Control of SOIL DRIFTING in Southwestern Manitoba

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BENEFICIAL PRACTICES

With proper soil management, crops can be grown successfully on the sandy soils of southwestern Manitoba. To avoid further damage from erosion by wind and to improve crop yields, particularly on eroded areas, several practices are beneficial:

- Planting field shelterbelts.
- Strip cropping.
- Seeding cereal cover crops on summerfallow in August.
- Permitting crop or weed residues to protect the soil by cultivating fallow only enough to control weeds and ending cultivation by mid-September.
- Using herbicides to control weeds on fallow or in crops.
- Cultivating after harvest to control broadleaved weeds and couchgrass.
- Including forage crops in rotations.
- Applying manure and commercial fertilizers on cereal or forage crops, particularly on eroded areas.

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Control of SOIL DRIFTING IN SOUTHWESTERN MANITOBA

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This is a report on methods of reclaiming the eroded land in southwestern Manitoba and growing crops satisfactorily. To find solutions to the problems, a substation was established near Melita in 1935. First, the fields were leveled as much as possible and grass or fall rye was sown to stabilize drift soil. Studies were carried out on several methods of controlling erosion by wind, including strip farming, trash cover, cover crops and crop rotations. Commercial fertilizers and barnyard manure were evaluated for use in growing cereal and forage crops. Studies were also carried out on growing forage, cereal and special crops.

The 1,280 acres of abandoned farm land on which the Substation was established represented an extensive area that had been badly eroded by wind. Soil drifting had removed up to one foot of topsoil in wide strips half a mile long on some fields. Fence rows were banked high with drift soil, and "blown-out" areas were transformed into sloughs when heavy rains fell. Many kinds of weeds had invaded abandoned fields. Several hundred acres were saved from further erosion by a dense growth of couchgrass.

SOILS

The Souris fine sandy loam soils of the Substation, in Township 4, Range 26, are representative of a large area of the Lake Souris basin, which comprises about 22 townships. The light-textured deposits, over glacial till, make up a sandy reservoir in which ground water occurs in the lower layers. The presence of this water table greatly affects the soils and vegetation. The level of ground water fluctuates considerably, depending on the season.

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Table 1.—Monthly precipitation, extreme and mean temperatures, and wind velocity, 1958 and 1959, and long-term averages

Reclamation Substation, Melita, Manitoba

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Precipitation, inches													
1958	.55	.88	.28	.30	.65	1.14	2.67	2.08	.82	1.53	1.88	.70	13.48
1959	.10	.45	.20	.80	2.52	2.41	2.21	2.33	4.29	3.95	.61	.05	19.92
Average, 1937-59	.71	.66	1.12	1.09	2.08	4.21	2.65	3.13	1.50	1.15	.93	.81	20.04
Maximum temperature (° F)													
1958	45	58	56	83	89	87	100	100	90	82	63	40	
1959	39	37	60	82	86	92	95	101	80	74	47	41	
Average, 1937-59	35.4	38.3	49.2	76.4	87.1	88.4	94.4	93.6	88.2	78.9	55.8	41.6	
Minimum temperature													
1958	−16	−35	−10	11	15	30	39	38	24	15	−30	−27	
1959	−33	−36	03	13	19	34	42	39	20	16	−16	0	
Average, 1937-59	−35.5	−31.8	−20.9	6.9	21.6	32.3	40.6	38.0	22.9	11.3	−12.7	−26.8	
Mean temperature													
1958	13.0	5.4	20.7	41.5	54.6	57.5	63.5	66.6	54.1	43.6	24.4	5.7	
1959	−2.2	3.5	29.8	40.0	50.6	63.8	68.2	66.7	53.2	35.8	18.6	16.6	
Average, 1937-59	2.3	4.9	18.1	38.9	51.9	57.3	66.9	64.7	54.2	42.8	23.4	9.6	
Wind velocity (hundreds of miles per month)													
1958	--	75.8	83.2	92.3	97.2	70.0	68.5	70.5	88.6	86.3	95.3	93.2	920.9
1959	89.6	78.1	85.6	95.4	99.3	74.1	67.3	71.1	84.0	94.3	85.1	76.1	1000.0
Average, 1937-59	75.2	75.2	88.2	89.6	90.7	76.9	67.6	70.1	73.4	87.6	83.0	82.6	960.1
Percent of total	7.8	7.8	9.2	9.4	9.5	8.0	7.1	7.3	7.6	9.1	8.6	8.6	100

Note: Monthly records for earlier years are given in progress reports of the Dominion Reclamation Station, 1936-1947 and 1948-1952, and of the Experimental Farm, Brandon, 1953-1957.

Meteorological observations taken in cooperation with the Meteorological Branch, Department of Transport.

The sandy soil varies widely in depth. On the Substation it is 6 to 7 feet deep. To the south, in Township 1, Range 28, the underlying till is only a few feet below the surface. Since the sandy deposits are shallow, the subsoils here show little or no evidence of ground water. To the north in Townships 6 and 7, hay swales and wet meadow soils are common between sand dunes.

For more details on the soils of southwestern Manitoba, see *Soil Survey Report No. 3, Southwestern Manitoba*, by J.H. Ellis, Soils Department, University of Manitoba, and W.H. Shafer, Canada Department of Agriculture, Winnipeg.

WEATHER RECORDS

Weather data, including temperature, precipitation and wind velocity, were recorded at the Substation from 1937 to 1959 (Table 1). The 23-year average annual precipitation was 20.0 inches, compared with the 6-year average of 14.6 inches during 1929-1934.[4] Thus, from 1937 to 1959, the average annual precipitation was 5.4 inches more than during the dry period.

The most frequent and damaging winds occur in April and May. Therefore, summerfallowed fields are highly vulnerable to wind erosion until protection is provided by the newly established crop. High winds also occur frequently in March, October, November and December. Therefore, protection of the soil against wind erosion is most critical during the spring and fall.

SOIL MANAGEMENT

Tree Shelterbelts for Controlling Erosion by Wind

From 1950 to 1959, tree shelterbelts on a quarter section of the Substation almost eliminated soil drifting. Three rows of trees were planted on three sides of the quarter section in 1937. Three double-row hedges of Manitoba maple running east and west subdivided it into four equal fields. In adjacent unprotected areas, trash cover had to be carefully conserved to keep the soil from being eroded by wind.

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[4] Mean values for all stations in the area, including Waskada, Deloraine, Pipestone, Pierson, Hartney, Souris and Melita. *Soil Survey Report No. 3, Southwestern Manitoba*, by J.H. Ellis and W.H. Shafer.

Damage by wind erosion, 1935.

Tree shelterbelts, 1943.

Strip Farming

Strip farming was very effective in controlling wind erosion. In tests, strips 10 rods wide were satisfactory, especially when adjacent fields were seeded to grass and fallow strips were worked to retain a trash cover.

Winds high enough to cause soil drifting come more often from the northwest than from any other direction. To be most effective, field strips should be at right angles to the prevailing high winds.

Cover Crops

Cover crops of cereal grain on summerfallow were very effective in controlling wind erosion and gave appreciable yields of forage (Table 2). The cover crops seeded late (August 5-15) gave valuable protection from soil drifting without seriously reducing wheat yields the next year. On the whole, the crops that were seeded on the earlier dates took more moisture and nitrogen from the soil than those seeded later.

Table 2.—Yields of forage in 1958 from oat cover crops seeded on summerfallow at various dates, the effects on soil moisture and nitrate nitrogen, and yields of wheat in 1959

Date of seeding	Tons of dry matter per acre	Soil moisture[1] %	Soil nitrate nitrogen[1] p.p.m.	Bushels of wheat per acre
No cover crop	--	13.5	27.1	26.9
July 15	1.21	7.9	3.2	21.3
July 25	1.00	8.9	6.7	22.3
Aug. 5	0.26	9.3	5.9	24.4
Aug. 15	0.17	10.6	12.2	24.8

[1]Sampled to a depth of 12 inches, October, 1958.

When summerfallow tillage is discontinued in August, the fall growth of annual crops or weeds often provides an effective cover crop. An application of 2,4-D in the fall or spring controls many of the weeds that are not killed by frost.

Tilling Summerfallow

Tests on tilling fallowed land susceptible to soil drifting were carried out for a number of years. The aim was to develop suitable methods of controlling weeds, maintaining trash cover and producing satisfactory crop yields. The control of couchgrass was a major problem.

The following practices were found best.

- Begin tillage with a blade or heavy-duty cultivator with sweeps soon after harvest. When the straw is heavy, a straw-chopping attachment for the combine may be needed to facilitate tillage.
- In May or early June, cultivate with 16-inch shovels. These operations help to control perennial weeds such as couchgrass.
- If possible, avoid tillage in late September or October, to permit the soil, crop and weed residues to become firm. There is little to be gained from September tillage if early-season tillage has been satisfactory. On the other hand, late-fall tillage is likely to cause serious losses from wind erosion because it buries a great deal of the trash.

Minimum Tillage

Summerfallow cultivated until September 15 gave the best combination of weed control, trash cover and crop yields. Yields of wheat were highest when tillage was ended then, and weed control and trash cover were satisfactory. The three-year average yields of wheat on summerfallow from 1956 to 1959 after various numbers of operations and dates of ending tillage were as follows:

Date of last tillage	*No. of operations*	*Bushels of wheat per acre*
July 30	4	15.0 c
Aug. 15	5	19.2 bc
30	6	23.8 ab
Sept. 15	7	26.2 a
30	8	25.3 a

Yields with the same letter, a, b or c, are not statistically different (P = 0.05, Duncan's multiple range test).

Methods of Tilling

Three different implements and methods of summerfallowing were studied in 1958-1959 to find their effects on soil structure and crop residue (Table 3).

Table 3.—Crop residues and erodible soil aggregates after various numbers of operations and methods of summerfallow tillage, 1958-1959

Method and sequence of tillage			No. of operations	Pounds of trash cover per acre straw only	Soil aggregates less than 0.84[1] %
1958	1959				
After harvest	Spring	Summer			
--	Cultivate	Cultivate	5	347	63.5
Cultivate	Cultivate	Cultivate	6	311	63.9
--	Disc	Disc	4	190	63.2
Disc	Disc	Disc	5	166	56.7
--	Moldboard plow	Cultivate	5	137	56.0
Moldboard plow	Cultivate	Cultivate	6	151	67.4
Difference necessary for significance at the 5 percent level				123	6.9

[1]Diameter of soil particles subject to erosion by wind, in millimeters. Samples were taken at the 1-inch depth in September, 1959.

The cultivator, with 16-inch shovels, kept more straw on the surface of the soil than either the oneway disc or the moldboard plow. Spring tillage with the cultivator or disc kept more straw than an after-harvest tillage. Spring plowing resulted in fewer erodible soil aggregates than fall plowing, spring or fall cultivating or spring discing.

Because of the high percentage of erodible soil with all treatments, it is very important to protect the soil with trash cover.

Although only a moderate amount of crop residue remained at the end of the fallow season (August), the straw and weed residues made soil conditions stable and all plots were protected against wind erosion. This was especially true of those that had been tilled with the cultivator only.

Surface tillage vs. plowing.—From 1948 to 1952, surface tillage with a duckfoot cultivator throughout the season gave slightly better crop yields the next year than moldboard plowing followed by cultivation for the rest of the summer. Also, surface tillage was less expensive than plowing and maintained trash cover better.

Fall Tillage of Crop Land

Fall and spring tillage of land containing straw and stubble from combine harvesting of cereal crops gave better yields of grain than preseeding tillage only. Tillage in the fall controlled broadleaved weeds and couchgrass and improved the seedbed for the following crop. The heavy-duty cultivator with 16-inch shovels was the most satisfactory implement for conserving trash cover and controlling weeds.

From 1955 to 1959, fall tillage with the moldboard plow, oneway disc or cultivator gave better yields than plots receiving no fall treatment. Burning the straw in the spring or chopping it in the fall also increased yields over untreated plots. Average yields of wheat in bushels per acre were as follows:

Fall and preseeding[5] tillage		*Preseeding[5] tillage only*	
Moldboard plow	21.8	Spring burning	19.7
Oneway disc	21.4	Fall chopping	15.3
Heavy-duty cultivator or wide-blade cultivator	17.7	Untreated	12.1

Straw residues from combine harvesting affected the preparation of the seedbed and germination of the crop more than those from the binder method, especially when the plots were tilled in the spring only. From 1941 to 1951, in a three-year rotation of fallow–wheat–oats, crop yields on binder stubble were greater than those on combine stubble. For oats, the soil was tilled once in the spring with a oneway disc. The average yields of grain in bushels per acre were:

	On binder stubble	*On combine stubble*
Wheat on fallow	22.5	20.8
Oats on stubble	44.3	33.3

Another test was conducted from 1941 to 1947 to determine the value of after-harvest cultivation with the oneway or cultivator. The average yield of oats on stubble from plots tilled in both fall and spring was 55.5 bushels per acre; that from plots tilled in the spring only was 48.4 bushels.

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[5] All plots were tilled in spring with the oneway disc.

Eroding soil, 1935.

Trash cover, 1942.

Trash Cover

Well-anchored trash cover is the best protection against soil drifting on the light-textured soils. The term *trash cover* is preferred to *stubble mulch* because it refers to weed as well as crop residue.

Heavy-duty cultivators with wide shovels keep the most trash on the surface and also do a good job of controlling weeds. A wide-blade machine is satisfactory on dry soil. A moldboard plow turns all trash under; a disc may cover half of it, especially if it is operated at high speeds. On summerfallow without enough protection from wind erosion, spreading straw or manure, particularly on exposed areas, is very effective.

Summerfallow Substitutes

In tests from 1937 to 1943, corn was not a very satisfactory substitute for summerfallow. Yields of corn without fertilizer on the eroded soil were low, and there were many weeds. Corn in widely spaced rows (16 feet) on summerfallow strips gave some protection in the fall and winter, but the weeds after corn reduced yields of the succeeding crops. As weeds were hard to control, this practice was not generally recommended at that time.

Crop Rotations

Crop rotations were studied on a field scale for various periods from 1937 to 1959. Grain rotations that included sweet clover or bromegrass and alfalfa hay gave greater returns than two- or three-year rotations of grain and fallow. In general, yields of forage crops varied less than those of wheat. Average yields of clover were 1.0 ton per acre; of bromegrass and alfalfa hay, 0.8 ton.

Yields of grain were generally low during 1937-1942, the average yield of wheat on fallow being only 10.2 bushels per acre. Therefore, two- and three-year rotations of grain and fallow were not profitable during this period. Three-year rotations of grain and sweet clover gave more satisfactory returns. The average yield of sweet clover hay was 1.3 tons per acre.

From 1942 to 1954, yields and prices for grain were higher, so that fallow–grain rotations became more profitable. By 1944, the eight-year average yield of wheat on fallow was 13.5 bushels per acre. But the four-year rotation fallow–wheat–clover–oats brought greater returns during this time than wheat–fallow or grain–grain–fallow.

From 1946 to 1954, the nine-year average yield of wheat on fallow increased to 17.7 bushels per acre. Although grain yields were greater on the wheat–fallow rotation, net returns were larger on an eight-year rotation that included clover, bromegrass and alfalfa hay.

Soil Fertility

Studies on soil fertility, particularly on areas that were extensively eroded by wind, showed that adding barnyard manure or commercial fertilizers improved yields of cereal and forage crops. Tests also showed that cereals grown after legumes gave better yields than those grown after grasses.

Manure and Commercial Fertilizer for Wheat

In tests begun in 1937, applications of rotted barnyard manure gave higher yields of wheat on fallow on eroded soil than did those of commercial fertilizers (Table 4). Applications were made in a summerfallow–wheat–wheat rotation, the fertilizers being applied to each crop with the seed but the manure only during the fallow year.

Table 4.–Average yields of wheat in a fallow-wheat-wheat rotation after commercial fertilizer or barnyard manure was applied, 1937-1959

Fertilizer	Amount per acre	Bushels of wheat per acre	
		On fallow	On wheat stubble
None	--	18.4	12.8
16-20-0	96 lb.	21.7	16.6
10-32-10	60 lb.	22.0	13.2
11-48-0	40 lb.	23.3	13.6
Manure	10 tons[1]	25.4	16.3

[1]About 100 pounds of nitrogen per acre, 50 pounds of phosphate and 100 pounds of potash.

Manure gave the highest average yield of wheat on fallow, 25.4 bushels per acre, or 7.0 bushels more than the untreated plots. Manure at 10 tons per acre increased the yields on fallow and stubble land by 10.5 bushels per acre; applications of 16-20-10 fertilizer at 96 pounds increased them by 7.1 bushels, and 11-48-0 at 40 pounds by 5.7 bushels.

Rates of Manure for Restoring the Fertility of Severely Eroded Soil

In a test from 1956 to 1959 to find the best rate for applying rotted manure on severely eroded soil, it was not economical to apply more than 30 tons per acre. Applications of 15, 30, 45 and 60 tons per acre were made in the fallow year of a fallow—wheat—wheat rotation. Three-year average yields[6] of wheat on fallow after manure were appreciably higher than those on untreated plots (Table 5). After manure at 15, 30 and 45 tons per acre, yields of wheat on second-crop land were 8.8, 8.4 and 9.6 bushels per acre higher than for untreated plots (15.6 bushels per acre).

Two applications of manure at 30 tons per acre or more increased the soil nitrogen at the 0- to 12-inch depth. The nitrogen at the 0- to 6-inch depth varied from 0.124 percent when 15 tons were applied to 0.168 percent when 60 tons were applied; the untreated plots contained 0.103 percent nitrogen.

Table 5.—Yields of wheat and percentage of soil nitrogen on eroded soil after manure was applied on summerfallow at various rates, 1956-1959

Tons of manure per acre	Bushels of wheat per acre		Soil nitrogen,[3] %		
	On fallow[1]	On wheat stubble[2]	0-6 inches	6-12 inches	0-12 inches
0	18.9	15.6	0.103	0.086	0.094
15	24.9	24.4	0.124	0.091	0.108
30	31.2	24.0	0.149	0.099	0.124
45	31.4	25.2	0.134	0.094	0.114
60	29.4	23.9	0.168	0.099	0.134
Difference necessary for significance					
at the 5% level					0.017
at the 1% level					0.028

[1]Three-year average.

[2]Two-year average.

[3]After two applications of manure; determined by the Kjeldahl method.

Rejuvenating Stands of Bromegrass and Alfalfa with Manure and Commercial Fertilizer

Fertilizer applied on old stands of bromegrass and alfalfa on eroded soil improved yields of forage.

From 1945 to 1951, applications of 16-20-0 fertilizer at 100 pounds per acre or barnyard manure at 6 tons per acre were made each year. The

[6]No yield in 1957 because of damage by hail.

fertilized crops yielded 0.32 to 0.96 tons per acre more than the unfertilized ones (Table 6). Applications of 16-20-0 on alfalfa gave the greatest increase in yield.

Table 6.—Average yields of forage[1] (tons per acre) in 1945-1951 after barnyard manure or commercial fertilizer was applied

Fertilizer	Amount per acre	Alfalfa	Bromegrass	Bromegrass and alfalfa
None	--	0.68	0.26	0.54
16-20-0	100 lb.	1.64	0.58	1.40
Rotted manure	6 tons[2]	1.38	0.83	1.46

[1]At 20 percent moisture.

[2]About 60 pounds of nitrogen per acre, 30 pounds of phosphate and 60 pounds of potash.

Commercial Fertilizers for Rejuvenating Stands of Bromegrass

In a test started in 1955, applications of commercial fertilizers on bromegrass on eroded soil appreciably increased forage yields and net returns in 1955 and 1956 (Table 7).

In April, 1955, nitrogen (ammonium nitrate, 33.5-0-0) was applied at 0, 30, 60 and 120 pounds per acre along with P_2O_5 (triple superphosphate, 0-44-0) at 0, 30 and 60 pounds. Plots fertilized with nitrogen alone at 120 pounds produced 0.76 ton of dry matter per acre more in 1955 and 1956 than the unfertilized plots (0.78 ton per acre). Adding 30 pounds of phosphate with the nitrogen increased the yields further by as much as 0.42 ton per acre. The increase in 1956 from 120 pounds of nitrogen per acre was notable, whether alone or in combination with 30 pounds of phosphate.

The highest net returns per acre, $8.55, were obtained by applying 120 pounds of nitrogen and 30 pounds of phosphate. The fertilizer that gave the lowest returns ($0.60) was phosphate at 30 pounds.

Effects of Grasses and Legumes on Yields of Subsequent Grain Crops

In a test from 1944 to 1948, wheat grown after legumes on fallow or stubble land generally yielded more (Table 8) and weighed more per bushel that that grown after grasses. Wheat after alfalfa gave the highest average

Table 7.—Average yields of forage and values of increases in yields (1955-1956) after nitrogen and phosphate fertilizers were applied once (1955) at various rates on old stands of bromegrass

Fertilizer Pounds per acre N	Fertilizer Pounds per acre P_2O_5	Tons of dry matter per acre 1956	Cost of fertilizer[1] $/acre/year	Tons of dry matter per acre	Increase over check	Value of increased yield[2] less cost of fertilizer $/acre
0	00	0.82		0.78		
30	0	0.86	1.95	1.08	0.30	2.55
60	0	0.97	3.90	1.33	0.55	4.35
120	0	1.15	7.80	1.54	0.76	3.60
0	30	0.86	1.35	0.91	0.13	0.60
30	30	0.94	3.30	1.26	0.48	3.90
60	30	1.03	5.25	1.59	0.81	6.90
120	30	1.12	9.15	1.96	1.18	8.55
0	60	1.04	2.70	1.13	0.35	2.55
30	60	0.90	4.65	1.26	0.48	2.55
60	60	1.00	6.60	1.67	0.89	6.75
120	60	1.16	10.50	2.00	1.22	7.80

Difference (tons per acre, 1956) necessary for significance at the 5% level: between fertilizer rates, 0.16; N, 0.20; P_2O_5, N.S.

[1] N valued at $0.13 a pound, and P_2O_5 at $0.09.

[2] Forage valued at $15 a ton.

Table 8.—Yields of wheat on fallow and stubble land after grass or legume crops, 1944-1948

Previous crop	Bushels of wheat per acre: On fallow A[1]	On stubble B	On stubble C
Alfalfa	21.4	15.8	14.8
Sweet clover	21.2	14.3	11.8
Slender wheatgrass	19.8	13.5	--
Crested wheatgrass	17.8	15.2	--
Bromegrass	17.0	12.4	9.4

[1] A, five-year average; B, two-year average; C, four-year average, including B.

yield and after bromegrass the lowest. Forage crops remained in production for three years, the plots were fallowed for one year, and then two crops of wheat were grown.

Effects of Continuous Grass and of a Fallow–Grain Rotation on the Fertility of Eroded and Noneroded Soil

Soil samples taken in 1952 showed that the soil had more nitrogen and organic matter after grass was grown for 16 years than after a fallow–grain rotation grown on an adjacent area, on both eroded and noneroded sites. The percentages of nitrogen and organic matter at the 0- to 4-inch depth were as follows:

	Noneroded		*Severely eroded*	
Cultural practice	*Nitrogen*	*Organic matter*	*Nitrogen*	*Organic matter*
Grass	0.32	4.71	0.18	3.45
Fallow–grain	0.23	4.00	0.14	2.83

Effects of Sweet Clover on the Fertility of Eroded Soil

The soil in 1951 had more nitrogen and organic matter after sweet clover had been used for 13 years as a green manure in a sweet clover – wheat – wheat rotation than after a fallow–wheat–wheat rotation. Average yields of wheat after sweet clover were similar to those on fallow, 12.8 bushels per acre; those on stubble were also similar, 10.4 bushels. The percentages of nitrogen and organic matter on summerfallow at the 0- to 6-inch and the 6- to 12-inch depths were as follows:

	Rotation			
Soil depth	*Fallow–wheat–wheat*		*Sweet clover – wheat – wheat*	
inches	*Nitrogen*	*Organic matter*	*Nitrogen*	*Organic matter*
0-6	0.116	1.98	0.135	2.57
6-12	0.083	1.59	0.083	1.67

FORAGE CROPS

Forage crops played an important part in reclaiming the eroded soil on the Substation. The area was especially good for growing legumes because the water table was usually high. By 1947, 362 acres were seeded to grasses and legumes for hay and pasture. Studies included a comparison

Top picture—Eroded soil, 1935. Wind removed more than a foot of topsoil from the area on the right.

Bottom picture—Heavy stand of alfalfa, 1943, on land that was formerly drifting sand.

of various species, varieties and strains of grasses and legumes; methods of seeding and dates of establishment of forage crops; and a comparison of yields of annual hay crops.

Methods of Establishment

Methods and dates of seeding grasses and legumes were studied from 1938 to 1946.

When moisture was adequate, seeding grasses and legumes in the same row was as satisfactory as seeding them in alternate rows. But when moisture was a limiting factor, stands of grasses and legumes were better with seeding in alternate rows. Seeding bromegrass and alfalfa in alternate rows yielded 1.46 tons of hay per acre; seeding them in the same row yielded 1.26 tons (two-year averages, 1944 and 1946).

For seeding in alternate rows, a single-disc press drill was tested for a number of years. The legume seed, delivered from a grass seed attachment, was placed ½ to 1 inch deep in every second row. Grass seed and grain were mixed and seeded in the remaining rows. For seeding in the same rows, grass and legume seeds were sown with the grain in each drill row.

Late fall was the best time for seeding grasses; for legumes, early spring was usually more satisfactory. Seedings were made in September, November and April. Alfalfa, sweet clover, crested wheatgrass, slender wheatgrass and bromegrass were included in the test.

In many years, seeding alfalfa in midsummer was satisfactory. The land was fallowed until July 1 to 15. Then, preferably after a rain, it was packed and seeded to alfalfa with ½ bushel of oats per acre, ½ to 1 inch deep. Satisfactory stands of bromegrass and alfalfa were also obtained by seeding then without a companion crop. Forage was not harvested the first year.

Yields

Most forage crops grow well in the area, and certain species and varieties give good yields of hay.

Alfalfa

Five varieties of alfalfa yielded well in tests from 1957 to 1959. The average yields, in tons of dry matter per acre, were: Rambler, 1.20;

Rhizoma, 1.19; Vernal, 1.17; Ladak, 1.16; and Grimm, 1.07. The yields include one cutting in the year of establishment, and two cuttings in 1958 and in 1959. Rambler was more resistant to winter injury than the other varieties.

Grasses and Grass–Alfalfa Mixtures

In tests from 1954 to 1957, mixtures of various grasses and alfalfa gave better average yields of forage than the grasses seeded alone. Yields of the grasses alone declined rapidly over the four years. The average yields, in tons of dry matter per acre, were:

Variety of grass	*At 15 lb. per acre*	*At 10 lb. per acre with 4 lb. of Ladak alfalfa*
Intermediate wheatgrass	1.26	1.49
Crested wheatgrass	1.10	1.63
Commercial bromegrass	1.10	1.38
Russian wild ryegrass	0.88	1.30

Seeding 6 pounds of alfalfa with the grasses did not significantly increase the yields of the mixtures further.

Annual Hay Crops

Annual hay crops of barley, oats, Hungarian millet and Siberian millet, grown on summerfallow in 1948-1951, each yielded an average of about 2 tons of dry matter per acre.

SPECIAL CROPS

Rape

In tests on rape begun in 1956, three-year average yields of seed for varieties of the late-maturing Argentine type were: Argentine commercial, 949 pounds per acre; Golden, 1,030 pounds. Those for varieties of the early-maturing Polish type were: Polish commercial, 718 pounds per acre; Arlo, 734 pounds. The main problems in growing rape were damage to seedlings in the spring by drifting soil and flea beetles.

Corn

In tests in 1956, 1958 and 1959, four varieties of corn gave satisfactory yields of forage. Corn matured enough for grain in 1958, but not in 1956 or 1959. The 1958-1959 average yields of forage and the 1958 yields of grain were as follows:

Variety	*Tons of dry matter per acre*	*Bushels of grain per acre*
Morden 74	2.04	30.8
Morden 77	1.69	35.9
A.E.S. 101	1.55	38.5
Manitoba 164	1.53	32.5

CEREAL CROPS

Varieties

In tests to find the most suitable varieties of wheat, oats, barley, flax and rye for the area, several varieties yielded well. The average yields in bushels per acre were as follows: Spring wheat, 1955-1959: Selkirk, 40.5; Lee, 38.2; Thatcher, 31.8. Oats, 1956-1959; Rodney, 84.4; Exeter, 81.7; Garry, 79.2. Barley, 1955-1959: Swan, 59.2; Traill, 57.5; Husky, 56.3; Vantmore, 54.7; Parkland, 54.6; Montcalm, 53.7. Flax, 1955-1959: Redwood, 26.0; Marine, 20.8; Raja, 20.2; Sheyenne, 20.2. Rye, 1958-1959: Dakold, 42.2; Antelope, 38.6.

Dates of Seeding

Tests from 1938 to 1951 to find the best dates for seeding spring wheat, durum wheat, oats and barley showed that it is best to seed spring wheat and durum wheat in the first week of the seeding season, oats in the first two weeks, and barley in the first three weeks.

The first seeding each year was made as early as the soil and weather permitted, the average date being April 30. Subsequent seedings were made at weekly intervals.

ACKNOWLEDGMENTS

The Reclamation Substation at Melita, Manitoba, was established in 1935 primarily to study problems of drought and soil drifting on the light-textured soils of southwestern Manitoba. The land was rented under the provisions of the Prairie Farm Rehabilitation Act. Since its beginning, the Melita substation has been supervised by the Superintendent of the Experimental Farm, Brandon, Manitoba.

M.J. Tinline, B.S.A., Superintendent of the Farm from 1925 to 1947, selected the site at Melita and initiated the experimental work there. The following officers were responsible at different times for conducting the experiments: H.A. Craig, B.S.A., 1937; A.J. Strachan, B.S.A., 1938-1941; W.H. Nelson, B.S.A., 1942-1945; F.S. Gugin, B.S.A., 1946-1949; W.K. Dawley, B.S.A., 1950-1955; and R.D. Dryden, B.S.A., M.Sc., 1957-1959. J.V. Parker was responsible for general supervision of the Substation during its entire operation.

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