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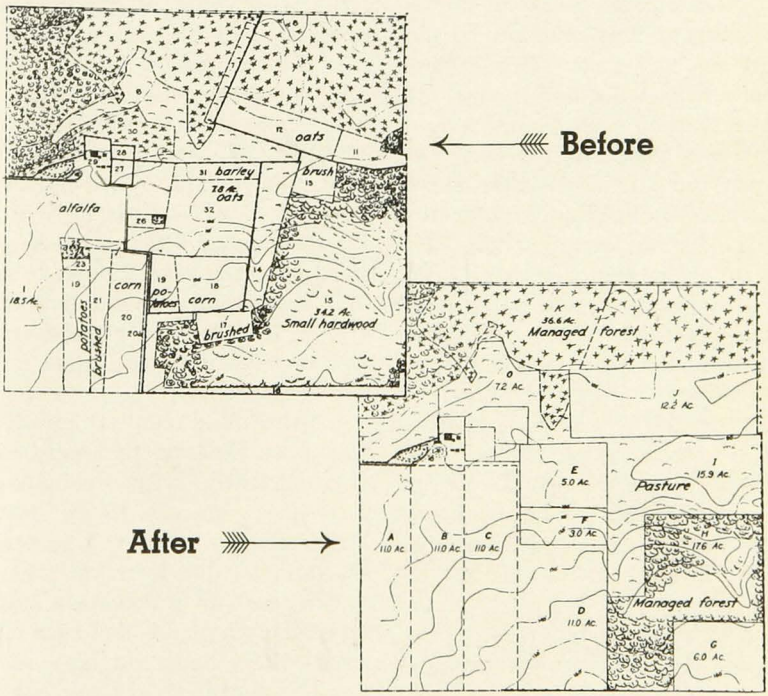
Planning the Physical Layout of Farms

by O. W. Howe



Agricultural Experiment Station—University of Minnesota

In Cooperation with the Bureau of Agricultural Chemistry and Engineering and the Bureau of Agricultural Economics

United States Department of Agriculture

Planning the Physical Layout of Farms[1, 2]

O. W. Howe[3]

THE PURPOSE of this bulletin is to present a systematic procedure and technique in planning a farm layout. The factors which must be considered are discussed, and methods of transition from the present practices to the new plan are suggested. This discussion closes with an example showing the application of such planning and transition to a given farm. It is not the purpose of this bulletin to make any general recommendations concerning such elements as drainage, land clearing, or field arrangement. Such recommendations as appear apply only to specific farms, but at the same time they illustrate the technique and procedure involved in farm planning.

A farm should be planned progressively 5, 10, or 20 years ahead. The long time farm plan should provide for land clearing, drainage, erosion control, irrigation, field design, crop rotations, farmstead layout, and fencing as needed.

When a map of the plan that seems most desirable has been prepared, a development schedule for the intervening years between the present and the full accomplishment of the new plan should be made. A year by year land-use schedule is designed keeping in mind these objectives:

1. Maintaining a satisfactory cropping sequence on each plot of land to provide the advantages of a rotation.

2. Directing the cropping sequence of each plot of land toward unification of the field of which it is to be a part.

3. Producing the desired acreage of each crop each year in order to stabilize feed production with the livestock program. In this connection a crop production schedule based upon estimated yields is prepared.

4. Scheduling required improvements in a work program that can be carried out efficiently with available labor. The improvements to be made are listed for each year as a general work schedule for the farm operator.

The result of following a systematic improvement plan is that each improvement when made not only serves its immediate purpose but also contributes directly to the fulfillment of an efficient ultimate long time operating plan. In this way the desired plan is gradually accomplished with the minimum cost in money and labor.

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[2] This bulletin is a result of a cooperative investigation by the Bureau of Agricultural Chemistry and Engineering, United States Department of Agriculture, represented by A. T. Holman, agricultural engineer; N. A. Kessler (resigned), associate agricultural engineer; and O. W. Howe, assistant agricultural engineer; the Bureau of Agricultural Economics, United States Department of Agriculture, represented by C. W. Crickman, senior agricultural economist; and the Agricultural Experiment Station, University of Minnesota, represented by G. A. Pond, Division of Agricultural Economics; and A. J. Schwantes, Division of Agricultural Engineering.

[3] The author wishes to express his appreciation to H. B. Roe, H. B. White, and S. B. Cleland of the University of Minnesota and others who have rendered assistance and counsel in the farm planning work that has been done under this investigation and in preparing this bulletin.

The Long Time Plan

The Present Organization

A description of the present organization is the first step in farm layout planning. This is for the most part a statement of the farm resources. A good farm map is a valuable aid in recording land resources. It shows all the important topographic features which influence farm layout. Certain features such as soils, timber, roads, fences, and buildings may be located on the map and further described in writing. Information on labor, power, machinery, crops, and livestock is helpful. Basic reorganization data such as crop histories should be included as an outline of the present operating plan.

Drafting the New Layout

A description of the present organization is the foundation for the new layout plan and transition program. It reveals weaknesses in the present layout and suggests opportunities for improvement. The problem, then, is to design changes in the farm layout that will most efficiently utilize the resources at hand. Only minor changes may be needed. On the other hand, reorganization may be desirable.

Farmstead layout.—In planning the farmstead the first point to consider is location. Before the development of rapid transportation, the tendency was to locate farmsteads as close as possible to the town, school, or other important destination. Now this is not so important, and location most accessible to fields is more important.

Field layout often works out best if the farmstead is located along the highway and not too close to a corner of the farm thus avoiding the necessity of long lanes and farm roads. Moving established farmsteads to more favorable locations may prove practical in rare cases. If either the house or barn or both are to be replaced, possibly the new structures can be built upon a new farmstead site and the remaining buildings moved to that site without excessive cost. The great majority of farmsteads are bound to their location by wells, concrete floors, basements, and other immovable improvements of sufficient value to preclude the possibility of moving them.

A farmstead arrangement that is unsatisfactory may gradually be changed into a good arrangement through the guidance of a plan that has been designed around a few permanent structures. More convenient locations may be provided for new buildings when they are needed to replace old ones and for additional buildings which will be needed in the event additional enterprises are added to the farm business. The possibilities of moving certain existing buildings and remodeling others to make them more serviceable and convenient should be considered.

Buildings and other objects on the farmstead may be cut out of cardboard to scale in their plan views and then arranged in different positions on the farmstead map. In studying the advantages and disadvantages of the various arrangements, principles discussed in University of Minnesota Extension Bulletin 175, *Farmsteads*, should be kept in mind.[4]

[4] Other publications of interest in this connection are: South Dakota State College Extension Circular 363, *Arranging the Buildings in the Farmstead;* University of Minnesota Extension Bulletin 196, *Planting the Standard Windbreak;* U.S.D.A. Farmers' Bulletin 1087, *Beautifying the Farmstead.*

Field Layout.—The number of fields should be as small as the desired rotation and the topographic conditions of the farm will permit. The ideal arrangement is for the fields to be of about a uniform size and equal in number to the number of years in the crop rotation. Topography, public roads, or the general shape of the farm often determine size and number of fields with very little choice left to the farm operator. However, many new possibilities will usually be discovered as the result of a systematic process of trying out numerous field arrangements and groupings on a skeleton map. Fields may be grouped into units of equal size to fit a desired crop rotation, several separate rotations may be used, a combination of these two ideas may serve best, or even other possibilities may be worked out.

Probably the first point to consider in laying out fields is to arrange them so one end is as near the farmstead as possible to minimize traveling distance to and from them. There may be other considerations, one or more of which are likely to oppose the ideal arrangement from the standpoint of travel on a given farm. The field arrangement must be found that will effect the best compromise among the several opposing factors.

The slope of the land may be a controlling factor in field arrangement. On long slopes the lengthwise direction of the fields should be across the slope to control erosion.

Where the soil varies considerably, each type should be segregated as nearly as is practicable into separate fields so that all the land in each field will be ready to work at the same time and will receive the proper fertilizer treatment and cropping sequence for its particular needs. In this connection a soils map is a valuable aid in planning field layout.

From the standpoint of efficiency in fencing and the operation of field machinery, the rectangular field as contrasted to the irregular shaped field is ideal. In general the longer and narrower the field, the less is the time lost in turning with machines and the more fencing is required. The more nearly square the field, the greater will be the power and machinery expense but the less fencing. Ordinarily a field that is two or three times as long as it is wide is satisfactory. In very large fields the effect of field shape on time lost in turning becomes less important. Where cross tillage, as of corn, is practiced, the field should not be extremely long and narrow. The use of the electric fence tends to lessen the importance of the fence factor thus favoring the narrow field. In crop rotations where pasture does not enter, no fence is required and a long narrow field may be desirable.

Contour farming creates irregular shaped fields, but in so far as uniform widths may be maintained in the contour strips the advantage of the rectangular field will be retained from the standpoint of minimizing turning.

It is sometimes desirable to replace a ditch with tile, to drain a pot hole, or to remove the stones from a small area of land in order to square up the field.

Frequently swales or pot holes in a field do not remain wet too long to produce a crop but are not ready to work as soon as the rest of the field. They must either be worked when they are too wet or operations in the remainder of the field must be delayed beyond the optimum time. In either

case crop yields must suffer and additional power, machinery, and labor expense is involved in working land that is too wet or that is dry and hard. It may pay to run a line of tile through such depressions.

An important factor in planning the farm layout for efficient operation is to arrange for the least possible conflict of farm roads and pasture lanes to avoid opening gates. At the same time accessibility of water to pasture should be considered, and availability of individual fields for supplemental pasture should not be overlooked.

Corners considerably less than right angles in field fences should be avoided unless they will contain desirable cover for wild life or in other ways will not merely become weed infested.

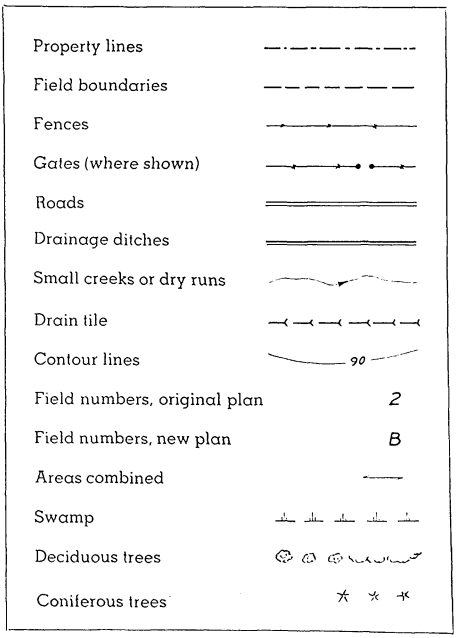
In developing new farms on unsubdued land, the tendency is to do the easiest clearing first regardless of the shape or location of the resulting fields. While this is often the practical procedure in getting the first few acres into crop, a systematic development schedule should be adopted in the early stages of the development program.

The meaning of the symbols that have been used in the maps shown in this publication are shown in the opposite column.

Figure 1a shows a Steele County farm as it was operated 10 years ago. Land was wasted in lanes, numerous headlands, and corners. In the absence of field organization, it was difficult to adhere to crop rotations. Figure 1b shows this farm as it is being operated at the present time. A three-year rotation of corn, grain, and sweet clover pasture is being used on fields A, B, and C. On fields E, F, and G a three-year rotation of corn, grain, and hog pasture is used. In field D a new strip of alfalfa is seeded down every year or two years on one side of the old alfalfa, and a strip of the old alfalfa on the other side is plowed up and planted to corn. The latter strip is then alternated between grain and row crop until again seeded to alfalfa. This type of rotation allows great flexibility in the cropping system.

Stock may pass through the lane on the east side of D directly to C, or to A or B, whichever is in sweet clover pasture at the time, through a temporary extension of this lane. From the sweet clover pasture they may be allowed to go directly to the native pasture area if from A or by way of a short temporary lane if from B or C. Thus the native pasture area is made accessible at very small expense in fencing and service space.

This arrangement also provides for a highly efficient farm road system.



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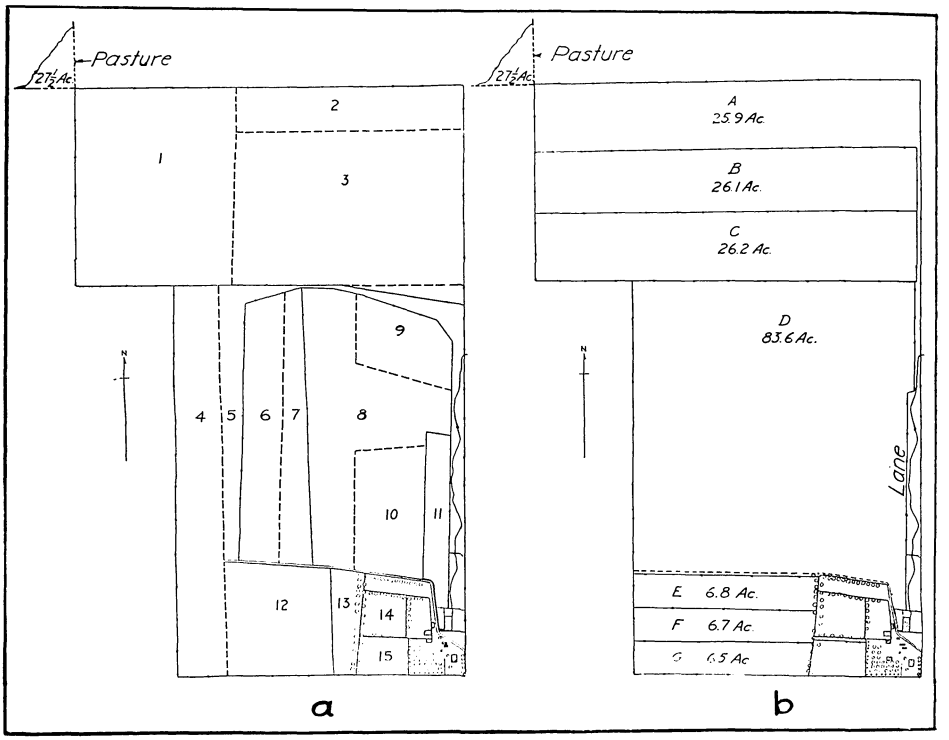

FIG. 1. THE FIELD LAYOUT OF A STEELE COUNTY FARM, (a) 1930 AND (b) 1940

Fields A, B, and C may be reached satisfactorily by means of the public road passing along the east edge of the farm since this is not a heavily traveled road. The map shows that all other fields may be reached by a short farm road passing along the north edge of the farmstead and extending to the west property line and by an east and west lane within the farmstead.

Figure 2 is an example of an irregular shaped farm that is cut up by roads and ditches. The area in the southeast corner is peat land and will remain in wild hay and pasture or phalaris.

The fact that several fields are isolated or partially isolated has established the size of the field unit at approximately 20 acres in the new plan for this farm, figure 2b. Seven fields of this size have been laid out and are cropped in two separate rotations; a four-year rotation north of the county road and a three-year rotation south of the county road. This leaves area K for a night pasture and 15.2 acres adjacent to the farmstead on the south which has been worked into a secondary three-year rotation and supplies pasture for the hogs.

In traveling between the farmstead and the public road in figure 3a, it is necessary to pass through two pasture gates as shown. Although there was no practical way to avoid crossing the pasture lane with the farmstead road, the new plan, figure 3b, shows how the

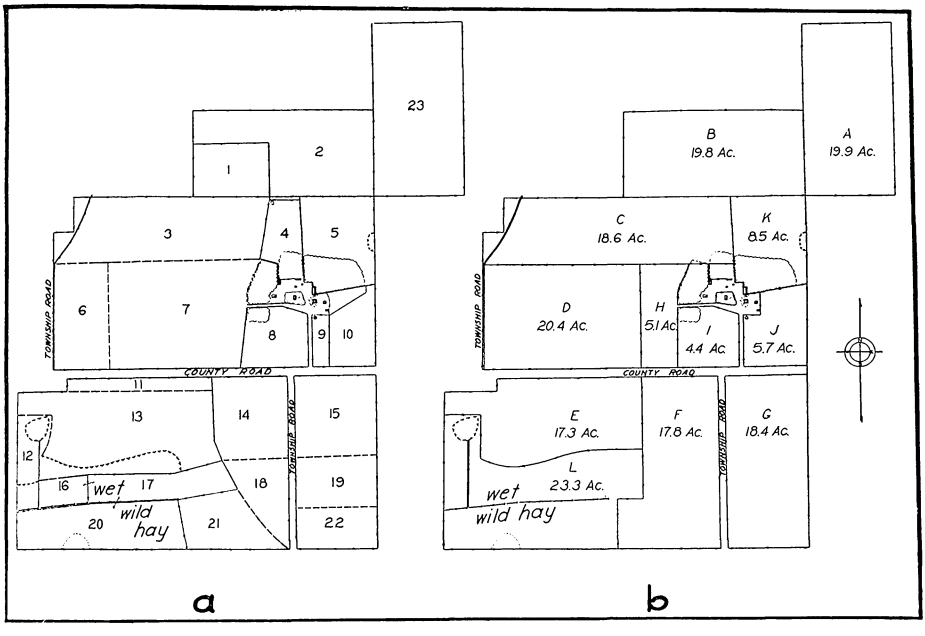

FIG. 2. (a) FIELD LAYOUT IN 1930, (b) THE PROPOSED PLAN

Field arrangement on this farm is largely determined by the presence of roads and the general shape of the farm.

old arrangement was improved. In the new plan the two gates are placed close together requiring only one stop to open or close both of them. By means of a two-way arrangement for each gate, it is possible to leave either the lane or the road open.

In figure 3b it will be noted that the fence on the east side of field D does not follow the border of the low area. The two small triangular parcels of the better drained land at the ends of this fence were thrown in with the pasture area since they would have been largely wasted if included in the field. It will be noted that sharp field angles have been avoided throughout this plan. Although the shape of the tillable area was the primary factor in determining that the fields should lie east and west, an important advantage to this arrangement is that each field may be connected independently to the main pasture.

In the farm plan shown in figure 4a, the easiest clearing was done first. The irregular sizes and shapes of the fields were further aggravated by the presence of ditches and a swamp. It is quite evident that savings in land, labor, fencing, power, and machinery will be effected as the new plan, figure 4b, for this farm develops. Tile drainage of the shallow swamp and substitution of a tile line for a ditch squares up the cropped area. Running the fields east and west provides a better arrangement of the peat and mineral soils within the fields than by running them north and south.

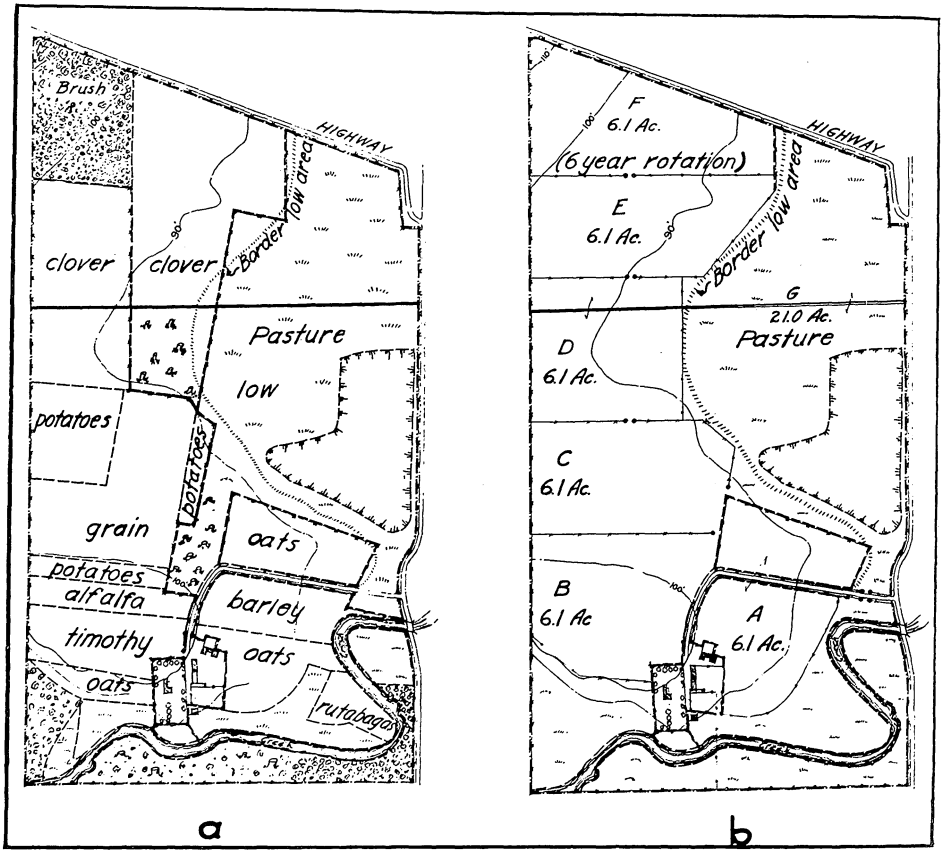

FIG. 3. (a) FIELD LAYOUT IN 1936, (b) THE PROPOSED PLAN

Field arrangement on this farm is largely determined by topographic conditions.

Figure 5a shows a Freeborn County farm as it was in 1931 when it was acquired by the present owner and operator. At that time 43 per cent of the area of this farm produced very little returns being partly wooded and in part poorly drained. The irregular sizes and shapes of cultivated fields made it impossible to follow a systematic crop rotation. Numerous point rows wasted power, labor, and land. Fences were necessarily crooked making them more expensive to construct and less efficient than they would be if the field divisions were straight.

In 1932 the field arrangement shown in figure 5c was decided upon as a goal for the development plan of this farm. Figure 5b shows this farm as it is at present with its land development plan well on the way toward completion.

The wood obtained by clearing the land has not only paid for all of the clearing cost but has supplied fuel for the home and enough fence posts to completely fence the farm.

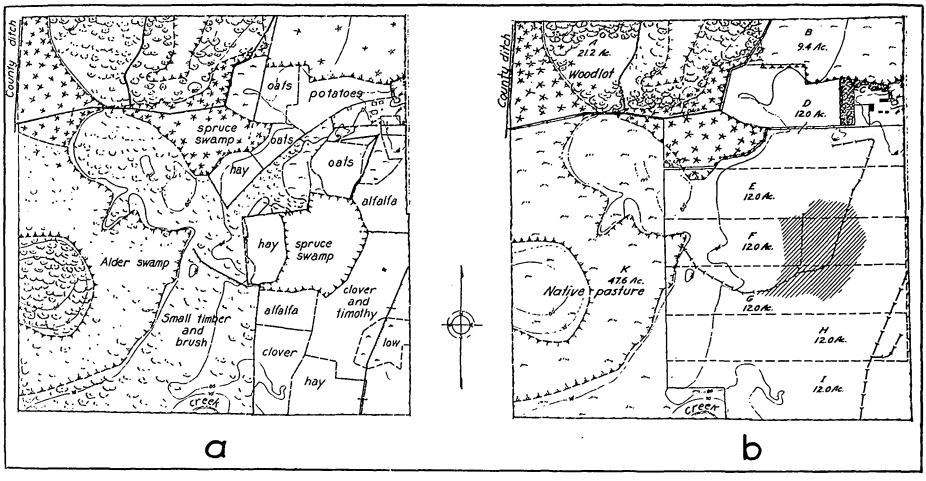

FIG. 4. (a) FIELD LAYOUT IN 1936, (b) REPLACING DITCHES WITH TILE AND CLEARING ADDITIONAL LAND WAS NECESSARY FOR A PLAN WITH REGULAR SHAPED FIELDS

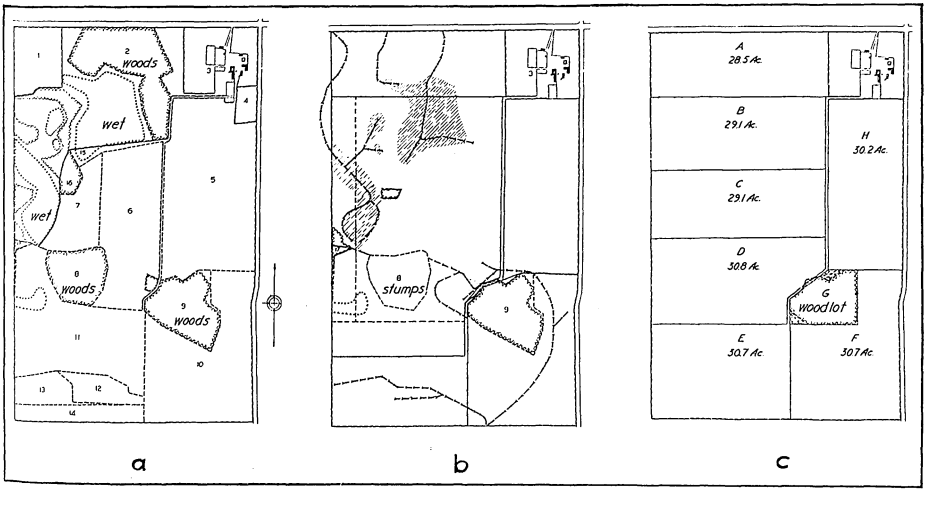

FIG. 5. BECAUSE OF FIELD IMPROVEMENTS INDICATED EVERY ACRE ON THIS FREEBORN COUNTY FARM CAN SOON BE EFFECTIVELY UTILIZED

Since 1930, 14,625 feet of drain tile have been installed at a cash cost of 32 dollars per acre for each acre benefited. Since this was previously waste or low grade pasture land (but not tax exempt), the benefit of draining it has been to add productive land to the farm at a cash cost of 32 dollars per acre and to gain the advantages of squaring up the fields.

Maps.—Available aerial maps facilitate effective farm planning in that they have greatly reduced the cost of obtaining a good farm map. Aerial maps may be obtained through the local agricultural conservation office. Penciled tracings may be made directly over the photographic enlargement for planning work or a draftsman may be employed to redraw the map to a more convenient scale. One inch equals 200 feet is a convenient scale for planning field layout. Blue line prints made from the tracings afford an economical supply of maps that are good for planning purposes. The exact scale of the aerial map can be obtained only by measuring some well defined line on the map and then measuring the corresponding line on the ground to obtain the ratio of the two distances. Figure 6 is a reduced presentation of an aerial map having a scale of one inch equals 371 feet from which the line drawing shown in figure 7 was made to a scale of one inch equals 200 feet by a simple process of replotting each distance and angle.

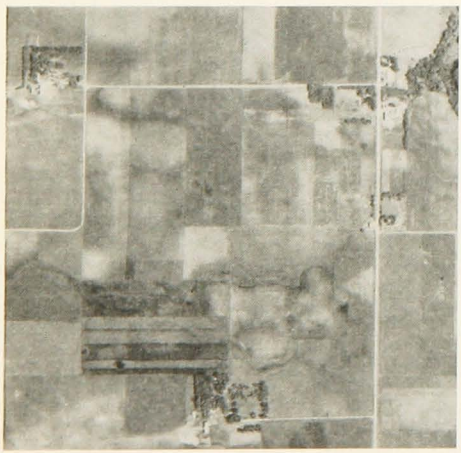

FIG. 6. AERIAL MAPS ARE A VALUABLE AID IN FARM PLANNING

In planning the farmstead layout a separate map of the farmstead drawn to a larger scale than that of the farm itself is desirable. A scale of one inch equals 50 feet is a satisfactory size for ordinary farmstead planning purposes. Aerial maps are of less value in preparing line drawings of the farmstead than for farm maps because of the small scale of the aerial maps and the fact that trees often obscure much of the farmstead detail on them.

The acreages of fields that are fairly regular and are bounded by straight lines may, of course, be determined by simple arithmetic. If a planimeter is not available, the following method of measuring the area of irregular fields will give satisfactory results:

Lay a sheet of semi-transparent cross-section paper over the area to be measured and carefully trace the area on it in pencil. Now count the number of squares included within the area progressively by rows, estimating in tenths the fractions of squares lying on the border. It is well to draw a line through each row of squares as it is counted in order to avoid errors in counting. It is easy to compute to the proper degree of accuracy the fraction of an acre each square represents so that the acreage of the area in question may be computed by multiplying the total number of squares included within its borders by the fraction of an acre represented by one square.

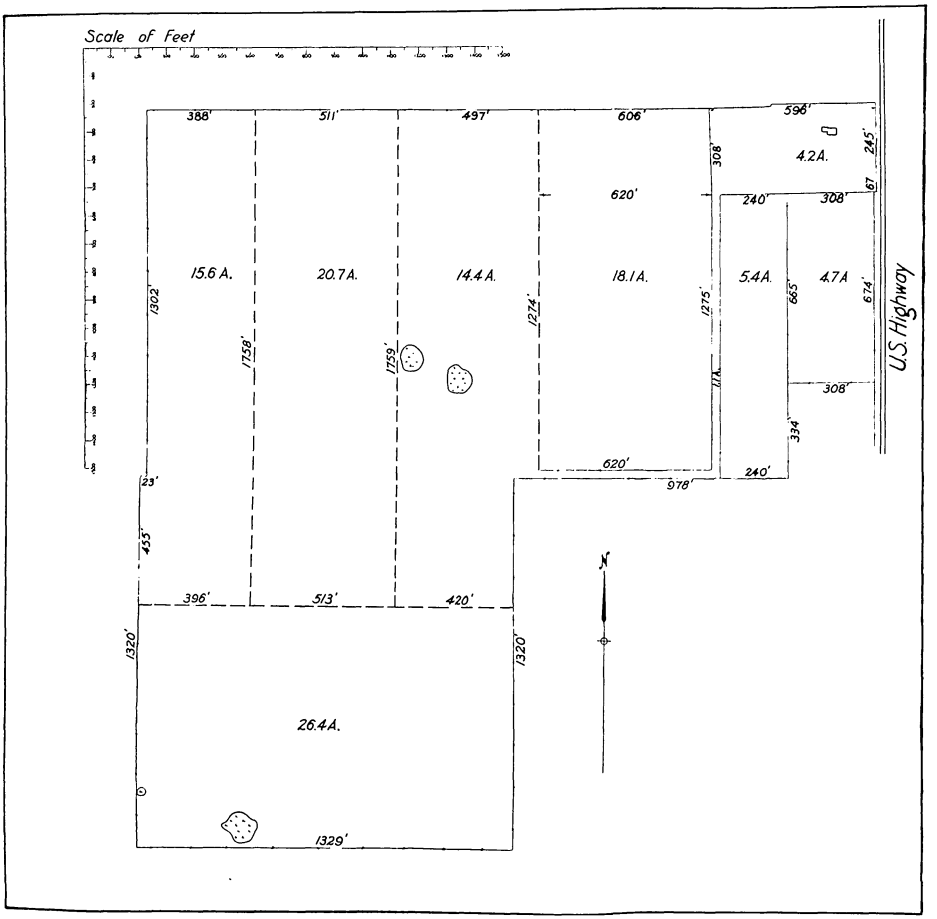

FIG. 7. THIS IS A SKELETON MAP DRAWN FROM THE AERIAL MAP SHOWN IN FIGURE 6. BOTH MAPS HAVE BEEN GREATLY REDUCED

Marking the New Field Lines.— When the new field arrangement has been decided upon, the field should promptly be staked out even though the new rotation will not immediately be effected. Permanent field boundaries should be measured in with a tape. Steel markers should be placed at the newly located field corners. These may be bars of steel from discarded machinery or sections of water pipe 18 inches or more in length which are driven vertically into the ground until the top end is nearly flush with the ground surface. Brightly painted marker stakes placed in fence lines or in other protected positions in line with the markers will save many times over the trouble it takes to set them by having the new field lines thus well marked throughout the transition period.

Practical Application to a Given Farm

The Present Organization

Statement of Farm Resources.—This St. Louis County farm has a total of 157.5 acres. Land use under the present organization is as follows:

	Acres
Total crop area	50.5
Native pasture	22
Woods and wooded pasture	81
Farmstead, roads, and lanes	4
Total	157.5

The locations of the principal soil types found on this farm are shown in figure 10.

The farm is operated by a young man assisted by his wife and parents in doing the chores and light field work. Extra labor is hired only at haying time or potato harvest.

The dairy herd of 14 cows, 4 to 6 young cattle, and a bull supplies most of the farm income through the sale of butterfat. Forty to 50 hens and a few turkeys are kept and one or two pigs are raised for home consumption.

The farm is well served with good public roads which make markets accessible. The farm road along the lake shore connects the farmstead with a good county road one-half mile to the west which leads to the nearest town 12 miles to the north. The farm road along the west edge of Area 16 is graded.

The farm is well fenced although fencing improvements will be required in the development of an improved layout plan.

An unlimited supply of good water for domestic use is available from three driven wells 30 to 35 feet deep. The lake provides a good source of water accessible to the fields for irrigation by pumping.

Crop Production and Disposal.—Table 1 shows a four-year record of crop acreages and yields.

Table 1. Distribution of Crop Acreage and Average Yield

Crop	Acres				Average yield per acre
	1936	1937	1938	1939	1936-39
Oats	1.1	6.2	6.8	1.5	7 bu.
Rye	.....	.....	.....	2.3	4 bu.
Barley	1.5	.....	1.0	.....	15 bu.
Wheat	.....	.....	1.0	.....	7 bu.
Potatoes	3.6	5.5	2.3	2.0	72 bu.
Rutabagas	.....	1.0	1.0	0.9	400 bu.
Alfalfa	0.8	4.6	3.8	4.6	1.9 T.
Alsike and timothy	39.5	34.0	34.4	39.0	1.8 T.
Garden	0.3	0.3	0.3	0.3	.....
Total	46.8	51.6	50.6	50.6	.....

There are 40 acres in hay and only 10 acres in other crops. The hay, grain, rutabagas, and cull potatoes grown are fed to the livestock. The marketable potatoes are sold. Additional grain and other concentrates are purchased for the livestock.

Weaknesses in Present Layout.—Eighty-two acres or 52 per cent of the total area is largely covered with woods, very little of which is of merchantable size and approximately half of which has been killed by fire. Cows graze over the entire area, except Area 23, and find grass on perhaps one acre in five. Except for supplying this small amount of pasture and the home fuel requirement, this part of the farm is nonproductive. If cleared and broken, all indications are that it would be about the same type of crop and pas-

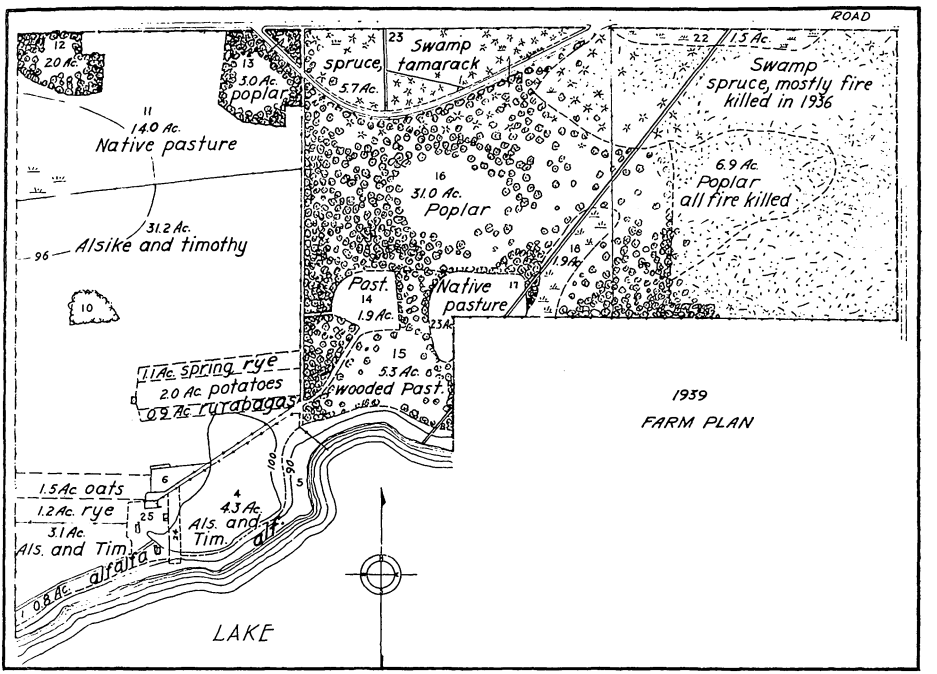

FIG. 8. THE PRESENT LAYOUT OF A ST. LOUIS COUNTY FARM

This farm has engineering problems that are a handicap to its earning power.

ture land that is now in use, again excepting Area 23 which is too low to justify the expense of reclaiming at the present time.

The dead timber area can be cleared cheaply at the present time. The roots are well rotted and a new stand of brush has not yet become established. Also the good fuel that remains in this area may be salvaged by immediate clearing.

Areas 10, 12, and 13 could be brought under cultivation cheaply by cutting off the poplar trees close to the ground and seeding to a hay crop without plowing until after they have been in hay sufficiently long for the stumps to have rotted.

Crop records and observations show that the crop land now under cultivation is inadequately drained for the production of grain and potatoes although alsike and timothy thrive very well (table 1). Drainage improvement must be provided before some of the crops adapted to this region can be grown successfully. The soil is not extremely tight and the deficiency of its drainage is not great; hence it appears that if the surface water were removed quickly, subdrainage would be adequate. A shallow open ditch drainage system would provide adequate drainage and could be installed at low cost by using home labor and equipment.

Without drainage improvement it appears that the entire crop acreage may as well be kept in alsike and timothy hay except for a few acres which might

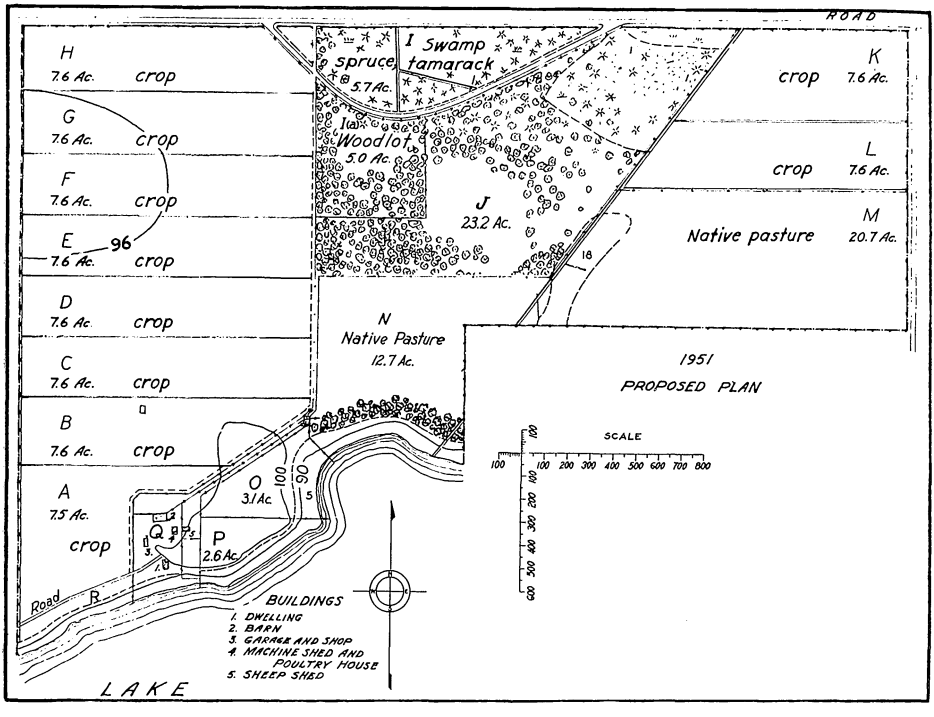

FIG. 9. THE SAME FARM AS IT IS EXPECTED TO APPEAR AT THE END OF THE 12-YEAR DEVELOPMENT PLAN WHICH WAS LAID OUT FOR IT

be broken each year and planted to rutabagas. The rutabagas do not seem to suffer from the temporary wet periods as do the potatoes.

With improved drainage there appears to be no reason why all of the crops adapted to this region could not be grown on this farm except perhaps alfalfa.

The New Plan

Briefly the new plan provides for improving about 30 acres of pasture land, increasing the cropping area to 78 acres, arranging fields for a crop rotation, installing a surface drainage system, and building a sheep shed.

Farmstead Layout.—Major changes do not appear to be needed in the farmstead layout. The farmstead is well situated on the highest area of the farm. The house commands a full view of the lake, the farmstead, and of the farm except as obscured by woods. The barn is favorably located 160 feet north of the house. The garage and shop on the west and the machine shed and poultry house on the east complete a desirable open court arrangement. If occasion should arise for rebuilding the machine shed, it might be located more favorably at the north end of the garage and shop where it would be more convenient to the shop and to the fields. The location for the

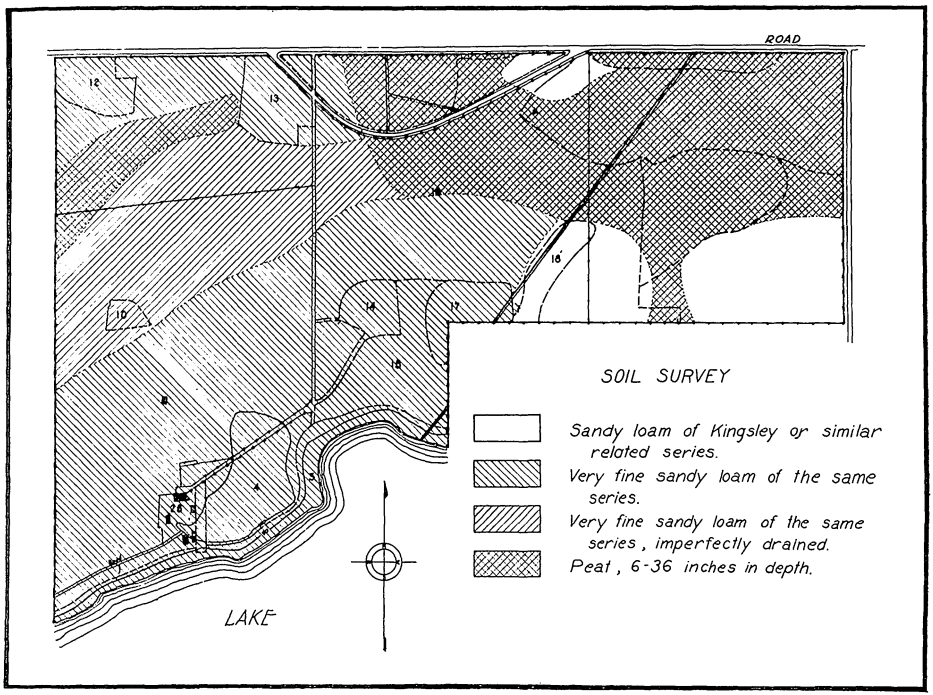

FIG. 10. WHERE SOIL TYPE VARIES A SOILS MAP IS A VALUABLE AID IN LAYING OUT FIELDS

new sheep shed is convenient to the pasture and not too far from the house. A granary, if ever needed, would be convenient to the barn, poultry house, and sheep shed if placed at the northeast corner of the court. Fenced areas have been squared up to make for better land use and orderly appearance.

Field layout.—The ideal arrangement for the fields in the west "80" would be to have them lie north and south so they would end up close to the farmstead minimizing traveling distance between them and the farmstead. However, other factors affect field arrangement.

Drainage must be improved and tile drainage is too expensive for this farm. It will be noted that in general the land slopes north and slightly west. By running the laterals westward, as shown in figure 9, they may be made broad and shallow with gently sloping banks and may be farmed similarly to a system of Mangum terraces. In this plan the main ditch is conveniently located along the west boundary fence and need be crossed only where it will be bridged for the farm road.

The new plan provides for 10 fields of approximately 7.6 acres each, of which 8 are in hay, 1 in grain, and 1 in cultivated crop.

In the absence of cross tillage this plan provides a good ratio of field length to width, nearly 5 to 1, and at the same time allows for a satisfactory spacing of the surface drainage ditches. The degree of drainage within individual fields will be most uniform with

this arrangement because drainage is and will be progressively better from north to south.

The topography is such that irrigation, if found to be desirable, would best be of the sprinkler type. So long as the fields are rectangular in shape, the effect of their arrangement upon this type of irrigation will be negligible.

In this plan the livestock have access to the east side of the farmstead, and the west side is open to the fields. No gates need be opened and closed for field traffic except when hay land is being pastured. Individual fields may be conveniently fenced for supplemental pasture. Sheep are alternated between night pastures O and P to control stomach worms. They enter J, a partly wooded area, through an underpass. The sheep will keep down the undergrowth in this area until it will gradually become cleared.

The cows are pastured in Areas M and N. They reach these areas through a lane and over a culvert which serves as the underpass for the sheep.

The woods in M will gradually be removed for fuel until this area is entirely cleared for pasture except for a strip of trees along the lake shore which will be reserved for prospective summer cottage sites.

Area I is isolated besides being difficult to drain and clear so this area will remain as it is at present a timber reserve. In addition to Area I a 5-acre managed woodlot, I (a), will be fenced away from the sheep.

Transition from Present to New Plan

Land Use Schedule.—Table 2 is an outline of the cropping or land use schedule for the transition period. The new field numbers and acreages are entered in the two columns on the extreme left of the sheet. The current year's land use plan (in this case 1940) is entered in the third column as the starting point for the schedule which will cover the period of years during which the cropping system is being changed from the present to the proposed plan. Cropping plans for successive years are then filled in.

The same outline may be presented graphically by laying out the proposed crop program for each year of the transition period on a separate map. For future reference these maps are more readable to the farm operator than the land use table. Preparation of the maps serves as a check against discrepancies in field layout which are not readily detected in the land use table. The table shows cropping sequence more clearly than does the map series.

Crop Production Schedule.—A crop production schedule, table 3, shows estimated production with cash crops and feed crops indicated. This is needed for reference in planning the livestock program.

Improvement Schedule.—The improvement schedule indicates the number of years that will probably be required to accomplish the new layout. The cropping schedule usually needs to be adjusted to prevent too much bunching up of required improvements into a single year.

Schedule of Improvements

1940 Dig main ditch and two laterals on south.
Fence Area 4 for sheep as shown on map.

1941 Dig six laterals on north.
Plow south half of Area 11.

Table 2. Cropping or Land Use Schedule
Acres Each Crop

Field		1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951
No.	Acres												
A	7.5	3.0 Pi 1.0 Ru 3.4 AsT 0.1 O	4.0 O 3.5 AsT	7.5 AsT	7.5 AsT	7.5 AsT	7.5 AsT	5.5 pi 2.0 Ru	7.5 O	7.5 AsT	7.5 AsT	7.5 AsT	7.5 AsT
B	7.6	3.0 O 4.6 AsT	3.0 Pi 1.0 Ru 3.6 AsT	4.0 O 3.6 AsT	7.6 AsT	7.6 AsT	7.6 AsT	7.6 AsT	5.6 Pi 2.0 Ru	7.6 O	7.6 AsT	7.6 AsT	7.6 AsT
C	7.6	1.3 O 6.3 AsT	7.6 AsT	3.0 Pi 1.0 Ru 3.6 AsT	4.0 O 3.6 AsT	7.6 AsT	7.6 AsT	7.6 AsT	7.6 AsT	5.6 Pi 2.0 Ru	7.6 O	7.6 AsT	7.6 AsT
D	7.6	6.9 AsT 0.7 Wo	6.9 AsT 0.7 Wo	6.9 AsT 0.7 Wo	3.0 Pi 1.0 Ru 2.9 AsT 0.7 Wo	7.6 O	7.6 AsT	7.6 AsT	7.6 AsT	7.6 AsT	5.6 Pi 2.0 Ru	7.6 O	7.6 AsT
E	7.6	7.6 AsT	7.6 AsT	7.6 AsT	7.6 AsT	5.6 Pi 2.0 Ru	7.6 O	7.6 AsT	7.6 AsT	7.6 AsT	7.6 AsT	5.6 Pi 2.0 Ru	7.6 O
F	7.6	3.8 NP 3.8 AsT	3.8 Nb 3.8 AsT	3.8 O 3.8 AsT	7.6 AsT	7.6 AsT	5.6 Pi 2.0 Ru	7.6 O	7.6 AsT	7.6 AsT	7.6 AsT	7.6 AsT	5.6 Pi 2.0 Ru
G	7.6	1.0 Wo 6.6 NP	1.0 Wo 2.6 NP 4.0 Nb	1.0 Wo 2.6 NP 4.0 O	1.0 Wo 2.6 O 4.0 AsT	1.0 Wo 6.6 AsT	1.0 Wo 6.6 AsT	1.0 Wo 6.6 AsT	1.0 Wo 6.6 AsT	7.6 AsT	7.6 AsT	7.6 AsT	7.6 AsT
H	7.6	4.0 Wo 3.6 NP	4.0 Wo 3.6 NP	4.0 Wo 3.6 NP	4.0 Wo 3.6 O	4.0 Wo 3.6 AsT	4.0 Wo 3.6 AsT	4.0 Wo 3.6 AsT	4.0 Wo 3.6 AsT	4.0 Wo 3.6 AsT	2.0 Wo 5.6 AsT	7.6 AsT	7.6 AsT
I	5.7	5.7 Smp	5.7 Smp	5.7 Smp	5.7 Smp	5.7 Smp	5.7 Smp	5.7 Smp	5.7 Smp	5.7 Smp	5.7 Smp	5.7 Smp	5.7 Smp
Ia	5.0	5.0 Wo	5.0 Wo	5.0 MWo	5.0 MWo	5.0 MWo	5.0 MWo	5.0 MWo	5.0 MWo	5.0 MWo	5.0 MWo	5.0 MWo	5.0 MWo
J	23.2	23.2 WoP	23.2 WoP	23.2 WoP	23.2 WoP	23.2 WoP	23.2 WoP	23.2 WoP	23.2 WoP	23.2 WoP	23.2 WoP	23.2 WoP	23.2 WoP
K	7.6	7.6 Wo	7.6 Wo	7.6 Wo	7.6 Wo	7.6 Nb	7.6 O	7.6 AsT	7.6 AsT	7.6 AsT	7.6 AsT	7.6 AsT	7.6 AsT
L	7.6	7.6 Wo	7.6 Wo	7.6 Wo	7.6 Wo	7.6 Wo	7.6 Wo	7.6 Nb	7.6 O	7.6 AsT	7.6 AsT	7.6 AsT	7.6 AsT
M	20.7	20.7 Wo	20.7 Wo	20.7 Wo	20.7 Wo	20.7 Wo	20.7 Wo	20.7 Wo	20.7 Wo	20.7 Wo	5.0 NP 15.7 Wo	10.0 NP 10.7 Wo	20.7 NP
N	12.7	12.7 WoP	12.7 WoP	12.7 WoP	12.7 WoP	12.7 WoP	12.7 WoP	12.7 WoP	12.7 WoP	12.7 WoP	12.7 WoP	12.7 WoP	12.7 WoP
O, P	5.7	5.7 TP	5.7 TP	5.7 TP	5.7 TP	5.7 TP	5.7 TP	5.7 TP	5.7 TP	5.7 TP	5.7 TP	5.7 TP	5.7 TP
Q	2.3	2.3 FS	2.3 FS	2.3 FS	2.3 FS	2.3 FS	2.3 FS	2.3 FS	2.3 FS	2.3 FS	2.3 FS	2.3 FS	2.3 FS
Rds	4.4	4.4 Rds	4.4 Rds	4.4 Rds	4.4 Rds	4.4 Rds	4.4 Rds	4.4 Rds	4.4 Rds	4.4 Rds	4.4 Rds	4.4 Rds	4.4 Rds
R	1.9	1.9 A	1.9 A	1.9 A	1.9 A	1.9 A	1.9 A	1.9 A	1.9 A	1.9 A	1.9 A	1.9 A	1.9 A
Total	157.5	157.5	157.5	157.5	157.5	157.5	157.5	157.5	157.5	157.5	157.5	157.5	157.5

Crop Key Letters: Pi, Potatoes; Ru, Rutabagas; O, Oats; A, Alfalfa; AsT, Alsike and timothy; Wo, Woods; MWo, Managed woodlot; WoP, Wooded pasture; NP, Native pasture; TP, Tame pasture; FS, Farmstead; Rds, Roads and lanes; Smp, Swamp; Nb, New breaking.

Table 3. Crop Production Schedule

Year	Oats		Potatoes		Rutabagas		Hay		Pasture		Woods	Service	Total
									native	tame			
	acres	bu.	acres	bu.	acres	tons	acres	tons	acres	acres	acres	acres	acres
1940	4.4	154	3.0	450	1.0	12	34.5	52	49.9	5.7	52.3	6.7	157.5
1941	4.0	140	3.0	450	1.0	12	34.9	52	49.9	5.7	52.3	6.7	157.5
1942	11.8	413	3.0	450	1.0	12	34.9	52	42.1	5.7	52.3	6.7	157.5
1943	10.2	357	3.0	450	1.0	12	42.7	64	35.9	5.7	52.3	6.7	157.5
1944	7.6	266	5.6	840	2.0	24	42.4	64	35.9	5.7	51.6	6.7	157.5
1945	15.2	532	5.6	840	2.0	24	42.4	64	35.9	5.7	44.0	6.7	157.5
1946	7.6	266	5.5	825	2.0	24	50.1	75	35.9	5.7	44.0	6.7	157.5
1947	15.1	528	5.6	840	2.0	24	50.1	75	35.9	5.7	36.4	6.7	157.5
1948	7.6	266	5.6	840	2.0	24	58.6	88	35.9	5.7	35.4	6.7	157.5
1949	7.6	266	5.6	840	2.0	24	60.6	91	40.9	5.7	28.4	6.7	157.5
1950	7.6	266	5.6	840	2.0	24	62.6	95	45.9	5.7	21.4	6.7	157.5
1951	7.6	266	5.6	840	2.0	24	62.6	94	56.6	5.7	10.7	6.7	157.5

Estimated yields: Oats—35 bushels per acre. Based upon yields from better drained soils of similar type in the locality.
Potatoes—150 bushels per acre. Based upon yields of years when drainage conditions were favorable.
Rutabagas—12 tons per acre. Based upon past yields.
Hay—1½ tons per acre. Based upon past yields.

1942 Install a sheep lane and underpass.
Plow north half of Area 11.
Fence J. Move fence west side J to east side of road.

1943 Start clearing K.
Build sheep shed.

1944 Finish clearing K.
Plow K.
Remove trees from Area 10.

1945 Dig lateral L-K.
Install fence L-K.

1946 Clear L.
Plow L.

1947 Dig lateral M-L.
Install fence M-L.

1948 Start clearing M.
Start removing trees from Areas 12 and 13.

1949 Clear M.
Remove trees from Areas 12 and 13.

1950 Clear M.
Remove trees from Areas 12 and 13.

1951 Finish removing trees from Areas 12 and 13.

Two things should always be posted where they will be constantly referred to. These are (1) the development schedule and (2) the land use table or the land use map for the current year.

Revision of the Long Time Plan

Farm layout plans require occasional revision to meet changing economic conditions and to take advantage of improvements in agriculture. The final objectives of a plan having once been carefully worked out and found feasible ordinarily will not change appreciably in their general aspects. If the plan is frequently reviewed and studied, other possibilities of improvements will be discovered and may be incorporated in the plan.

Figure 11a shows the condition of a Beltrami County farm when mapped in 1936. Immediately after mapping plans were made for improving the farm layout. The first plan, Figure 11b, has not been changed basically but has been revised as development progressed.

The fields were first laid out in five 12-acre units—A, B, C, D + F, and G to accommodate a five-year rotation of three years alfalfa, one year corn and potatoes, and one year oats. Field E being a steeply sloping area was eliminated from the rotation in order to keep it in pasture as much of the time

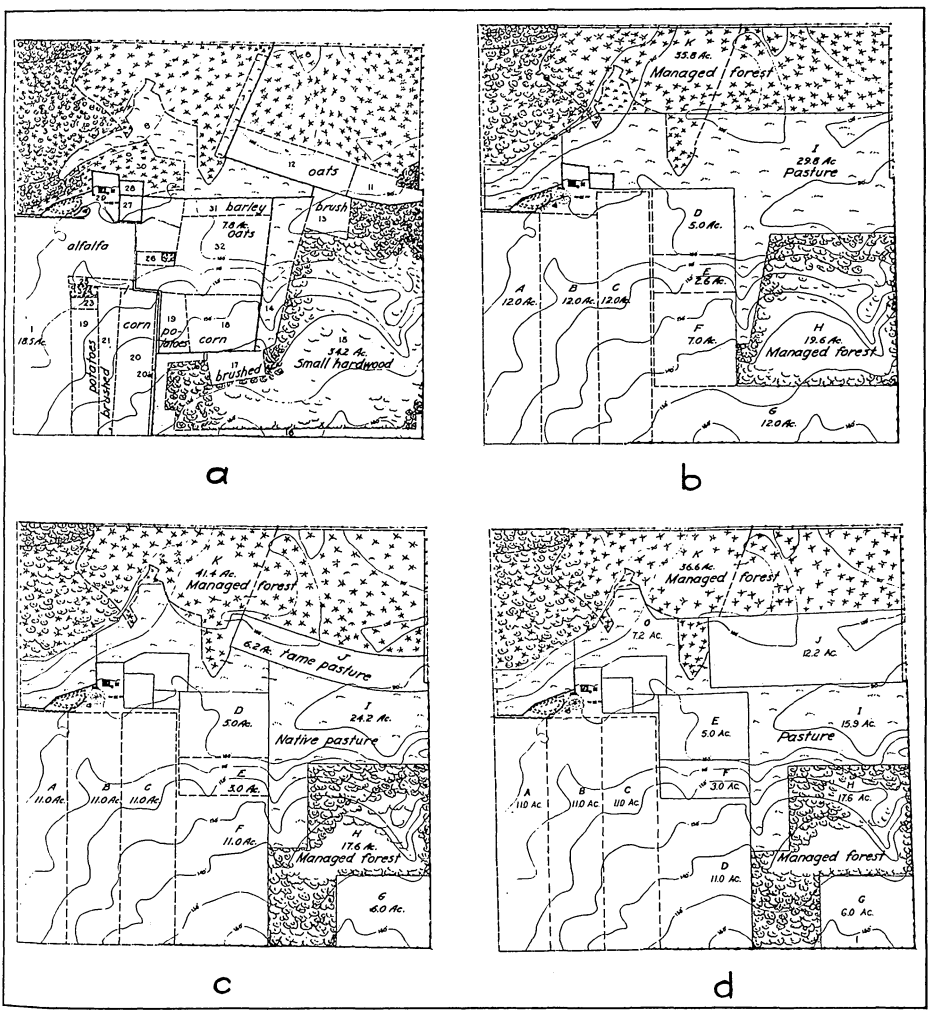

FIG. 11. NEW IDEAS AND NEW CONDITIONS MAKE OCCASIONAL REVISION OF PLANS DESIRABLE: (a) A BELTRAMI COUNTY FARM BEFORE SYSTEMATIC LAYOUT PLANNING WAS BEGUN, (b) THE FIRST PLAN THAT WAS LAID OUT FOR THIS FARM, (c) THE FIRST REVISION, (d) THE SECOND REVISION

as possible as an erosion control measure. The north part of the farm has been allocated to managed forest because the soil here is light and has a stand of good timber on it. The first revision was made when the owner decided that he would like to include a portion of Field G, figure 11b, with the managed forest, Area H, because of a stand of young sugar maples in this area. In order to do this Field G was reduced to 6 acres and extended north to the edge of the steep slope (fig. 11c). Each field unit was decreased by one acre. The revised plan provided for five 11-acre units—A, B, C, D + G, and F. It was decided also to change I as shown to avoid clearing the thick timber on its north edge and to make up the pasture area thus lost by minor changes elsewhere as may be seen by comparing figures 11b and 11c.

The second revision was made in 1939 when a shortage in corn and grain acreage was foreseen. Under the plan then existing, figure 11c, the production of 5 acres of potatoes each year left only 6 acres for corn, all of which was put into the silo, leaving no acreage for grain. Since a few more acres of oats also could be used to good advantage, it was decided that Field J should be squared up and expanded to 12 acres as shown in figure 11d, again calling for the clearing of a portion of the timber on the north and also necessitating the clearing of an acre of the extremely stony land on the south. This acre was cleared with the aid of a bulldozer at a cost somewhat in excess of the value of the land for the sake of squaring up the field. This field will be divided into three 4-acre units which will be handled in an independent rotation of legumes, corn or potatoes, and oats.

Thus, from the two rotations, 15 acres of corn and potatoes, 15 acres of grain, and 37 acres of legume hay and pasture will be provided each year.

Summary

Farm layout should be planned on a long time basis. First, farmstead and field arrangement should be designed in the best way possible taking into account all farm resources, and, secondly, a year by year development schedule should be prepared showing how and when the transition from the present to the proposed plan may be accomplished.

An accurate farm map is needed to lay out fields in suitable size and number to fit a desirable crop rotation and in the best possible shape and arrangement considering such factors as their convenience to the farmstead, the topography of the land, variation in soil types, efficiency in the use of machinery and economy in fencing. Skeleton maps may be made for planning purposes by tracing on semi-transparent paper over photographic enlargements of aerial maps. Aerial maps may be obtained through the local Agricultural Conservation office.

Through the use of systematic long time planning, the groundwork of an efficient production unit may be developed in the ordinary course of farm operation and improvement without drastic, costly changes may be made.