 12.12 tons which followed seeding May 11-20. June 1-10 seeding suffered a drop of 2 tons, June 11-20 seeding another 2 tons, and July 1-10 seeding almost 2 tons more.

7. **Does date of harvest affect yield?** It does. From tests running up to 11 years, largest crops came from October 22-28 harvesting (19.56 tons). Smallest harvest came with harvesting the week of August 22-28 with yields of 6 tons. With each week delay, yields increased from ½ ton to almost 2 tons.

FERTILIZERS

1. **How helpful is manure in growing rutabagas?** No other crop grown at this Station has shown so regular an increase to increasing applications of either organic or mineral fertilizer. Over 21 years untreated rutabagas averaged 5.8 tons per acre; with 5 tons manure once in 5 years, 7.87 tons; with 10 tons manure, 9.58 tons; with 20 tons manure, 10.27 tons.

What about timing? It makes little difference when the manure is applied in the rotation or in the season. The gain was only .54 to .7 tons when the manure was spread on sod the fall before growing the crop compared with spreading 2 years before on grain stubble. Plowing under manure instead of topdressing and disking after plowing increased yields ⅔ ton per acre.

2. **What about commercial fertilizers?** They also help. Tests have been run six years. The average gains on all treatments, above check, is slightly less than 3 tons per acre. As with potatoes, nitrogen applied alone decreased yields. But phosphates, unlike with potatoes, definitely increased yields, slightly more so than potash. The range, in the six-year test, was 5.04 to 12.25 tons using complete fertilizer.

3. **Is there an optimum amount to use?** No maximum has been found under existing soil conditions. Yields increase with increased fertilization. Using 220, 440, and 660 pounds of a complete fertilizer per acre, yields ranged

regularly upward from the check at 11.37 tons to 15.16 tons where 660 pounds per acre was spread.

4. **Does rock phosphate help roots?** Yes. In a seven-year test, the rock phosphate plots exceeded all others, with yields of 17.88 tons per acre. The acid phosphate plots were low with 10.49 tons. Manure and acid phosphate brought yields of about 13 tons. The acid form, superphosphate, is used exclusively now. It acts quicker and, being concentrated, costs less in freight charges.

5. **What about sewage sludge?** Using 5 tons per acre, the yield was increased by 3.3 tons in a four-year test. This was a residual, second year effect. The cost, though, was prohibitive.

6. **Is lime a factor in root crop yield?** Using 1 to 3 tons per acre gave a modest gain of only 1.22 tons per acre. Liming, however, increased turnip yields 3 tons per acre.

Vegetable Crops

VARIETY TESTS

Twenty-nine years of vegetable work on yield, earliness, and quality are reported here. Disease resistance also might have been tested, but susceptible varieties soon disappear anyway from the tests. Those vegetables grown many years survived disease attacks best and were healthiest. Since hundreds have been tested, it is impossible to list all adaptable varieties here. Only those that have been given top ratings over the period are listed, so this varietal list is quite comprehensive. Ripening dates have been omitted for certain crops that are all season in character.

FERTILIZERS

Over a five-year period, the 4-8-6 formula, in varied amounts, was compared with 8-16-12, 4-16-4, ammonium sulfate, and 10½-22-0. Surprisingly, 400 pounds per acre produced about as much as 600 pounds of 4-8-6. Under existing soil conditions, the 400-pound application would seem to be the optimum to use.

When the 400 pounds was condensed into 200 pounds of 8-16-12 (same plant food content), yields increased slightly with less bulk to handle. A 200-pound application of 4-16-4 rated just below these followed by ammonium sulfate. In fourth place was the 200-pound application of 4-8-6 followed by the 200-pound application of 10½-22-0. This latter poor showing could indicate a potash deficiency.

Fertilizer vs. Manure for Vegetables

The 1926-27 biennial report stated: "Using 30 tons manure per acre as a base, these relative efficiency ratings are indicated: 15 tons manure, 82 per cent as productive as 30 tons; 15 tons manure plus ½ ton commercial fertilizer, 139 per cent; 1 ton commercial, 170 per cent. Fifteen tons manure has proved equal to 30 tons for beets, onions, and cabbage, but only half as good for rutabagas and turnips.

"For general gardening purposes, extremely heavy manure applications appear wasteful. For general farm practice, economy considered, the manure fertilizer combination may be preferred to all others. Considering the 15-ton allotment of manure as most efficient, and using the average of all garden crops under test, 1½ tons has produced the same return as 100 pounds of 2-4-8. Expressed in reverse, 65 pounds (of a given formula) commercial fertilizer about equals 1 ton manure in production."

Table 15. Vegetables Receiving Top Rating in Yielding Ability, Earliness, and Quality at Northeast Agricultural Experiment Station, 1928-53

Vegetable	Top yielding	Earliest	Top quality
Beans	Bountiful	Bountiful	Logan
	Stringless GP	Longfellow	
	Logan	Black Valentine	
Beets	Detroit Dark Red		Early Wonder
	Early Wonder		Early Blood
	Imperial Early Blood		
Early cabbage	Gold Acre	Gold Acre	Gold Acre
	Copenhagen Mt.	Copenhagen Mt.	
	E. J. Wakefield	E. J. Wakefield	
Late cabbage	Flat Dutch		
	Danish Ballhead		Red Haco
Carrots	Chantenay		Coreless
	Danvers		Half-long
	Nantes		Red Cored
	Coreless		Chantenay
Cucumber	Early Fortune	Early Pickling*	Mincu
	Davis Perfect	Early Fortune	Straight-8
	White Spine	White Spine	
Sweet corn	Pickaninny	Early June	Golden Midget
	Sunshine	Golden Gem	
	Early June	Pickaninny	Orchard Baby
	Golden Gem	Sunshine	
Onions	Sweet Spanish		Sweet Spanish
	Yellow Globe		Yellow Globe
	White Globe		
	Red Globe		
Parsnip	Hollow Crown		Guernsey
	Guernsey		
Peas	Hundredfold	World's Record	Early June
	Peter Pan	Alaska	Little Marvel
	Sutton Excelsior	Early June	Laxtonian
	American Wonder		
Pumpkin	Cheyenne Bush		Cheyenne Bush
	Sweet Sugar		
Squash	Buttercup	Crookneck	Buttercup
	Crookneck		
	Butternut		
Tomato	Bounty	Bison	Orange King
	Red River	Red River	Orange Chatham
	John Baer	Yellow Pear	Bounty
	Bison	Farthest North	Chatham

* Five other varieties picked same day but in lesser amount.

Fruits

SMALL FRUITS

No recent work has been done. The water table here is too high for raspberry culture. Earlier work on currants, gooseberries, and strawberries, has been reported elsewhere (16, 23, 32).

PEARS AND APRICOTS

Both pears and apricots have made good vegetative growth but little else. Patten, Bantam, and Tait Dropmore have been growing here for 10 years or more. A few pears set fruit, but

lightly. The trees come into bloom too early in the spring. Patten has given greater promise than Bantam. Tait Dropmore from Northwest Manitoba should surpass both when regular fruiting starts. It was in heavy bloom in May 1953. A few pears set in 1952. Scout apricot was also in bloom in May 1953.

PLUMS

The plum unit at Duluth is now 30 years old. There is little left. The immediate question is, "What varieties have survived? What did they do in 1952, the 30th year?" Field notes for 1952 indicated:

1. **Underwood**[2]—has passed its prime. Trees are in good size and fair condition, but fruiting is very light and scattered.
2. **Waneta**[2]—is the most dependable variety, though trees are frail. On September 10, "Fruit very fine and ripe, medium large and quality good."
3. **Mound**—One big plum partly ripe September 10.
4. **Monitor**[2]—Half gallon crop, very large and of good quality, September 12.
5. **Elliott**[2]—A large plum, good stand, ripe about September 20.
6. **Surprise**[2]—A fair crop but late and small, September 25.
7. **Cooper**—A quart yield may be all, ripe September 12.
8. **Mordena**—A gallon of purple colored plums, greenish yellow flesh.
9. **Kaga**[2]—All colored September 12, much splitting, undersize, half gallon yield, greenish yellow fruit.
10. **DeSoto**—Picked 3 gallons, September 20, small, hard, some still green.
11. **Red Wing**—Good size, flat taste, light crop.
12. **Winona**—September 20, one bushel, largest single tree crop ever picked.

In summary, Waneta rates well for quality, size, earliness, and tendency to bear some fruit, with limited rest period. When it fruits Winona produces heavily but sometimes it is too late to ripen.

APPLES

The work with apples has been very popular in Northeast Minnesota since it was widely felt apples could not grow back from the Shore. With the 1952 crop, the largest on record, the

Table 16. Yields of Apples of the Duluth Orchards, Northeast Agricultural Experiment Station, 1926-52

Year	North unit (4 acres)	South unit (2 acres)	Total
	bushels		
1926	102.5	.....	102.5
1927	21.0	.....	21.0
1928	78.0	.....	78.0
1929	112.0	.....	112.0
1930	.....	.....	.....
1931	160.0	3.5	163.3
1932	130.7	30.4	161.0
1933	709.0†	56.5	765.5
1934	103.0	17.8	120.8
1935	754.3	84.0	838.3
1936	78.5	22.8	101.3
1937	464.5	78.8	543.0
1938	292.0	171.6	463.6
1939	322.5	48.0	370.5
1940	640.0	270.0	910.0
1941	139.3	153.3	292.0
1942	15.0‡	93.0	108.0
1943	340.0	188.6	528.6
1944	592.0	412.7	1,004.7
1945	130.3	113.1	243.0
1946	610.0	271.0	881.0
1947	470.7	307.1	777.8
1948	703.4	409.2	1,112.6
1949	596.5	169.7	766.2
1950	313.0	435.6	748.6
1951	440.0	200.4	640.4
1952	470.0	835.0	1,305.0

* Crop stolen.

† Frosted October 12, 1933, heavy loss.

‡ Killing frost, May 15, took about all north orchard bloom except Anisim.

[2] These only commercially available at nurseries.

Part of one tree crop of Patten's Greening apples, south orchard, 1952.

work at this Station has proved the crop can and will grow inland if a few principles are carefully followed. The north unit was set in 1915 and the south unit in 1923. Management rules followed include:

1. A windbreak is provided on north and west sides. Some men do a good job with a natural windbreak of tall brush with snow trap inside.

2. Nitrogen fertilizer is supplied either each spring or biennially. The usual allowance is a maximum of 4 pounds ammonium sulfate per tree. Current recommendation is ½ pound ammonium nitrate per inch of trunk diameter.

3. Two sprays are applied, one when fruit buds show pink at the tip and the second when the petals fall (calyx spray). Additional sprays may be needed to control scab.

4. Pruning is done annually after fruit is picked and leaves fall.

5. Young trees are protected from mice and rabbit injury over winter and early spring by use of hardware cloth.

Table 17. Lifetime Production Records, Best Trees, 14 Apple Varieties, Northeast Agricultural Experiment Station, 1927-52

Variety	Best crop	Year	Life records	Bearing began
	bushels		bushels	
Patten Green	18.5	1952	81.8	1929
Hibernal	15.7	1952	63.0	1933
Anisim	12.6	1952	39.7	1931
Erickson	11.5	1952	53.9	1935
Duchess	9.5	1952	38.8	1931
Yellow Transparent	8.7	1952	42.2	1932
Virginia	8.7	1952	28.3	1932
Dolgo	7.3	1952	31.1	1929
Charlamoff	7.8	1952	17.9	1932
Haralson	7.4	1952	21.6	1933
Red Wing	6.6	1952	33.0	1932
Wedge	6.5	1952	23.0	1932
Beacon	6.2	1952	23.7	1933
Okabena	5.7	1952	36.7	1929

Both orchards are in sod. It is the simplest system of management and has worked well. With many projects competing for attention through the growing season, this is necessary.

In 1944, 1948, and 1952 the Station orchards passed the 1,000-bushel crop mark. The north unit reached its peak in 1935 and again approached it in 1948.

The south unit produced its maximum to date in 1952, establishing not only a new high for the 27 years of recorded production but also new tops for individual varieties. Although the frost of May 15, 1942, was heavy enough to cause ice breakage in the sprayer, Anisim survived in the north orchard, and a fair crop was grown in the south unit.

Nitrogen fertilization began in a small way in 1924 and has continued regularly since. The nitrogen perhaps may be credited for the first worthwhile crop harvested in 1926. It unquestionably has sustained production since.

The north orchard is in decline. The Wealthies are dying fast. The Whitney, Okabena, and Yellow Transparent are also passing. A further thinning operation may well extend the orchard's life. Hibernal is still vigorous.

Some trees listed as starting to bear in 1931 actually bore lightly in 1930. The entire crop was stolen that year so records are not available. While these top trees are the elite of the orchards, there are others with records almost as strong.

How frequently do these trees bear? Okabena has never missed a year; Hibernal only one; Erickson, Patten, and Virginia have passed three each; Red Wing has had four blank seasons; Haralson and Duchess, five; Anisim, six; and Wedge, seven. Some trees started to bear at the sixth year. Erickson was a slow starter, but it has been a vigorous grower and regular bearer for many years.

Soil Fertility

The reaction of the several crops, grains, grasses, tilled, vegetable and fruit, to various fertilizer treatments has been reported individually in this bulletin. But the major projects of fertilization of crops and soils in their composite relationship to all crops, remains to be explored.

1. **Lime tests** (26). The prevailing soil type is very acid. The use of lime, 1 to 3 tons per acre, through a five-year test indicated little if any effect on grains or tilled crops such as potatoes, sunflowers, and rutabagas. Except for red and alsike clover, there was a substantial increase in hay yields.

2. **Lime vs. slag for hay.** See hay crop fertilization, page 13.

3. **Clover utilization.** For 31 years the Station has tried both converting all the roughage grown into manure as well as turning green manure back into the ground. Two lots were grazed off. On two others the hay crop was plowed under, and the hay was harvested on still two other lots. Later, every third year, half of all plots were reinforced with 100 pounds per acre of phosphate and 200 pounds potash. About two-thirds of the potato crop and almost half of the oat crop were lost before reinforcement. The amount of phosphorus and potash furnished did not regain the lost tonnage. More is necessary. Naturally the sod land where the grass crop was neither fed nor plowed under suffered most. And, so far, green manuring has not proved satisfactory. It seems better to grow the grass and feed the hay than to plow it under on this tight soil.

4. **Crop rotation without manure, fertilizer, or grass sod.** What happens when you grow two grain crops (barley, oats) and one tilled crop (potatoes) in rotation without grass or any fertilizer whatsoever? The Station tried this on virgin soil for 22 years. The effort to "run out" the soil was deliberate—to

see what would happen and which crop would "give" first.

The first three years potatoes averaged 114.8 bushels per acre; barley, 7.2 bushels; and oats, 33.9 bushels. Remember these crops were being grown on raw, thin timber land. The last three years (1936-38) the potato average fell to 24.5 bushels; there was only one crop of oats yielding 3.43 bushels and no barley. This raw land had little reserve and barley was the first victim. There were ten failures of barley in 22 years and five of oats. There were always a few potatoes. This virgin land will not take pressure.

In 1939 the series was quartered, with one check plot reserved. It was limed, fertilized, seeded. The first crop (1940) ran above 1½ tons of hay per acre on land "run out" two years before.

5. **Crop rotations.** The three-, four-, five-year rotation project began in 1919. The 1952 harvest marked the thirty-fourth year. The object in this work was to determine any advantage in length of rotation, through longer resting periods; and how far manure alone will support yields. The allowance was 2 tons per acre per year, 1919-38, and 2½ tons per acre per year, since then. The average of the first five crops of barley (1919-24), hay (1920-25), and oats (1931-35) have been compared with the average production, same crops, same rotations, for 1951-52. The results follow:

a. The longer (five-year) rotation seems to increase barley yields over the short (three-year) rotation. Oat crop gains are even more pronounced.

b. Manure has sustained barley yields in the four-year cycle and increased them in the five-year rotation. It has increased oat yields in both four- and five-year rotations.

c. The short rotation hay crop enjoys a slight advantage. But manure has sustained hay yields, irrespective of age of stand, in both three- and five-year rotations.

6. **Rate of manuring.** The rate of manuring experiment began in 1917 on virgin soil. Starting as a three-year rotation, it was expanded to a four-year term in 1928 including grain, hay, and tilled crops. The purpose was to learn how much manure to use and when to put it on. Three plots and duplicates were dressed at rates of 5, 10, and 20 tons manure per acre, respectively, once every four years. Manure was spread over the grain stubble in advance of hay. Two plots, with duplicates, were given 10 and 5 tons, spread in the fall between second hay crop and the tilled crop. Since oats, first year hay, potatoes, and roots were the only crops running through both early and late years, these were used for sampling. Comparison is made between the first and last three years with almost 30 years in between. Through 1952, 36 potato, 35 oat, and 34 hay crops have been grown and harvested. Conclusions follow:

a. Ten tons manure, spread either time, have both sustained and slightly increased the oats yield in 30 years.

b. Five tons manure (before hay only) has also sustained and slightly increased hay yields. Ten tons did this regularly.

c. Rutabaga crops were also sustained and slightly increased by 10 tons regularly, by 20 tons before hay, and by 5 tons after hay only.

d. Potato yields declined with every treatment from 1917-19 to 1950-52. Smallest decline, 28 bushels, came with 10-ton applications after hay.

e. A good farmer wants to increase yields, not just "hold the line." But a 2½-ton annual rate (10 tons in four years) is just a holding action with the line sagging for some crops such as potatoes. However, the average farm can probably produce no more than this quantity per acre. The formula then should be the 10-ton rate in the four-year cycle (and more if he has it) plus commercial supplement.

f. There is no substantial difference in crop if a field is manured first and then plowed, or if the process is reversed and the manure disked in.

g. Whether to manure after grain or between hay and tilled crops is a matter of choice. If you want more hay, choose the first; if you grow cash tilled crops, elect the second.

7. **Sewage sludge.** Sewage sludge and manure were used on hay for five years at rate of 5 tons per acre each. Sludge plots yielded slightly higher than manured plots and about .6 ton more hay than the check. If the price of the hay is $1.00 per hundredweight and if sludge is sold for the same price in hundredweight lots, even granting that later crops benefited, the cost of sludge is prohibitive for general field crop use.

8. **Nitrogen in varied amounts for permanent meadows.** See hay crops.

9. **Nitrogen vs. manure for permanent meadow.** See hay crops.

10. **Commercial fertilizers, exclusive.** In 1928 a commercial fertilizer project was initiated, with complete exclusion of organic matter supplement.

What production can you expect using nitrogen, potash or phosphorus alone or in combination on virgin land? Strip liming was done and later (1951) was extended to cover three-fourths of the area. The work was set up on four series of plots in a four-year rotation of oats, hay, and potatoes. Rutabagas was included in 1946. The fertilizer goes to the tilled crop only so each series is reached once in four years. Two plots were kept free until 1947. Then they were given manure at rate of 10 tons per acre plus nitrogen, phosphorus, and potash in the amount a 200-bushel crop takes off. The twenty-fifth potato crop was harvested in 1952. Yields for the first five and last three years of the project have been compared. Certain principles seem established for local application:

a. Commercial fertilizer even in large amounts, over 360 pounds per acre, has failed to sustain oat and potato yields.

b. However, commercial fertilizer has not only sustained but also modestly increased hay yields on all plots. Check plots are also up.

c. Since these hay yields are far below manured plot levels and since 10 tons manure actually increased oat, hay, and barley tonnage, commercial fertilizers, even in quantity, must be supported by organic matter to build production on these soils.

11. **Rock vs. acid phosphate.** How good is rock phosphate? How does it compare to acid type? Both were tried side by side in a seven-year test (1916-23) on virgin land.

	Potatoes	Rutabagas	Hay	Oats
	bushels	tons	tons	bushels
Rock phosphate	176.80	10.35	1.57	45.70
Acid phosphate	170.67	11.09	1.75	56.29

Acid phosphate held the advantage with three crops out of four. It is used exclusively now. It works quicker than raw rock, and being concentrated, it is less expensive to ship.

Livestock

The Station owns a flock of poultry. This flock is not used for research. It also still owns one team of horses for emergency duty and winter service, a swine herd of Minnesota No. 2 hogs, and a herd of grade and purebred Guernsey cattle. The cattle herd dates back nearly 40 years.

Swine

In 1943 the junior foundation herd of Minnesota No. 2 was assembled at Duluth. The unit rarely exceeds a dozen brood sows.

Cattle

ANCESTRY

As of July 1, 1952, the entire purebred herd at Duluth was descended from three imported Guernsey heifers—Antona, Dolly, and Mimosa. They reached the Station in early 1914. In early 1950 a check on female ancestry of the then existent herd was made—50 per cent descended from Dolly; 43.75 per cent traced ancestry to Antona; and only 6.25 per cent to Mimosa. Her line is running out. One individual only remains in the herd in May 1953. Yet Mimosa was the best cow of the three, and Antona slightly outrated Dolly.

CALF CROPS

A careful record of the sex of all calves born for the period, 1941-50, when the herd was accredited as Bang's disease-free, has been assembled. Three years out of ten the bull calves were most numerous; one year the sexes tied; and heifers exceeded bulls six seasons. The total count for the decade was 112 bull calves and 144 heifers.

PASTURE GAINS

The dairy farmer has a primary interest in grass as a cheap source of milk. But with growing numbers of white faced cattle feeding off northern grasslands, there is growing interest in grass fed beef as well. This Station has carried blocks of dairy heifers annually for 34 years on continuous day-night grazing through the summer months. The practice began in 1919. Data is available for 31 years of the 34. Heifers are weighed when going out June 1 and on returning November 1. A portable shelter is provided for rough weather. Four to 15 heifers went out each year. The normal feeding period was June 1-October 31 (153 days). Gains ranged from 93-269 pounds per season, averaging 171 pounds per season or 1.11 pounds per day.

Smallest gains were recorded for very dry seasons like 1934 when pastures were crowded or when the heifers were grown out and close to freshening.

DISEASE PROBLEMS

The Station is concerned with the control of the major diseases that attack mature herds: tuberculosis, so-called shipping fever, and brucellosis or Bang's. The herd has been free from tuberculosis since 1918 and has been so certified annually. Shipping fever is rather prevalent in northeast Minnesota during the tight housing period of middle and late winter.

Major concern is with brucellosis. The problem is still acute in many counties. Complete eradication has not yet come. A case history of a given herd, twice accredited for extended periods, may be helpful to farmers currently vexed with the disease. This case history is broken down into three periods—1914-29, 1929-37, and 1938-52.

1914-29. The herd was established in 1914. No females were brought in after 1915 till 1952. The years, 1914-28, were times of mild infection and ineffective controls. An old report states, "Perhaps the sanitary measures employed kept

the number of losses down to two per year. But the occasional abortion indicated the subdued persistence of the disease. The first test bleeding of the herd was done March 14, 1927; the second, April 14, 1928. At that time the herd was divided and the dry positives sold. In the December 1928 test, nine months after herd division, the entire herd remained negative except one individual. Six months later this heifer (daughter of reactor) cleared up to perfect a 100 per cent score.

1929-37. During the drouth of 1934 pastures were so short and hay supplies so lean the herd was grazed along the roadsides adjacent to the Station. It is possible contacts were made with other cattle and infection was reintroduced. In any case the herd was negative from 1929 to 1935. When the herd was tested March 6, 1935, six suspects showed up. On April 29 when tested again, the herd had two positives and five suspects. The last positive was detected and removed December 21, 1937. So it took almost three years this time to clean up the herd.

1938-52. The years, 1938-50, constituted the "golden age" of the Duluth herd. The herd was tested twice per year, and the findings were so monotonously negative that the threat of Bang's disease seemed as remote as that of tuberculosis. It was ancient history. The herd was honored in the possession of Certified Bang's Disease-Free Herd Certificate No. 1 issued by the Minnesota Livestock Sanitary Board, May 6, 1941.

Then late in 1950 the ring test indicated reappearance of Bang's. Subsequent to this finding, the herd was tested by the regular agglutination blood test. The November test netted one reactor, the December test another. The system of test and slaughter was invoked for the third time. For a while it seemed successful. The milking herd went through almost all of 1951 without trouble and with negative blood tests. But the heifer herd looked suspicious by midsummer.

All through 1952 the disease took heavy toll of the producing herd, sup-

MINNESOTA STATE LIVE STOCK SANITARY BOARD

Certified Bang's Disease-Free Herd Certificate

To Whom It May Concern: *No.* 1

THIS IS TO CERTIFY that the herd consisting of 47 P. B. & grade Guernsey (Number and description of cattle)

cattle, owned by Northeast Exp. Station (Name) *of* Duluth, (Address)

Minnesota, is a CERTIFIED BANG'S DISEASE-FREE HERD.

This certificate is issued in accordance with the Rules and Regulations adopted by the Minnesota State Live Stock Sanitary Board April 16, 1941, for the control and elimination of Bang's disease in cattle and the establishment of certified Bang's disease-free herds. No evidence of Bang's disease has been found in three successive agglutination blood tests of the cattle in the herd, at least six months apart. This certificate is valid for ONE YEAR, expiring May 6 *1942, unless revoked at an earlier date.*

(duplicate)

Secretary and Executive Officer

The dairy herd at the Northeast Station was awarded the first Certified Bang's Disease-Free Herd Certificate issued by the Minnesota State Livestock Sanitary Board.

porting the theory that when a herd has been negative for a long time, it is highly susceptible when infection again threatens.

The experience of the Northeast Station herd is identical with that of other large institutional herds in the metropolitan district of Duluth-Superior. The test and slaughter method was effective in clearing the herd in 9 months the first time; it took 31 months to regain accreditation the second time. On third return, infection was more rapid and widespread, quickly extending to the heifers of breeding age.

What to do? When a herd has suffered three outbreaks in 35 years and when the infection has penetrated deeper and wider, and has been slower to heal on successive attacks; when the very existence of the herd is threatened by attrition, one comes to feel the test-and-slaughter method used three times is inadequate protection for an institutional herd public and exposed.

In order to achieve some degree of insurance and some assurance of a measure of permanent relief, early in 1952 the Station was privileged to follow the policy that has worked so well with neighboring institutional herds of the district, calfhood vaccination.

Farm Engineering

Major concerns on Station properties have to do with reclamation of wet, timbered, and stony lands. Five special problems exist: (1) disposition of overburden of timber, brush, and stumps; (2) drainage; (3) breaking procedure on stony, sodded lands; (4) recurrence of stone crop through successive cropping years; and (5) upheaval of field stones.

Methods used in land clearing at the Station are obsolete now, of course.

The drainage system of the Station was completed long ago although it requires annual mending. This has been less a research project than an object lesson in how tile drainage works in the Cloquet-Milaca stiff and stony clay loam. On the positive side it has no doubt advanced planting dates and made otherwise wasted land usable. But regionally it had negative values. Adequate tile drainage in these type soils would be too expensive. Surface drainage apparently is the answer for the small farmer on these tight, level, clay loam soils.

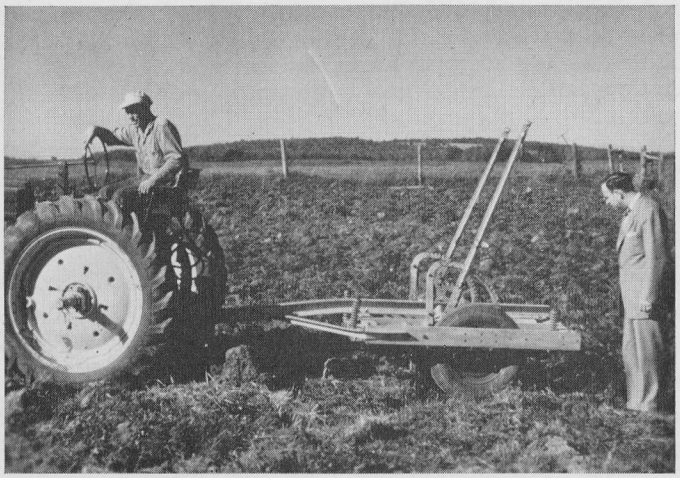
Making a seedbed on these hostile, stony lands, often capped with a tough old sod, has been worked out by trial and error as different kinds of equipment have come on the market. An extra-heavy, channel steel, frame-type of field cultivator with spring releases has been used without breakage in two old pasture fields. To date, it has answered the problem.

A quarter century ago picking stones was an important project. A stone picking project was begun on the rotation plots in 1926. The stone crop was picked annually from (1) tilled plots, one-tenth acre in size; (2) grain stubble plots; and (3) sod plots about to be broken. They were also weighed for exact comparative record. The final pick was made in 1952. This 25-year story has some surprises.

a. The biggest crop came, not the first year, but the third, 1929. The stone harvest that year averaged 13 tons per acre.

b. The 1931 crop fell to 2½ tons per acre, a trifle more in 1943. But the 1933 crop was double that of two years earlier; in 1942 it reached 10 tons, or four times as much.

c. Starting with 1944 there has been a steady decline from 9,060 pounds per acre to 5,020 pounds in 1952. Yet the



Stubborn, stony, clay, sod-bound pastures yield to a field cultivator.

1952 crop was almost identical with that of 1931, 21 years earlier. All data is from tilled field pickings.

This might sound discouraging, but after 26 years of stone picking indications are that the Station will be almost but never quite done. The mass of stones will be smaller than a softball and stone picking becomes a casual job with big breaks between on given fields. But, occasionally, once in five years perhaps, a big stone crops up. For 30 years it is plowed over, then it is hit; finally erosion exposes it some more, and it must be extracted.

Does frost "heave" stone? Evidence indicates not. At Duluth, Grand Rapids, and Itasca State Park there are stone cemeteries, not planted by man. The glaciers planted stones in the area at differing depths. Their positions at varying levels have been determined and mapped, with pipe connections extending to the surface. Readings have been made annually or biennially from permanent bench marks. There has been no change in elevation anywhere. Apparently man is going down to the stones; they are not coming up. Their exposure is the work of erosion.

Public Relations

Most branch stations in Minnesota also have schools. Students, alumni, and faculty provide contacts with the people they serve. Duluth has no school so other channels to its constituency had to be provided. This objective has been realized quite thoroughly in many ways including:

1. Individual services, correspondence, and conferences with visitors.

2. Cooperative relations with the Extension Service, Vocational Agricultural teachers, Chambers of Commerce, daily press.

3. Speaking engagements throughout the district.

4. Special field days such as the Senior Farmer Honor Roll picnic in June and the Crops-Soils day in August.

5. Weekly radio broadcast.

6. Press stories including a monthly story in *Stock and Dairy Farmer* now in its twenty-sixth year; a weekly story in *Cooperative Builder* now in its tenth year.

7. The feature event of the year, the Northeast Minnesota Farmers' Week during the first week of April. This event is now in its thirty-second year.

The Station Today

During the past 15 years an additional 30 acres of land, bordering original holdings on the north, have been acquired. A new underground water system has been installed with fire hydrants, and a 50,000-gallon 130-foot water tower was erected in 1949. A secondary well has been drilled to support the original one. A new dairy barn was built in 1948-49. The herd is protected with a concrete slab ceiling.

During recent years the original buildings, erected in 1913, have been serviced with new roofs, insulation, fresh stucco, painting, and general reconditioning. Supplementary service buildings including greenhouse, seedhouse, and root storage cellar complete the working unit.

The office building serves as administrative center and the auditorium provides facilities for large groups of visitors at institutional events. The landscaping features and plantings of the early thirties have made the 20-acre campus a retreat of beauty and distinction in sharp contrast in its appearance to the dreary waste of brush and water when the first buildings were raised 40 years ago.

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7. Biennial Report for 1922-23.
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9. Biennial Report for 1926-27.
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*†11. Five Crop Years at Duluth: Field Crops (1927-31).

†12. Five Crop Years at Duluth: Hay Crops (1927-31).

†13. Five Crop Years at Duluth: Potatoes (1927-31).

†14. Five Crop Years at Duluth: Rutabagas (1927-31).

†15. Five Crop Years at Duluth: Sunflowers (1927-31).

†16. Fruit Culture at Duluth (1927-31).

*†17. Five Years Arrowhead Vegetable Varieties and Fertilizers at Duluth (1927-31).

*†18. Duluth Field Crops up to Now (1932-34).

*†19. Duluth Hay Crops up to Now (1932-34).

*†20. Duluth Potato Crops up to Now (1932-34).

*†21. Duluth Root Crops up to Now (1932-34).

*†22. Duluth Sunflower Crops up to Now (1932-34).

†23. Duluth Bush Fruits up to Now (1932-34).

†24. Duluth Tree Fruits up to Now (1932-34).

†25. Duluth Vegetable Crops up to Now (1932-34).

†26. Lime Tests at Duluth, 1934.

†27. Duluth Field Crops Through Three Seasons (1934-36).

†28. Duluth Hay Crops Through Three Seasons (1934-36).

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†66. Arrowhead Crop Tests Through a Dozen Years (1924-35), 1936.
67. Three Crop Years at Duluth, Vegetables (1937-39).
68. Three Crop Years at Duluth, Rutabagas (1937-39).
69. Three Crop Years at Duluth, Potatoes (1937-39).
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* Out of print.
† Mimeographed.
‡ Issued by the Department of Agricultural Engineering with the Northeast Agricultural Experiment Station cooperating.