CHAPTER 6 Laying Out the Cropping System

A GOOD CROPPING PROGRAM IS DESIGNED to maintain a high level of total production, especially of the crops that help the farmer realize the largest possible continuous profit. As the wise manager knows, a well-planned cropping system will help make the whole farm program more profitable.

In the Midwest, farmers produce a wide variety of crops. Maps included with this chapter show the importance farmers in different areas give to various crops in their efforts to maximize farm income. The maps also show where certain natural or market advantages have encouraged the growing of special crops.

Of the cultivated row crops, corn is far in the lead. Soybeans hold second place. Sorghums are grown in the drier areas, although some are grown for silage or fodder where rainfall is greater.

Wheat is the important small grain of the Plains Area. It also is important as a cash or feed crop in the south central Corn Belt. Oats are the main small grain of the northern Corn Belt and the Dairy Area and extend into the spring wheat country. While barley is grown in cooler climates, some winter barley

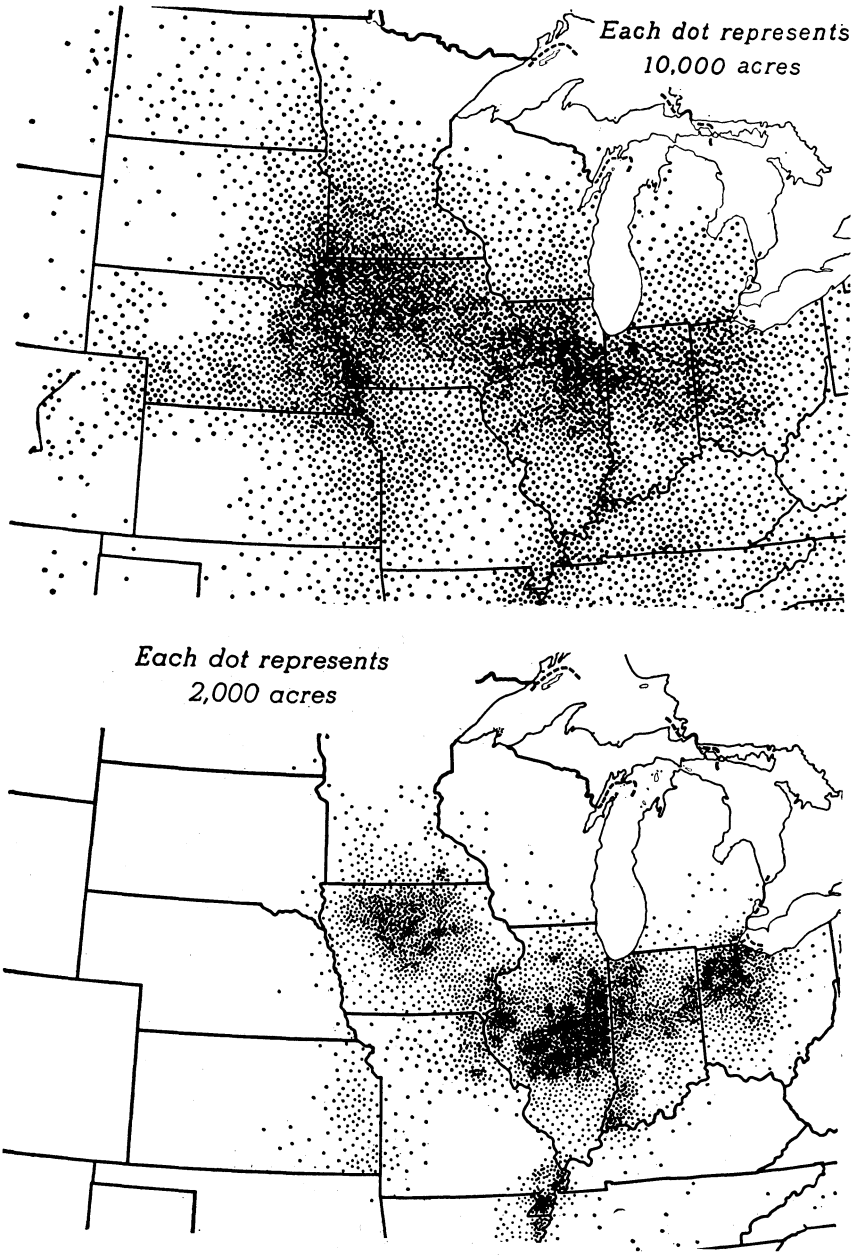


FIG. 30—While corn production (top map–acreage 1939) is general over the Midwest, the heavy producing area extends from western Ohio to eastern Nebraska. Soybean production (bottom map–acreage 1944) is concentrated in much the same area but largely on farms raising crops for sale. Note differences in acres per dot on map. *Bureau of Agricultural Economics.*

shows up in southern Missouri. Flax is grown in lower rainfall areas because weeds are a hazard and wet harvests cause a heavy loss.

Clover or clover and timothy are the principal hay crops in the short rotations of the Corn Belt and Dairy Area. Where the meadow is left more than one year, alfalfa or an alfalfa-brome mixture are common.

In drier years the use of legumes is limited in the Plains Area because they take up too much soil water and handicap the crop that follows. Lespedeza, a crop that will grow on thinner land than most legumes, is well liked in the southern Corn Belt for hay or pasture, especially as a mixture in pastures.

The total acreage of such cash crops as potatoes, tomatoes, peas, sweet corn, dry field beans, vegetables for fresh market, and the like is not very great. But these crops may be quite important to individual farmers who depend on them for a cash income.

In the areas adapted to roughage-consuming livestock, farmers give a good deal of attention to their pasture crops as a cheap source of feed. In some cases the pastures are permanent, while in others they are fitted into the crop rotation plan.

Whatever his program, the farm manager should have detailed information about the best varieties of crops for his locality. He also needs to know about good cultural practices—seedbed preparation, seed treatment, ideal seeding rates, time of planting, proper cultivating methods, best time of harvest, adequate storage conditions, and similar things. Since these vary widely over the Midwest, the farm operator will want bulletins from his own experiment station, and counsel from his local county agent and from skillful farmers in the community.

Since one year's crops affect the yield of those that follow, any crop plan should look to the future as well as to the present. Corn, for example, is a heavy-yielding grain crop that takes a good deal of fertility out of the soil, so it seldom is raised more than two years in a row. Clover, on the other hand, is a soil-building crop—a legume that adds nitrogen to the soil and tends to raise the yield of the following crop. It also may improve the physical condition of both the top soil and subsoil. Obviously, the farmer should consider his whole rotation, not just one year's crops, when he makes his future plans.

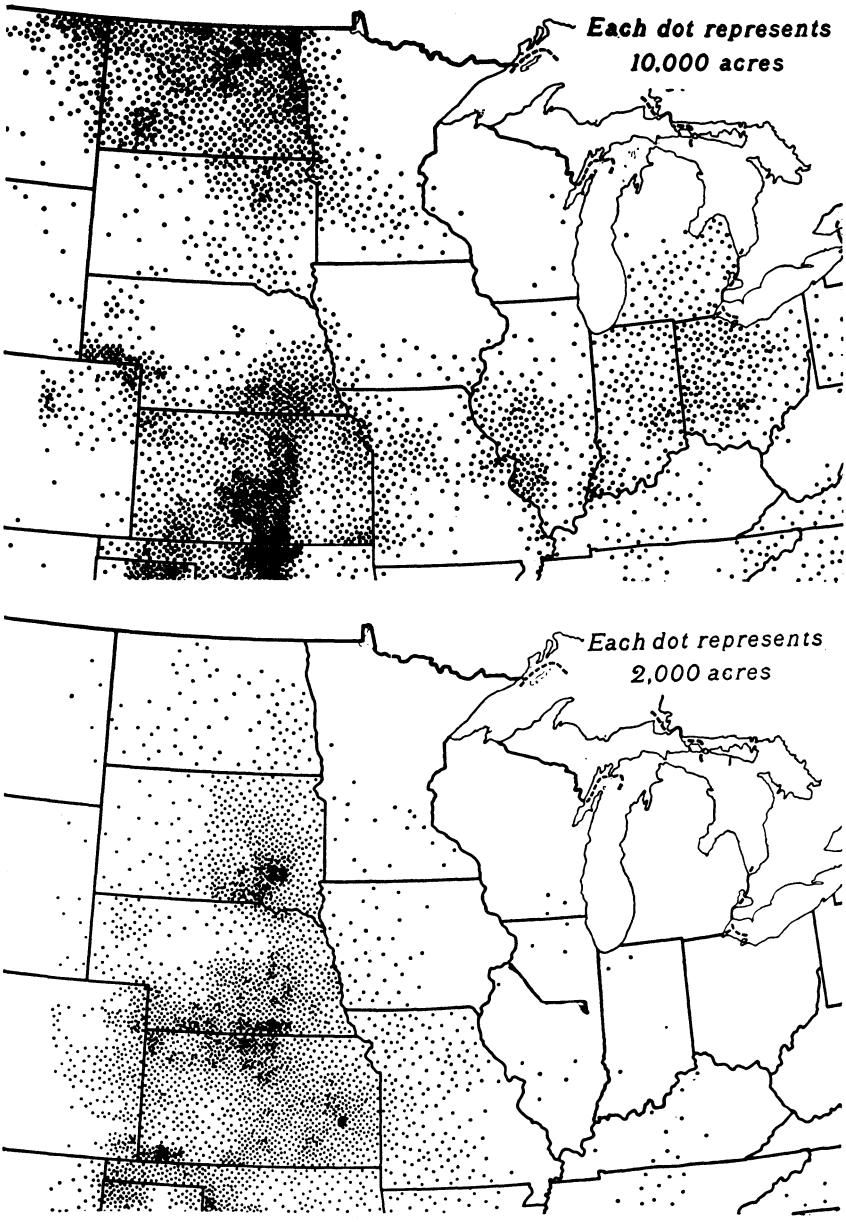


FIG. 31—Wheat production (top map–acreage 1939) is concentrated in two areas, winter wheat being centered in Kansas and spring wheat in North Dakota. A much less intensive area producing soft winter wheat runs from Missouri to Ohio and Michigan. Sorghum (bottom map–acreage 1939) is grown in the drier area west of the main Corn Belt. Note difference in acres per dot on the maps. *Bureau of Agricultural Economics.*

Choose High Profit Crops

When he draws up his cropping system, the farmer's chief question is not whether a crop will produce a reasonable yield. Instead it is: *which crop plan, all things considered, has the greatest advantage?*

From the list of high profit crops for his area, the farmer chooses those that fit his farm. He looks for the best feed grain crops, both cultivated crops and small grains. He also looks at cash crops—wheat, flax, soybeans, potatoes, field beans, canning crops, seed crops, or others. Third are the hay crops, especially the legumes, and pasture crops for rotation use.

The farm manager can determine the high profit crops for his area by asking local farmers. Their answers will boil down to this: The high profit crops are the ones local farmers want to expand the most, providing their soil will stand it. When they talk about increasing these crop acreages, farmers count both the *value* of the crop and the *cost* of producing it, not the gross value of the crop alone. Because of soil differences, the high profit crops for one kind of soil may not be the best ones for another, even in the same community. It's up to the farm operator to find out which crops fit the soil conditions on his farm best.

Take Risks and Costs Into Account

The Risk Factor

Part of determining which crops to grow is weighing the risks and costs that are involved. There are three kinds of crop risks—weather, insect and disease, and price. Weather risks include the hazards of drouth, hail, frost, wind, and so on. The wise farm manager will investigate which ones are typical of his area and decide whether crop insurance will pay. Insect and disease risks vary from crop to crop—chinch bugs, corn borers, grasshoppers, smuts, rusts, blights, and others. Chemicals, seed treatment, and like measures give adequate protection for some crops, but help others very little.

In the realm of prices, some are more stable than others—corn compared to potatoes, for example. Corn prices have a fairly dependable seasonal pattern but potato prices vary a great

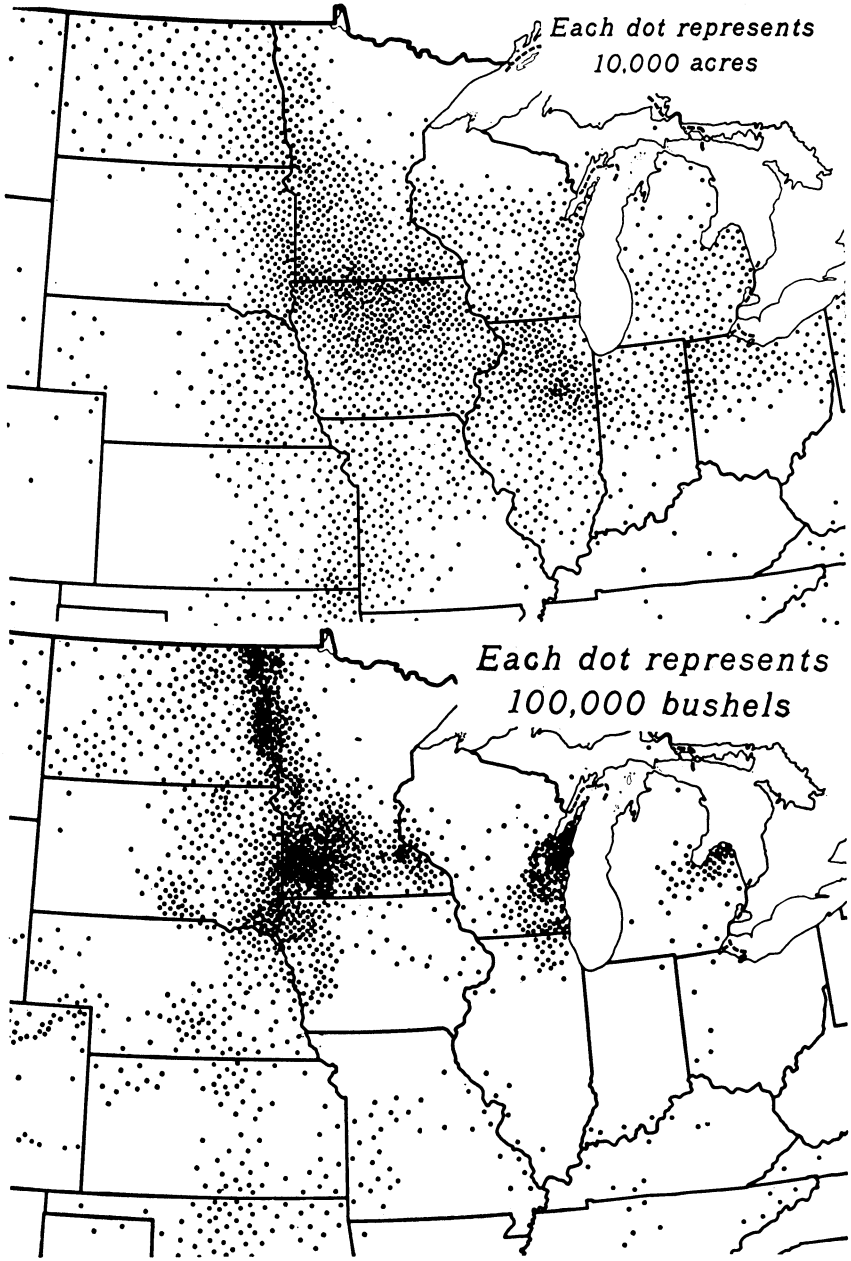


FIG. 32—Oat growing is more widely scattered than barley (top map–acres of oats; bottom map–bushels of barley). Both are more prominent in the area with a cooler and shorter growing season. *Bureau of Agricultural Economics.*

deal. Crops like corn, wheat, and soybeans can be stored if the price is low at harvest time, but perishable crops like tomatoes and melons must be sold regardless of price. Some crop prices have a long-term downtrend while others may have an uptrend. With apples and other tree fruits, the price trend must be estimated for many years ahead before setting out an orchard.

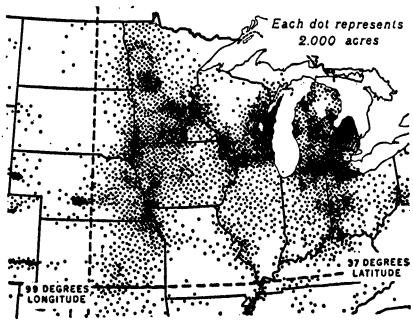
The Cost Factor

On the cost side, the amount of labor needed to raise the crop, harvest it, and get it in storage or to the market varies from crop to crop. In the Plains Area as little as fifteen minutes per bushel may be required to raise and harvest wheat. On small fields in the eastern Corn Belt, on the other hand, wheat may require forty-five minutes per bushel, even with much higher yields. With potatoes, since less machinery is used, as much as thirty to forty minutes of labor per bushel may be required even where yields are quite good.

A varying cost factor is due to the *time* when labor is needed for the different crops. Some crops—corn and soybeans, for example—compete with each other for labor. The first cutting of alfalfa and corn cultivation is another example. Corn and oats, on the other hand, fit "hand in glove" from the labor standpoint.

The number and cost of machines that are needed also should be considered. Machines like a tractor, disc, or harrow are used for nearly all field crops. Several machines serve two or more crops—a combine for oats, wheat, soybeans, and grass seeds; a cultivator for corn, soybeans, and potatoes. Still others (some very expensive) can be used for only one crop—corn pickers or hay balers, for example. On a family-sized farm, certain machines may be in use as little as three to six days a year. The farmer must decide whether his cropping program will justify having an expensive machine sit idle for 360 days so he can have it handy for the few days he will need it.

Other costs include seed, fertilizer, lime, spray material, twine, and so on, as well as the cost of storage buildings if the crop is to be kept. With some crops, storage costs are an important part of the total cost and should be given careful consideration. It doesn't pay, however, to have too much money tied up in



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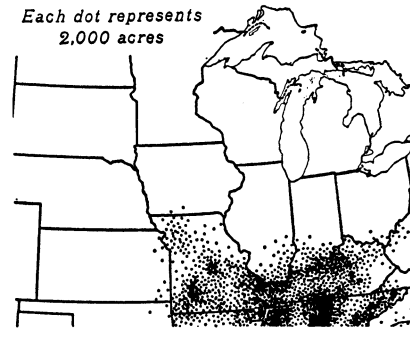
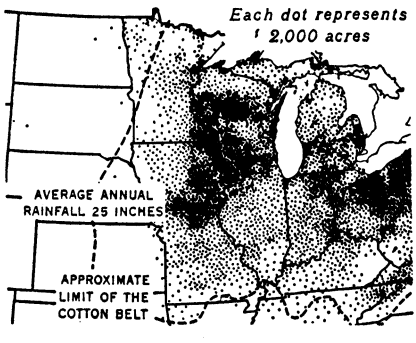
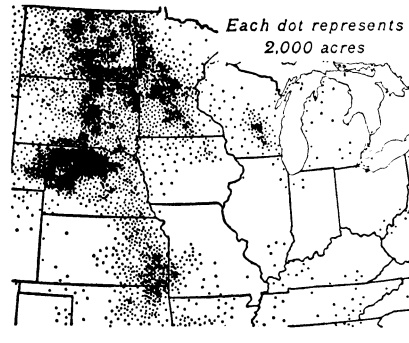


LESPEDEZA



CLOVER AND TIMOTHY HAY



WILD HAY

FIG. 33—Farmers choose the one or more kinds of hay best adapted to their situation. Alfalfa and clover are widely grown but do best in a cooler climate with sufficient rainfall. Lespedeza is strictly a long season legume in the higher rainfall area. In the drier climate of the plains, wild hay has few competitors. *Bureau of Agricultural Economics.*

expensive storage space, especially if the cropping program is a modest one.

More important than many consider it is the cost in soil fertility or soil loss. Some crops, such as corn and sorghums, are hard on the soil. Others, like soybeans on rolling land, cause the soil to wash away easily. Or the crop may pull heavily on some soil elements but not on others. Thus, while alfalfa takes a great deal of lime and phosphate out of the soil, it can be used to build up soil nitrogen by feeding the crop and returning the manure to the land.

Make A Soil Map

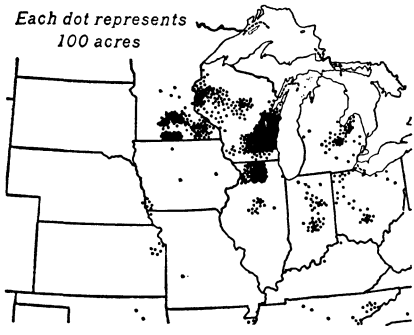
Before starting his crop plan, the farmer should study the ability of his soil to produce. Many men have lived on a farm for several years without doing this job carefully. A good soil map is an inventory of the farmer's land that should show the strong and weak points of each field.

To map his farm, the operator should make a reasonably accurate outline of the farm area and mark on it the different kinds of soil according to physical characteristics. Several divisions may be needed since it's not uncommon to find a half-dozen kinds of soil on a single farm. A typical list might be:

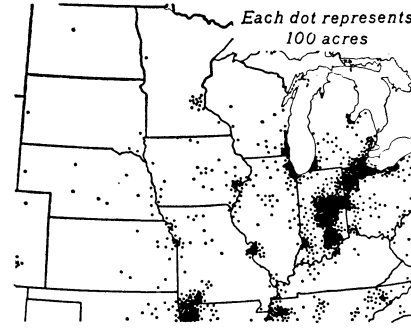
1. Good cropland
   (a) level to gently rolling
   (b) where soil erosion is a problem
2. Medium cropland
   (a) level to gently rolling
   (b) where soil erosion is a problem
3. Fair cropland
4. Permanent pasture land
5. Land for timber or other non-tillable uses

The operator may find that the level and more rolling land needs a different rotation. Perhaps terraces or other erosion control measures will help save soil. Drainage ways should be marked on the map as well as the sandy land, wet spots, stony places, and similar problem areas.

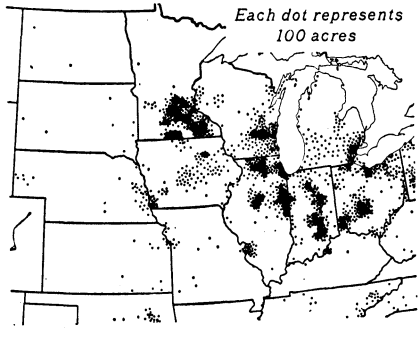
By using a soil auger, the farmer can make a really thorough soil examination. A one-inch wood auger with the shank length-



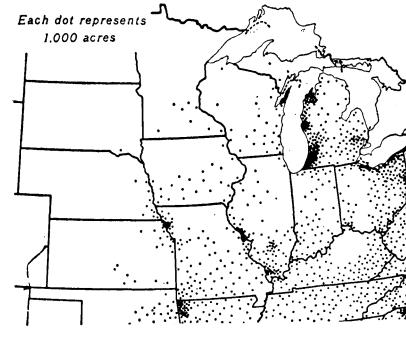
GREEN PEAS



TOMATOES



SWEET CORN



ORCHARDS AND VINEYARDS

FIG. 34—The canning crops are specialty ones; peas are a cool weather crop and tomatoes a warm weather one. Sweet corn is more widely grown. Commercial fruit growing is limited, for the most part, to certain favorable spots. *Bureau of Agricultural Economics.*

ened to three feet will do. Both subsoil and topsoil should be examined since they affect the ability of the land to produce. Depth and texture of topsoil and subsoil should be checked too. Some soils are underlaid with sand, gravel, or rock which may mean that they are drouthy. Lime and fertilizer put on them may leach out rapidly. Some land has a tight subsoil which makes it slow to take in water, slow to dry out, and which interferes with deep rooted crops. Soils may be "cold" or "warm" where crops start slowly or quickly in the spring. Fine-grained soils that puddle easily should not be tilled when too wet or too dry or clods will form that are hard to work into a decent seed bed. The young farmer or a man who is new to the community should talk these problems over with experienced farmers for useful suggestions.

Save Your Soil

Because the soil is one of the farmer's main resources, good judgment tells him not to let it go to waste. In earlier days when farmers could move to new land if a farm became too poor, people gave little thought to the need for saving the soil. Now a farmer who lets his soil wash away without trying to save it is no different from a careless man who doesn't bother to plug a hole in the bottom of his granary. In both cases resources are wasted, but soil erosion has longer time effects as well.

The long neglect of soil conservation has focused public attention on this important problem. Actually, though, the farm family has as big a stake as anyone else in keeping the soil from washing or blowing away. While many say that the farmer's motto should be "Save the soil," the good farm manager knows this is only part of the truth. The real motto both for himself and in the public interest is: "Keep the soil but use it too."

On any particular farm, one or more of the following three soil-conserving methods may be needed:

1. *Use of soil-conserving crops in the rotation.* Fine-rooted grasses hold soil in place the best. Some are low value crops like timothy and redtop, some higher value like bromegrass. Legumes are next best to hold the soil in place. Legume-grass combinations such as alfalfa-bromegrass or red clover-timothy mixtures often are used. Small grains stand third in line in

reducing erosion. Fall-seeded ones such as winter wheat protect the land in winter and early spring while spring-seeded ones do not. Crops grown in cultivated rows such as corn or soybeans are the most erosive kind.

Much can be done to reduce erosion by growing more soil-conserving crops in the rotation. But the farmer must remember that an extra large amount of hay or rotation pasture in proportion to feed grain often is hard to market at a profit. The result is that many farmers prefer to use other erosion control methods rather than have so much grass in the rotation.

2. *Use of erosion control practices.* Contour farming or "farming around the hill on the level" is the most common control practice. This farming across the slope instead of in straight rows calls for the use of carefully established contour guide lines.

Sometimes crops are laid out in strips on the contour. Known as *strip cropping,* this practice works best when laid out across long, moderate slopes. It is harder to manage where rotation pastures are needed and may cause losses where chinch bugs and some other insects are troublesome. Where the land is more steeply sloping, contour planting alone may not be wholly effective.

Other practices include *buffer strips* of grass left across the slope on the contour, usually twenty feet or so in width. Grassed waterways in the drainage ways should be standard practice.

3. *Use of mechanical controls.* One of these is terracing, or man-made waterways constructed on the contour. Skilled help is needed to determine where they can be used to advantage, how they should be spaced, and in their construction. *Erosion control dams* are used under certain conditions—when deep gullies are a problem, for example. In place of mechanical controls, *tree planting* may not only save the soil but produce a crop of timber as well.

FIG 35—A good crop plan includes a well designed crop rotation. Soil conservation methods and other practices used should be suited to the area. The careful manager sets up a plan that gives a large total output in proportion to the land, labor, and capital used. The two scenes, taken in the same community, show a sharp contrast between a carefully planned crop program and a carelessly planned one. Photos by "Parma."

TABLE 26
How Contour Farming Affects Crop Yields

Crop	Yield Per Acre		Percentage Increase
	Without Contour Farming	With Contour Farming	
	(*Bushels*)	(*Bushels*)	(*per cent*)
Corn*	57.5	64.4	12
Corn†	69.7	78.9	13
Soybeans*	20.8	23.5	13
Soybeans†	23.6	26.3	11
Oats*	43.1	50.0	16
Oats†	47.5	52.9	9
Wheat*	20.0	23.4	17
Wheat‡	15.8	18.8	19

* 7-year average, Illinois farm records.
† Iowa—Corn 6 years; soybeans 3 years; oats 2 years yield results.
‡ 5-year average, Dodge City, Kansas.

The county agent and Soil Conservation Service worker can give advice on methods adapted to the area. In some communities, experienced farmers will have suggestions. In others, few have had enough experience with the more complicated practices to furnish the necessary details.

Table 26 shows typical increases in crop yields resulting from contour farming.

Of course, not every farmer can increase crop yields by the amount shown in Table 26 simply by contour planting. Depending on local conditions, results may be better or poorer than those shown, and at times yields may even be reduced. From the long-time viewpoint, however, contour farming is a wise practice on farms where it will help stop soil erosion, whether yields are increased greatly or not.

In many areas of low total rainfall, much of the water falls in quick, dashing rains. Contour cultivation helps prevent heavy soil washing on the gently sloping land in these areas by leaving hundreds of small water channels that hold the water back until it can soak into the soil. Unless the cultivation follows the correct contour, however, more erosion may occur rather than less. Other water conservation methods are clean ground fallow and basin listing. They are used in the Plains States to save rainfall for the following crop.

Check on Soil Fertility

If high profit crops are to be grown successfully, it is important to know a good deal about the farm's different soils. There are four factors to consider.

First is the degree of acidity. Some soils are slightly acid, or sour, and need a ton or two of ground limestone, while others require four to six tons to grow most legumes successfully. The county agent can make a simple test to determine limestone needs.

Plant food content is an important guide to soil fertility. On most soils, nitrogen, phosphorous, and potash are the elements that may be lacking. Their abundance or scarcity in available form is a big factor in deciding what rotation should be used and if commercial fertilizer is needed. Reasonably accurate fertility tests can be made at a qualified laboratory. Again, the county agent is the man to see, since he can tell the farmer where to send soil samples.

The third thing to look for is humus content. Humus comes from decayed plant material, and soils with enough of it are more easily tilled and absorb moisture better.

Finally, many farms have areas where special soil problems exist. Some soils have high lime or alkali spots, or peat or muck areas. Others have claypan (or hardpan) layers, or other conditions that affect the cropping system or call for special treatment.

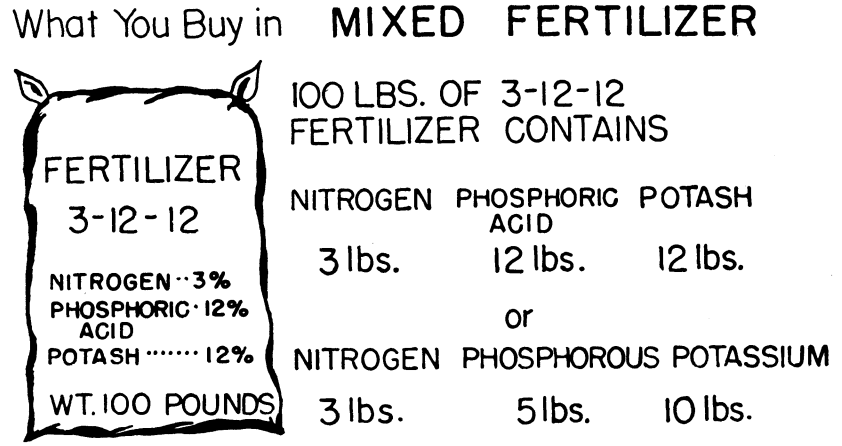


FIG. 36—Mixed fertilizer usually contains three fertility elements as shown on the fertilizer bag above. The needs of the particular soil and crop as well as the cost and expected crop prices should guide the choice of mixture and the amount to be used.

Where good county soil maps are available, the farmer can find out a lot about the soils of any particular community. However, the maps probably will not tell him as much about a particular farm as he would like. He can get some information from experienced local farmers, but there is no substitute for careful study of the soil by the farmer himself.

What About Fertilizer?

Once his soil tests are made and he knows what is needed, the farmer must find the most economical way to put into this soil the elements that are lacking.

Nitrogen usually can be added most cheaply by raising legume crops, clover, or alfalfa, or by spreading barnyard manure. Legumes cannot build up soil nitrogen, however, if all the hay crop is removed and nothing returned. Some crops and soils, of course, can use profitably the larger amounts of nitrogen found in commercial fertilizers. These usually are mixed fertilizers that have other elements too, although at times straight nitrate applications (such as ammonium nitrate) will pay. Because nitrogen is expensive to buy, the wise manager will take care of his nitrogen needs by good rotations and careful handling of barnyard manure as much as he can.

Phosphorus is the scarce element in many soils. Barnyard manure contains some, but the usual source is to buy it in commercial fertilizer. Acid phosphate, or super phosphate, is the most common form in mixed fertilizers, although there are other kinds with a higher percentage of phosphate per pound of fertilizer. Phosphates, together with lime, are especially useful in starting a legume or legume-grass seeding. They also are used on grain crops such as corn and wheat in the Corn Belt and on such crops as potatoes, tomatoes, or truck crops.

Potash, like phosphorus, must be purchased as commercial fertilizer if much is needed. Sulphate and muriate of potash are common forms. Many crops do not remove potash from the soil as rapidly as they do nitrogen and phosphorus, so it is needed less often. But there are many soils where crops do respond profitably to potash fertilizers. The only way to know is to check up on the soil conditions on the particular farm.

Lime, while not primarily a fertilizer, is a most important soil element. It is necessary for a good growth of legume crops, especially sweet clover and alfalfa. Limestone should be finely ground to be of most value, since coarsely ground limestone usually will not dissolve enough to be available to the plant. Marl is another form of lime available in some areas, but whatever lime product is used, its value will depend on its purity and fineness.

How To Know if Fertilizer Will Pay

Three management problems are involved in deciding whether a farmer should use fertilizer on a particular crop. They are the same kinds of decisions that appear again and again in managing a farm.

1. Should the practice be used at all—in this case, should fertilizer be used?
2. If used, in what way will the practice pay best—in this case, how much fertilizer should be used, what kind, and on which crops?
3. How will time and money used in adding this practice to the farm business compare with other profit opportunities—in this case, will the work and money involved pay best if used to put on fertilizer, or would they make a greater profit if put somewhere else in the business?

A farmer must have some facts to start from. In the case of fertilizer he usually gets them from his state experiment station or local experimental field. He needs to know that the results have been carefully measured and checked. Even so, he must be careful to see whether they apply to the kind of soil on his own farm.

Suppose, for example, an Indiana farmer looks at fertilizer results as his experiment station reports them in Table 27. His question is, "Will it be profitable to top dress wheat with nitrogen in the spring?" The experiment station report in Table 27 shows the results of tests when mixed fertilizer was applied to wheat in the fall and nitrogen was used as a top dressing in the spring.

Table 27 shows that thirty-six pounds of nitrogen per acre used in top dressing wheat in the spring gave the greatest in-

TABLE 27
How Top Dressing Wheat Affects the Yield

Treatment	Wheat Yield	Increase Due To Nitrogen
	(*Bushels*)	(*Bushels*)
No Nitrogen	27.7	
12 lbs. Nitrogen	29.7	2.0
18 lbs. Nitrogen	31.4	3.7
24 lbs. Nitrogen	32.7	5.0
36 lbs. Nitrogen	34.6	6.9

(*Somewhat simplified summary from Purdue Circular 242 [revised]*)

crease in yields. But that doesn't necessarily prove that thirty-six pounds is the ideal rate of application.

The next step is to take these figures and find out how much extra wheat was produced as more and more nitrogen was used. This is shown in Table 28.

The results now show that the largest rate of increase comes when eighteen pounds is used. But an increase also was obtained with thirty-six pounds of nitrogen per acre. Which is the best amount—eighteen, twenty-four, or thirty-six? To answer that question the farmer needs to know how much will be added both to his income and expenses if various amounts of nitrogen are used. Table 29 shows the net gain per acre from applying nitrogen at different rates. In compiling the table, fertilizer was figured at two price levels. A flat charge per acre was made for the use of the tractor and fertilizer spreader, again at two price levels. Three different selling prices for wheat were used. The detailed arithmetic is not shown, only the gain or loss per acre from top dressing wheat at the different rates.

TABLE 28
Effect on Wheat Yields of Using More Nitrogen Fertilizer

Pounds of Nitrogen Used Per Acre		Extra Wheat Yield Bushels	Pounds of Wheat From Each 6 Pounds More Nitrogen
Total	Additional		
None	None		
12	12	2.0	60
18	6 more	1.7	102
24	6 more	1.3	78
36	12 more	1.9	57

Making the Decision

If the farmer works all this out, he has a definite guide for deciding how much fertilizer to use in top dressing wheat. In using Table 29, however, there is one important point for him to keep in mind: His "out-of-pocket" costs were included but the use of labor in putting on the fertilizer was not included. If the time to top dress wheat comes when he is very busy, he should put a high value on the labor needed. If it comes during a slack period, any additional income he gets for his extra work

TABLE 29

POSSIBLE PROFIT FROM TOP DRESSING WINTER WHEAT

Situation	Price of Wheat Per Bu. Is:	Added Income After Paying for Fertilizer and Machine Cost When Nitrogen Used Per Acre Is				
		12 Lbs.*	18 Lbs.*	24 Lbs.*	24 Lbs.†	36 Lbs.‡
Ammonium Nitrate costs $65 per ton. (10c per lb. for nitrogen) Tractor and machinery cost for spreading is 50c per acre.	$1.00	$ .30	$1.40	$1.90	$1.70	$1.80
	1.50	1.30	3.25	4.30	4.25	5.25
	2.00	2.30	5.10	6.75	6.80	8.70
Ammonium Nitrate costs $100 per ton. (15.4c per lb. N.) Tractor and machinery cost is 70c per acre.	$1.00	$ .45	$ .20	$ .40	$ .00	$-.75
	1.50	.45	2.05	2.80	2.55	2.70
	2.00	1.45	3.90	5.20	5.10	6.15

* Put on in one application.
† Put on in two applications.
‡ Put on in three applications.

in top dressing wheat will be money in his pocket. Moreover, he may have other uses for his money besides buying fertilizer and he should take this into account.

The farmer must allow for the fact that the extra wheat yield will not be exactly as the experiment shows. His soil may differ, and yields from year to year are never the same. Neither does he know when he applies fertilizer in the spring, the exact price he will get for wheat at harvest time.

After weighing all these points, the farmer decides whether it seems worth while to top dress wheat. At $1.50 or $2.00 per bushel for wheat and $65.00 per ton for ammonium nitrate, it

looks like a pretty sure thing for the farmer in Table 29. Very likely he will use twenty-four pounds in one application. Or he might try thirty-six pounds in three applications if he has plenty of time and doesn't consider this too much of a chore. But at $1.00 per bushel for wheat, the small additional income might not be worth the risk and effort. And at $100.00 for fertilizer and $1.00 for wheat, he would not consider using the fertilizer.

Look Beyond Experimental Results

Few farmers will take time to do the detailed pencil work shown in Table 29. And this much figuring isn't altogether necessary unless a lot of money is involved in the decision. What the example does is to demonstrate the thinking process that every farmer must go through in making such a decision. In other words, many additional steps are necessary after the farmer looks at the usual report of a yield experiment before he is ready to decide what to do about using the practice on his farm. Sometimes a practice will pay, sometimes not, even when profitable results are shown in the experimental test.

TABLE 30
Fertilizer Results in Four States

Location and Time Period	Treatment	Average Yield Per Acre Per Year				
		Corn 1st Year	Corn 2nd Year	Oats	Wheat	Hay
		(*Bu.*)	(*Bu.*)	(*Bu.*)	(*Bu.*)	(*Tons*)
3-year rotation	None	43.8	.....	.....	18.0	1.4
Lafayette, Ind.	Lime, Manure	65.9	.....	.....	28.4	1.9
1917–1940	Lime, Manure, 0–12–6	69.6	.....	.....	33.2	2.1
3-year rotation	None	47.4	.....	49.0	.....	1.2
Urbana, Ill.	Lime, Manure, Phosphate	66.5	.....	67.6	.....	2.6
1904–1940						
4-year rotation	None	56.1	51.5	59.9	.....	2.1
Ames, Iowa	Manure	67.9	61.1	63.7	.....	2.7
	Lime, Manure	70.0	61.5	63.3	.....	2.9
1915–1938	Lime, Manure, Superphosphate	75.2	62.3	71.6	.....	3.3
4-year rotation	None	44.9	.....	29.1	22.4	1.2
Columbia, Mo.	Commercial Fertilizer	50.1	.....	40.4	29.6	1.6
1914–1938	Lime and Commercial Fertilizer	51.4	.....	45.0	27.6	2.1
	Manure	56.1	.....	49.6	26.2	1.9

Many reports of experiments are incomplete. For example, the different rates of fertilizer application may be missing. When this happens, the farmer may want to write his experiment station for information of that sort. Each farmer must find his own way of using the results of experimental work as a basis for decisions on his own farm.

Results of the use of various fertilizers on Corn Belt rotations are shown in Table 30. Only one rate of application is reported, not the several different rates that the farmer really needs to make a good decision.

Local Fertilizer Studies

Fertilizer results vary a great deal on different types of soil, on the same soil type on different farms, and in the same field in different years. It is impossible to give any but general recommendations. On certain soils, especially in the western part of the central states, the use of commercial fertilizer seldom pays. For local fertilizer recommendations, the farmer should see his county agent.

The wise manager continually studies the question of which pays more: to spend money for fertilizer or put it to other possible uses. This means the kind of careful planning that is especially important to the young farmer who is short of capital. Money spent for fertilizer gives a rapid turnover of capital, which is in its favor *where the use of fertilizer is profitable.*

The choice between buying a mixed fertilizer of the separate elements depends on whether a complete fertilizer is needed and the cost of the separate ingredients. With mixed fertilizer, the bag is marked with figures showing nitrogen as the first element, phosphoric acid as the second, and potash the third, such as 4-16-4. Some states require the bags to be labeled not only with the analysis but with the ingredients as well. Although responsible firms put out a dependable product, the results from the use of their fertilizer may not be all that is claimed, since they are likely to report only the most successful results. Mixed fertilizer of low analysis ordinarily contains a good deal of filler.

Crop Fertility and Feed Value

Table 31 shows the fertility elements contained in common Midwest feed crops as well as their feed value per acre. The wide variation in fertility elements removed by the different crops

TABLE 31

FERTILITY CONSTITUENTS AND FEED NUTRIENTS PER ACRE OF CERTAIN CROPS*

Crop	Reasonable Yield	Fertilitzer Equivalent of Fertility Contained in Crop†			Type of Feed	Digestible Feed Per Acre†	
		Nitrogen as Ammonium Nitrate	Phosphorus as 20% Superphosphate	Potash as 60% Muriate		Protein	Total Nutrients
		(*Lbs.*)	(*Lbs.*)	(*Lbs.*)		(*Lbs.*)	(*Lbs.*)
Grains‡							
Corn	50 bu.	127	86	17	Fattening	196	2,210
Oats	40 bu.	76	48	10	Growing	120	915
Barley	30 bu.	84	62	15	Grows and fattens	134	1,130
Wheat	20 bu.	78	60	11	Like barley	136	1,000
Sorghum	20 bu.	55	39	7	Like corn	87	800
Soybeans‖	22 bu.	240	90	51	High protein (also contains oil)	433	1,140
Silage							
Corn	9 T.	205	123	108	Starchy roughage	234	3,370
Sorghum	12 T.	177	110	178	Like corn silage	192	3,620
Alfalfa§‖	4.5 T.	443	134	219	Protein silage	460	2,600
Hay							
Alfalfa§‖	2.5 T.	362	120	203	High in protein	530	2,510
Red Clover§‖	1.8 T.	210	74	114	Med. in protein	250	1,870
Soybean‖	2.0 T.	292	115	66	High in protein	440	2,020
Clover and Timothy	1.8 T.	153	70	105	Varies in protein	160	1,730
Lespedeza‖	1.3 T.	164	56	44	High in protein	240	1,350

Example: 50 bushels of corn as grain contains as much nitrogen as 127 pounds of ammonium nitrate, as much phosphorus as 86 pounds of 20% superphosphate and as much potash as 17 pounds of 60% muriate.

For comparison with the fertility removed by crops, a six ton (average) application of barnyard manure contains as much nitrogen as 180 pounds of ammonium nitrate, 150 pounds of 20% superphosphate and 100 pounds of 60% muriate of potash.

* By feeding the crops to livestock and returning the manure to the land, a good deal of the fertility is kept on the farm.

† Computed from Morrison's "Feeds and Feeding."

‡ Fertility and digestible feed in grain only.

§ The full year's crop.

‖ These crops are legumes. Under proper conditions, much of the nitrogen they contain is taken from the air. They are "soil builders." When all of the crop is removed from the land, their soil building value is greatly reduced.

indicates the large amount of soil fertility that needs to be present in a form available to the plant if continuing high yields are to be obtained. While water requirements are not given, lack of timely rainfall can be a greater factor in reducing yields than fertility shortages. The table is not meant to be a guide to the use of fertilizer, and neither should it be used for a fertility "balance sheet."

Table 31 also indicates the importance of rotations. Corn needs to follow a legume handled so that some of the nitrogen is left in the soil. Oats, on the other hand, requires much less fertility for a normal crop so can readily follow a heavy user of fertility like corn and still give satisfactory yields.

Rotations Increase Crop Yields

While both natural and commercial fertilizers are important to good farm management, "keeping the soil and using it too" depends mainly on sound crop rotation plans.

Good rotation programs will increase total production, reduce soil erosion, and build fertility. Although no set of rotation experiments will show a farmer the exact results he will get on his own farm, he can use them as a general guide. Figure 37 shows the expected production from 100 acres of cropland in the Corn Belt based on rotation experiments in Missouri, Indiana, and Iowa.

The results in Figure 37 are from experimental fields and are on better than average land. Only the effect of the rotations on production is shown. Rotations also affect physical structure of the soil and may increase or decrease both its water holding capacity and its tendency to wash or blow away.

In Missouri, on medium grade land, a rotation with one-third of the land in legumes increased the total crop output by one-fourth over corn alone. A little less grain was raised. On this soil a four-year rotation with two years of small grain had less merit than one year of small grain since oats do not produce a large amount of grain per acre.

In Indiana, on good soil, a five-year rotation with 20 per cent of the land in legumes and 80 per cent in grain gave a larger grain output than where all of the land was in corn and oats. In addition, hay production was good. On rolling land, however, a rotation with three years of row crops out of five would make the erosion control problem harder to handle.

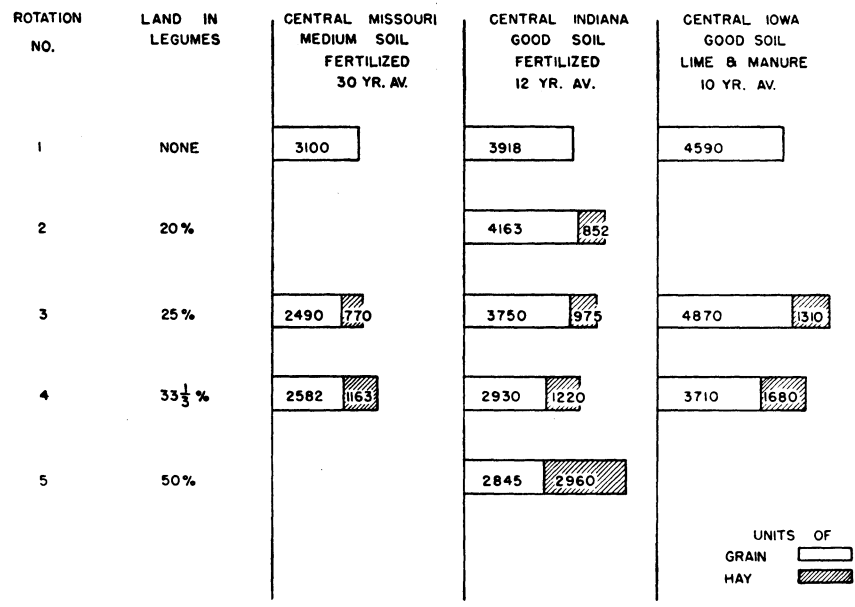


FIG. 37—Feed units per 100 acres with five rates of legume use. One feed unit is one bushel of corn or its equivalent in feeding nutrients.

Rotations:	Central Missouri	Central Indiana	Central Iowa
	1. C	1. C-O (sw. cl.)	1. C-O
	2. —	2. C-C-SB-W-CL	2. —
	3. C-O-W-CL	3. C-C-W-CL	3. C-C-O-M
	4. C-W-CL	4. C-O-CL	4. C-O-M
	5. —	5. C-C-W-A-A-A	5. —

The proper rotation to use depends on the soil, location, prices, costs, and the farm plan. Note how more or less legumes in the rotation affect both the total grain production and the production of all crops. Good managers prefer a rotation that produces a large total amount of grain rather than one that gives the highest grain yield per acre.

One-fourth of the land in legumes on good Indiana soil gave a good balance of crops and a large total yield. But the three-year rotation that kept one-third of the land in legumes had little to recommend it from the production point of view. A three-year rotation of corn-wheat-alfalfa (not shown in the diagram) was much better since it provided nearly as much grain as where half of the land was in corn.

The six-year rotation with three years of alfalfa produced a lot of feed but not as much grain. Nearly half of the feed units were hay, which would fit well only on intensive dairy farms. Farmers producing meat animals would use a larger proportion of feed grain than this.

Iowa Rotation

Many of the most fertile soils in Iowa have been cropped for less than 100 years. As a result the native fertility is not yet drawn down far enough so that a large proportion of legumes in the rotation seems important to many farmers. But on less fertile Iowa soils, the farmers are in a situation more like those in Indiana or Missouri and should plan accordingly.

On fertile Iowa soils, keeping less than half of the land in corn seems to have little merit from the production standpoint. Because of the high yields, farmers on good bottom land soils and some fertile, level uplands plant more than half their acreage to corn. Where more roughage-consuming livestock are kept, however, extra legumes in the rotation are more easily used at a profit. Wherever Iowa soil is highly productive, the low output of the three-year rotation including one year of oats shows up.

If soil erosion is a problem, farmers should consider the erosive effects of the rotations they use.

Rotations in the Plains

An important part of the rotation problem in the western Plains Area is to hold the water where it falls so that enough moisture can be built up to grow a crop. Since corn requires a lot of moisture and has limited drouth resistance, it finds less favor than wheat or sorghum under such circumstances. But in the eastern Plains Area where more rain falls, a cultivated crop like corn may help hold back moisture that otherwise would run away. In the drier areas to the west, alfalfa saps the subsoil so deeply if left down more than one or two years that several years of rainfall are needed to restore the ground water. A moisture-saving measure in these areas is to keep part of the cropland fallow and free from a green growth.

The effects of two cropping plans on wheat production in various parts of the Plains Area are shown in Table 32.

In the lower rainfall area of the Plains States, wheat following fallow yielded much better than wheat every year. Where soil moisture is the main factor limiting yields, as is true in parts of North Dakota and western Kansas, half of the land in wheat brings a higher total yield than putting all of the land in wheat. The production costs of putting in and harvesting fewer acres are less too.

TABLE 32
Yield From 100 Acres of Land

Location	Kind of Wheat	Wheat Every Year	Wheat and Fallow Alternate*
		(*bushels*)	(*bushels*)
S. West Kansas	Winter	930	965
W. Central Kansas	Winter	1,650	1,165
S. West S. Dakota	Spring	1,190	1,035
S. West N. Dakota	Spring	1,100	1,060

* Production from 50 acres since the other is lying fallow.

Fit Rotation to Type of Farming

The rotation and the type of farming to be used must be considered together. Cash crop farmers, for example, give much emphasis to producing a large total of high value crops. When they plan their rotations, these are the considerations that guide them:

1. Both the value of the crop above the cost of growing, and the total value.
2. Whether there is a ready sale for the crop, and whether it can be stored without serious loss.
3. The drain on soil fertility if the crop is sold.
4. The cost of replacing fertility, either now or in the future.

Livestock farmers give special attention to the way the crop plan balances up as to feed supply. If more hay is needed, for example, it will have a high value in the rotation. But if the farm already has a surplus, more grass would have little added value. Often a lower value crop such as oats is included in the rotation simply because it fits well as a nurse crop or supplies a kind of feed that cannot readily be bought. Obviously the usual supply of feed crops in the area, whether scarce or plentiful, will affect the rotation plan of the farmer who buys part of his feed.

Because crops vary greatly in their value per acre, the farmer needs to know what yields he can expect and what the crop usually is worth. He also should be aware of the risk in growing the crop. Some crops are quite dependable producers even with variations in weather, while others are sensitive to abnormal conditions. Flax, for example, is hard to save during a rainy

harvest. In the Corn Belt, soybeans, on some soils, is considered a more dependable crop than corn. By talking to good farmers of the community, the beginner can find out what crops fit best in the area and what cropping practices seem to be most profitable.

Getting Maximum Crop Output

The following three-step example summarizes the effect that improving the rotation system can have on crop production where rainfall is not the limiting factor.

1. Suppose a farmer is raising grain entirely and no legumes are being grown in the rotation. He will harvest a certain total production of grain in an average year. Now let the farmer add a small acreage of legumes to the rotation, say one year in five. On most soils, two results will be noted; the total crop output will be increased and the total production of grain will increase as well. Obviously, legumes are unusually valuable at this stage of the rotation plan because they result in additional grain production. The farmer could discard all of the legume crop and still be ahead.
2. Next the farmer adds a larger acreage of legumes to the rotation and reduces the acreage of grain. He soon sees another change. He reaches the point where grain production begins to decline even though the total output of all crops may still increase. The yield of grain per acre may be rising but this is more than offset by the smaller acreage of grain crops. He is now at the stage where forage begins to be a substitute for grain in the cropping system. Farmers often find it to their advantage to stop increasing the legume acreage when the maximum amount of grain is obtained.
3. If the farmer adds an even larger acreage of legumes and decreases the grain acreage further, he comes to still a third change. Both the total production of crops and the amount of grain decline. He now is past the point of largest total production, even though the production of forage still is increasing. The point of diminishing grain output was passed earlier and he has carried the legume part of his rotation plan so far that even total crop output is going down.

On a particular farm, the combination of legumes to grain at which these changes take place depends on many things: the

type of soil and its depth, previous cropping program, kind and variety of crops used, kind and amount of fertilizer applied, soil management methods used, effect of the particular season, skill of the farmer, and so on.

The farmer, of course, wants to know the point of maximum production for his particular farm. He is interested in a crop production maximum that covers a period of from one to several years, depending on his situation. His plan may call for either a maximum of grain or a high output of total crops, whichever suits his needs best. But no matter what his production goals are, he takes into account the cost side as well as the quantity produced—the effect of high production on future crop yields and the effect of the crops produced on his total business.

The farm manager should study rotation results from nearby experimental fields and the experience of farmers in his community. In the end he must make the best estimate he can for his particular farm, remembering that no other conditions are exactly like his own. Research and experience are useful guides to him but should not be taken as a rule-of-thumb. There is no substitute for the judgment of the farmer himself.

Keep Weeds Under Control

No crop plan can be successful, of course, if weeds are allowed to get out of hand. Some deep-rooted perennials are so hard to kill out once they become established that the only safe course is to do everything possible to prevent them from getting a start. Using clean seed is a big help in weed control, and proper rotations will keep some weeds in check.

For the more stubborn weeds, spraying may be necessary. Since many of the sprays are selective weed killers, the farmer should follow directions carefully so he will know exactly how and when to apply them.

Farmers in most areas will find that state bulletins are a good source of information on weed control.

Pasture

On most farms, particularly those with roughage-consuming livestock, pastures fit into the general farming program as one of the cheaper sources of livestock feed. Each farmer, of course, should appraise his own needs. If, for example, he is short of

succulent, early spring pasture his problem is quite different than if he usually runs short of pasture during a summer dry spell.

Many farmers have a general livestock program that includes the need for clean ground pasture for pigs and chickens, a productive all-season pasture for milk cows, and additional grass for heifers and stock cattle. Others may have a herd of beef cows with calves at side, or perhaps be grain-feeding calves or short yearlings on pasture. For the beef cow herd the farmer will want a succulent, high protein type of pasture. For the calves and short yearlings he'll want more of a fattening type of pasture.

Permanent pastures produce a good supply of high quality feed for a period during the spring. The fresh, green grass—palatable and high in protein content—is excellent feed for young animals and milk cows. However, because the very early spring growth is watery, the grass should be given a good start before the pasture is opened to livestock. During the hot summer months, the feed supplied by permanent pastures begins to fall off and is much lower in protein. If milk cows or cows nursing calves must depend entirely on it for their feed at that time of year, the milk supply drops sharply. And if young stock graze on such pasture, their growth is retarded.

Planning the Pasture Program

Farmers east of the Plains Area use three systems to improve their pasture program. The first is to plow up most of the permanent pasture wherever that is possible, and put it into the rotation. The rotation ordinarily used is corn one year (on the contour if on rolling land), then small grain seeded to a pasture mixture, and the pasture left down from two to four years. Lime and fertilizer often is used with the new seeding. Sometimes the small grain is used for pasture. Many farms have two or more fields of permanent pasture. By plowing them at different times, the farmer will not run short of pasture during the year when one of the fields is in corn.

This is an excellent system for increasing both the amount and quality of the pasture and the length of pasture season. A pasture mixture, with the soil properly limed and fertilized, produces a good supply of feed and will not dry up badly during

the summer months, as permanent pastures are likely to do. Moreover, the farmer gets some extra grain to feed when the field is in corn or oats.

A second method is to carry out a pasture improvement program without putting the land into a rotation. The improvement may run all the way from seeding lespedeza on thin pastures to a complete pasture renovation program. To get helpful pasture improvement information, the farmer can obtain experiment station bulletins or talk with his county agent.

For those who have timber pasture of land too steep to renovate, another improvement method is to have an extra rotation pasture to use when the permanent pasture begins to dry up. The rotation pasture may be a legume mixture. Some sow a field to Sudan grass to carry through the summer dry period. However, Sudan grass is a high-yielding plant that needs a fertile soil or the use of manure and fertilizer.

Men who are fattening beef cattle on permanent pasture often feed protein cake, usually cotton cake, to advantage during the

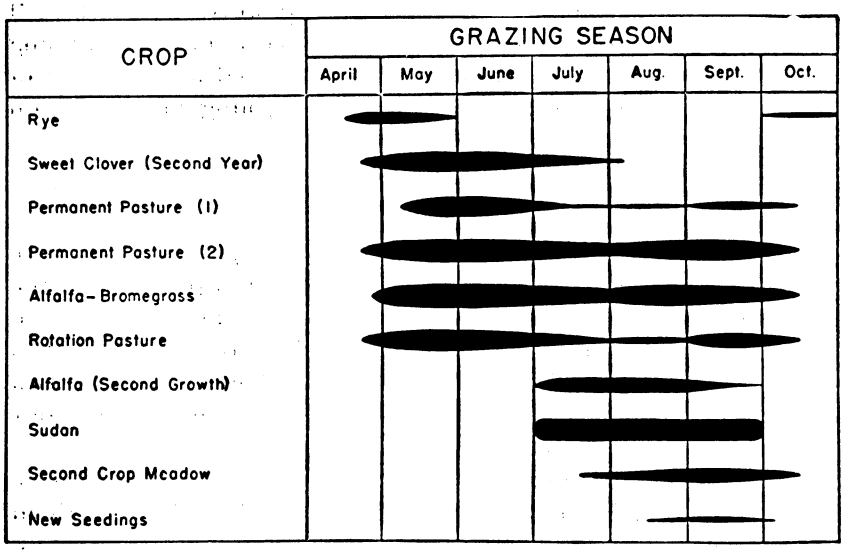


Fig. 38—Pasture calendar. (1) Untreated. (2) Improved with lime, fertilizer, and legumes.

A good pasture program on the livestock farm includes a pasture combination that gives an all-season feed supply during the growing season. The kind of pasture crops to be chosen must fit the location, kinds of soil on the farm, and the livestock program. The calendar is for the central Corn Belt.

TABLE 33
PRODUCTIVITY OF VARIOUS PASTURES*

Type of Pasture	Location	Animal Gains Per Acre
		(*lbs.*)
Alfalfa	Central Illinois	270
Alfalfa-brome	Central Illinois	250
Brome	Central Illinois	136
Bluegrass (untreated)	Southern Iowa	107
Bluegrass, limed and reseeded	Southern Iowa	174
Bluegrass (untreated)	Missouri	100
Bluegrass and lespedeza	Missouri	155
Bluegrass and lespedeza and sweet clover (lime, phosphate)	Missouri	185

* From Experiment Station Reports.

late summer. The hard summer grass provides a fattening feed but it may need to be supplemented by protein.

In the Corn Belt, a good pasture combination can be worked out by planning ahead for the full pasture season. A helpful guide is the Pasture Calendar, although it must be adjusted to fit local conditions.

Some idea of the productivity of various grasses in areas of good rainfall can be gained by studying Table 33. Quite noticeable is the improvement that comes from having legumes in the pasture mixture. Larger forage yields are obtained because legumes supply nitrogen to the soil and the feed furnished to livestock by the pasture is better balanced. The extra cost of improving the pasture, however, should not be overlooked.

Keep Grassland in Balance

With all the important and good things that can be said about pastures, they have three limitations. First, where land can be used for rotation crops without serious soil loss, the value of pasture per acre usually is lower than that of the better adapted grain crops. Second, most pasture does not "keep" very long. If not used when ready, it has little value later on. Third, a farmer often must use large amounts of capital to get any return from his grass. For example, a man may buy $2,000 worth of steers to harvest $300 worth of pasture—quite a lot of

capital to risk for such a small amount of feed. Part of the income from the steers must be credited to capital, management, and risk, and part to the pasture itself.

The farmer's ability to make wise decisions about his pasture land from the soil-saving, fertility, and income standpoints is one mark of a good manager.

Choosing a Rotation

On succeeding pages are common rotations used in the North Central States and comments on their use. Beneath each rotation is the percentage, first of row crops, second of small grain, and third of meadow. If a catch crop for hay, pasture, or plowing under is used, it is shown in parentheses.

Rotation	*Comments*
Rotations for fertile river bottoms or special conditions on good, level land for a short time. These deplete the soil rapidly.	
1. Corn – soybeans – small grain (swcl) 66⅔%—33⅓%—0% (33⅓%)	An intensive rotation adapted only to fertile, level land. With sweet clover used as a catch crop in the small grain, and fertilizer applied as needed, this rotation gives a high cash return in the central Corn Belt.
2. Corn – small grain (swcl) 50%—50%—(50%)	Too intensive a grain rotation for long use. Where sweet clover is used as a catch crop on fertile soils, it can be used for a short period of time if the land is level.
3. Corn – soybeans 100%—0%—0%	Not quite as hard on the soil as continuous corn but is not recommended except for short periods under special conditions.
4. Continuous corn 100%—0%—0%	Has little place except on river bottoms that frequently overflow.
Rotations for good to excellent grade cropland, level to moderate slopes.	
5. Corn – Corn – small grain – clover 50%—25%—25%	A standard rotation for high fertility soils using 50 per cent row crops. Not so good where erosion is a difficult problem. Corn yields likely will average some 10 per cent less than the comparable three-year rotation, but on good soils the total bushels of corn per farm will be larger.

6. Corn – oats – (swcl) – corn – wheat – clover 40%—40%—20% (20%)	A feed crop—cash crop combination for good quality land. The cash crop is wheat. By using sweet clover as a catch crop, legumes appear twice in the rotation. Oats can be used twice in the rotation where wheat does not fit in well.
7. Corn – small grain – alfalfa 33⅓%—33⅓%—33⅓%	Preferred by some farmers because the new seeding of alfalfa may be more drouth-resistant and higher-yielding than red clover. The alfalfa hay yield usually is higher but the seeding cost may be greater. Many farmers dislike to plow up a good alfalfa stand after only one year's crop is harvested.
8. Corn – soybeans – small grain – clover 50%—25%—25%	A rather intensive rotation including soybeans as a cash crop. The soybeans may cause sloping soils to erode more than corn does. If winter wheat is the small grain, this will not be so serious since some winter cover is provided. Where wheat is used, the rotation combines a moderate amount of feed crops with considerable cash crops. By using oats, more feed grain is provided.
9. Corn – soybeans – corn – small grain – clover 60%—20%—20%	An intensive rotation for fertile, level soils. Provides both feed and cash crops.

Rotations for medium grade land, or on good land with considerable slope.

10. Corn – small grain – clover 33⅓%—33⅓%—33⅓%	A good rotation from the soil standpoint. On better soils, grain production is lower than with most other rotations. On medium grade soils where erosion is not a serious problem, this rotation can be use indefinitely if phosphate and potash fertilizers are supplied as needed along with manure and lime.
11. Corn – corn – small grain – alfalfa – alfalfa 40%—20%—40%	Rotation with 40 per cent row crops and 40 per cent legumes. The large alfalfa acreage is often difficult to use profitably. Is not widely adapted except on dairy farms or those with a large cattle program. May be used as a minor rotation near the buildings to furnish clean rotation pasture for pigs and young chickens. Corn can be reduced to one year or alfalfa increased to three years if the farmer so desires.

12. Corn – small grain – alfalfa – alfalfa 25%—25%—50%	A rotation that is soil conserving but the proportion of hay to grain requires a large roughage-consuming livestock program unless much grain is purchased. An excellent minor rotation for use near the buildings to provide a clean ground hog system. It also fits dairy farms.
13. Corn – oats – wheat – –clover 25%—50%—25%	A less intensive rotation with only 25 per cent row crops. Fits better on rolling land or less fertile soils.
14. Corn – corn – small grain – clover – timothy 40%—20%—40%	Moderately intensive with erosion control value. Not a very desirable rotation in most areas. Has the fault of the timothy using up the nitrogen provided by the clover crop when it is needed more by corn.

Rotations for fair grade cropland; may or may not have considerable slope.

15. Corn – small grain – clover – timothy 25%—25%—50%	A good soil conserving rotation for soils of medium fertility but is not very desirable from other standpoints. Timothy is a low value crop and would use up nitrogen from the clover crop. It pays much better to follow the clover crop with corn.
16. Corn – soybeans for hay – wheat (swcl) 33⅓%—33⅓%—33⅓% (33⅓%)	A rotation for medium grade, level land with a tight subsoil. Soybeans make a more dependable hay crop than deeper rooted legumes. Uses sweet clover to furnish nitrogen for the corn, help open up the subsoil.
17. Small grain – lespedeza 0%—100%—0% (100%)	A one-year rotation for medium grade soils in the lespedeza area. Provides either grain and hay, grain and pasture, or all season pasture. Helps to control erosion where the land is not too steep.
18. Wheat – clover (red or sweet)	This rotation has limited used. It could be used as a short rotation on sloping land not well adapted to corn or other row crops and where a cash or feed crop is wanted.

Rotations for use in the Plains Area where the moisture supply is limited.

19. Wheat – sorghum – fallow or wheat – wheat – fallow or wheat – barley or oats – fallow 33⅓%—33⅓%—0% or 0%—66⅔%—0%	A cash crop-feed crop combination or a straight cash crop rotation for the Plains. Sorghum is commonly used as the feed crop in the winter wheat area and barley or oats in the spring wheat section. Sweet clover may be used as a catch crop in the second year small grain where moisture is sufficient.
20. Wheat – fallow 0%—50%—0%	A standard plan in the western wheat belt where soil moisture is insufficient to grow a crop every year.
21. Continuous wheat 0%—100%—0%	Is used in the Plains States, but is being replaced by a longer rotation.

Although a wide variety of rotations are outlined, the list is by no means complete. Rotations may run all the way from one to six years in length. Many farms can use two separate rotations to advantage on parts of the farm that differ because of soil or slope differences. None of the rotations described on the foregoing pages includes special crops. Such crops usually can be worked into one of the plans in place of all or part of one of the crops that fills a similar place in the rotation. For example, potatoes, tomatoes, sugar beets, or sweet corn can be substituted for field corn. Or field peas could be planted in place of part of the small grain.

All these, of course, are only suggestions. When the farmer sets out to plan his own rotation system they will be helpful. But he also must keep some important general facts in mind. They are:

1. *His farm*—its type and kind of soil; fertility level; whether the land is level or rolling; climatic conditions; size of the farm.

2. *Type of farming*—whether he wants to raise beef cattle or feed them; whether he favors dairying; whether hogs will fit into the enterprise; whether he is interested primarily in grain crops or in other types of crop farming.

3. *The future*—whether his rotation will save the soil or rob it of its fertility and increase erosion; whether he needs to farm intensively at first with the idea of modifying his plan

later; what buildings and other improvements will be needed; the part his family will play in operating the farm as time goes on.

These are some of the questions the farm manager must answer. And if he does a systematic job of acquiring the information he'll need to answer them, his final decision should be a wise one.

Making a Field Layout Plan

Once his rotation system is outlined, the farmer must design the best possible field arrangement. Good planning here will save time in field work, cut fencing costs, make the rotation plan easier to carry out, and reduce erosion on rolling land. Because a well laid out system may last most of a lifetime, farm owners should plan it carefully. Tenants can improve the field layout, too, but unless the landlord cooperates they will be working under a handicap. Usually, though, the landlord can be sold on a better system if the tenant has sound reasons for making the change.

If a minor rotation is to be used around the buildings, this part of the plan should be worked out first. Most minor rotations make use of three or four small fields, although some farmers use two with permanent fences and divide them by temporary fences if necessary. A minor rotation may supply clean ground pasture for pigs and young chickens close to the buildings. Other farms also may need a night pasture for milk cows. The acreage needed depends on its use and the number of livestock of various kinds. For example, one acre of good rotation pasture will handle about three litters of pigs, and one-half acre per milk cow for night use should be ample. Chickens do not use a great deal of grass but do better if they can be moved occasionally.

Fit the Fields to the Land

Farm conditions, as well as the rotation plan, have a lot to do with field arrangement. Level and near level farms can have straight, rectangular fields, while in rolling areas, fields may have curved sides to fit the lay of the land. So far as possible, the farm should be divided into fields of about the same acreage to make it easier to follow a definite rotation plan. Not all fields need to be fenced separately with permanent fences, however, if

other rotation fields join them. When some fields are smaller because of ditches or other non-tillable areas, two of these may be matched to make one field in the rotation plan.

On level land, long narrow fields make more efficient use of machinery than square ones and large fields are better than small ones. But square fields require the least fencing per acre so it does not pay to go too far in trying to plan for long fields. Temporary electric fence often can be used to keep out livestock, but does not work well for smaller pigs and sheep. For convenience the end of the field should be toward the buildings, if possible, or the nearest place of entrance. Several outline maps of the farm can be used for trial arrangements before choosing the final plan.

Put Fences on the Contour

In areas where farming on the contour should be the regular practice, the wise farmer will lay out his field arrangement in that fashion. Contouring fields within rectangular fence lines, however, may be used at the start. The farmer will save time in the long run if he moves his fences to fit the contour pattern. Many corners can then be avoided, and the whole plan worked out more successfully.

If a pond, well, or a pipe outlet is a source of livestock water in the field there is a big advantage in having it located where two or more fields join. With this system one water source serves more than one pasture.

Even though livestock farmers generally want to grow all their own pasture and roughage, the beef cattle pasture need not always be on the home farm. By renting satisfactory pasture, the home farm can be cropped more intensively, providing the land is adapted to it. Dairymen, however, want their pasture at home where the cows will be close by.

Finishing Up the Crop Plan

In summary, these are guide posts in making up a cropping plan:

1. Keep as much land in the rotation as seems reasonably possible. Most land yields enough more if used in a rotation to pay better than if left in permanent pasture. But where the farmer has trouble in getting a new grass seeding, this

must be kept in mind in planning for the next year's hay and pasture supply.

2. The crop combination to use is the one that gives the greatest income advantage, all things considered. Crop yields and values, risks, assurance of getting a crop, avoiding undue erosion, operating costs, labor needs, and having a well-balanced plan all go into this decision.

3. The plan should be kept reasonably flexible to allow for the usual crop hazards that occur in the community.

4. The farmer should not spend more time in making up and operating the crop plan than is justified in view of the importance of crops in the whole farm plan. A complicated cropping plan may not be worth the extra time required compared to a simpler plan.