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MIXING FERTILIZERS on the farm

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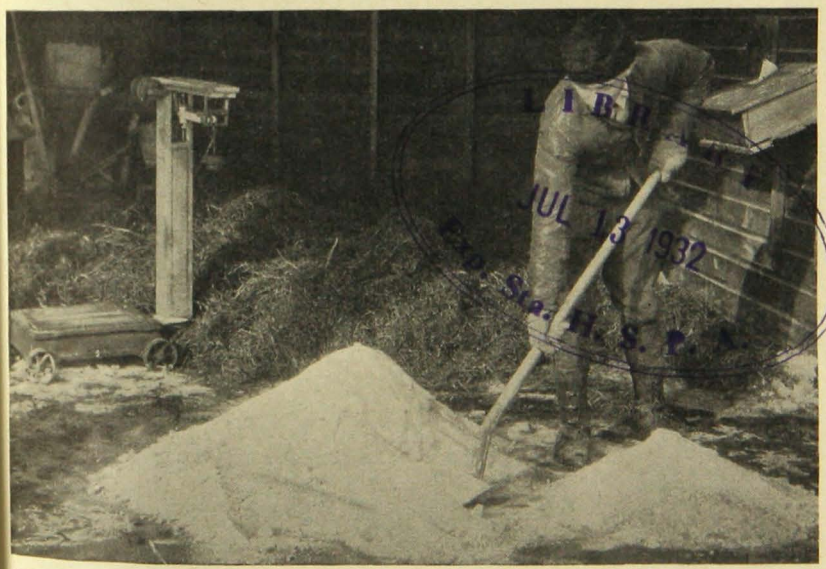

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MIXED fertilizers may be easily prepared on the farm, and at times with considerable saving to the farmer or gardener. All that is needed is an understanding of the principles involved, a few simple tools ordinarily found on the farm, and a supply of the proper unmixed fertilizers.

The advantage of home-mixed fertilizers lies chiefly in the possible saving in cost, which at times amounts to $10 a ton, or more. There is also a certain educational value to home mixing. The farmer will learn much about the composition, availability, and relative merits of different fertilizer materials by mixing them. This will lead to a more intelligent use of fertilizers.

When home-mixed and factory-mixed fertilizers are alike in composition they contain the same amount of available plant food, and experiments have shown that the home-mixed goods are equal in plant producing power. The economy of mixing will depend upon both the saving per ton and the amount mixed, as the cost of materials purchased in relatively large amounts will ordinarily be lower than if purchased in small amounts. With lots of less than 1,000 pounds, home mixing is of doubtful economy because the amount saved will rarely pay for the trouble.

Some advantages are claimed for factory-mixed goods over home-mixed fertilizers—the product is more uniform, more free from caking, and in better mechanical condition, making possible a more uniform and easier application with the planter or drill. This should not discourage the farmer that wants to prepare his own mixtures. If the ingredients used are in good condition and are mixed carefully the results will be satisfactory.

Home-mixed fertilizer may harden or cake if it is mixed too long before it is used and will seriously interfere with the use of the drill. If the fertilizer is kept in a dry, unheated place after being mixed no difficulty in this respect need be feared for at least two or three weeks. The larger the proportion of filler used the less likely is the mixture to cake. If the fertilizer is to be applied soon after mixing it is unnecessary to use filler.

PLANT FOOD SUPPLIED BY FERTILIZERS

Nitrogen, phosphate (often referred to as phosphoric acid), and potash are the three kinds of plant food most likely to be deficient in soils and accordingly to be supplied in commercial fertilizers. Fertilizers containing only one of these are commonly referred to as "straight or unmixed;" those containing two or all three are called "mixed fertilizers." When a product contains nitrogen, phosphate, and potash it is spoken of as a "complete fertilizer."

Unmixed fertilizer materials may be purchased from most firms

engaged in the sale of fertilizers. A list of the Minnesota companies may be had by writing to the Division of Soils, University Farm, St. Paul, Minnesota.

THE FERTILIZER UNIT

Fertilizers are often sold on the basis of the unit. A unit means one per cent of a ton, or 20 pounds of plant food. A ton of 45 per cent superphosphate carries 45 units of phosphate and a ton of complete fertilizer of the formula 4-16-4 carries 24 units—4 units of nitrogen, 16 of phosphate, and 4 of potash. The cost of one unit is obtained by dividing the cost per ton by the number of units. If 20 per cent superphosphate costs $32 per ton, the cost of one unit is $1.60. If two fertilizers supplying the same constituent are being considered, such as 20 per cent and 45 per cent superphosphate, the calculation of the cost per unit shows which is the less expensive.

FERTILIZER FORMULAS AND WHAT THEY MEAN

The composition of mixed fertilizers is expressed by such formulas as 4-16-4 and 0-9-27. The first figure stands for the percentage of nitrogen (N), the second for the percentage of available phosphate (expressed as phosphoric acid, P_2O_5), and the third for potash (K_2O). Thus a 4-16-4 fertilizer contains 4 per cent of nitrogen, 16 per cent of phosphoric acid, and 4 per cent of potash; the 0-9-27 formula contains no nitrogen, 9 per cent of phosphate, and 27 per cent of potash. The Minnesota fertilizer law requires that the composition of both mixed and unmixed fertilizers shall be printed on the container or on a tag attached to it. The manufacturer guarantees this composition and it is commonly referred to as the "guaranteed analysis." Usually the fertilizer actually contains slightly more of each constituent than is shown by the guaranteed analysis, but seldom less.

Straight or Unmixed Fertilizers

A considerable variety of straight or unmixed fertilizers is offered for sale. Table 1 gives those generally obtainable and the kind and approximate percentage of plant food in each. Any of these materials may be mixed without danger of loss of nitrogen or of the change of the phosphate to less readily available form if a filler is used, as dry soil, dry fine sand, or sifted coal ashes.

New Concentrated Fertilizers

Several very concentrated fertilizers now manufactured are given in the last part of Table 1. The 43 to 46 per cent superphosphate and ammonium phosphate (13-52-0) are easily obtainable in Minnesota. Urea, a nitrogen fertilizer carrying 46 per cent of nitrogen; and nitrophoska, a complete fertilizer, may be purchased but not so readily. The most common nitrophoska is one having the formula

15-30-15, one ton of which is equivalent in plant food to 3 tons of a 5-10-5 complete fertilizer.

Table 1

Fertilizer Materials Suitable for Home Mixing

Fertilizer	Nitogren, per cent	Phosphoric acid, per cent	Potash, per cent
1. Nitrogen fertilizers			
Nitrate of soda	15 to 16	.....	.....
Sulphate of ammonia	20	.....	.....
Dried blood	14	.....	.....
Nitrate of lime *	17	.....	.....
Leunasaltpeter *	26	.....	.....
Urea	46	.....	.....
2. Phosphate fertilizers			
Superphosphate	.....	16	.....
Superphosphate	.....	20	.....
Superphosphate	.....	43 to 47	.....
Steamed bonemeal	1 to 1½	22 to 29	.....
3. Potash fertilizers			
Imported muriate of potash †	.....	.....	48 to 50
Trona or Kemfert muriate of potash ‡	.....	.....	58 to 60
Sulphate of potash	.....	.....	48 to 50
4. Concentrated mixed fertilizers			
Ammonium phosphate	11 to 13	48 to 52	.....
Nitrophoska	15	30	15

* Ordinarily not so readily obtained as the others.
† From Germany or France.
‡ From California.

FERTILIZERS OF HIGH ANALYSIS COST LESS PER UNIT OF PLANT FOOD

Of two fertilizers supplying the same constituent in equally available form, the one carrying the higher percentage will cost more per ton but ordinarily less per unit of plant food. For example, in 20 per cent superphospate costing $32 a ton the price per unit of phosphate is $1.60 ($32 divided by 20) and of 45 per cent superphosphate costing $60 per ton the price is $1.33 ($60 divided by 45). One ton of the latter would furnish as much available phosphate as 2¼ tons of the 20 per cent material and the cost at the above prices would be $60 for the 45 per cent material and $72 for the 20 per cent. While the cost per ton of the 45 per cent material is very much higher, the price per pound of plant food is considerably less. The cost per unit of nitrogen in two nitrogen fertilizers or two potash fertilizers may be compared in the same way. When making such comparisons, however, the comparisons must be made only between fertilizers that contain the constituent in equally available form. Generally the cost per unit of plant food is less in the concentrated materials and accordingly usually more economical.

When selecting fertilizer material for home mixing, the purchaser should be guided by the cost per unit of the constituents needed, remembering that in purchasing the lower grade materials a greater

weight must be hauled home and later handled in the field. It is necessary to use ingredients of high analysis if a mixture of high analysis is to be made. For mixing fertilizers of lower analysis it is desirable under some conditions to use less concentrated materials, as less filler is needed. In general, mixed fertilizers of high analysis are to be recommended, with a proportionately lower rate of application per acre. If a 4-24-4 instead of a 2-12-2 mixture is made and applied at 100 pounds per acre instead of 200 pounds, the same amount of plant food per acre would be supplied. The former can be made by using 40 to 45 per cent superphosphate but not with 16 or 20 per cent superphosphate, as more than a ton of either would be required to furnish 24 units of phosphate.

FINDING THE COST OF A TON OF ANY DESIRED FORMULA

When the price per unit of nitrogen, phosphate, and potash in unmixed material is known, the cost of the constituents to make a ton of fertilizer of any desired formula may be easily computed. In the following examples the unit prices assumed are:

	Price 1 per unit	Price 2 per unit
Nitrogen	$ 2.50	$ 3.00
Phosphoric acid	1.30	1.45
Potash	1.00	1.20
Cost per ton of 4-16-4		
4 units of nitrogen	10.00	12.00
16 units of phosphate	20.80	23.20
4 units of potash	4.00	4.80
Total	$34.80	$40.00
Cost per ton of 0-9-27		
No nitrogen needed		
9 units of phosphate	11.70	13.05
27 units of potash	27.00	32.40
Total	$38.70	$45.45

AMOUNTS OF STRAIGHT MATERIAL NEEDED FOR A DESIRED FORMULA

In the preparation of a mixed fertilizer, the quantity of straight or unmixed material required will depend upon the composition desired. In order to mix a fertilizer with a definite formula it is necessary to calculate the number of pounds of each material needed. Knowing the composition of the unmixed goods, this is not difficult. For instance, let it be assumed that a mixed fertilizer having 4 per cent of nitrogen is desired and nitrate of soda containing 16 per cent nitrogen is to be used to supply it. For a ton, 80 pounds of nitrogen would be required (4 per cent of 2,000 pounds). As each 100 pounds

Table 2

Calculated Pounds of Straight Fertilizer Needed to Furnish a Desired per Cent of Nitrogen, Phosphate, or Potash in a Ton of Mixed Fertilizer

Per cent of plant food	Nitrogen fertilizers					Phosphate fertilizer						Potash fertilizer			
	Nitrate of soda	Sulphate of ammonia	Dried blood	Leuna-salt-peter	Urea	Superphosphate						Muriate or sulphate of potash			
	16 per cent	20 per cent	14 per cent	26 per cent	46 per cent	16 per cent	20 per cent	43 per cent	44 per cent	45 per cent	46 per cent	48 per cent	50 per cent	58 per cent	60 per cent
1	125	100	143	77	43*	125	100	46*	45*	44*	43*	42*	40	34*	33*
2	250	200	286	154	87	250	200	93	91	89	87	84	80	69	67
3	375	300	429	231	130	375	300	140	136	133	130	126	120	103	100
4	500	400	572	308	174	500	400	186	182	178	174	167	160	138	133
5	625	500	715	385	217	625	500	232	227	222	217	209	200	173	167
6	750	600	858	461	261	750	600	279	272	267	260	250	240	207	200
7	875	700	1,000	538	304	875	700	325	318	311	304	292	280	241	233
8	1,000	800		615	348	1,000	800	372	363	355	347	334	320	276	267
9		900		692	391	1,125	900	418	409	400	391	375	360	310	300
10		1,000		769	435	1,250	1,000	465	454	444	434	417	400	345	333
11				846	478	1,375	1,100	511	499	489	477	459	440	379	367
12				923	522	1,500	1,200	558	545	533	521	500	480	414	400
14					608		1,400	651	636	622	608	584	560	483	467
16					694		1,600	744	726	710	694	667	640	552	533
18					784			837	817	799	784	750	720	621	600
20					870			930	908	888	868	834	800	690	667
22								1,023	999	977	955	917	880	759	733
24								1,116	1,089	1,065	1,042	1,000	960	828	800
26								1,209	1,180	1,154	1,128	1,084	1,040	897	867
27								1,255	1,225	1,194	1,172	1,126	1,080	931	900
28								1,302	1,271	1,243	1,217	1,166	1,120	966	933
30								1,395	1,362	1,331	1,304	1,250	1,200	1,034	1,000

* The nearest whole numbers are used instead of fractions

of nitrate of soda contains 16 pounds of nitrogen, 500 pounds of nitrate of soda is used in making a ton of the mixture. In the same way the necessary amounts of phosphate and potash may be calculated.

The amounts of different kinds of straight material needed for any desired formula are given in Table 2. To use the table, find in the first column the per cent coinciding with that in the formula of the fertilizer desired and follow the line to the right to the column headed by the unmixed fertilizer. The figure found is the number of pounds of that particular fertilizer to be used in making up a ton of the desired mixture.

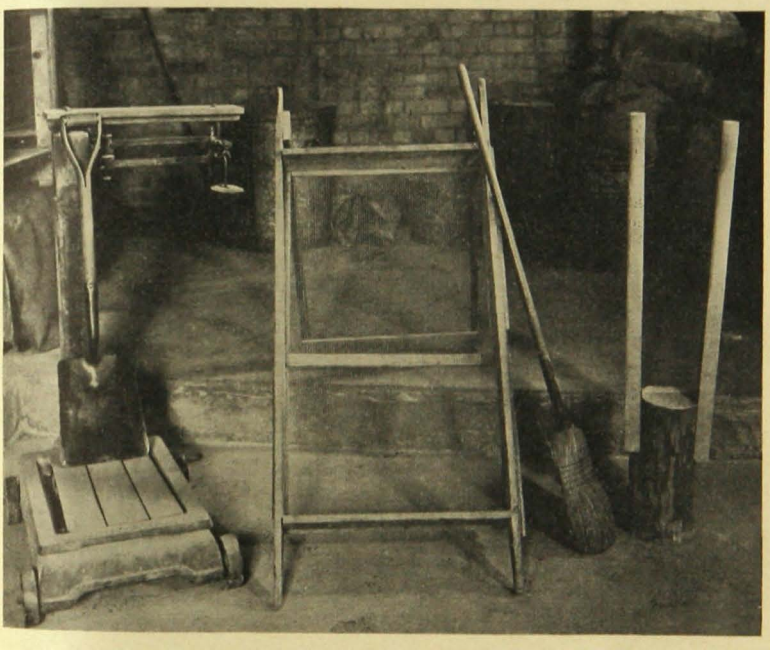


Fig. 1. Equipment for Mixing Fertilizers at Home

Suppose a 4-8-6 fertilizer is desired. The 4 per cent of nitrogen may be supplied by any one of the nitrogen fertilizers by using the weight on line with 4, or part may be obtained from one fertilizer and part from another, as 2 per cent may be obtained from nitrate of soda and 2 per cent from sulphate of ammonia or dried blood. If a very high percentage of nitrogen is desired, some urea or leunasaltpeter could be used. Any of the phosphate fertilizers may be used to supply the 8 per cent of phosphate and the necessary weight is found by reading along the line to the right of 8 until the column is reached which gives the weight for the phosphate fertilizer to be used. Proceed in the same way for the 6 per cent of potash. The amount of

filler necessary to add to make up the ton is found by subtracting the sum of the three weights from 2,000 pounds.

EXAMPLES OF HOME MIXING

The examples given below will illustrate the use of the table. The formula of the desired fertilizer is given first and then the necessary materials, in tabular form.

In preparing a mixed fertilizer of any exact formula the sum of the weights of straight fertilizers used must be equal to one ton; or if less than a ton, enough filler must be added to bring the weight up to that amount. If the weights of the straight fertilizers total more than 2,000 pounds, it is impossible to make a mixture of the desired formula with the materials used.

Materials suitable for use as filler include dry sifted coal ashes, dry fine loam, or dry fine sand.

A. 4-8-6 fertilizer

1. 4 per cent of nitrogen — 400 lb. sulphate of ammonia
   8 per cent of phosphate — 347 lb. 46 per cent superphosphate
   6 per cent of potash — 250 lb. 48 per cent muriate of potash
   997 lb.
   1,003 lb. filler
   2,000 lb.

2. 4 per cent of nitrogen
   2 per cent — 286 lb. dried blood
   2 per cent — 250 lb. nitrate of soda
   8 per cent of phosphate — 800 lb. 20 per cent superphosphate
   6 per cent of potash — 250 lb. 48 per cent sulphate of potash
   1,586 lb.
   414 lb. filler
   2,000 lb.

B. 8-16-12 fertilizer

   8 per cent of nitrogen — 800 lb. sulphate of ammonia
   16 per cent of phosphate — 694 lb. 46 per cent superphosphate
   12 per cent of potash — 500 lb. 48 per cent muriate of potash
   1,994 lb.
   No filler needed

C. 4-16-4 fertilizer

   4 per cent of nitrogen — 400 lb. sulphate of ammonia
   16 per cent of phosphate — 710 lb. 45 per cent superphosphate
   4 per cent of potash — 167 lb. 48 per cent muriate of potash
   1,277 lb.
   723 lb. filler
   2,000 lb

D. 8-32-8 fertilizer

   8 per cent of nitrogen — 348 lb. urea
   32 per cent of phosphate — 1,389 lb. 46 per cent superphosphate
   8 per cent of potash — 267 lb. 60 per cent muriate of potash
   2,004 lb.
   No filler needed

E. 4-30-8 fertilizer

4 per cent of nitrogen	400 lb.	sulphate of ammonia
30 per cent of phosphate	1,304 lb.	46 per cent superphosphate
8 per cent of potash	320 lb.	50 per cent muriate of potash
	2,024 lb.	
		No filler needed

F. 0-10-20 fertilizer

1. No nitrogen needed

10 per cent of phosphate	1,000 lb.	20 per cent superphosphate
20 per cent of potash	834 lb.	48 per cent muriate of potash
	1,834 lb.	
	166 lb.	filler
	2,000 lb.	

2. No nitrogen needed

10 per cent of phosphate	454 lb.	44 per cent superphosphate
20 per cent of potash	690 lb.	58 per cent muriate of potash
	1,144 lb.	
	856 lb.	filler
	2,000 lb.	

G. 0 9-27 fertilizer

1. No nitrogen needed

9 per cent of phosphate	400 lb.	45 per cent superphosphate
27 per cent of potash	1,126 lb.	48 per cent muriate of potash
	1,526 lb.	
	474 lb.	filler
	2,000 lb.	

2. No nitrogen needed

9 per cent of phosphate	900 lb.	20 per cent superphosphate
27 per cent of potash	1,080 lb.	50 per cent muriate of potash
	1,980 lb.	
		No filler needed

H 0 8-24 fertilizer

No nitrogen needed

8 per cent of phosphate	1,000 lb.	16 per cent superphosphate
24 per cent of potash	1,000 lb.	48 per cent muriate of potash
	2,000 lb.	
		No filler needed

FILLER NOT NECESSARY

Filler is not necessary in home mixtures if the fertilizer is to be used soon after mixing. Not all factory-mixed fertilizers contain filler. Home-mixed fertilizers of high analysis need not be diluted with filler if the rate of application is reduced. For instance, in Example E the 4-30-8 fertilizer applied at the rate of 50 pounds per acre with an attachment to the corn planter is equivalent to 100 pounds per acre of 2-15-4. Likewise the 8-16-12 (Example B) applied at the rate of 200 pounds per acre would give the same results as 400 pounds per acre, or 4-8-6. The filler may be omitted from any mixture regardless of the formula if the rate of application is reduced proportionably. In Example C the proposed mixture contains 1,277 pounds of fertilizer, equivalent to a ton of 4-16-4. Dividing 1,277 by 20 (the number of hundreds in a ton) gives 63.8 pounds. Then 63.8 pounds, or 64 pounds (for practical purposes) of the mixture is equal to 100 pounds of

4-16-4. If the contemplated rate of 4-16-4 is 125 pounds per acre with a fertilizer attachment to the corn planter, the same amount of plant food would be supplied in 80 pounds (64x1¼) of the mixture without filler.

THE MIXING OPERATION

The equipment necessary for mixing fertilizer need not be elaborate. A smooth floor, a quarter-inch screen, a tamper to crush lumps, one or two shovels, a scale, and a broom are sufficient (see Fig. 1). The materials are mixed in the same way as are sand and cement, and the more thoro the operation the better the product. All lumps must be crushed, otherwise the mixture will not be uniform. When there are even small lumps the materials should be screened, the lumps crushed with the tamper, and the crushed material put through the screen (Fig. 2).

Fig. 2. Screening the Mixed Fertilizer

The size of the batch to be mixed at one time depends upon the size of the floor or box. Usually 400 to 600 pounds is advisable. If the batches are large there is greater difficulty in making the mixture uniform.

First spread on the mixing floor a 3- or 4-inch layer of the fertilizer of greatest bulk and a corresponding layer of each of the other materials, including the filler, if any is used (Fig. 3). When the batch is large, repeat the layers. Shovel the heap over three or four times, stirring at the same time.

If the mixture is to be used in a drill or fertilizer attachment it

should be put through the screen after mixing and then shoveled over once more before sacking. When the straight fertilizers are in good mechanical condition, screening is not necessary before mixing.

An ordinary barrel cement mixer can be used to advantage when a large amount of material is to be mixed. The material should be fine, that is, free of lumps, and in each charge the materials must be in the right proportion.

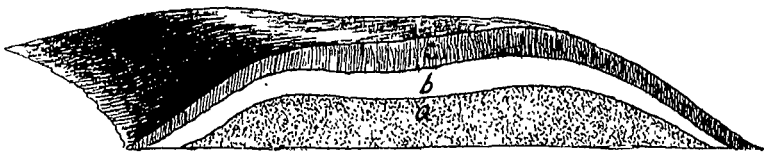


Fig. 3 Method of Spreading Three Fertilizer Ingredients (a, b, and c) Before Mixing with Shovels)

EXAMPLE OF ECONOMY OF HOME MIXING

A possible saving in cost may be illustrated by one case of actual home mixing supervised by one of the authors. Two men working 32½ hours each (a total of 65 man hours) mixed and sacked 6.6 tons of 48 per cent superphosphate and 13.2 tons of 48 per cent muriate of potash to make 19.8 tons of a fertilizer with the formula 0-16-32. The 19.8 tons of 0-16-32 was equivalent to or contained as much phosphate and potash as 31.7 tons of 0-10-20, or 28.8 tons of 0-11-22.

The price of fertilizers may vary from season to season and with the amounts purchased and the terms. The farmer was offered fertilizers at the following prices in carload lots for cash.

	Per Ton
48 per cent superphosphate	$48.90
48 per cent muriate of potash	48.40
9-10-20 factory-mixed	41.99
0 11-22 factory-mixed	45.09

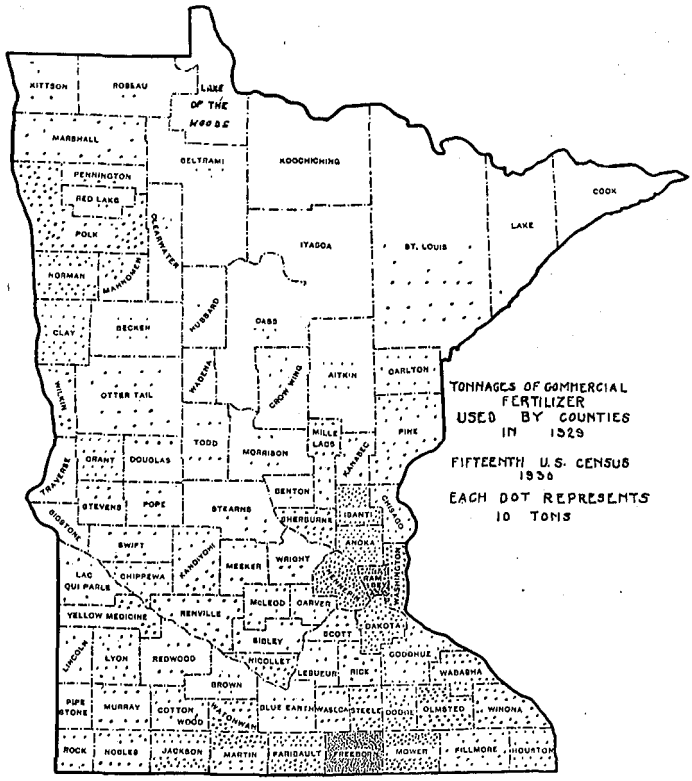
By buying the materials and mixing them at home he made the following saving:

Cost of Materials and Labor

6 6 tons of 48 per superphosphate at $48.90	$322.74
13 2 tons of 48 per cent muriate of potash at $48.40	638.88
65 man hours at 35 cents	22.75
Total	$984.37

Comparison of Costs

Factory-mixed, 31.7 tons of 0-10-20 at $41.99	$1,330 08
Home-mixed, the equivalent of 31.7 tons of 0-10.20	984.37
Saving by home mixing	$345.71
Factory-mixed, 28-8 tons of 0-11-22 at $45.09	$1,298.59
Home-mixed, the equivalent of 28.8 tons of 0-11-22	984.37
Saving by home mixing	$314.22



Tons of Commercial Fertilizers Used in Counties of Minnesota in 1929.—Fifteenth U. S. Census, 1930

Aitkin	68	Isanti	466	Pipestone	59
Anoka	491	Itasca	15	Polk	668
Becker	63	Jackson	373	Pope	39
Beltrami	43	Kanabec	46	Ramsey	370
Benton	9	Kandiyohi	165	Red Lake	18
Big Stone	4	Kittson	31	Redwood	67
Blue Earth	84	Koochiching	12	Renville	205
Brown	53	Lac qui Parle	38	Rice	102
Carlton	100	Lake	5	Rock	58
Carver	56	Lake of the Woods	1	Roseau	20
Cass	36	LeSueur	41	St. Louis	227
Chippewa	112	Lincoln	29	Scott	48
Chisago	157	Lyon	160	Sherburne	160
Clay	299	McLeod	84	Sibley	66
Clearwater	28	Mahnomen	80	Stearns	51
Cook	2	Marshall	179	Steele	212
Cottonwood	99	Martin	417	Stevens	46
Crow Wing	47	Meeker	46	Swift	69
Dakota	450	Mille Lacs	123	Todd	74
Dodge	272	Morrison	51	Traverse	6
Douglas	45	Mower	731	Wabasha	220
Faribault	473	Murray	92	Wadena	4
Fillmore	188	Nicollet	158	Waseca	77
Freeborn	2,634	Nobles	132	Washington	229
Goodhue	326	Norman	315	Watonwan	172
Grant	166	Olmsted	428	Wilkin	82
Hennepin	885	Otter Tail	163	Winona	239
Houston	172	Pennington	33	Wright	39
Hubbard	12	Pine	281	Yellow Medicine	107
				Total	15,803