

The Value of Crop Rotation

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[Note.—The following article should have particular meaning to the Western farmers after such a season as we have just had. Besides making better use of the plant food, and keeping the physical condition of the soil such that the maximum yields can be produced, rotation of crops also removes the great risks involved in staking everything on one crop. Perhaps there has never been a season in the history of the West when it was possible to produce such a large amount of food from the soil as could have been produced this year, and perhaps there has never been a season when the farmers as a whole have been more disappointed and discouraged through crop failure. The reason is that they have staked everything on one or two grain crops.]

Weather conditions at a certain two or three weeks of the year have not been favorable to their particular crop. The result has been failure. Who is to blame? The weather, of course; but the weather that was unfavorable to the wheat crop might have been very favorable to some other crop. Weather conditions, like soil conditions, must be adapted to a variety of plants, because man's needs are variable. When man undertakes, in defiance of natural law, to grow only one crop on a soil and in a climate that was intended for a variety of crops, who is to blame when every two or three years his particular crop meets with disaster? Wise rotation of crops is simply bringing our system of farming into harmony with the unalterable laws of nature, which laws, it must be remembered, are after all best suited to meet man's needs. If our Western farmers would follow such a system they would insure against periodical crop failures, so disastrous both to the individual and the community (city and country), and they would also do much to overcome the present scarcity of farm labor by dividing the work more evenly over all parts of the year. While such a system of farming may not be practicable in newer parts where the settlers are just making a start and must have quick returns, it is applicable in the older parts and must ultimately be adopted.]

The chemist tells us that the value of crop rotation lies in the consequent provision of an abundant supply of organic and mineral matter containing all of the essential elements of plant food; the physicist that it lies in the consequent betterment of the physical texture of the soil; and the bacteriologist that the value is in the more numerous forms of bacterial life found in a soil upon which the crops have been rotated. The farmer who has practised a well balanced scheme of crop rotation tells us that the value of rotation lies in the greater net profit per acre returned each year from his land. And each one is right in his way of thinking. Larger yields invariably follow a systematic rotation, because the growth of the grass crops, including the clovers, results in an accumulation in the soil of roots, leaves and stems of plants which we call vegetable

matter. The tillage of cultivated crops following the grass crops in a well planned rotation breaks down this vegetable matter more rapidly, introduces air and moisture freely and hastens fermentation or bacterial action, resulting in greater warmth in the soil. As a result, decomposition is hastened, available plant food is abundant and the chemist has reason for his statement that the soil fertility has been increased. It is the combination, however, of physical, chemical and bacteriological forces, rather than the separate effect of any one of them, that gives the results.

Composition of Soil

As is well known by most people, the elements most likely to be lacking in the soil, are nitrogen, phosphoric acid, potash and lime. To show that it would take a long period of time to deplete the normal soil of these elements, I offer the following figures taken from Snyder's Soils and Fertilizers, calling attention also to the fact that most of our farm crops feed in the surface foot of the soil:

Surface—1 foot of soil contains	Crops require annually	Time to exhaust elements
	Lbs.	
Nitrogen 5,000—10,000	25—100	50—400 yrs.
Phos. Acid 1,000—9,000	25—	40—360 yrs.
Potash 3,000—18,000	35—60	50—514 yrs.

A study of the figures indicates that most soils contain sufficient of each of the elements to last approximately 200 or more years if all were used. It is common knowledge, however, that only a small proportion of these elements becomes available at one time. Owing to improper tillage and physical condition of the soils there is often a scarcity of available elements even though a large supply of the essential elements is known to be present in the soil. On new lands the available elements are usually abundant and but little attention is paid to the needs of the growing crops. But on land that has been farmed for some time, the farmer must consider the needs of the crops and so arrange his cropping scheme and till his land as to render available for the growing plants an abundance of these elements. It is in affording a regular arrangement of crops which can be followed from year to year that crop rotation becomes especially valuable in increasing soil productivity. The matter of making such arrangements is not nearly so difficult as many suppose.

What Rotation Means

Crop rotation means simply the classification of crops according to their habits of growth and methods of cultivation, and systematic and regular change in the order of growth. Crops are classified as (1), grain crops, including wheat, oats, barley, rye, flax or other cereals; (2) grass and legume crops, including the grasses, clovers and alfalfas commonly grown; and (3), the cultivated crops, including corn, potatoes, roots or any other crops requiring intertillage. The grain crops have fibrous roots, feed close to the surface and are almost entirely removed from the land in harvesting. A small amount of stubble and the roots of the plant are returned to the soil so that the amount of vegetable matter is not seriously depleted. They are therefore said to be neutral as to effect on the humus content of the soil. The grass and legume crops, through the development of leaves, crowns and tap roots, add materially to the vegetable matter of the soil and they are classed as humus builders. The cultivated crops, on account of frequent tillage of the land and rapid decomposition, rapidly reduce the amount of vegetable matter in the soil and are therefore said to be humus destroying. It is the proper combination of these three classes of crops in such manner as to provide for the food products required on the farm without depleting the natural productivity that results in increased returns from the soil.

Results Achieved

To illustrate the value of rotation of crops, I am going to ask your attention to the results of some work in the cro-

rotation at University Farm, St. Anthony Park, Minnesota. On some plots of land we have been growing cultivated crops continuously since 1894. The soil on these plots is becoming devoid of vegetable matter and crop yields are low. This soil bakes easily and is hard to handle. On plots sown to mangels each year, great difficulty is experienced in getting a stand of roots, owing to attacks of fungus or parasitic organisms on the germinating seeds. On an adjoining plot where a five-year rotation is practiced, the soil is open and pliable, good stands are obtained and yields are quite satisfactory.

The true value of rotation is shown in the yields of the crops grown under the different schemes of cropping. A comparison of the tables submitted herewith will show that rotation increases the yield of each of the three classes of crops materially.

Yields of Wheat in Continuous Cropping and in 3- and 5-Year Rotations Compared

	Continuous wheat	Continuous wheat 6 lbs. clover	Wheat in 3-year rotation	Wheat in 5-yr rotation
1900	14.5	10.8	27.3	25.6
1901	16.0	11.3	13.5	15.2
1902	17.0	15.0	18.1	25.1
1903	16.3	24.1	24.4	30.8
1904	20.8	32.5	27.3	32.0
1905	20.8	23.3	20.6	30.9
1906	14.1	15.0	13.3	22.6
1907	24.5	25.3	19.1	23.9
1908	19.1	20.0	22.4	25.0
1909	22.7	25.0	20.3	35.5
10 yr. ave.	18.58	21.13	20.63	26.66

3-year rotation, wheat, clover, corn.
5-year rotation, wheat, timothy and clover, pasture, oats, corn. Eight tons barnyard manure on oats stubble.

Yields of Corn Continuous Cropping and in 3- and 5-year Rotations Compared

	Continuous corn	Corn in 3-year rotation	Corn in 5-year rotation
1900	37.5	42.6	58.0
1901	13.9	42.8	42.8
1902	Lost	62.0	78.6
1903	23.6	54.7	85.3
1904	11.1	45.1	37.1
1905	25.1	64.1	64.4
1906	27.6	36.1	60.5
1907	23.6	35.2	52.2
1908	33.3	38.6	53.6
1909	41.6	39.2	76.1
	26.4	46.4	60.8

Average of corn in cont. plots yrs. 1899, '04-'09, 24.5.
Average of corn in standard rotation plots, 1899, '04-'09, 60.01.

*Average of 9 years only. Weights of 1901 not used.

Yield of Hay in Continuous Cropping and in 3 and 5-Year Rotation Compared

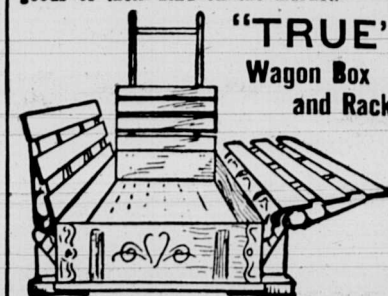
	Continuous hay tons	3-yr. M.F. Rotation clover tons	5-yr. M. F. clover and timothy tons
1901	.95	1.58	2.36
1902	1.27	2.25	1.95
1903	3.65	3.86	6.10
1904	1.95	4.26	5.77
1905	1.70	4.86	5.81
1906	...	1.91	2.18
1907	1.10	1.25	1.30
1908	1.55	3.24	5.01
1909	...	...	...
1910	...	.6	1.00
Av. 10 yrs.	1.22	2.33	3.15

Wheat continuously yielded an average of 18.6 bushels per acre. Six pounds of clover sown with the grain in the spring and plowed under in the fall gave an increase of 2.5 bushels per acre or 13½ per cent. Wheat grown in a 3-year rotation of wheat, clover and corn for the same years, yielded 20.6 bushels per acre, an increase over continuous cropping of 2 bushels per acre or 11 per cent.

In the 5-year rotation, the yield of wheat for this period was 26.6 bushels per acre, an increase of 8 bushels per acre which is 43 per cent. over the continuous cropping to wheat, and an increase of practically 30 per cent. over the three-year rotation. The five-year rotation calls for eight tons of barnyard manure preceding the corn crops.

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The manure and the extra year in grass are doubtless responsible for the increased yields from the five year rotation.

Corn continuously yielded during the ten years 1900—1909, 26.4 bushels per acre. In the three-year rotation of wheat, clover and corn, corn yielded 46.4 bushels, or 20.0 bushels more, an increase of 76 per cent. due directly to rotation with the use of clover. During the same years in the five-year rotation, the yield was 60.8 bushels per acre or 34.4 bushels per acre more than was grown on the land continuously to corn. This is an increase of 130 per cent. The increase of the five-year over the three-year rotation was 14.4 bushels per acre or 31 per cent.

Result on Hay Crop

The yield of hay in the continuous cropping plan was 1.22 tons per acre as compared with 2.33 tons in a three-year rotation and 3.15 tons in the five-year rotation. This shows an increase of 1.1 tons per acre or 91 per cent in favor of the three-year rotation and 1.9 tons or 158 per cent. in favor of the five-year rotation. The five-year rotation is .8 tons or 35 per cent. more productive than the three-year rotation.

To make the comparison in another way, a short rotation (three years) without manure, increased the wheat yield 11 per cent., the corn yield 76 per cent. and the hay yield 91 per cent. A five-year rotation in which eight tons of barnyard manure is applied once in the rotation, the increase is 43 per cent. on the wheat crop, 130 per cent. on the corn crop, and 158 per cent. on the hay crop.

The difference between the values of the three and five-year rotations and in favor of the five-year rotation is 300 per cent on the wheat crop, 31 per cent. on the corn crop and 35 per cent. on the hay crop.

This seems perhaps like a mass of figures and percentages, but it indicates clearly to me that rotation of crops alone, without manure, has a marked value in increasing production. And that a combination of rotation and manures properly applied will practically double the yields of all of our crops.

Couple with this value the more even distribution of labor throughout the year, the less expensive handling of the crops, the reduction of weeds and crop pests and the possibility of producing a product of higher grade where good rotation schemes are followed and you have a suggestion of the value of crop rotation

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