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12-1-1945

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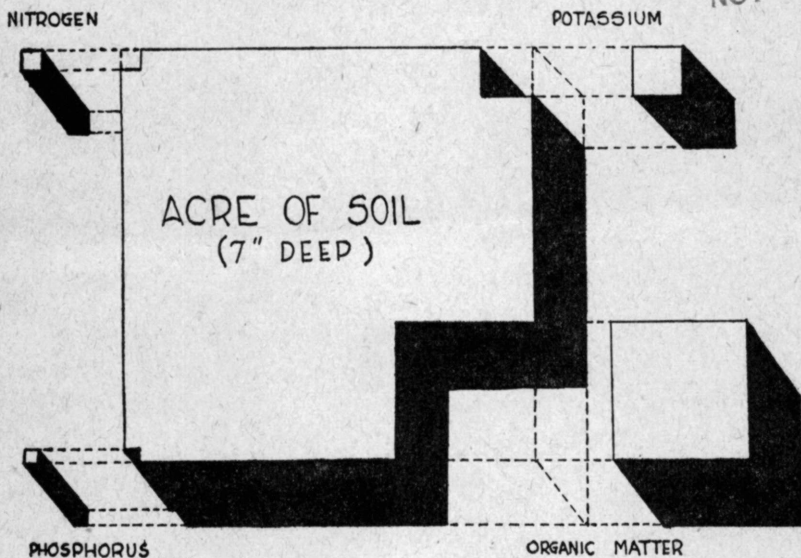
South Dakota Agricultural Experiment Station, "Field Trials with Fertilizers in South Dakota 1945" (1945). *Agricultural Experiment Station Agronomy Pamphlets*. 6.  
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# FIELD TRIALS WITH FERTILIZERS IN SOUTH DAKOTA 1945

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**Corner Stones of Soil Wealth**

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# Field Trials With Fertilizers in South Dakota, 1945

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## INTRODUCTION

Successful agriculture is dependent upon the maintenance of soil fertility. The problem of maintaining the fertility of our soils is not new. Since the early settlers first tilled the soil, more fertility or plant food has been taken out of the soil than has been returned through soil building practices. The high productivity of virgin soils has been attributed to their higher content of plant food and organic matter. Continuous cropping has depleted our soils of a considerable portion of their original plant food. This is especially true for the plant food elements nitrogen and phosphorus. Maintenance of the productive capacity of the soil requires the restoration of plant food through soil improvement practices which include returning manure, crop residues, plowing under legume crops, and the application of fertilizer. Of the ten primary elements essential for the growth of crops, only three may be deficient in soils, nitrogen, phosphorus and potash. These elements or plant food materials occur naturally in the soil in varying amounts, depending upon the type of soil and past soil management practices. When the fertility of the soil is not high enough for maximum crop production, plant food may be added by the application of fertilizers. In order to determine the kind and quantity of plant food to apply to the soil it is necessary to conduct field trials with fertilizers. Therefore, experiments are being conducted on different soil types and with different crops to determine the fertilizer need of South Dakota soils.

## EXPERIMENTAL PROCEDURE

In 1945 field experiments were conducted on private farms in order to study the effect of the application of plant food in the form of fertilizer on the yields of crops. Soil fertility plots were located in 15 counties. The plots were so distributed that the locations would be representative of the major crop and soil areas. County Agents and Soil Conservation Service assisted in locating and making arrangements with the farm cooperators.

These plots were established on private farms by arrangement with the owner of the farm. The entire field including the plot is farmed in the usual manner by the farmer and the plots received no special cultural practices except the application of the fertilizer. The fertilizer applications and the samples of the crop taken for yield were made by members of the Experiment Station staff. From time to time during the growing season the plots were inspected to note the condition of the crop or any damage which may have occurred due to insects, hail or excessive water, etc.

## FERTILIZERS AND RATE OF APPLICATION

The plant food elements, nitrogen, phosphorus and potash are the principal elements which enter into the makeup of commercial fertilizers. These three elements are sometimes called the primary elements of plant food because they are used heavily in crop production and may become deficient in soils. These elements may occur singly or in combination in commercial fertilizers. If all three elements enter into the composition of the fertilizer it is known as a complete fertilizer.

The plant food was applied to the fertilizer test plots in the following forms: nitrogen in ammonium sulphate, phosphorus in treble superphosphate and potash in muriate of potash. The rates were 100 pounds ammonium sulphate, 100 pounds treble superphosphate and 50 pounds muriate of potash, respectively per acre. The same rates were used whether the fertilizer was applied alone or in combination.

## FERTILIZERS FOR SMALL GRAINS

The influence of various fertilizer treatments on the yields of small grains is shown in Table 1. Increases in the yields of small grains followed the application of fertilizer containing nitrogen and phosphorus.

Table 1. Small Grain Yields in Bushels per Acre on Fertility Plots

Treatment*	Rye		Barley		Wheat		Oats			
	Grant County	Day County	Grant County	Day County	McCook County	Clay County	Union County	Lincoln County	Average for Oats	
None .....	21	37	39	23	81	61	40	38	55.0	
N .....	22	47	42	29	69	75	56	62	65.5	
P .....	27	46	42	32	88	59	58	38	60.7	
K .....	26	39	42	28	92	61	47	39	59.7	
NP .....	27	52	42	35	92	82	90	64	82.0	
NPK .....	29	53	43	35	97	80	90	78	86.2	

\*N—Nitrogen, P—Phosphorus, K—Potash

While either nitrogen or phosphorus alone increased the yield, the largest increases were obtained when the two elements were applied together. In some instances potash gave some increase in grain yields, but the data indicates that South Dakota soils are relatively well supplied with potash for small grain production. For the oats crop the average increase in yield following nitrogen-phosphorus was 27 bushels and following nitrogen-phosphorus-potash the increase is 31.2 bushels. The fertilizer trials for small grains were conducted on several distinct soil types having considerable variation in fertility. For this reason the response to fertilizer varies in the different counties. The soils which were deep, dark and level gave the least response, while the shallower, lighter colored soils developed on rolling land gave the most response. For this reason it will be necessary for farmers to be guided by the condition of their soil in determining the kind and quantity of fertilizer to be used on the small grain crop.

## FERTILIZERS FOR CORN

The effect of fertilizer treatments on the yields of corn are given in Table 2. The largest increases in yield were obtained when the fertilizer treatment included nitrogen-phosphorus-potash. In the counties where corn reached maturity the effect of fertilizer treatment is more pronounced. This is especially true for Union and Lincoln counties. Nitrogen or phosphorus applied alone gave increases in every county where the corn ripened normally. Potash applied alone gave very little if any increase on corn. The average increase in corn yields for all counties was 7.2 bushels for nitrogen-phosphorus and 10.3 bushels for nitrogen-phosphorus-potash.

Table 2. Corn Yields in Bushels per Acre on Fertility Plots

Treatment	Clay* County	Union County	Lincoln County	McCook County	Moody* County	Grant County	Average Bu./Acre
None .....	65	63	42	41	32	54	49.5
N .....	71	75	61	45	30	55	56.2
P .....	75	78	47	47	36	58	56.8
K .....	63	67	45	43	30	49	49.5
NP .....	60	85	55	48	33	59	56.7
NPK .....	69	80	61	51	34	64	59.8

\*Corn very prematurely killed by frost.

## FERTILIZERS FOR POTATOES

Data in Table 3 gives the results of fertilizer trials for potatoes. Each of the three major elements of plant food—nitrogen, phosphorus and potash—increased the yields of potatoes when applied alone or in combination. However, the largest increases in yield were obtained by a combination of nitrogen-phosphorus, and nitrogen-phosphorus-potash.

Table 3. Potato Yields on Fertility Plots

Treatment	Hamlin County Bushels	Codington County Bushels	Clark County Bushels	Average Bushels/Acre
None .....	168	199	118	161.7
N .....	167	214	160	180.3
P .....	228	267	171	222.0
K .....	196	268	144	202.7
NP .....	248	287	174	236.3
NPK .....	260	298	175	244.3

## YIELDS OF HAY AND GRASS SEED

The yields of hay and grass seed from variously fertilized plots may be seen in Tables 4 and 5. The application of nitrogen had the greatest effect on increasing hay yields. The heavier application of nitrogen produced the largest returns. Phosphorus was helpful only in Deuel county on the bromegrass. Grass seed yields were increased only with nitrogen fertilizer.

**Table 4. Hay Yields on Fertility Plots**

Treatment	Crested wheatgrass	Ree wheatgrass	Smooth bromegrass		Average Pounds/Acre
	Jackson County Pounds	Brookings County Pounds	Hand County Pounds	Deuel County Pounds	
None .....	748	4483	1625	1001	1964
N .....	1012	5450	1957	1717	2534
2N .....	1504	5266	3250	2353	3093
NP .....	1189	4702	2335	2097	2581
2NP .....	1388	5302	3223	3046	3240

**Table 5. Grass Seed Yields on Fertility Plots**

Treatment	Crested wheatgrass	Ree wheatgrass	Smooth bromegrass		Average Pounds/Acre
	Jackson County Pounds	Brookings County Pounds	Hand County Pounds	Deuel County Pounds	
None .....	32	39	2	255	82.0
N .....	87	59	21	299	116.5
2N .....	124	59	60	419	165.5
NP .....	70	42	29	366	126.7
2NP .....	104	75	41	408	157.0

## METHODS OF APPLYING FERTILIZER FOR CORN

The effect of method of fertilizer application to crops is of considerable importance. In Table 6 are presented the results of various methods of applying fertilizer to the corn crop. The amount and kind of fertilizer applied was the same for each treatment. The results of this test for one year show that the placement of fertilizer in a narrow band in the plow sole with a fertilizer attachment on the plow is superior to all other methods. This method of application has the distinct advantage of placing the fertilizer where the soil is usually moist and where the plant roots may easily reach the fertilizer. The corn planter attachment which places the fertilizer close to the soil surface near each hill was found to be the least effective.

**Table 6. Method of Applying Fertilizer for Corn in Brookings County**

Method of Applying Fertilizer*	Average Yield Bushels/Acre
None .....	30.1
Broadcast on surface and disked in .....	36.0
Corn planter attachment .....	34.7
Broadcast on surface and plowed under .....	42.8
In plow furrow with plow attachment .....	45.8

\*250 pounds of 10-12-6 analysis fertilizer per acre was used.

## FERTILIZERS ON SUBSOIL FOR CORN

It is frequently necessary to level land before irrigation practices can be carried out. This process results in removing the surface soil and exposing the subsoil. The subsoil is lacking in nitrogen and available phosphorus. In Table 7 are presented the effects of various soil treatments on the yields of corn. The data indicates that soil treatments which return nitrogen and phosphorus either in commercial fertilizer or manure are very effective in increasing the yields of crops growing on the subsoil.

Table 7. Yield of Corn Under Irrigation on Subsoil in Lawrence County

Treatment*	Average yield in bushels per acre on 15% moisture basis
No treatment .....	6.7
Nitrogen .....	4.5
Nitrogen-Phosphorus .....	51.1
Nitrogen-Phosphorus-Potash .....	40.4
$\frac{3}{4}$ NPK + $\frac{1}{4}$ Manure .....	45.2
$\frac{1}{2}$ NPK + $\frac{1}{2}$ Manure .....	39.2
Manure .....	41.8

\*Manure applied at the rate of 25 tons/acre, Ammonium sulphate 300 pounds, Treble superphosphate 200 pounds, and potash 100 pounds.

## RECOMMENDATIONS

The following general recommendations for fertilizer are made for South Dakota.

Crops	Amount per acre	Analysis
Small grains .....	100 to 150 lbs.	4-24-12 or 10-20-0
Corn .....	100 to 200 lbs.	4-24-12 or 10-20-0
Hay and pastures, and grass seeds .....	100 to 200 lbs.	20-0-0
Potatoes .....	300 to 500 lbs.	4-24-12

On soils prepared by leveling for irrigation heavy applications of fertilizer and manure must be used to produce a crop. About 200 to 400 pounds per acre of a complete fertilizer, containing a 10-10-5 analysis, plus manure and crop residues are recommended.

A combination of fertilizer-grain drill is recommended for applying fertilizers to small grains or grass seedings. For corn the placement of fertilizer in a narrow band in the plow sole with a fertilizer attachment on the plow has proven best. The corn planter attachment was found to be least effective. For potatoes the fertilizer attachment on the planter or plow sole application with the attachment on the plow are recommended methods.

In conclusion, it should be emphasized that commercial fertilizers are not a substitute for other well established soil management practices. Crop rotations including legumes and grasses, the return of crop residues, and the use of manure supplemented with commercial fertilizers constitute good soil management.