Can Nitrogen Fertilizer and Modern Weed Control Methods

ELIMINATE SUMMERFALLOW?

By Ralph A. Young

IN 1954, almost 4½ million acres of land in North Dakota were summerfallowed (7). This represents 11 percent of the total acreage and 16 percent of the cropland. Many farmers consider the practice an essential part of their cropping system from the standpoint of moisture storage, control of weeds and stabilization of yields.

Not recognized by many is the fact that fallow favors the release of available forms of nitrogen from soil organic matter and allows their accumulation in soil. More soil moisture, fewer weeds and the increased supply of available nitrogen usually result in moderate yield increases of the next crop. The increased yield is obtained at the expense of one season's operations with no crop. Fallow causes a more rapid rate of loss of soil organic matter and allows more soil erosion by wind and water. Is it worthwhile?

Several developments in recent years have lessened the need for summerfallowing. These include selective herbicides and improved short-season row crops which help in weed control, increased supply of commercial nitrogen fertilizer which can be purchased at a more favorable cost, and an increased knowledge concerning the use of fertilizer and the needs of plants for water. Let us look more closely at the benefits and detriments of fallow and the practices which may be used in its place.

Benefits of Fallow

Moisture Is Saved. The amount of water stored during the fallow period varies with the nature of the soil, topography, nature of surface and climatic conditions (especially amount and distribution of rainfall.) In North Dakota the main losses of water are by evaporation and runoff. Small amounts may be lost by leaching below the root zone in years of exceptionally heavy precipitation and on coarse textured soils.

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TABLE I.—**Average Inches of Precipitation and Average Inches and Percentage of Water Saved in the Surface 6 Feet of Soil During the Fallow Period for Wheat for the Years, 1914 to 1934 Inclusive.**

Type of data	PERIOD			
	Harvest to seeding	Seeding time to harvest	Harvest to seeding	Whole fallow period
Precipitation—inches....	6.83	8.62	6.78	22.23
Water saved—inches ...	2.31	1.42	0.76	4.48
Water saved—percent...	34	16	11	20

Table I gives results of moisture storage during the fallow period at Mandan (8) for the period 1914 to 1934. About 4.5 inches or 20 percent of the precipitation during the whole fallow period was saved. From seeding time to seeding time only 2.2 inches, or 14 percent of the precipitation, were retained by the soil. In southern Saskatchewan (6) at 6 to 10 stations in each of 7 years during 1939 to 1950 an average of 4.0 inches of water was saved during the 21-month fallow period. This represents 21 percent of the precipitation. During the fallow season of May one year to April of the next, 1.7 inches, or about 14 percent of the precipitation, were saved.

These results indicate fallow is rather inefficient in saving water. However, even a small amount of water saved, when in addition to that normally available to a crop, may be fairly efficient in increasing yields.

Aids Weed Control. It is well-known that properly managed fallow is quite effective in eliminating or greatly reducing the weed problem. Wild oats and some hardy perennial weeds are not controlled effectively by this practice, but even these may be reduced in number or weakened.

Accumulates Available Nitrogen. Nearly all nitrogen in soil is in the form of organic matter. Plants cannot use this nitrogen until it is converted to available forms such as ammonia or nitrate. The conversion is brought about by soil micro-organisms. Rate of conversion is controlled by numerous factors among which are temperature, moisture, aeration, soil reaction (pH), nutrients, and kind and amount of organic materials.

Bare soil gets much warmer than soils covered with vegetation and normally is well supplied with moisture and air. The rate of conversion of nitrogen from the organic to the simple available forms under these conditions is rapid. Since no plants are present on properly managed fallow, the released nitrogen accumulates in the soil where it may be used by the following crop.

That fallow is effective in releasing available forms of nitrogen from North Dakota soils is indicated by the results

of nitrogen fertilizer trials on fallow land conducted by E. B. Norum, Armand Bauer, and J. C. Zubriski (9). Table II presents the data of these trials.

Since only the soils low in organic matter (some in the western part of the state and the sandy soils) showed any response to nitrogen fertilization it is concluded that fallowing usually is effective in allowing accumulation of available nitrogen. Fallow started late or allowed to get weedy, and that on poorly drained soils, may be exceptions.

In a preliminary study of 6 soils of the "Red River Valley", Young and Marifjeren (9) found as much as 280 pounds of nitrogen in the ammonium and nitrate forms in the top 4 feet of fallowed land. This also indicates that fallowing permits the accumulation of large quantities of available nitrogen.

Detriments of Fallow

Increases Loss Rate of Organic Matter. The increased level of available nitrogen in fallowed fields is obtained at the expense of soil organic matter. During the fallow year not only is decomposition rate increased, but no crop residues are returned. Additional loss of organic matter from the surface soil may occur by erosion which is accelerated by bare land. The data in table III bear out the fact that soil organic matter loss is stimulated by fallowing.

Where fallow occurs only once in three or four years, the rate of loss is intermediate between the two situations shown in table III. The loss of organic matter from row crops is intermediate between close-growing crops and fallow.

Increases Erosion Loss. It is a common observation that summerfallow permits more wind and water erosion than any other practice in North Dakota.

Numerous investigations in other areas indicate soil losses by wind and water are much greater from bare land than from land cropped to small grains. In fact, spring sown small grains grown on spring plowed stubble allows very little erosion. One year's loss of surface soil from fallow may not appreciably affect soil tilth or nutrient supplying capacity of soil, but

TABLE II.—**Influence of Nitrogen Fertilization on Yield of Wheat on Fallow Land.**

			FERTILIZER TREATMENT	
No. of Trials	Situation	Years	P	NP
18	Statewide	1952	19.1	19.1
25	East 2/3 of N. D.	1956-57	35.5	35.3
17	West 1/3 of N. D.	1956-57	28.5	29.4
3	Sandy Soils	1956-57	26.3	28.9

TABLE III.—**Influence of Continuous Small Grains and Small Grains Alternated with Fallow on the Percentage Loss of Total Nitrogen* from Soils. Adapted from Reference 4.**

Location	Years	Continuous small grains	Alternate fallow
		(percent)	(percent)
Mandan	30	18	27
Dickinson	40	44	50
10 locations in Central and Northern Great Plains	30-40	23	31

*Loss of organic matter roughly parallels loss of total nitrogen.

over many years the accumulated loss can result in considerable soil deterioration.

On the unconsolidated or loose parent materials common in North Dakota, erosional loss will not "ruin" the soil, but it makes raising a crop more expensive because of greater fertilizer requirements and the more concentrated effort which must be expended to raise a crop.

A Crop Is Lost. Summerfallow operations require spending money and labor without a return that year.

How Effective Is Fallow? Since 1908, personnel of the various experiment stations in North Dakota have compared yields of grains after small grains and after fallow. Results of these trials are shown in table IV.

Yields of wheat after fallow varied from 27 to 54 percent greater than after wheat and from 11 to 32 percent greater than after corn. If nitrogen fertilizer had been used on the nonfallow land, the apparent benefit of fallow probably would have been less. Conversely, the farmer may obtain greater benefit from fallow than indicated by these data because some benefit, especially from weed control, may carry over into the second and subsequent years after fallow.

TABLE IV.—**Effect of Previous Crop on Yields of Wheat at Various Locations in North Dakota.**

Location	Years	PREVIOUS CROP		
		Fallow	Wheat	Corn
Minot (2)	1947-56*	26.4	18.3	....
Edgeley (2)	1941-53	22.7	17.9	....
Langdon (2)	1941-52	28.1	20.3	....
Mandan (5)	1915-50	21.9	14.9	16.6
Dickinson (1)	1908-52	20.6	13.4	18.1
Hettinger (5)	1912-22	16.9	11.5	15.2
Williston (5)	1910-20	18.6	12.1	15.2
Fargo (2)	1918-53	....	20.5	27.4
Fargo**(9)	1929-55	30.3	22.8	25.9

*Includes yields only for 1948, 1951, 1953, 1954 and 1956.
**Data from 2 separate but similar rotations. Flax was previous crop in place of wheat.

Fallow at best no more than pays for itself in short-term benefits. This, plus the more rapid soil deterioration, points to the fact that fallow is not a desirable practice and should be reduced or eliminated if possible.

Alternatives For Fallow

For Weed Control. During the past 20 years, numerous weed control chemicals have been developed, more reliable short-season row crops have been bred and various improvements in power and tillage equipment permit more effective weed control. Weeds can be controlled with fair effectiveness by proper use of selective herbicides, row crops, late-seeded crops and competitive perennials.

For Available Nitrogen. Commercial fertilizer nitrogen is plentiful and can be purchased at prices much more favorable than 10 to 20 years ago. Its use at moderate to heavy rates can eliminate the need for fallow for the purpose of accumulating available nitrogen. The use of strong legumes such as alfalfa in rotation may reduce the amount of fertilizer nitrogen needed and also help in weed control.

For Moisture Conservation. There is no substitute for water. Alternatives for fallow in this area lie primarily in preventing unnecessary losses and in efficient utilization of the precipitation received. In a very small proportion of the state, irrigation is possible. On the non-irrigated land, loss of water can be reduced by practices such as spring plowing instead of fall plowing, wise use of residues, elimination of excess tillage and by contour farming.

Utilization of water can be made more efficient by eliminating weeds and by keeping fertility high. The results of 29 trials conducted by Zubriski and co-workers (10, 9) in North Dakota between 1952 and 1957 show that fertilized plots yielded an average of 7.7 bushels more wheat that unfertilized plots, yet contained only 0.6 inch less soil moisture in the top 5 to 6 feet at harvest time.

Much of the benefit of fallow commonly attributed to improved moisture relations, in reality, is due to improved nitrogen nutrition. Much of the state receives enough precipitation to produce good yields most years if fertility is kept at high levels and weed competition is eliminated. The same is true of many favored moisture sites in the rest of the state.

Are The Alternatives For Fallow Practical?

At Dickinson, corn is considered a desirable substitute for fallow (1). Wheat after fallow yielded an average of about 2.5 bushels more than after corn. This is without the benefit of

nitrogen fertilization. The 17.9 bushels of corn grain, or 4 tons of silage, and less prospect of soil deterioration, certainly should be worth more than 2.5 bushels of wheat.

During the 3 years, 1954 to 1956, wheat on sweetclover fallow at Fargo averaged 42.5 bushels per acre (9). On corn ground it yielded 27.0 without nitrogen fertilization and 40.9 bushels per acre with an application of 60 pounds of nitrogen.

On corn plots which had been manured and phosphated over a 40-year period, the corresponding yields of wheat were 32.0 without nitrogen and 44.8 bushels per acre with nitrogen fertilization. These results were obtained from separate but similar rotations. The corn crop which averaged over 75 bushels per acre during this period can pay for the $8.00 to $9.00 worth of nitrogen fertilizer used on the wheat and still give a good profit over that obtained from fallow.

At Mandan, the results for the period 1955 to 1957 showed that wheat treated with adequate nitrogen and phosphorus fertilizer following corn or small grain has yielded nearly as much as it has yielded after fallow (3).

These data are too few to permit secure conclusions, but they indicate the use of nitrogen fertilizer and good weed control methods can bring yields of wheat on nonfallow land to the levels obtained on fallow, and you avoid the loss of the crop which accompanies fallow.

Conclusions

1. With modern techniques of weed control and use of adequate amounts of nitrogen fertilizer, summerfallow can almost be eliminated from the cropping systems of Eastern North Dakota and the favored moisture sites in the rest of the state. This is especially true in the areas where row crops are profitable.

2. In the drier portions of the state and where row crops are not profitable, there is less chance of eliminating it, but its acreage can be reduced.

3. In seasons when soil is moist to a depth of 2 feet or more at seeding time and weeds are under control, there is little or no justification for fallowing in any part of North Dakota.

4. An occasional fallow may be required to control some weeds, such as quackgrass.

5. By reducing or eliminating fallow, current income should be increased, and better long-term maintenance of soil will be accomplished.

REFERENCES

1. Douglas, Raymond J. and Thomas J. Conlon. 1953
Tillage Methods and Crop Rotations in Southwestern North Dakota.
N. Dak. Agr. Exp. Sta. Bul. 381.

2. Geiszler, G. N. 1957.
Crops Yields are Affected by Tillage Practices.
N. Dak. Agri. Exp. Sta. Bimonthly Bulletin Vol. XIX, No. 6, 3-8.

3. Haas, H. J.
Correspondence Dec. 1957 and Annual Report 1957.
Agri. Res. Serv., U.S. Dept. Agr., Mandan, N. Dak.

4. Haas, H. J., C. E. Evans and E. F. Miles. 1957.
Nitrogen and Carbon Changes in Great Plains Soils as Influenced by Cropping and Soil Treatments.
U. S. Dept. Agr. Tech. Bul. No. 1164.

5. Matthews, O. R. 1951.
Place of Summerfallow in the Agriculture of the Western States.
U. S. Dept. Agr. Circ. No. 886.

6. Staple, W. J. and J. J. Lehane. 1952.
The Conservation of Soil Moisture in Southern Saskatchewan.
Scientific Agriculture 32:36-47.

7. Taylor, Fred R., C. J. Heltemes and R. F. Engelking. 1957.
North Dakota Agricultural Statistics.
N. Dak. Agr. Exp. Sta. Bul. 408.

8. Thysell, J. C. 1938.
Conservation and Use of Soil Moisture at Mandan, N. Dak.
U. S. Dept. Agr. Tech. Bul. 617.

9. Unpublished data.
North Dakota Agricultural Experiment Station.

10. Zubriski, J. C. and E. B. Norum. 1955.
What Effect do Fertilizers Have on Soil Moisture Utilization by Wheat?
N. Dak Agr. Exp. Sta. Bimonthly Bulletin, Vol. XVII, No. 4, 126-127.

Cover Story

Field experiments in all parts of North Dakota generally have shown profitable increases by using fertilizer on farm crops. Small grains have responded to phosphate used on fallow in 80 percent of these trials. Phosphate has given an average per acre yield increase of 4.8 bushels of wheat and 8 bushels of barley when used for these crops on summerfallow.

There is some evidence available that shows nitrogen fertilizer and modern weed control methods may, in some cases, eliminate summerfallow. You can draw your own conclusions from the story on page 3.