Crop Yields are affected by tillage practices

By G. N. Geiszler[1]

EXPERIMENTS to determine the effects of different types of tillage on crop yields, especially the yield of wheat, have been carried on over a long period of years in North Dakota. They show that types of tillage used to prepare land for crops materially affect the resulting crop yields.

In considering tillage we must differentiate between that used for preparing a seedbed on stubble land and that used for performing summerfallow and final seedbed preparation on such fallow.

Spring vs. Fall Plowing

Generally, spring plowed stubble produces higher yields of wheat and other cereals than fall plowed stubble in the western two-thirds of North Dakota. The opposite is true in the eastern third.

Seasonal variations can and must be expected. In years of above average rainfall, fall plowing is as good as and, sometimes is better than spring plowing in the west. However, since precipitation is average or below normal in most seasons, longtime average yields are in favor of spring plowing.

Spring plowing is best in seasons of below normal rainfall in the eastern sections of the state. However, again, longtime averages favor fall plowing. The findings for the various stations in the state are reported in table I.

Yield differences are smaller than would prevail under field conditions. This is because standing stubble on adjoining areas holds snow on the small, fall plowed plots.

In addition, the extra cost of tillage required in the spring to prepare the fall plowing for seeding must be considered. Usually, this requires a shallow cultivation with disk, or cultivator, and harrowing, whereas spring plowed land can be seeded immediately following the plow and packer.

In general practice, farmers in western North Dakota may find it an advantage to fall plow fields which have many wet areas in the spring, or clay soils which are difficult to cultivate when wet. While in the east they would find it an advantage to spring plow light soils which are subject to wind erosion if fall plowed.

Plowing vs. Subsurface Cultivation

Plowing stubble land for seedbed preparation has produced higher yields of wheat than subsurface and

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TABLE I.—**Yield of Wheat on Spring and Fall Plowing.**

	1909-1920 (1) Williston	1908-1951 (2) Dickinson	1917-1951 (2) Mandan	1946-1956 (3) Minot	1906-1921 (1) Edgeley	1941-1952 (4) Langdon-a
Spring plowing...	12.1	11.6	14.9	14.5	12.0	19.5
Fall plowing.....	11.5	11.0	12.5	14.0	10.7	20.5
Number of years averaged	11	44	34	9	15	11

a–1951 yields omitted

surface types of tillage. Factors which affect the crop adversely on plots tilled to leave a part or all of the stubble on the surface are: Lower soil temperatures in the spring which possibly retard nitrate formation, and heavier weed stands.

The findings at the experiment stations where tests have been run are given in table II. Comparisons are made with spring plowing at all stations, except at Langdon, where fall plowing is the more common practice.

Burning stubble and tandem disking were used for seedbed preparation at Edgeley for 6 years and at Langdon for 5 years. Comparable yields for spring plowing are 21.4 and 20.2 bushels per acre, and for burning 18.7 and 15.4, respectively, for the two stations.

At Minot, weed counts were made in 1955 and 1956 when wheat plants were 4 to 5 inches tall. These showed much heavier stands of pigeongrass and Russian thistle on the surface or subsurface tilled plots than on plowing. Weed checks, based on pounds of oven dry plant material, were made at Edgeley and Langdon in 1943 and 1944. The checks were made about midway between heading and maturity of the wheat.

Engelhorn[4] states, "With the exception of the 1943 season at Edgeley, the degrees of weediness of wheat under continuous cropping did not vary significantly between method of tillage used in seedbed preparation. The situation during 1943 was unusual; horseweed (*Erigeron canadense*), which had not been observed during the 1942 season, appeared during the spring of 1943. The extent of its growth appeared to vary directly with the amount of surface residue. Based on

TABLE II.—**Yield of Wheat on Stubble Under Different Seedbed Preparations.**

	1924–1951 (2) Dickinson	1955–1956 (5) Dickinson	1946–1956 (3) Minot	1945–1953 (7) Edgeley	1941-1952-(b) (7) Langdon
Moldboard plow...	12.8	14.2	14.5	14.6	20.5
One way disk.....	....	11.5	11.1	11.6	16.8
Tandem disk.....	8.9	9.3	6.2-(a)	....	....
Field cultivator....	....	....	9.6	11.8	16.1
Stubble mulch.....	....	....	....	11.3	....
Burn Stubble.....	....	....	12.4	....	....
Number of years averaged.....	28	2	9	8	11

(a) Four year average 1946 to 1950, the 1949 yields are omitted at Minot due to hail damage.
(b) Omitting 1951.

quadrat determinations, horseweed occurred to the extent of 1,137 pounds of dry plant material per acre on stubble mulch, 164 pounds on plots tilled with the field cultivator, 3 pounds on plowing, and a trace on disking." Engelhorn also states, "At Langdon, weed growth varied little between method of tillage for seedbed preparation."

That weediness of surface tilled fields is a factor in lowering crop yields is suggested by findings at other stations.

The Conservation Experiment Station at Cherokee, Okla., reports, "There was an average of 5.6 times more weeds, based on air dried weight, on continuously mulched areas than on the plowed land."[6] Here, crop rotation kept weed population down but did not overcome the problem of volunteer grain.

Plot tests do not permit evaluating tillage practices for reducing wind erosion, nor for the effect of erosion on crop yields. Yield loss depends on how severely the seedling plants are injured by the moving soil particles.

The question of value of fall surface or subsurface tillage with similar tillage repeated in the spring for seedbed preparation is answered by the Langdon data. Here, the fall surface and subsurface tilled plots are tilled in the spring with a field cultivator and packed before seeding.

TABLE III.—**Yield of Wheat and Oats on Corn Stubble.**

	Dickinson (2) 1908–1951	Mandan (2) 1917–1951	Williston (1) 1909–1920 (oats)	Edgeley (1) 1906–1921
Fall plowed	16.5	14.9	....	17.0
Spring plowed	18.4	16.7	35.2	15.9
Disked	19.5	16.0	33.5	17.0
Years averaged	44	34	11	15

Plowing Versus Disking Corn Stubble

Longtime tests indicate yields of cereal grains on disked corn stubble are as good as on plowed corn stubble land. The tests involved clean corn stubble. Where the corn stubble is weedy this may not hold true. Also, where heavy plant residues remain, as after picking ear corn, their presence on the surface would be undesirable from the standpoint of insect control. This would also interfere with getting uniform depth of seed placement. Therefore, it can be expected to have an adverse effect on the yield of the following crop.

Yields of wheat in bushels per acre are given in table III. Yield of oats is given for Williston where wheat was not grown on these tillages.

Where minor differences favor plowing, they are not considered sufficient to pay for the extra cost of plowing.

Frequently, drying winds in the spring will dry the soil the full depth of tillage and cause uneven emergence and stands. Under such conditions, the shallower tillage, which permits placing the seed in the undisturbed soil beneath a soil mulch, has a decided advantage.

Tests have not been made on summerfallow to determine the best

method of preparing the seedbed. However, yield responses to plowing and disking would fall in the same pattern as found on clean corn stubble.

Fall Tillage Preceding Spring Plowing

Subsurface tilling stubble land in the fall preceding spring plowing is a very common practice. A test has been conducted at Minot to measure the value of this practice. The fall tillage is done about Sept. 1.

Results to date show no significant yield advantage for the fall subsurface tilled plots. In some seasons, especially when there is a fall growth of Russian thistle, small benefits are realized. However, on the average, little yield benefit results from the fall tillage, nor can greater weed control be claimed with any degree of certainty.

Possibly, such fall tillages are of more value in areas of higher fall rainfall which induces fall weed growth. There is no indication in the Minot experience that wet falls, of which there have been several during the life of the experiment, have favored fall tillage.

Average wheat yields in bushels per acre and weed counts are given in table IV.

Mustard, wild oats, frenchweed and wild buckweat also were counted. Stands of these were so light that such differences as did exist are not considered of significance.

Summerfallow Tillage

Types of tillage used to control weeds in the fallow year are of minor importance, while timeliness and thoroughness are very important.

Delaying the first cultivation from June 1 to July 1 results in a significant decrease in the yield of wheat. Delaying subsequent cultivations so that weeds can make use of some of the moisture stored in the fallow also reduces wheat yields.

Data on time and method of fallow are given in table V. The different types of tillage were used for the first cultivation only. Subsequent cultivations were identical on all plots. Fallow started later requires one less cultivation than early fallow. Also, "trashy fallow" performed entirely with surface tillage implements usually requires one more cultivation than plowed fallow to get comparable degree of weed control.

The small depression of yield on the one way disk plot at Minot is not of statistic significance. However, a small difference has been consistent throughout the experiment.

TABLE IV.—**Yield of Wheat on Stubble Land Receiving Fall Tillage Preceding Spring Plowing—Minot.**

	1951–1956 5 year average yield	Weeds per square foot-(a) Pigeongrass	Russian thistle
Check—spring plow	16.9	45	11
Fall subsoil 18 inches, spring plow	16.9	61	1
Fall spike 10 inches, spring plow	17.2	78	3
Fall subsurface 3 to 4 inches, spring plow	17.4	60	1

(a) Two year average 1955 and 1956 from unpublished data.

TABLE V.—**Yield of Wheat on Summer Fallow.**

	1927-1951-(a) (2) Dickinson Time		1947-1952-(b) (3) Minot Time		1941–1953 (7) Edgeley	1940–1952 (7) Langdon
Duckfoot	5–1	19.6	6–1	30.1	22.0	27.9
Molboard plow	5–1	19.9	6–1	30.4	22.7	27.8
One way disk plow	...	....	6–1	29.2	....	....
Moldboard plow—straw mulch	...	...	6–1	30.2	....	...
Duckfoot fallow	5–15	21.2	...	....	....	....
Moldboard plow	5 15	21.2	...	....	....	....
Duckfoot	6–1	19.1	...	....	....	....
Moldboard plow	...	....	7–1	27.9	....	....
Moldboard plow—pit	...	....	...	....	22.9	27.9
Number of years avaraged	...	16		5	12	12

(a) Omitting 1934, 1936, 1938, 1940, 1942, 1944, 1946, 1948 and 1950.
(b) Omitting 1949, 1950, 1953, 1954 and 1955.

Engelhorn says, "For summerfallow, stubble mulch tillage has proved as satisfactory as moldboard plowing. Especially was this true at Edgeley. The five year mean yields do not vary essentially with tillage practice. The slightly higher yield obtained by fall pitting of plowed fallow is of no significance. This can be expected since the practice resulted in no increased storage of soil moisture."[4] This statement is supported by data on soil moisture percentage studies to a depth of 60 inches.

Wheat on Fallow versus Continuous Cropping with Small Grains

The principal purpose of summerfallowing is to destroy weeds, to save moisture for the succeeding crop. Fallow also provides a favorable environment for soil organisms to release available nitrogen and other minerals for the following crop. Where corn can be grown and used, this inter-tilled crop can replace fallow economically in the crop sequence.

The yield advantages of fallow are given in table VI.

TABLE VI.—**Yield of Wheat on Fallow and Continuous Wheat.**[7]

	Fargo 1918-1953-(a)	Edgeley 1941–1953	Langdon 1941–1952	Mandan 1915–1953	Dickinson 1908–1951	Minot 1947-1956-(b)
Fallow	27.4	22.7	28.1	21.0	20.9	26.4
Wheat	20.5	17.9	20.3	14.6-(c)	15.2-(c)	18.3
Number of Years Av.	36	13	12	39	44	4

(a) Corn substitute for fallow at Fargo.
(b) Includes yields for 1948, 1951, 1953, 1954 and 1956. The 1953 and 1954 yields were affected adversely by heavy stem rust. Yields for other years were lost to heavy weed infestations on continuously cropped plots. In 1952 they were lost to wind scattering the swathed grain.
(c) After oats.

Yield differences in favor of fallow are greatest in years of below normal rainfall and least in years when moisture conditions are favorable, especially if high moisture brings on a heavy infection of black stem rust.

References

(1) "The Relations Between Crop Yields and Precipitation in the Great Plains Area" by E. C. Chilcott, Sup. 1, USDA Misc. Cir. No. 81.

(2) "Rotation and Tillage Investigations at the Dickinson Experiment Station", N. D. Agr. Exp. Sta. Bul. 383.

(3) ..Results of Nine Years of Crop Experiments on the North Central Agr. Exp. Sta.", N. D. Agr. Exp. Sta. Bul. 389, and data for subsequent years from unpublished data.

(4) "The Effect of Tillage on Soil and Moisture Conservation and on Crop Yields at Langdon and Edgeley", N. D. Exp. Sta. Bul. 341, and for subsequent years from unpublished data.

(5) From unpublished data furnished by the Dickinson Experiment Station.

(6) "Stubble Mulch and Other Cultural Practices for Moisture Conservation and Wheat Production at the Wheatland Conservation Experiment Station, Cherokee, Okla., 1942-1951", Production Research Report No. 6, Agricultural Research Service, USDA.

(7) From unpublished material.

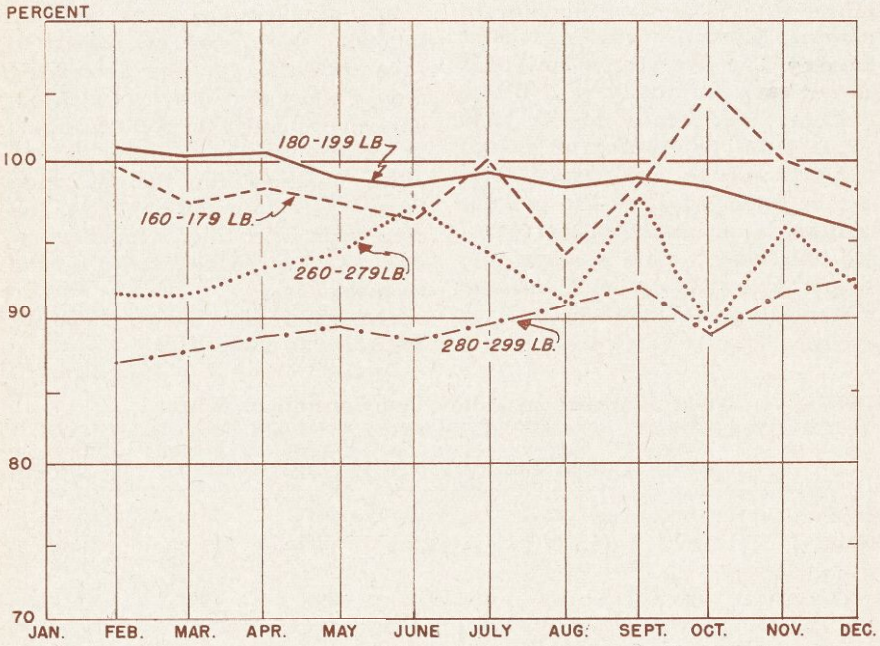

Figure 1.—Average monthly prices of selected weight classes of hogs as a percentage of average monthly price of 200 to 220 pound hogs, Union Stockyards Company, West Fargo, North Dakota, preliminary data for 1955. There are no data listed for January because the study was not begun until February, 1955.