Soil Survey of Iowa, Report No. 80—Decatur County Soils

Roy W. Simsonson
Iowa State College

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SOIL SURVEY OF IOWA
DECATUR COUNTY

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS

Agronomy Section
Soils Subsection

Soil Survey Report No. 80
May, 1941
Ames, Iowa
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SOIL SURVEY OF IOWA

Report No. 80—DECATUR COUNTY SOILS

By Roy W. Simonson
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Decatur County lies in the south-central part of Iowa, immediately bordering the state of Missouri. Leon, the centrally located county seat, is situated 60 miles south of Des Moines, the state capital, and 115 miles east and a little south of Council Bluffs. The county is the fifth one east of the Missouri River and the sixth west of the Mississippi River; the general location is indicated in fig. 1. The region is part of the drainage basin of the Missouri River, to which waters flow through the Thompson (also called Grand River), Weldon and Little Rivers, the latter two being tributaries of the first.

Flood plains along the rivers and their tributary streams make up slightly less than one-fifth of the county area and a little more than half of the level land. Other level or nearly level lands occur in the form of table-like upland divides that appear to be remnants of a former, extensive plain. The plain apparently occupied all of this general region at one time, but it has now been thoroughly dissected by streams. The tabular divides which remain, however, make up approximately 15 percent of Decatur County, whereas the remainder of the upland—64.6 percent of the county—consists of rolling and hilly areas.

The total area of Decatur County is 533 square miles or 341,120 acres divided among 16 townships. Approximately 95 percent of the land, or 333,430 acres, was in farms in 1938, with 46.9 percent in pasture, 43.5 percent as cropland and the remainder in miscellaneous uses. The general utilization of the farm land in Decatur County in 1938 is given in table 1.

**TABLE 1. GENERAL UTILIZATION OF FARM LAND IN DECATUR COUNTY, IOWA, IN 1938.**

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<th>Utilization</th>
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<td>All land in farms</td>
<td>333,429</td>
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<td>Cropland, all kinds</td>
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<tr>
<td>Idle cropland</td>
<td>145,108</td>
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<tr>
<td>Pasture, all kinds</td>
<td>13,627</td>
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<tr>
<td>Plowable pasture</td>
<td>159,935</td>
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<td>Woodland pasture</td>
<td>75,306</td>
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<tr>
<td>All other pasture</td>
<td></td>
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<td>Farmsteads, feedlots, highways</td>
<td>49,002</td>
</tr>
<tr>
<td>Woodlots used for timber only</td>
<td>35,627</td>
</tr>
<tr>
<td>Waste land not used for any purpose</td>
<td>4,573</td>
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*Data from Iowa Yearbook of Agriculture for 1938.

*Field work by A. W. Goke, United States Department of Agriculture, and E. R. Webster and D. F. Moine, Iowa Agricultural Experiment Station. See Soil Survey of Decatur County, Iowa, Series 1935 No. 7, published by Bureau of Chemistry and Soils. Project 698 of the Iowa Agricultural Experiment Station.
THE TYPE OF AGRICULTURE IN DECATUR COUNTY

In 1938 there were 2,005 farms in Decatur County with an average size of 166 acres as compared to 2,090 farms with an average size of 159 acres in 1930. The decrease in the number of operating units and the corresponding increase in average size has largely occurred since 1935, when the number of farms was 2,080. The average size of farm in Decatur County has increased a little more rapidly during the past 10 years than that for the state as a whole, and it seems probable that the trend toward slightly larger farms will continue in the southern part of the state, as more extensive methods of agriculture are applied to the more rolling lands. Among the 2,005 farms in the county in 1938, 43.8 percent were being operated by owners and 56.2 percent by tenants.

Slightly more than half of the farms in Decatur County, or 56 percent, were classed as animal specialty farms by the United States census of 1930. An additional 27 percent of the entire number were classed as general farms, 8 percent as cash grain farms, 2 percent as dairy farms and the remaining 7 percent as miscellaneous, minor types. The definitions of the various types of farms provide that 40 percent or more of the total income of a farm unit must be derived from a particular enterprise or closely related group of enterprises before that farm is included in any one class. For example, 40 percent or more of the total income must be derived from the sale of livestock and livestock products on an animal specialty farm, 40 percent or more from the sale of grain on a cash grain farm. On general farms, no one enterprise contributes as much as 40 percent of the total income.

As indicated by the proportion of animal specialty farms, the largest share of the total farm income in Decatur County is obtained from the sale of livestock. The principal income on some farms, however, is derived from the sale of grain or dairy products, and supplementary income from small sidelines such as poultry raising is obtained on all farms. The most numerous types of livestock are cattle and hogs, and the more important field crops of the region are corn, oats and hay. Nearly all farmers have a few head of workstock, and on scattered farms there are fair-sized flocks of sheep. Soybeans, alfalfa, wheat and other crops are produced in varying but usually small quantities in the county each year. The kinds and amounts of crops grown in Decatur County and the numbers and types of livestock produced are discussed under separate headings in the remainder of this section of the report.

CROPS GROWN IN DECATUR COUNTY

The more widely grown farm crops in Decatur County in 1938 in the order of decreasing acreage were corn, oats, clover-timothy hay, timothy for seed, soybeans, alfalfa and wheat. Minor crops included rye, clover for seed, sweet clover, barley and various grain sorghums. The total acreage, average acre-yield and total production of individual crops grown in Decatur County in 1938 are given in table 2.

2All statistical data in this section of the report are from Iowa Yearbooks of Agriculture for the stated years unless otherwise noted.
### TABLE 2. ACREAGE, PERCENTAGE OF FARM LAND AND YIELDS OF CROPS GROWN IN DECATUR COUNTY, IOWA, IN 1938.*

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<th>Crop</th>
<th>Acreage</th>
<th>Percentage of farm land</th>
<th>Average acre-yield</th>
<th>Total yield</th>
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<td>Corn</td>
<td>48,761</td>
<td>16.2</td>
<td>26.2 bu.</td>
<td>1,277,538 bu.</td>
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<td>Husked or snapped</td>
<td>45,894</td>
<td>15.2</td>
<td>26.2</td>
<td>1,199,785</td>
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<td>Cut for fodder</td>
<td>2,528</td>
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<td></td>
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<tr>
<td>Cut for silage</td>
<td>76</td>
<td>**</td>
<td>7.8</td>
<td></td>
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<tr>
<td>Hogged down or grazed</td>
<td>263</td>
<td>.1</td>
<td></td>
<td></td>
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<tr>
<td>Oats</td>
<td>29,602</td>
<td>9.8</td>
<td>32.6</td>
<td>963,596</td>
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<td>Winter wheat</td>
<td>2,952</td>
<td>1.0</td>
<td>11.1</td>
<td>32,908</td>
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<td>Rye</td>
<td>1,230</td>
<td>.4</td>
<td>10.7</td>
<td>13,226</td>
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<td>Clover seed</td>
<td>785</td>
<td>.3</td>
<td>.79</td>
<td>617</td>
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<td>Timothy seed</td>
<td>13,151</td>
<td>4.4</td>
<td>2.7</td>
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<td>Sweet clover, all</td>
<td>374</td>
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<td></td>
<td></td>
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<tr>
<td>Seed</td>
<td>121</td>
<td>**</td>
<td>2.87</td>
<td>348</td>
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<td>Soybeans for seed</td>
<td>794</td>
<td>.3</td>
<td>15.8</td>
<td>12,514</td>
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<td>Hay, all kinds</td>
<td>31,692</td>
<td>10.5</td>
<td>1.11 T.</td>
<td>35,045 T.</td>
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<td>Clover and timothy</td>
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<td>7.4</td>
<td>1.03</td>
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<td>Alfalfa</td>
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<td>All other tame hay</td>
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<td>All other crops not listed</td>
<td>2,131</td>
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*Data from Iowa Yearbook of Agriculture for 1938.
**Less than 0.05 percent.

Considered from the standpoint of total acreage or value, corn is the most important crop to the agriculture of Decatur County. It was produced on 16.2 percent of the farm land in 1938, as compared to 10.5 percent in hay of all kinds and 9.8 percent in oats. The total acreage in corn has decreased considerably in recent years, declining from 68,120 acres in 1930 to 38,313 acres in 1935 and rising again to 48,761 acres in 1938. The total acreage in corn will probably remain at or below present levels for some time to come. Much of the land in Decatur County is not well adapted to the production of corn, and if rotations to maintain the fertility and productivity of the soil are followed on the suitable land, less than half of that land will be available for this crop in any 1 year.

The average yield of corn in Decatur County in 1938 was 26.2 bushels per acre, 3.1 bushels per acre below the county average for the period of 1924-33. The county average of 29.3 bushels per acre for the 10-year period is approximately 8 bushels below that for the state of Iowa. Considerable variations in yield from year to year or from one part of the county to another disappear in the process of averaging. For instance, the average yield of corn by townships for the 10-year period of 1924-33 ranges from a low of 25 bushels per acre to a high of 34 bushels per acre. Average yields for the entire county during the last decade have ranged from a minimum of 3.3 bushels per acre in 1934, a season of extreme drouth, to 38.8 bushels per acre in 1937. Differences in yield which are just as large may sometimes occur within one field in a single year, provided that a number of different soils and soil conditions occur in that field. In studies carried on by the Iowa Agricultural Experiment Station in nearby areas in 1938 and 1939, differences in yield of 40 bushels per acre were sometimes observed on different locations within a single field. Such differences only arise where there are rather extreme differences in soil conditions due to soil type, slope or erosion.
Practically the entire crop of corn in Decatur County is husked or snapped for grain, a very small proportion being cut for fodder or silage each year. In 1938, 94 percent of the corn was harvested for grain, and the remainder was cut for fodder, hogged down or used for silage.

Varieties of corn now grown are chiefly hybrid, although some open-pollinated corn is also produced. In many instances farmers purchase about as much hybrid seed as seems necessary and, after planting all of it, finish out the remaining rows in the field with open-pollinated seed. A number of farmers do use open-pollinated varieties entirely, but the larger share of the corn planted in 1939 was hybrid.

The acreage devoted to oats in 1938 was smaller than that used for hay of all kinds but larger than that of any one hay crop. Oats were grown on 9.8 percent of the farm land in 1938 with an average yield of 32.6 bushels per acre. The average yield of oats for the 10-year period from 1925-34 was 22.1 bushels per acre in Decatur County as compared to 31.5 bushels per acre for Iowa. The average yield for the county in particular years has ranged from 4 bushels per acre in the drouth year of 1934 to 32.6 bushels per acre in 1938. Data for earlier 10-year intervals also indicate large fluctuations in yields from year to year, but no yield has been as low as the one in 1934.

The oats produced in Decatur County are all fed to livestock on the farms in most years. Occasionally, small quantities are offered for sale locally, and at rare intervals some of the grain is shipped out of the territory. The general region does not, however, produce as much feed as is ordinarily needed by the livestock population so that buying of grain from other regions is of relatively common occurrence. The grain shipped in is more often corn than oats.

Oats serve as a nurse crop for legume or mixed legume-grass seedings on many farms, and on others they are used as part of a corn-oatsrotation. The crop is commonly sown broadcast in corn stubble ground after the field has been disced to cut up the stalks and prepare the seedbed. Varieties that are widely used in the county include Albion (Iowa 103), Green Russian, Iowar and Richland (Iowa 105).

Hay of all kinds occupied 10.5 percent of the farm land in Decatur County in 1938, and the average yield was 1.11 tons per acre. Clover-timothy mixtures were grown on 22,453 acres of the 31,692 acres devoted to hay production, whereas alfalfa, soybean hay and all other remaining hay crops each occupied about 3,000 acres. The total acreage of clover-timothy hay has far exceeded that of all other kinds combined for a long period of time, and it has not fluctuated widely. There were 24,158 acres of the crop in 1930, as compared to 25,717 acres in 1935 and 22,453 acres in 1938. The acreage of soybean hay apparently has tended to increase when the clover-timothy catches were poor and to decrease when the catches were good. Rather wide fluctuations have occurred in the acreage of soybean hay. There were 6,962 acres grown for hay in 1935 (after the drouth season of 1934) and slightly less than half as much in 1938. The amount of land used for alfalfa production has been increasing slowly, rising from 810 acres in 1930 to 3,347 acres in 1938. Acreages of minor hay crops have fluctuated slightly but much less than soybean hay or even the clover-timothy mixtures.
The total production of clover-timothy hay, 23,127 tons in 1938, is almost twice as large as that of all other hay crops combined. Alfalfa ranks second with a total of 6,025 tons and soybean hay third with 3,502 tons. Various minor types of hay produced during 1938 amounted to 2,391 tons and include such crops as millet, sudan grass and grains cut for hay. Clover-timothy mixtures for some time in the past have been the most important source of hay in Decatur County.

Clover-timothy mixtures are generally sown with a small grain as a nurse crop and are then left on the land for a period of 3 or 4 years. The clover dies out after the second year, and the field is afterward often used as a timothy meadow. Mixtures of clover and timothy can be grown on a number of the soils of Decatur County without previous application of lime to correct acidity, but the stands are seldom good. The application of ground limestone to a field at the rate needed to neutralize the acidity of the soil should be made about 1 year before the hay crop is to be seeded. Inoculation of the legume seed with suitable cultures of bacteria is always desirable.

Alfalfa is sown with a small grain nurse crop in much the same manner as clover-timothy mixtures or clover alone, but the crop is kept on the same field for a longer period of years. The addition of limestone to the soil before sowing alfalfa is necessary on most of the soils of Decatur County. Such additions or applications should follow lime-requirement tests of the soil from different parts of the field so as to determine the amounts of limestone that are needed.

Soybeans are more tolerant of acid soil conditions than either red clover or alfalfa, and the crop can be grown on a number of the soils in Decatur County without prior application of lime. The growing of soybeans, however, should be restricted to smooth uplands, level or gently sloping terraces and the better-drained soils of the flood plains where the land has little slope. Otherwise, serious accelerated erosion may follow the growing of the crop. As a general rule, where soybeans have been grown, the upper layers of the soil are left in a loose, fluffy condition that permits rapid erosion during any heavy rains that may come after the soybean crop is harvested in the fall and before the next crop has become established in the spring.

Crops which are grown occasionally for hay include sweet clover, lespedeza, sudan grass and sorghums. Sweet clover is used less often for hay than for pasture and for plowing under as a green manure crop. It requires about the same conditions for successful growth as does alfalfa. Lespedeza will grow fairly well on most of the soils of Decatur County, including those which are too acid to support good stands of red clover, and it has been used to a limited extent. Lespedeza is used best for pasture, particularly in the late summer months when the permanent pastures are dormant. Sudan grass has been grown to a limited extent as an emergency hay and pasture crop, whereas the sorghums are being used on an increasing number of farms to provide forage. Growing a number of different varieties of sorghums has become increasingly common during recent years.

Some of the crops usually cut for hay, especially timothy, are also grown for seed production. Timothy seed was produced on 13,151 acres in 1938, with
an average yield of 2.7 bushels per acre. Minor seed crops were red clover, grown on 785 acres, and sweet clover, grown on 121 acres. The acreage devoted to the growing of timothy seed in 1938 was nearly half as large as that used for oats and slightly more than half as large as the total acreage of clover-timothy hay. There have been rather wide fluctuations in the acreage of timothy being grown for seed, however; 4,649 acres were used for the production of seed in 1933 as contrasted to 18,719 acres in 1937. Considerable variations from 1 year to another are to be expected in the acreage used for timothy. Timothy meadows that originally were clover-timothy hay fields, but in which the clover has died out, produce much of the total seed crop. The number of meadows which are left unplowed for the production of timothy seed will vary with the price of the crop and with the cropping system on individual farms.

Small grains other than oats are grown to a very limited extent in Decatur County. One percent of the farm land in the county was used for growing wheat in 1938 and an additional 0.4 percent for the production of rye. Barley, not listed in 1938, is occasionally grown as a feed crop on a small number of farms.

In addition to cereal crops and hay, most farms in the region produce vegetables and small fruits for home consumption. A few farms also have small orchards of apple, peach or cherry trees, but these are much less numerous than they were many years ago. Occasional quantities of the locally grown vegetables and fruits are offered for sale, but more than the family itself can use is produced on only a few farms.

**LIVESTOCK PRODUCTION IN DECATUR COUNTY**

All of the farmers in Decatur County keep at least a few head of livestock, and the production of cattle and hogs is one of the most important farm enterprises of the region. The kinds and numbers of livestock and poultry on farms in Decatur County on Jan. 1, 1939, are presented in table 3.

The average number of hogs on farms throughout the year is about equal to that of cattle, although wide fluctuations in numbers of swine occur with the different seasons of the year. The largest numbers of swine on farms are present from farrowing time in the spring until the hogs begin to go to market in the fall. The pigs are usually farrowed in the spring, kept over the summer and then fattened for shipment in the fall or winter months. Hogs are gen-

<table>
<thead>
<tr>
<th>Kind</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle, all kinds</td>
<td>26,161</td>
</tr>
<tr>
<td>Cows and heifers milked</td>
<td>8,192</td>
</tr>
<tr>
<td>Swine, all</td>
<td>28,650</td>
</tr>
<tr>
<td>Sows</td>
<td>7,919</td>
</tr>
<tr>
<td>Sheep</td>
<td>15,484</td>
</tr>
<tr>
<td>Horses</td>
<td>5,693</td>
</tr>
<tr>
<td>Mules</td>
<td>489</td>
</tr>
<tr>
<td>Chickens</td>
<td>167,921*</td>
</tr>
</tbody>
</table>

*Number of chickens from federal agricultural census of 1935.
erally raised and fattened on the same farm with only a small number of feeders being shipped into the county. Among the sows kept over the winter of 1939-40, 2,129 farrowed in the fall of 1939 and 5,790 were bred to farrow the following spring. The pigs are generally kept and fed until they reach weights of 250 or 300 pounds before being sent to market. Popular breeds of hogs include Poland China, Duroc-Jersey, Chester White and Berkshire.

The total value of cattle on farms in Decatur County is ordinarily greater than that of swine, although the two types of livestock contribute approximately equal shares to the farm income. The annual turnover in the number of hogs is much greater than that of cattle, and numbers of cattle increase or decrease slowly except during periods of forced selling after drouth. The total number of cattle on farms on Jan. 1, 1939, was 26,161 head, of which 8,192 were cows and heifers kept for milk production. Most of the cattle in the county are grades, either of the Hereford or Shorthorn breeds with only a few purebred herds. Except on the limited number of dairy farms located near the towns, cattle are kept for the production of beef rather than milk.

The raising of sheep, not of general importance in Decatur County as it is in some sections of southern Iowa, is practiced to a greater extent in the more rolling portions. Flocks of sheep may be found in all townships in the area, however. The total number of sheep in Decatur County on Jan. 1, 1939, was 15,484, slightly more than half as large as that of cattle or hogs. Most of the sheep have been raised locally, and only a very few are shipped in annually to be fed and fattened for market.

The number of work animals has been steadily declining in the county for the past 20 or 30 years. According to federal census data, there were 14,231 horses and 894 mules in the county in 1910, 11,789 horses and 1,350 mules in 1920 and only 6,507 horses and 728 mules in 1935. Many of the work animals on farms have been replaced by tractors, and this trend apparently has not stopped, although there seems to have been more horses and mules foaled during very recent years.

Dairy farms are relatively few in Decatur County, although some income is usually derived from the sale of cream or butter. Enough milk, cream and butter for the use of the farm family is generally produced, and small quantities of the latter two products are often sold. Cream is the product most commonly sold, and small cream-buying stations are located in most of the towns.

Small flocks of poultry, almost invariably chickens, are kept on all the farms. These flocks may range in size from 50 to 150 birds, and occasionally larger flocks are kept. In addition to chickens, other forms of poultry such as turkeys, geese or ducks are sometimes found.

GEOLOGIC FACTORS AFFECTING SOILS OF DECATUR COUNTY

A brief discussion of the topography and the nature and origin of the soil parent materials in Decatur County should contribute to a better understanding of the soils. The predominating topography consists of rolling or hilly lands which have developed as a result of thorough penetration and dissection of a former level plain by a network of streams. Remnants of the old plain
persist in the form of occasional elevated flats which act as divides between
the principal drainage systems of the region. The more rolling and hilly
lands are usually adjacent to the major stream valleys, particularly near
the junction of two large streams. Soil parent materials consist primarily of
three types of unconsolidated sediments: Glacial drift (left by ice), loess
(deposited by wind) and alluvium (laid down by water). Glacial drift, most
of which is the unsorted till, occurs much more extensively than does either
loess or alluvium. In addition to the unconsolidated deposits which form the
bulk of the soil parent materials, there are a number of outcroppings of lime­
stone in the steeper slopes along the largest streams. These steep valley
slopes, indicated as rough, stony land on the map, occupy only 192 acres in
Decatur County, and limestones are therefore not important as soil parent
material.

All of Decatur County is underlain by limestones and shales which were
no doubt exposed at the surface for a long period of time prior to the deposition
of the glacial drift and the loess. During the interval that they were exposed
the sedimentary rocks were deeply weathered, and a considerable regolith\(^3\)
was formed. This regolith later served as a source of material and probably
supplied the bulk of the debris transported by moving ice when glaciers first
invaded the region.

As a glacier moves across a region, much of the unconsolidated material
at the surface and occasional fragments of solid rock are picked up by the
moving ice. Part of the accumulated debris is simply carried along by the
glacier as it slowly advances, part is ground or crushed by the movement of
the ice, and all of it is redeposited when the ice melts. Although the great
bulk of the sediment deposited by glaciers consists of debris from local
sources, some part of the till is often transported over considerable distances.
The mixture of sands, silts and clays which form the large share of the glacial
drift in Decatur County was apparently derived from the unconsolidated
surface deposits of the immediate region, but sediments such as the granite
boulders or gravel in the till seem to have come from places as far away as
Manitoba or Wisconsin. Practically all of the glacial deposits in Decatur
County were left in place by the melting ice and are of the type known as
glacial till. In some regions additional small quantities of rock debris are
carried beyond the margin of the ice by outflowing waters and laid down as
sorted gravels, sands or silts. Sediments laid down by waters flowing over
or away from melting glaciers are known as outwash deposits. The glacial
drift found in Decatur County is predominantly till; none of the soils has
been developed from outwash sediments.

Two separate glacial advances occupied Decatur County at some time
in the past, apparently a long while ago. Both glaciers covered the entire
county, but the deposits from the first, or Nebraskan, ice sheet have either
been reworked or buried by the action of the second, or Kansan, glacier.
Nebraskan till has been identified with certainty only in some of the deeper
valleys and roadcuts and does not appear to have contributed parent materials
for the present soils. Furthermore, both drifts have been strongly weathered

\(^3\)The regolith is the mantle of unconsolidated earth materials exposed at the surface. It includes both
the disintegrated rock and the soil.
since their deposition, and it is improbable that soils developed from the two would differ appreciably.

After the glaciation of the region, probably a long while later, a deposit of loess (windblown silts and clays) was laid down over the surface of the till plain. The loess now persists as a capping on the ridge tops and flat upland areas, having been removed wherever stream dissection was most active. In contrast to the glacial till, much of the loess appears to have been derived from regions to the west rather than from local sources, and it probably was deposited very slowly over long intervals of time.

The alluvial deposits in the county are younger than either of the other types of soil parent materials, having been laid down and gradually reworked by the existing streams. Most of the alluvium has been derived from local sources, i.e., the loess and till of the uplands, but part of the sediments along the Thompson River have probably come in from other counties.

SOIL PARENT MATERIALS

Four types of soil parent materials, all of which have already been mentioned and one of which is unimportant, have given rise to the various soils in Decatur County. Among the three important types of unconsolidated materials, glacial drift is the most extensive, covering 53.4 percent of the county. Loess, found on the ridge tops and flat upland divides, occupies about half as large an area, or 27.6 percent of the land. Alluvial materials are the least extensive of the three major types of parent materials; the flood plains and terraces along the streams comprise 18.9 percent of the land in Decatur County. Limestone outcroppings which form steep valley slopes along the Thompson River comprise the fourth type of soil parent material but are unimportant because of their limited extent.

The Kansan till exposed on the valley slopes in Decatur County consists of a mixture of sand, silt and clay with some gravel and boulders. This mixture, sometimes known as a boulder clay, ordinarily consists of a matrix of clay loam or clay through which there is a scattering of gravel, boulders and rock fragments. Variations in the character of the till are common, however, some of them due to differences in the original physical and chemical composition and others to differences in the degree of leaching and weathering.

When the Kansan till was originally deposited, it apparently consisted of a mixture of slightly weathered and strongly weathered minerals, the former including some coarse and some finely divided calcareous materials. One of the early steps in the chemical weathering of a geologic deposit, preceded in the case of till only by oxidation, is the leaching out of the calcareous substances by percolating waters. Leaching of the Kansan till began as soon as the glaciers had retreated and apparently continued for a long period of time in a landscape that was essentially a level, extensive plain. As a result of the long-time weathering of the till in such a landscape, three different zones have been developed in the till deposits, and all of these have been exposed in different places on the valley slopes by the dissection of the former plain.

The uppermost zone of the Kansan till, which is exposed only to a limited extent in Decatur County, is a dense, blue-gray or dull gray clay con-
taining few pebbles or gravel of any kind. This clay, known as gumbotil, appears to be the result of extreme weathering of the till and sometimes attains a thickness of 11 feet. The gumbotil can be found from time to time in the form of bands along the slopes occupied by the Shelby and Lindley soils, usually a short distance below the boundaries of the Grundy and Weller areas. The heavy, dull gray clay is extremely dense and compact, acid in reaction and decidedly infertile. Such areas are recognized as being unproductive and have been called "push soils" because they tend to stick to the moldboard and fail to scour when plowed.

Below the gumbotil now present or exposed at the surface where the gumbotil has been removed, there is a leached, yellowish-brown zone of clay or clay loam. This leached zone of the Kansan till has lost its carbonates, is acid in reaction, but is relatively friable in comparison with the gumbotil above. The leached till comprises the soil parent materials for all of the Shelby loam and for a large part of the Lindley loam and Shelby loam, steep phase. It is found on the more gentle slopes some distance below the boundaries of the loess cap but not on the steepest slopes in the deeper valleys. The leached till usually contains considerable quantities of sand, more than occasional scattered gravels and a number of boulders. Pockets of sand and gravel may also occur within this zone of the till.

The deepest and least weathered zone of the Kansan till is exposed only in the ravines and on the steepest slopes. It is generally bluish-gray in color, though it may be brown or yellowish-brown at times, and always contains carbonates either in finely divided form or as concretions. The unleached till often resembles the gumbotil in color and to some extent in general physical appearance, but it is moderately friable and calcareous rather than acid. Part of the Lindley loam and Shelby silt loam, steep phase, are in the process of development from the unleached till. Very little soil development has generally occurred on this type of till; only the first stages of the process are in evidence.

The loess which occurs on the flat uplands and on the ridge tops is considered to be Peorian in age. It consists of a grayish-yellow silty clay loam that has been leached free of carbonates, is often mottled with rust-brown and contains some iron concretions. Gravel and boulders are absent from the mixture of silt and clay, but there is a small proportion of sand present. The maximum depth of approximately 10 feet of loess occurs on the flat upland divides that are coextensive with the Grundy and Edina soils. On the narrower ridge tops where Weller silt loam or Grundy silt loam, slope phase, are found, the thickness of the loess is less than 10 feet and may range downward to 2 or 3 feet. The loess becomes thinner near the boundaries between the ridge tops and the adjacent valley slopes occupied by Shelby and Lindley soils.

The alluvial deposits along the streams are derived largely from the till and loess of the uplands and therefore resemble them in a number of characteristics. The alluvial materials, however, have been sorted by the action of water so that mixed deposits of sand, silt, clay and boulders similar to the till of the uplands do not occur in the bottomlands. Most of the flood plain and
terrace deposits consist of rather heavy-textured sediments and are silty clay loams or silty clays. In a few places along the Thompson River, beds of gravel may be found in the bottoms, but such deposits are of rather limited occurrence. Very recent sandbars or riverwash also occur along the rivers, but these are ineffectual and have not been represented on the map. Soils formed from alluvium in Decatur County include the Chariton, Wabash and Bremer series.

PHYSIOGRAPHY AND DRAINAGE

The topography of Decatur County is that of a dissected till plain, once nearly level over its entire surface but now generally rolling because of the work of streams. Rolling to hilly uplands make up almost two-thirds of the county or 64.6 percent of the total acreage, and they are distributed over all of the townships. Tabular upland divides between the larger drainage basins in the county comprise 16.5 percent of the land. These divides are apparently remnants of the former loess-mantled till plain, and they now constitute the highest portions of the landscape, as well as being the only level areas in the uplands. Other level or gently undulating areas are found in the bottomlands, particularly along the larger streams, and amount to 18.9 percent of Decatur County.

The more rolling and hilly lands of Decatur County occur in belts of varying widths along the principal stream valleys. Bands along both sides of the Thompson River, Little River, Wolf Creek, Elk Creek and Weldon River consist of sharply rolling or hilly landscapes. Less rolling bodies of land exist along the smaller drainageways that penetrate the flat, upland divides. As a general rule, the slopes immediately adjacent to and below the tabular divides are gentle, whereas those near the stream channels are much sharper and are oftentimes steep. Sharply rolling areas and steep slopes are generally occupied by Lindley loam and Shelby loam, steep phase, the two most extensive soils in the county. The less sharply rolling and the gently rolling landscapes include soils such as Shelby loam, Weller silt loam and Grundy silt loam, slope phase. The latter two soils commonly occur on ridge crests which no longer have flat tops; such ridges represent an intermediate stage in the dissection of the tabular divides by stream action.

The flat upland divides usually have the form of long, narrow areas that are very irregular in outline. These table-like areas may extend for a number of miles along a winding ridge top, but they are seldom more than ½ mile in width. The longest continuous ridge in the county, usually narrow and sometimes almost broken, extends from the central part of the north county line in a southeasterly direction for an airline distance of approximately 20 miles. Another long, narrow ridge occurs east of the Weldon River in the northern part, extending southwest from Le Roy and Garden Grove. The largest of the tabular uplands occurs around Lamoni in the southwestern part of Decatur County, with other large ones adjoining Van Wert and Weldon in the north-central part and extending southwest from Le Roy and Garden Grove in the northeast portion. These larger divides are usually 5 or 6 miles long and range up to 1½ miles in width. Soils found on the flat upland areas are Grundy silt loam and Edina silt loam.
The bottomlands along the streams are of two general types, the wide flood plains along the rivers and large creeks and the smaller bottoms along the intermittent streams. The flood plains along the larger streams, the most extensive of which occurs along the Thompson River, range from less than \(\frac{1}{4}\) to as much as 2\(\frac{1}{2}\) miles in width. The generally occurring widths range from \(\frac{1}{2}\) to 1 mile. The wider flood plains are very nearly flat, most of them having an almost imperceptible slope downstream, and they are occupied by the Chariton and Wabash soils. The total acreage of the large bottoms is about equal to that of the flat, upland divides. The bottomlands along the smaller, intermittent streams are usually narrow, ranging up to a width of \(\frac{1}{4}\) mile, and they are generally bordered by rolling or hilly uplands. The downstream slope of the narrower flood plains is usually greater than that of the large bottoms, and their surface configuration is commonly irregular. Because of their limited size and variable local relief, the smaller bottoms are not, in general, well adapted to cultivation. Soils found along the smaller bottoms are chiefly Wabash loam and Wabash silt loam, with occasional bodies of Chariton silt loam.

The widely distributed, sharply rolling or hilly relief in Decatur County brings about rather marked local variations in elevation, even though the maximum range recorded in the area is only 261 feet. Pleasanton, located along the southern county line almost at the center, lies at an elevation of 1,175 feet above sea level, whereas Davis City, 5 miles to the northwest in the flood plain of the Thompson River, has an altitude of 915 feet. In the more hilly regions of the county, differences in elevation of 75 or 80 feet commonly occur within a single square mile, and sometimes within a 40-acre tract. On the flat upland divides, there is but little change in elevation over the entire county. Most of the towns situated on the tabular divides (Lamoni, Van Wert, Garden City, Weldon, Le Roy and Pleasanton) lie at approximately the same altitude, though there is an indication that the divides are a little lower toward the east. Slopes along the streams range from 20 percent (a fall of 20 feet per 100 feet horizontally) or even more along some of the steep draws in the uplands to an average of less than \(\frac{1}{2}\) feet per mile along the Thompson River from Westerville to Davis City. The gentle slope along the Thompson River and other large streams is clearly indicated by the meandering, irregular course followed by the channels.

The streams of Decatur County, with the exception of a few in the extreme southwest corner, are tributaries of the Thompson River (also called Grand River) which crosses the county from the northwest corner to the approximate center of the south side. The Thompson River, arising to the northwest, flows southeastward and then south to join the Grand River in Missouri. The more important tributaries of the Thompson River in Decatur County are Weldon River and Little River, which drain the eastern half of the county and cross the state line into Missouri before reaching the master stream. Small tributaries which join the Thompson River within Decatur County are Wolf Creek and Elk Creek which, together with a number of intermittent streams, drain most of the western half of the area. Approximately 30 square
miles in the extreme southwestern corner of Decatur County are drained by streams that flow into the Grand River through Big Creek.

Drainage waters are carried to the larger creeks and rivers by a system of intermittent streams that branches out to reach every section of the county. These intermittent streams, although they all carry water only during part of the year, range in size from the shallow swales reaching the tabular, upland divides to streams which have small flood plains \( \frac{1}{6} \) of a mile wide. The network of intermittent streams and drainageways, illustrated in fig. 2, provides adequate natural drainage for about 85 percent of the upland in Decatur County.

The natural drainage of most of the land in Decatur County ranges from good to excessive, but there are some areas in the flat uplands and in the flood plains of the streams that require artificial drainage before they will produce satisfactory crops. Varying degrees of restricted drainage will be found both on the upland divides and in the bottomlands. Areas of Grundy silt loam, for example, usually have slightly restricted drainage, particularly in the central portions of large bodies of the soil, but fair crops can be produced without the use of tile or ditches. Drainage is more completely re-
stricted in bodies of Edina silt loam, and the improvement of the present drainage conditions is more difficult. Within the bottomlands, the soils with restricted natural drainage include Chariton silt loam, Wabash silty clay loam and Wabash loam. Artificial drainage is feasible in a number of areas of these soil types, and ditches have been used for that purpose in many places. Channels of the Weldon and Thompson Rivers have also been straightened and dredged in some localities to improve the drainage conditions and to reduce the danger of overflow.

The possibility of damage to crops from overflow waters is present on all of the soils in the flood plains of the streams, but it is greatest on the lower-lying areas of Wabash soils. Measures to prevent or to minimize overflow have therefore been taken in a number of places, particularly on Wabash silty clay loam. The large bodies of Wabash silty clay loam in the bottoms of the Thompson and Weldon Rivers near the south county line are protected by dikes in many localities. Ditches to remove surplus water more rapidly are also present. Areas of Wabash loam, a soil type commonly found along the smaller streams, are usually subject to annual overflow. This soil occurs in narrow valleys between relatively steep slopes occupied by Shelby and Lindley soils, as a rule; so it receives large volumes of water in a short time during and after heavy rains. Wabash silt loam is not extensive in Decatur County, and most areas of the soil type occupy positions not readily subject to floods. Chariton silt loam is found chiefly in the bottoms along the larger streams, and only the lower-lying group of terraces is subject to overflow except during times of extremely high water. The higher group of terraces may sometimes be flooded but only at very infrequent intervals.

**SOILS OF DECATUR COUNTY**

The formation of soil is a very slow process which goes on in three overlapping steps. First of all, soil parent materials must accumulate, either by the breakdown of rock in place or by the deposition of weathered rock by ice, wind or water. After the parent materials have accumulated, or sometimes while they are collecting, simple forms of life such as bacteria and fungi invade the mass of loose rock and begin to grow there. As they grow, multiply and die, they leave their dead bodies to decay slowly in the rock debris, and thus organic matter begins to accumulate. The gradual accumulation of organic matter is the second step in the formation of soil. It is due in part to the activity of the microorganisms but also in part to higher forms of plants such as the trees and grasses, which soon follow the simpler forms in growing on the weathered rock materials and profoundly influence the soil-forming processes. As plants continue to grow and organic matter gradually accumulates, the upper layers of the unconsolidated mass which constituted the soil parent material are slowly changed and begin to differ from the layers below. This is the beginning of the development of the soil profile, the last step in the formation of soil.

A soil profile, which can be seen on the walls of any freshly dug pit or roadcut, consists of the succession of layers or horizons exposed in a vertical cut down through the soil. In most profiles the horizons grade into one another
and are separated by transitional zones rather than sharply defined boundaries. Some profiles do include horizons that are set apart by distinct boundaries, but such soils are not widespread in Iowa. In most of the upland soils of Iowa, the profile consists of a deep, dark-colored surface horizon merging with a transitional, lighter-colored layer which separates it from the parent material beneath. All three horizons, the dark-colored one, the transitional layer, and the upper part of the parent material, are ordinarily included within a depth of 5 feet.

The first step in soil formation, namely the accumulation of parent materials, is a geological rather than soil-forming process. The disintegration of rock and the transportation of the weathered materials are forerunners of soil formation; such processes do not in themselves give rise to soils. Occasionally, the second and third steps in soil formation begin before the rock is fully broken down and soon give rise to a very young soil. In a large area such as the state of Iowa, soils can be found in all the different stages of formation, ranging from the sandbars recently laid down by the Mississippi River to soils with distinct profiles like Edina silt loam in Decatur County. Most of the soils used for the production of crops in Iowa have advanced beyond the stage of accumulation of soil parent materials and have reached the third step in soil formation—the development of the profile.

Although the steps in the formation of soil are the same, the processes operating in each of the three steps differ from place to place. The accumulation of soil parent material by deposition from running water leaves a well-sorted, rather fine-textured sediment in most instances, whereas the materials left by ice are unsorted and include particles that range from huge boulders to the finest clays. The soils formed from each of these two types of parent materials will differ in a number of important respects. Similarly, soils formed under different climatic conditions or under different types of native vegetation on identical parent materials will not be the same once profile development has started. The nature of a soil depends upon the combined influences of climate, native vegetation, parent materials, relief\(^5\) and age (the interval during which the soil has been developing). Regional differences in the nature of soils, as between Iowa and Maine, for example, are commonly due to influences of climate and native vegetation. Local differences within smaller areas are most often due to parent materials or relief, sometimes to native vegetation.

Within the area of Decatur County there is little change in the general nature of the climate, but there are marked changes in the other factors of soil formation. There is an intermingling of regions originally occupied by grasses or by broad-leaved trees. There are considerable variations in the nature of the local relief and soil parent materials, both of which were discussed in a preceding section of the report. There are also differences in the age or period of development of the various soil types; for example, the soils of the bottomlands are relatively young in comparison to those of the flat uplands.

Soils have developed under grass vegetation in Decatur County from loess in flat and rolling uplands, from till in rolling and hilly uplands and from allu-
vium in terraces and flood plains. Other soils have been formed under forest vegetation from loess in narrow upland ridges and from till on the steeper valley slopes. The soils formed under grass on flat uplands and terraces lack adequate natural drainage and have therefore not developed normal Prairie profiles, although most of them are Prairie-like in nature. Soils formed under forest vegetation in gently rolling uplands have light-colored surface horizons overlying darker and heavier-textured layers and belong to a group technically known as Gray-Brown Podzolic soils.\(^6\) In regions with strong relief, i.e. in the more hilly portions of the county, the soils are all shallow and exhibit little profile development whether formed under grasses or trees. Sharply rolling or hilly areas occur extensively in Decatur County, so that there are large bodies of soils which have shallow and imperfectly developed profiles.

The various soils and soil conditions which have developed in Decatur County because of the different combinations of soil-forming factors have been represented in the survey by 13 separate mapping units. These mapping units include 10 soil types, 2 phases and 1 miscellaneous land type. The acreage and proportionate extent of each mapping unit are given in table 4, and the distribution of the soils and land types is shown on the accompanying map (in attached envelope in back of book).

**TABLE 4. ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS MAPPED IN DECATUR COUNTY, IOWA.**

<table>
<thead>
<tr>
<th>Type of soil</th>
<th>Acres</th>
<th>Percent</th>
<th>Type of soil</th>
<th>Acres</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grundy silt loam</td>
<td>40,768</td>
<td>12.0</td>
<td>Shelby loam, steep phase</td>
<td>84,992</td>
<td>24.9</td>
</tr>
<tr>
<td>Grundy silt loam, slope phase</td>
<td>6,848</td>
<td>2.0</td>
<td>Weller silt loam</td>
<td>31,168</td>
<td>9.1</td>
</tr>
<tr>
<td>Edina silt loam</td>
<td>15,488</td>
<td>4.5</td>
<td>Lindley loam</td>
<td>68,224</td>
<td>20.0</td>
</tr>
<tr>
<td>Shelby loam</td>
<td>29,056</td>
<td>8.5</td>
<td>Wabash loam</td>
<td>12,288</td>
<td>3.6</td>
</tr>
<tr>
<td>Chariton silt loam</td>
<td>35,968</td>
<td>10.5</td>
<td>Rough stony land</td>
<td>192</td>
<td>.1</td>
</tr>
<tr>
<td>Bremer silt loam</td>
<td>320</td>
<td>.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wabash silt loam</td>
<td>3,520</td>
<td>1.0</td>
<td>Total</td>
<td>341,120</td>
<td>100.0</td>
</tr>
<tr>
<td>Wabash silty clay loam</td>
<td>12,288</td>
<td>3.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For purposes of discussion and to bring out relationships among the various soils, the individual types and phases have been placed in four groups on the basis of a few properties such as the color of the profile and the nature of the associated topography. The one miscellaneous land type in the county includes rough, stony land which, because of the lack of soil development, has been omitted from the four groups of soils and is described and discussed separately. The features which are common to all soil types and phases within a single group are discussed, and the differences between them are indicated. Each soil type and phase and the one miscellaneous land type are then described individually as to occurrence, extent, profile characteristics, general utilization and special management problems. General questions of management which apply to groups of soils are discussed in subsequent sections of the report.

DARK-COLORED SOILS OF THE ROLLING TO HILLY UPLANDS

The dark-colored soils of the rolling to hilly uplands include those types and phases which were formed under grass vegetation on well-drained sites. One soil type, Shelby loam, and two phases (Shelby loam, steep phase, and Grundy silt loam, slope phase) have been placed in this group. These three soils, especially Shelby loam and the steep phase, are widely distributed over Decatur County and together they comprise 35.4 percent of the land.

All of the well-drained, dark-colored soils are either members of the Prairie group or are Prairie-like in their important characteristics. Shelby loam, an example of the Prairie soils, has been formed from leached glacial till under grass cover in gently to moderately rolling uplands. Grundy silt loam, slope phase, has been developed from loess, also under a grass cover but on rounded divides or ridge tops rather than on sloping lands. It is intermediate in profile characteristics between the normal Prairie soils and the associated claypan soils (Planosols) found on flat uplands and terraces. Lack of free drainage during the early stages of development of the Grundy silt loam, slope phase, permitted the formation of a heavy-textured horizon in the lower part of the profile, not as distinct as that of the Grundy silt loam on the flat divides but more pronounced than any ordinarily found in Prairie soils. Shelby loam, steep phase, has been formed from glacial till under predominantly grass vegetation in which scattered trees were present. The soil occupies steep slopes and sharply rolling areas where little profile development was possible because of the strong relief. The upper horizons of the profile are much less deep and are lighter in color than those of Shelby loam or Grundy silt loam, slope phase.

Shelby Loam (S) (79)

Shelby loam occurs chiefly on valley slopes bordering the small streams that penetrate the table-like uplands. It is also found on positions intermediate between the flat upland divides and the sharply rolling or hilly sections along the deeply entrenched streams. Bodies of the soil type occur in the form of long, irregular tongues extending into a large body of Grundy silt loam or, less commonly, as small areas around the borders of Grundy or Edina flats. The relief of Shelby loam generally ranges from gently to moderately rolling, with sharply rolling or hilly areas being mapped as the steep phase. Individual bodies of Shelby loam range in size from 10 to 1,000 acres, generally falling between 100 and 200 acres. Areas of the soil type are widely distributed in the northern and western parts of the county, and their total acreage makes up 8.5 percent of the land.

The surface layer of the Shelby profile is a friable, dark grayish-brown loam, 8-10 inches thick, which is underlain by a transitional horizon of yellowish-
brown, gritty clay loam. The transitional horizon is 16 or 20 inches in thickness and grades into leached glacial till, the soil parent material, at depths of 24-30 inches. The glacial till ranges from a clay to a clay loam in texture, contains numerous small rock fragments and gravel and has a highly variegated pattern of colors. The colors include yellowish-brown, reddish-brown and dull gray, the three being arranged in the form of an irregular patchwork. Rock fragments, gravel and boulders are more numerous in the till than in the upper part of the soil profile, but they can be found in both places. Some rocks and rock fragments are scattered over the surface of the soil. The entire soil mass is acid in reaction, except in those rare locations where splotches or streaks of lime are present in the glacial till.

Variations in the profile of Shelby loam are rather common, particularly in the regions where the relief is moderately rolling. The principal variations consist of changes in the depth and texture of the upper horizons, and these commonly occur within relatively small areas. The texture of the surface layer of the soil ranges from a loam to a clay loam, but some areas of clay may also be found. The variations in texture are most numerous in sloping, cultivated fields, and they are often associated with changes in the depth of the surface layer. Heavier textures usually accompany the shallower surface layers, and the thickness may range all the way from 0 to 10 inches in cultivated fields. The complete absence of a dark-colored surface layer is usually limited to small patches on the shoulders of ridges or on the steeper portions of a slope, sites on which harmful erosion is active. The texture of the plowed layer of the soil in the small, shallow patches ordinarily ranges from a clay loam to a clay and rarely is as light as a loam. Other variations in texture, due to differences in the physical composition of the till rather than to harmful erosion, may occur within cultivated areas or in pastured lands. Outcrops of gumbotil, a dense, heavy clay, sometimes are found in bodies of Shelby loam in the form of bands along the valley slopes. Such areas are marked by very poor growth of crops and grasses, and the improvement of their productivity is difficult.

The large part of the Shelby loam, approximately 75 percent, is being cultivated, and the remainder is in permanent pasture. Crops grown include corn, oats and hay, with small acreages of sorghums and similar forage crops. Yields obtained during seasons of average rainfall range from 20-30 bushels of corn per acre, 20-25 bushels of oats per acre and 1 to 1½ tons of hay per acre. These yields are obtained from areas of Shelby loam which are gently rolling and have been handled with some degree of care in the past; lower yields are produced on the steeper areas or on fields which have been allowed to erode.

Care must be exercised in the cultivation of most areas of Shelby loam in order to maintain productivity and to prevent harmful erosion. Rotations followed should include a high proportion of legumes and grasses; intertilled crops should not be grown more than 2 consecutive years. Reseeding to legumes or grasses may require the addition of lime in many instances, and the new seedings would often be benefited by the prior application of phosphate. Good stands of bluegrass have been obtained on Shelby loam, however, in which 2 acres of pasture would support a cow during the grazing season.
Shelby Loam, Steep Phase (S-x) (266)

Shelby loam, steep phase, occurs more extensively than any other soil in Decatur County, occupying 24.9 percent of the total area. It is found in the sharply rolling to hilly uplands in all parts of the county, generally a short distance back from the valleys of the major streams. The steep phase adjoins Lindley loam in the more completely dissected portions and borders the Weller, Edina and Grundy soils of the upland ridges and flat divides. Shelby loam, steep phase, commonly lies between the table-like, upland divides and the valleys of the major streams, and it almost surrounds the ridges of Grundy silt loam, slope phase.

Since Shelby loam, steep phase, occurs in hilly areas, most of it has only a very shallow profile. There is generally a thin, dark-colored layer on the surface which begins to grade into the glacial till at depths ranging from 2-6 inches. The till may either be leached, in which case it is a moderately acid, yellowish-brown clay or clay loam; or, as sometimes happens on the steepest slopes, it may be unleached and consist of a bluish-gray, calcareous clay. In the less hilly sections, the profile consists of a friable, dark brown loam, 4-5 inches deep; a transitional layer of yellowish-brown or reddish-brown clay loam, 10-12 inches thick; and the weathered glacial till. The till is generally leached of its lime and moderately acid in reaction in the less hilly portions of the Shelby loam, steep phase. The upper horizons of the profile are also acid. Coarse and fine gravel, large boulders and irregular rock fragments are common throughout the soil profile and within the till.

Only a small part, perhaps one-fifth of the steep phase of Shelby loam, is being cultivated, and the yields obtained are relatively low. Fair yields of crops can be produced on the soil when it is first farmed, but the steep phase is not highly fertile, and it is readily subject to severe erosion because of the steep topography it occupies. Many of the steeper areas which have been plowed out and cultivated in the past have been seriously eroded; there is now little indication of any dark-colored surface horizon, and frequent gullies are present. Some of the areas which were cultivated in the past have been abandoned and are not being utilized at the present time. Where Shelby loam, steep phase, is under cultivation, average acre-yields of crops range from 10-15 bushels of corn, 5-15 bushels of oats and up to 1 ton of hay.

Eighty percent of the total acreage of Shelby loam, steep phase, is now in permanent pasture and should be continued in this type of utilization. Most areas of the soil will support a fair stand of bluegrass if brush is kept out and overgrazing is prevented. Where a good stand of bluegrass has been established, the carrying capacity of the steep phase is about 1 cow per 3 acres of land. The establishment of good stands of grass in some areas may require
applications of lime or phosphate and subsequent restriction of grazing for a period of time. After a stand of bluegrass has occupied the land, however, the soil will be more productive as pasture land than it can be for the production of crops.

**Grundy Silt Loam, Slope Phase (Gs-x) (264)**

Grundy silt loam, slope phase, occurs on narrow stream divides in the northern half of Decatur County. These divides are found where stream dissection has entirely destroyed the level of the former plain but has not as yet removed the loess cap from the ridge tops. The relief over the ridge tops ranges from gently to moderately rolling so that surface drainage is adequate. Ridge tops occupied by Grundy silt loam, slope phase, usually finger out between the drainageways as narrow prongs which are seldom more than ¼ mile wide. The narrow divides of the slope phase are most plentiful in Grand River, Center, Franklin, Garden Grove and High Point Townships, with only a few occurring in other parts of the county. Total acreage of Grundy silt loam, slope phase, makes up 2 percent of Decatur County.

The profile of the Grundy silt loam, slope phase, is similar in many respects to that of the Grundy soil found on upland flats, but it does show indications of better drainage conditions. The surface layer of the former soil is a very dark grayish-brown silt loam, 6-10 inches deep, which grades into a dull yellowish-brown silty clay loam with scattered mottlings. The mottlings increase in number in the lower part of this transitional horizon and are numerous in the dull yellowish-brown clay beneath. The clay horizon begins at a depth of approximately 20 inches and grades into grayish-yellow silty clay loam or clay loam at 28 or 30 inches. The parent loess, a silty clay loam with a few mottlings of rust-brown, is usually encountered at a depth of 40 or 42 inches. All of the different horizons in the profile, except the surface layer and the loess below 40 or 42 inches, are generally more friable than the corresponding layers in the Grundy silt loam of the flat divides. The entire soil mass in the profile of the Grundy silt loam, slope phase, is acid in reaction, ranging from moderately to slightly acid.

A number of variations occur in the profile of the slope phase, chiefly because of the occurrence of the soil on moderately rolling ridge tops. The common range in depth of the uppermost horizon is from 6-10 inches, but in some places the dark-colored layer may be entirely absent and in others the surface layer may be as much as 12 inches thick. The shallower surface horizon is found in those areas of the phase which lie on the shoulders of the ridges or very near the drains, whereas unusually deep ones occur where the slope phase joins Grundy silt loam. Variations in the degree of mottling and in the development of the heavy-textured clay horizon, although not frequent,
may be noted in association with changes in position of the soil. Some of the lower-lying areas of Grundy silt loam, slope phase, are apparently moistened by seepage water, and in such locations the soil closely resembles the Grundy of the flat uplands.

Most of the Grundy silt loam, slope phase, is under cultivation, with approximately 30 percent of the cultivated acreage in timothy and clover and the rest in oats or corn. Yields of crops are quite similar to those obtained on Grundy silt loam, provided the slope phase is well farmed. Care must be exercised in the selection of rotations and in tillage operations on the slope phase in order to prevent harmful erosion. If this is done, average acre-yields will range from 25-30 bushels of corn, 20-25 bushels of oats and 1½ tons of hay.

LIGHT-COLORED SOILS OF THE ROLLING TO HILLY UPLANDS

The light-colored, well-drained soils of the uplands have been developed under forest vegetation, either from glacial till or from loess. These soils, technically known as members of the Gray-Brown Podzolic and associated groups, are found in the more dissected portions of Decatur County and include two soil types, Lindley loam and Weller silt loam. The Lindley and Weller soils occur extensively in the southern part of the county and in belts bordering the principal streams, making up 29.1 percent of the county area.

The light-colored soils, as their name suggests, have pale grayish-brown surface layers overlying darker-colored, heavier-textured horizons that merge with the parent material. Before the light-colored soils are cultivated, the profiles include a very shallow, dark grayish-brown layer at the surface, but this horizon is mixed with the underlying pale grayish-brown material when the soil is first plowed. In the cultivated areas, therefore, the surface layer of the soil appears light-colored throughout its entire depth. On steep slopes—whether occupied by forest or grass vegetation—there is but little profile development and the soils found on such sites are either in the early or intermediate stages of development. Lindley loam generally occurs in sharply rolling or hilly areas and on steep valley slopes where glacial materials have been exposed. The glacial till on these steep slopes has been occupied by deciduous forest vegetation, and in a number of places shallow Gray-Brown Podzolic profiles have developed. On the very steepest areas no evidence of profile development except a thin, gray-brown layer at the surface can be observed. Lindley loam differs from Shelby loam, steep phase, in the lighter color of its surface horizon. Both soils have been formed from identical glacial till, the former under forest vegetation and the latter under grasses with a scattered stand of trees. Weller silt loam, also formed under forest vegetation, is developed from the loess on ridge tops which extend into the larger bodies of Lindley loam. The profile of Weller silt loam in most areas is well developed and is characterized by fairly deep and rather distinct horizons.

Lindley Loam (Lm) (65)

Lindley loam, a soil developed from till under forest cover, occurs extensively in the southeastern and south-central parts of Decatur County. It is also found in bodies of varying size in the northern parts of the area, particularly along the valleys of the Thompson and Weldon Rivers and their prin-
principal tributaries. All of the areas of Lindley loam are located immediately adjacent to stream valleys and are characterized by sharply rolling to hilly relief. Many areas of the soil type consist of a succession of ridges and narrow valleys which are the result of dissection of the old till plain by stream action. Most individual bodies of Lindley loam are large and continuous, except for occasional tongues of Weller silt loam or islands of Shelby loam, steep phase. The total acreage of Lindley loam comprises 20 percent of Decatur County.

Over most of its area, Lindley loam exhibits very little profile development because of the marked relief. In the less sharply rolling sections, however, a shallow profile has been formed from the till materials. In gently rolling, forested areas the surface horizon of the Lindley loam consists of a friable, dark gray loam which contains numerous decaying leaves and plant roots. This surface layer extends to an average depth of 2 inches where it merges with a pale grayish-yellow or grayish-brown loam. The lower boundary of the second horizon is usually quite distinct and separates it from a brown or reddish-brown clay loam that digs out in nut-like fragments and contains much sand and gravel. The clay loam horizon is approximately 16 inches in thickness and grades into the dull yellowish-brown or yellow clay of the glacial till. Sometimes the glacial till is unoxidized and unleached, even in the moderately rolling areas, and consists of a bluish-gray clay. The various horizons of the Lindley profile are commonly acid in reaction, with the upper horizons ranging up to strongly acid. The glacial till is also acid in most places, but it is neutral or alkaline wherever there are outcrops of unleached material.

Variations in the profile of Lindley loam are common and are widely distributed. In the few areas which are cultivated, the shallow, dark-colored surface layer has been mixed with the layer immediately below it, so that the soil seems to have a surface horizon of pale grayish-brown loam, 4-8 inches deep. In some of the steeper cultivated fields, the surface horizons are entirely absent, and the brown clay loam will be found scattered over the steeper part of a field in the form of small patches or spots which are surrounded by areas of soil with a loam texture. In the steeper portions of Lindley loam, whether cultivated or not, the surface horizons of the profile are either shallow and indistinct or they may be absent. The shallow, dark-colored layer found at the surface on the steeper forest slopes merges with the glacial till at depths ranging from 2-4 inches. The underlying pale grayish-brown and brown clay loam horizons found in the profiles on moderate slopes are not ordinarily found in the Lindley loam of hilly regions.
With the exception of a few scattered patches of cleared land, Lindley loam carries a stand of trees and shrubs which include oak, elm, hickory, hazel-brush, buckbrush and sumac. The stand of trees and shrubs varies in density from one place to another over the different areas of the soil type, but it is usually thick enough to prevent the growth of many grasses. Some types of grass grow fairly well in the open areas within the forested lands, but such openings constitute only a small part of the total acreage of Lindley loam. Because of the commonly dense undergrowth and the sparse growth of palatable grasses, much of the Lindley loam furnishes rather poor pasture. The pastures can be improved by removal of the brush and undergrowth, but such efforts must be repeated if the land is to supply fair grazing. The shrubs and trees tend to reoccupy the Lindley loam unless they are periodically cleared away. Cultivated areas of Lindley loam are very limited in total acreage and are of low productivity. Little, if any, of the soil type is adapted for cultivation.

**Weller Silt Loam (Ws) (261)**

Weller silt loam occupies positions on ridge tops similar to those on which Grundy silt loam, slope phase, is found, but the former soil type was developed under forest rather than grass vegetation. The ridge tops occupied by Weller silt loam are narrow and finger-like, generally extending into larger bodies of Lindley loam. Since the areas of Lindley loam constitute the more thoroughly dissected portions of Decatur County, the relief of the Weller soils on the loess-capped ridges ranges from moderately to sharply rolling. Some narrow strips of Weller silt loam extend into areas of Shelby loam, steep phase, and others join flat upland divides of Edina silt loam. The strips are invariably narrow and irregular, and the individual ones occupy relatively small acreages. The total acreage of Weller silt loam amounts to 9.1 percent of the area of Decatur County.

The Weller profile in uncultivated areas includes a shallow surface layer of dark grayish-brown silt loam, usually 1-2 inches thick, which may be replaced by a light grayish-brown silt loam, 3-6 inches deep. The lower boundary of the surface horizon is not well defined, and the darker-colored silt loam usually merges with a pale grayish-yellow silt loam that has a platy structure in place but crushes readily to a floury mass when removed. The pale grayish-yellow horizon is underlain by a transitional layer of yellowish-brown silty clay loam with a nut-like structure. Below the transitional horizon and beginning at a depth of 16 or 20 inches, there is a brown or yellowish-brown silty clay or clay with a distinct nut structure. The nut-like aggregates in this horizon and in the one immediately above are often partially coated with a gray film or have a sprinkling of fine, light gray grains over their
surfaces. Some mottling is also present in the silty clay material, and it becomes more common below a depth of 28 or 32 inches where the silty clay gives way to the mottled silty clay loam of the loess. All of the horizons in the profile are acid in reaction, ranging from moderately to very strongly acid.

In cultivated fields, the uppermost layers of the profile have been mixed and the surface horizon appears to be a pale grayish-brown silt loam 5-8 inches in thickness. On some of the more sloping, cultivated areas, the yellowish-brown silty clay loam occurs at the surface, the lighter-colored and lighter-textured layers being absent either because of accelerated erosion or lack of development. Some variations in the depth of the various layers may occur in any area of Weller silt loam; these are to be expected in a soil which occupies moderately rolling topography.

Approximately half of the Weller silt loam is being cultivated and half used as permanent pasture. Corn, oats and hay are produced on the cultivated areas, with yields obtained somewhat lower than those on Shelby loam or Grundy silt loam, slope phase. Average acre-yields range from 20-25 bushels of corn, 15-20 bushels of oats, 10-12 bushels of wheat and up to 1 ton of hay. Lower yields are obtained on the less carefully handled fields, and higher ones on fields which have been well farmed. Applications of lime to correct soil acidity, the use of manure to increase the content of organic matter and the selection of proper rotations will improve the fertility of Weller silt loam and increase the average production.

**DARK-COLORED SOILS OF FLAT UPLANDS AND TERRACES**

The dark-colored soils of the flat uplands and terraces have been formed under grass vegetation where natural drainage was restricted. Four soil types, each of which has either a well-developed or imperfect claypan horizon within its profile, have been included in the group. The four soil types are Grundy silt loam, Edina silt loam, Chariton silt loam and Bremer silt loam, which comprise 27.2 percent of the land in Decatur County. Of this group of soils, Grundy silt loam and Edina silt loam occur on flat upland divides, whereas Chariton silt loam and Bremer silt loam occur on terraces. All four soil types are members of a group of soils technically known as Planosols, characterized by compact and heavy-textured claypans and generally occurring on flat positions.

The soils on the flat uplands and terraces in Decatur County are marked by similar relief and the presence of the heavy-textured layer in the deeper portions of the profile. Grundy silt loam and Edina silt loam have both been formed from loess on flat upland divides, but the Edina profile has a more compact claypan horizon with a distinct gray, leached layer above it. The more compact claypan layer is commonly associated with an overlying leached, platy layer, which is indistinct or lacking in the Grundy profile. The Chariton silt loam has a profile which is essentially similar to that of the Edina soils, but the former has been formed from alluvium in terraces rather than loess in the uplands. Bremer silt loam resembles Grundy silt loam in many

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Planosols are a group of soils which develop either under grass or forest vegetation where soil parent materials are exposed for a long period of time in a topographic position which is flat or nearly so. Extensive areas of Planosols occur in the southern portions of the Corn Belt and in other places in the United States.
profile characteristics; it also lacks a gray, leached horizon, and the soil material becomes heavier in texture with increasing depth. The deeper horizons of the Bremer profile are generally less compact, less heavy in texture and more friable than those of the Grundy profile. The Grundy and Bremer soils may be considered intermediate stages in profile development between the normal Prairie soils and the well-defined Planosol or claypan soils.

**Grundy Silt Loam (Gs)** (64)

Grundy silt loam is a dark-colored, imperfectly drained soil which occurs on flat, loess-capped divides. The relief on these divides is commonly very slight, and most areas of Grundy silt loam are almost level. In a few places where the Grundy of the flat uplands joins the Shelby soils of the valley slopes, the former soil type has a slight slope toward the drainageway. Since the Grundy silt loam areas are remnants left by stream dissection of an old plain, they tend to be very irregular in outline and to extend for long distances. The largest bodies of the soil type each cover several square miles and are found near Lamoni in the southwest part of the county, south of Van Wert in the north-central part and extending east and west from Weldon along the north county line. A narrow, winding divide occupied by Grundy silt loam extends southward to Leon, and scattered small bodies are found in other portions of the northern half of the county. Total acreage of the soil type comprises 12 percent of Decatur County.

The profile of Grundy silt loam consists of five separate but not well-defined horizons: A friable, very dark silt loam which is 6-8 inches thick, a transitional layer of dark grayish-brown silty clay loam extending downward to 19 inches, a highly mottled clay (B horizon), a mottled yellowish-brown clay loam and the grayish-yellow silty clay loam of the parent loess. The surface horizon is black or very dark grayish-brown in color and has a granular structure which is more distinct in the lower part. Tongues and streaks of dark-colored material extend downward from this surface layer into the transitional horizon, which contains some soft iron concretions. Concretions become numerous in the heavy clay horizon, which is dense and intractable when dry, extremely sticky and plastic when wet. The clay horizon grades almost imperceptibly into the silty clay loam of the loess somewhere between 36 and 45 inches. The loess is more friable, less compact and sticky and less highly mottled than the clay above it. All of the horizons in the profile are acid in reaction, and the loess appears to have been leached of its lime throughout its entire depth.

Practically all of the Grundy silt loam is cultivated, the only areas not in fields being those occupied by roads or farmsteads. Some of the fields located on the soil type are used occasionally
as rotation pasture, but most of the Grundy silt loam is used continuously for crop production. The repeated utilization of the soil type for crops, particularly for corn, is due to the fact that less than half of the land in Decatur County is suitable for intertilled crops. Yields obtained on Grundy silt loam are higher than those from any of the other soils in the uplands in the seasons with well-distributed and not too heavy rainfall. Average acre-yields of corn range from 30-40 bushels, oats from 25-30 bushels, wheat from 15-20 bushels, clover-timothy mixtures from 1-1½ tons and alfalfa, if it is grown on limed areas which have good drainage, 2-3 tons.

Crop production is more often limited by drainage conditions on Grundy silt loam than by any other factor under the farmer's control. Surface drainage is slow over most of the soil type, and internal drainage (percolation downward through the profile) is restricted to some extent. Water has been observed standing in the fields after heavy rainfall, but it usually disappears in a few days. Improvement of drainage through the soil mass can be achieved by the growing of legumes (notably alfalfa and sweet clover) and grasses in the rotation to improve the structure of the soil. Deep-rooted plants such as sweet clover and alfalfa will tend to penetrate the clay horizon and make it somewhat more permeable.

Edina Silt Loam (Es) (211)

Edina silt loam occurs, in general, in the same kinds of positions as Grundy silt loam, but when the two soils occur together the former type is found in the flatter and more depressed areas. The upland divides occupied by Edina silt loam are not as wide as the largest Grundy areas, seldom being as much as 1 mile and more commonly being less than ½ mile in width. The larger bodies of Edina silt loam are narrow, irregular in outline and extend for 7 or 8 miles. The principal areas of the soil type are found in the northern half of the county, southeast of Leon and east of the Weldon River. Isolated small bodies of Edina silt loam occur in the central portions of the larger Grundy flats in some places, but this is not the common mode of occurrence. The largest of the long and narrow bodies of Edina silt loam covers as much as 2,000 acres, whereas the smaller ones occupy less than 30 acres each. The aggregate area of the soil type makes up 4.5 percent of Decatur County.

The surface horizon of the Edina profile is a very dark grayish-brown silt loam, ranging from 5-12 inches in thickness, which appears black when it is wet. The lower boundary of this horizon tends to be wavy and irregular, separating the surface layer from a light gray silt loam with a finely platy structure in place which crushes readily to a soft, floury mass when removed. Small black concretions and a number of thread-like black stains are present
in the gray layer, which ranges from 3-10 inches in thickness. There is a rather abrupt change at the lower boundary of the gray horizon to a dull gray, highly mottled clay that is extremely intractable and hard when dry but sticky and plastic when wet. The mottlings are pale yellowish-brown, reddish-brown and dull orange in color, and they are accompanied by numerous black or dull brown concretions. The number of concretions is greatest in the heavy claypan horizon and gradually decreases as the clay merges with the silty clay loam of the loess at depths between 40 and 50 inches. The loess is grayish-yellow in color, faintly mottled with reddish-brown, and it is relatively friable. All parts of the soil profile are acid, but the light gray horizon is more acid than any of the others.

Almost all of the Edina silt loam is under cultivation. The soil type has a favorable relief and produces fair yields of crops even though it is not highly fertile. The crops grown include corn, oats, wheat and hay, with yields obtained somewhat lower than those from the Grundy silt loam. The differences in yield on the two soils are particularly marked in wet seasons, when the more restricted drainage of the Edina soil seriously hampers plant growth. Average acre-yields range from 20-25 bushels of corn, 20-25 bushels of oats, 15-20 bushels of wheat and up to 1 1/2 tons of clover-timothy hay.

Drainage is generally restricted in areas of Edina silt loam. The combination of flat relief with a highly impervious claypan horizon tends to hinder the movement of water and prevent it from flowing away either over the surface of the soil or through the profile. Moreover, improvement of drainage by artificial means is commonly difficult on the flat divides of Edina silt loam. Tile lines must be laid very close together in order to be effective, and generally they must be placed within or below the claypan horizon to prevent damage from frost. If placed in the claypan layer, the tile drains should be covered by gravel, small rock fragments and materials from the surface horizon of the soil in order to prevent rapid clogging of the tile by the clay. Ditches to remove surplus water are feasible in some places, but it is often hard to obtain enough fall so that water will flow. Some improvement of the internal drainage of the Edina profile can be obtained by the growing of certain legumes and grasses which would tend to make the structure of the upper horizons granular and to increase the permeability of the claypan. Deep-rooted crops such as sweet clover are particularly useful for this latter purpose, but the successful growing of the crop requires previous applications of lime.

Chariton Silt Loam (Cs) (105)

Chariton silt loam, which has a profile quite similar to that of Edina silt loam, has developed on terraces at two general levels above the present beds of the streams. One group of terraces has an elevation very little above that of the first bottoms occupied by Wabash soils. Such terraces occur extensively along all three of the rivers and along the larger creeks in Decatur County. They are subject to overflow to about the same extent as the Wabash soils of the flood plains, but the soil profile that has developed is quite similar to the one found on the higher-lying Chariton benches. The second group of terraces is found principally along the Thompson River, with scattered exam-
ples along the other large streams. These latter bodies of Chariton silt loam lie at elevations of 10-15 feet above the first bottoms, are generally level or very gently sloping and are essentially similar to the soil type as it has been mapped in other counties. The very low terraces included with the Chariton silt loam in Decatur County are not entirely similar to the soil type as it has been recognized in other areas. Most of the individual areas of Chariton silt loam are large, and a few occupy a number of square miles. The total acreage of the soil type comprises 10.5 percent of the county area.

The surface horizon of the Chariton profile is a very dark grayish-brown silt loam, approximately 10 inches deep, which appears dark gray when it is dry. Below the surface layer and separated from it by a narrow transitional zone, there is a light gray silt loam which has a finely platy structure in place but crushes readily to a floury mass when removed. The average thickness of this gray, leached horizon is 10 inches, though it varies somewhat from place to place. Occasional small concretions, either black or dull brown in color, and some dark-colored stains are distributed through the light gray silt loam. The lower boundary of the leached layer is generally quite abrupt and separates it from a dull brown or dull gray claypan horizon. The clay is sticky and waxy when moist, very hard and dense when dry and contains numerous small, dark pellets and occasional soft spots of yellowish-brown materials. Mottlings are very common in this horizon, particularly in the upper part, but they tend to become less numerous where the claypan layer merges with the alluvial parent material between depths of 30 to 38 inches. The alluvium consists of a dull grayish-yellow silty clay loam or silt loam which has a few mottlings of reddish-brown and dull orange. All of the horizons in the profile are acid in reaction, ranging from moderately to strongly acid.

About 95 percent of the Chariton silt loam on low-lying terraces and the entire area of the higher ones are being cultivated. The common field crops are grown on the soil type, with perhaps a greater proportion of corn in the usual rotation than would be found on the rolling uplands. The average yields of crops are approximately the same on the higher-lying and lower-lying areas of Chariton silt loam, though the crops on the lower terraces are sometimes damaged by flood waters. The actual yields obtained on the higher terraces are somewhat below those from the lower ones in years with well-distributed rainfall. Occasional damage to crops by overflow waters on the lower terraces tends to equalize the yields, however. The average acre-yields range from 25-30 bushels of corn, 15-25 bushels of oats and 1-1½ tons of clover-timothy hay.
A small part of the total acreage in the lower-lying areas of Chariton silt loam is used as permanent pasture. The pasture areas are commonly those which include a number of stream meanders and are therefore difficult to cultivate. Such bodies of land furnish good grazing and are especially valuable in the late summer months.

The entire acreage of Chariton silt loam is subject to restricted drainage because of its flat relief and the impervious nature of the deeper horizons of the soil profile. After periods of heavy rains, water may remain on the surface of the soil for several days, not being able to drain away either over the soil or through it. Chariton silt loam resembles Edina in this respect, but improvement of the natural drainage is somewhat more difficult on this soil type than it is on Edina silt loam because of its lower topographic position. The lower group of terraces occupied by Chariton silt loam can be drained in some places by means of ditches, though they have not been used extensively. Tile drains, if they are to be effective, must be laid at such close intervals that drainage operations become very costly. Some improvement of the natural drainage is often feasible, and steps to improve it are similar to those recommended for Edina silt loam.

Bremer Silt Loam (Bl) (88)

Bremer silt loam is one of the minor soil types in Decatur County, occupying only 320 acres on 2 parts of a terrace in the northwestern part of the county. The local relief of the terrace ranges from level to gently undulating so that external drainage is fairly good. There are only two areas of Bremer silt loam separated by a strip of Chariton silt loam, which occur along the edge of the flood plain of the Thompson River.

The Bremer silt loam profile consists of a deep, very dark upper horizon grading through a lighter-colored transitional zone into the dull gray alluvium of the parent material. The surface layer is a black or very dark grayish-brown silt loam, relatively friable when moist but becoming sticky when wet. Below a depth of 12 inches, the dark colors begin to fade somewhat and are replaced by a dull gray that is streaked with rust-brown and black. The transitional horizon, beginning at 12 or 14 inches, extends downward to 28 or 30 inches, below which the soil material is a highly mottled, dull gray silty clay loam or silty clay. The mottlings present below 20 or 22 inches are yellowish-brown, rust-brown and black in color and are associated with occasional, small, black concretions. The deeper horizons tend to be heavy and compact and are relatively impervious. All of the layers in the soil profile are acid in reaction, with the surface layers more acid than the others.
The entire acreage of Bremer silt loam is under cultivation and has been used repeatedly for the production of corn. Acre-yields of 45 bushels have been obtained quite commonly, and they have been exceeded in favorable years. Yields of crops other than corn have ranged from 25-35 bushels of oats, 20-25 bushels of wheat, and 1½-2 tons of clover-timothy hay per acre.

Bremer silt loam is naturally fertile, and it is highly productive under favorable seasonal conditions. Natural drainage is not entirely adequate in wet years, and crop yields are reduced, but in dry years production is maintained at or near the average level. Artificial improvement of the natural drainage would, however, have beneficial effects in most years.

**DARK-COLORED SOILS OF THE FLOOD PLAINS**

Three soil types in the Wabash series have been included in the group of dark-colored soils found in the flood plains or bottomlands of Decatur County. The three soil types are the loam, silt loam and silty clay loam, all three having been formed from alluvial materials. Wabash loam occupies the narrow valleys along the streams in the more rolling and hilly portions of the county where much of the sediment is derived from the glacial till. Wabash silt loam, much less extensive than the other two types, is found along the smaller drainageways that penetrate the smooth or gently rolling uplands where loess deposits were the sources of a large part of the alluvium. Wabash silty clay loam is limited in its occurrence to the flood plains along some of the rivers and large creeks, in which the alluvial parent materials are partially of local origin and partially brought in from other regions. The total area occupied by the three soil types makes up 8.2 percent of the land in Decatur County.

The three Wabash soils are included in one series because they have profiles that are very much alike except for the texture of the uppermost horizons. The differences in texture are noted in the soil type names, which represent the predominant one in the areas as mapped. All three of the soils in the bottomlands have been derived from alluvial materials, were formed under a mixed vegetation of grass and trees and are relatively young in profile development as compared to soils like Edina silt loam. Differences in the three soil types are due to variations in the texture of the alluvium deposited in the flood plains of the streams.

**Wabash Silty Clay Loam (W) (48)**

The largest areas of Wabash silty clay loam occur along Thompson and Weldon Rivers in the southern part of Decatur County. Extensions of the large body of the soil along the Weldon River are located in the valleys of two of its tributaries, along Steele Creek and Caleb Creek. Isolated areas also occur along the upper portions of the Thompson River and a few of its tributary streams. The bulk of the soil type, however, is included in the two large continuous areas, one in each of the flood plains of the Thompson and Weldon Rivers. Wabash silty clay loam, restricted to the relatively flat and sometimes even depressed portions of the river flood plains, comprises 3.6 percent of the land in Decatur County.
The surface layer of the soil is a very dark grayish-brown (almost black) silty clay loam which is friable under favorable moisture conditions but may be sticky when wet or hard when dry. At a depth of 6-10 inches, the surface layer grades into a dark gray silty clay which is mottled with rust-brown stains. The silty clay horizon gradually becomes heavier in texture and somewhat duller in color with increasing depth, merging with a heavy, dull gray clay somewhere between depths of 18 and 22 inches. There is little change in the soil material below a depth of 20 or 30 inches; mottlings and stains seem to persist in about the same numbers below that depth as above it. Lime is absent from all layers of the profile, as a general rule, and the entire soil mass is acid in reaction.

Wabash silty clay loam is almost entirely under cultivation, with perhaps 5 percent being devoted to other uses. The soil type is one of the more productive ones in the county, and the yields obtained are relatively high for the region. Crops are sometimes damaged by flood waters or by the lack of adequate natural drainage, especially in the narrower bottoms or in the isolated bodies of the soil type. The wider bottoms, as for example the ones south of Davis City, generally have better natural drainage and good crops of corn are commonly grown. Average yields of corn in the wider bottoms range from 25-45 bushels per acre, but they may be much higher in the more favorable years. Crops other than corn are grown to only a limited extent.

For the successful cultivation of Wabash silt clay loam, it is usually necessary to protect the land from overflow and to improve the natural drainage. Dikes have been built in a number of places to prevent water from entering fields, and river channels have been straightened and deepened. Drainage has been improved in a number of localities by the digging of ditches to facilitate runoff into the stream channel. Although the hazards of overflow and poor drainage have been only reduced and have not been eliminated, production on Wabash silty clay loam compares favorably with that from other soils in Decatur County.

Wabash Loam (Wa) (49)

Wabash loam usually occurs in the flood plains of narrow valleys which are bordered by steep slopes occupied by Lindley loam or Shelby loam, steep phase. These narrow valleys, commonly located in the more thoroughly dissected portions of the county, are often flooded because of the large quantities of water they receive from the surrounding steep slopes during heavy rains. Considerable amounts of sediments are also brought down from the steep areas of Shelby and Lindley soils and distributed over bodies of Wabash loam. Relatively recent deposits of sand, silt and gravel are common in the narrow
valleys in the more hilly parts of Decatur County. In addition to the narrow valleys in which most Wabash loam occurs, there are some larger areas of the soil type in wider flood plains. The widest flood plains occupied by Wabash loam are not more than \( \frac{1}{4} \) mile across, and the narrowest ones cannot be indicated on the scale of 1 inch per mile. The total acreage of Wabash loam, widely distributed in the form of narrow bands, comprises 3.6 percent of the land in Decatur County.

The profiles found in bodies of Wabash loam may vary considerably over short distances, and the variations are relatively numerous. The principal variations that exist are in the texture and color of the surface layers of the soil, though there are also numerous changes in the texture of the deeper portions of the profile. Generally, the surface layer of the Wabash loam is dark grayish-brown in color, 15-20 inches in depth and may range from a sandy loam to a silt loam in texture. Below the surface layer, there is a transitional zone which ranges from brown to dark grayish-brown in color and from a loam to a silty clay loam in texture. The transitional zone gives way to a dark, mottled silty clay loam at a depth of 36 inches. No lime is present in the profile, and all of the layers are acid in reaction.

Approximately 75 percent of the total acreage of Wabash loam is being used for pasture, partly because of difficulties of cultivation due to topographic position and partly because of the likelihood of overflow damage. Where the soil is cultivated, the average crop yields are reduced considerably by floods, and individual crops may be entirely destroyed. In some of the wider bottoms occupied by Wabash loam, small areas of the soil type are being cultivated successfully. Corn is the principal crop grown in such areas, and the average acre-yield ranges from 25-40 bushels. Except for occasional local bodies of Wabash loam which are large enough to be suitable for cultivation, the soil type will be more productive when used for pasture than when used for crops.

Wabash Silt Loam (W1) (26)

Wabash silt loam occurs in two different forms, either as narrow strips along the drainageways in the smoother uplands or as isolated areas along the flood plains of the larger streams. Most of the soil type occurs in the form of the narrow valleys which are associated with the upland flats of Grundy and Edina soils. Wabash silt loam has been formed from silty materials washed down from the dark-colored, higher-lying soils and still receives sediments from time to time. The total acreage of the soil type is small, occupying only 1 percent of the land in Decatur County.
As is characteristic of alluvial soils, particularly those which frequently receive additional sediments, the profile of Wabash silt loam exhibits marked variations from one place to another. Perhaps the most commonly occurring profile includes a surface horizon, 18-22 inches deep, of very dark grayish-brown or black silt loam which grades into a dark brown silty clay loam extending downward for another 20 or more inches. Occasionally, a heavy silty clay may be encountered at depths of 36 or 40 inches, and this layer is more common in the soil in the larger bottoms than along the small drainageways. Variations in texture, depth and friability of the different horizons are widely distributed. All of the horizons in the profile of Wabash silt loam are commonly acid in reaction, although variations in acidity also occur.

Some of the smaller valleys occupied by Wabash silt loam are bordered by steep or rolling lands not well suited for cultivation, and they themselves are generally too narrow to be farmed alone. Areas of Wabash silt loam along small streams are also commonly flooded after heavy rains, and receding flood waters often leave accumulations of debris over the surface of the soil. Approximately 50 percent of the total acreage of the soil type is therefore being used as pasture. Wabash silt loam supports a good stand of bluegrass which will carry 1 cow per 2 acres of land during the grazing season. The bottomland pastures are especially valuable in the latter part of the summer when most grasses become dormant because of the warm, dry weather.

The cultivated areas of Wabash silt loam include the bodies of the soil type found in the larger flood plains and those in the narrower flood plains which are bordered by gently rolling lands. Corn is the principal crop grown on such areas of land, and the acre-yields obtained range from 35-45 bushels.

ROUGH, STONY LAND (Rs) (78)

Rough, stony land, a miscellaneous land type, not included with any group of soils, occupies only 192 acres in Decatur County and has no agricultural value for crop production or grazing. Most of the rough areas consist of bluffs or very steep slopes due to the outcropping of limestones, and all of them are found along the valley of the Thompson River. In the few places where there are short gentle slopes or small shelves, the surface limestone has been weathered to form a shallow regolith in which scattered small trees are now growing. The bulk of the rough, stony land, however, consists of bare outcrops of limestone. The limestone, although it will not support crops or grasses, does have an agricultural value as a source of lime for the acid soils of Decatur County. It is being quarried in several different localities at the present time and can be used much more extensively to good advantage.
MANAGEMENT OF SOILS IN DECATUR COUNTY

High yields of crops of good quality are desired by all farmers, but such yields are obtained only when all of the factors which govern productivity are favorable. Agricultural production depends upon a complex group of factors, among which climate, soil, topography and management are some of the more important ones. Of these factors, management is the only one over which the farmer can exercise any large degree of control. Elements of climate or topography or the nature of the soil on a farm cannot be readily changed; they must be used about as they occur. Considerable differences in the levels of management are possible, however, within a group of farms of the same type on similar soils. Such differences, particularly those in soil management, may bring about large differences in the amounts and quality of crops produced. Various desirable and undesirable management practices, as they are related to the soils of Decatur County, are therefore discussed in this section of the report.

Much information regarding the yields obtained with different levels of soil management have been accumulated through the experiences of farmers and the trials made by experiment stations. Such information is not as yet complete, but it can form a basis for improving present methods of handling the soil on many farms. The various recommendations outlined in this report are based on information obtained from farmers regarding their more successful practices, on field observations made in Decatur County and on the results obtained in field and laboratory studies of the Iowa Agricultural Experiment Station. The recommendations may be adopted on an ordinary farm with little difficulty, as a rule, and with the assurance of satisfactory results under normal seasonal conditions.

It should be recognized that soil management practices must be adapted to fit the organization of a farm unit as well as being designed to maintain the fertility level of the soil. The kind of management necessary to obtain maximum production for a particular kind of soil may not fit into the operating scheme of a given farm, and some other type must then be selected that will provide satisfactory long-time yields. A number of satisfactory alternatives are usually possible, and some one of these can be selected by the farm operator. Decisions as to which type of soil management is the most desirable for a given field or tract of land have to be made repeatedly by farmers. The need for the making of such decisions cannot be eliminated by the group of recommendations that follow, but it is felt that a discussion of possible ways of handling the soil will help to form a basis for the making of sound decisions. Different phases of soil management are discussed under the following headings: Crop Rotations, Improvement of Pastures, Liming, Maintaining Organic Matter, Tillage and Erosion Control, Drainage and Use of Commercial Fertilizers.

CROP ROTATIONS

The value of crop rotations as an aid in maintaining high yields is now generally recognized. Even such simple rotations as the alternating of corn and oats, for example, results in better acre-yields of both crops than does
the continuous growing of either. In spite of the higher yields obtained by
the use of good rotations, however, there is a tendency to grow a larger pro-
portion of high-value, intertilled crops in the rotation than seems desirable
from the standpoint of soil fertility maintenance. The continuous or often
repeated growing of corn or other intertilled crops eventually lowers the con-
tent of organic matter and plant nutrients in the soil and brings about a gradual
deterioration of soil structure. To offset this tendency it is necessary to grow
other types of crops, notably the legumes and grasses, or to retire land from
cultivation for a period of time. The growing of legumes and grasses, both of
which are types of close-growing vegetation, have beneficial effects upon the
soil and leave it in better condition for succeeding crops even though they
may not bring in as large a cash return.

The selection of a rotation or rotations for a given farm must be made on
the basis of the nature of the soils and the organization of the farm unit. No
one rotation is generally adaptable to all of the farms or soils in Decatur
County or even to all areas of one soil type as it occurs on different farms.
Separate areas of a soil type such as Weller silt loam may differ considerably
in productivity because of different methods of management in the past; such
areas cannot be handled in the same way in the future if production is to be
maintained or improved. Furthermore, the rotation that is followed on a
well-stocked, well-equipped farm might not be at all feasible on another farm
with less livestock and less machinery. Many other similar considerations
are involved in the selection of the best rotations for a particular field or farm.

A number of rotations are suggested for the different groups of soils in
Decatur County. It will be noted that no rotations are recommended for the
hilly and more rolling types of soils. Such areas are better adapted for use
as pasture or forest land than for the production of crops. A later section in
this part of the survey report is devoted to a discussion of the improve-
ment of pastures. The various suggested rotations are as follows:

**Rotations for Dark-Colored Soils of Level or Nearly Level Areas**

1. *Six-year rotations*

<table>
<thead>
<tr>
<th>First year—Corn</th>
<th>First year—Corn</th>
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</thead>
<tbody>
<tr>
<td>Second year—Soybeans</td>
<td>Second year—Corn or soybeans</td>
</tr>
<tr>
<td>Third year—Corn</td>
<td>Third year—Oats</td>
</tr>
<tr>
<td>Fourth year—Small grain</td>
<td>Fourth year—Alfalfa**</td>
</tr>
<tr>
<td>Fifth year—Mixed hay*</td>
<td>Fifth year—Alfalfa</td>
</tr>
<tr>
<td>Sixth year—Mixed hay</td>
<td>Sixth year—Alfalfa</td>
</tr>
</tbody>
</table>

* Mixed hay is meant to include all legumes and grass mixtures. Such seedings can
be used for hay or as rotation pasture.

**Alfalfa seedings should ordinarily include some grass seed with the alfalfa.

2. *Five-year rotations*

<table>
<thead>
<tr>
<th>First year—Corn</th>
<th>First year—Corn</th>
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</thead>
<tbody>
<tr>
<td>Second year—Corn or soybeans</td>
<td>Second year—Corn</td>
</tr>
<tr>
<td>Third year—Small grain</td>
<td>Third year—Small grain</td>
</tr>
<tr>
<td>Fourth year—Mixed hay</td>
<td>Fourth year—Winter wheat</td>
</tr>
<tr>
<td>Fifth year—Hay or pasture</td>
<td>Fifth year—Clover</td>
</tr>
</tbody>
</table>
3. **Four-year rotations**

First year—Corn  
Second year—Corn  
Third year—Small grain  
Fourth year—Mixed hay

First year—Corn  
Second year—Soybeans  
Third year—Small grain  
Fourth year—Clover

First year—Corn  
Second year—Small grain (with sweet clover)

**Rotations for Dark-Colored Soils of Gently to Moderately Rolling Areas**

1. **Six-year rotation**

First year—Corn  
Second year—Corn  
Third year—Small grain  
Fourth year—Mixed hay  
Fifth year—Hay or pasture  
Sixth year—Alfalfa

2. **Five-year rotations**

First year—Corn  
Second year—Small grain  
Third year—Alfalfa  
Fourth year—Alfalfa  
Fifth year—Alfalfa

3. **Four-year rotations**

First year—Corn  
Second year—Oats (with clover)  
Third year—Clover  
Fourth year—Winter wheat (without clover)

4. **Three-year rotation**

First year—Corn  
Second year—Small grain  
Third year—Mixed hay  
Fourth year—Hay or pasture

**Rotations for Light-Colored Soils of Gently to Moderately Rolling Areas**

1. **Six-year rotation**

First year—Corn  
Second year—Small grain  
Third year—Alfalfa

2. **Five-year rotations**

First year—Corn  
Second year—Small grain  
Third year—Mixed hay  
Fourth year—Mixed hay  
Fifth year—Hay or pasture

3. **Four-year rotation**

First year—Corn  
Second year—Small grain  
Third year—Mixed hay  
Fourth year—Hay or pasture
IMPROVEMENT OF PASTURES

The total acreage of pastures (all kinds) in Decatur County slightly exceeded the land in crops in 1938. Pastures made up 46.9 percent of the land in farms, of which plowable pastures comprised about one-half, woodland pastures slightly less than one-third and all other kinds the remainder. Many of the permanent pastures, especially those which are classed as woodland, are of inferior quality. Some of the plowable pastures also provide poor grazing and could be improved materially. Woodland pastures are usually found on Lindley loam, practically all of which is used for grazing, on Weller silt loam and on Shelby loam, steep phase, wherever there are open or scattered stands of timber. Permanent pastures not classed as woodland may occupy these same soils, and they are also found on other soil types in the rolling uplands and in the flood plains of the streams. Plowable pastures include areas of Shelby loam, Grundy silt loam, slope phase, and some Weller silt loam with but minor acreages of other soil types. Certain parts of the total acreage indicated as plowable pasture could be successfully cultivated, but other areas which are used for crop production should be retired to permanent vegetation. The total area best adapted to grazing in Decatur County is perhaps slightly larger than the acreage now in pasture. Most of this acreage will be more productive as pasture land than if used for crops, particularly if a good system of pasture management is followed.

Steps to improve the pastures of Decatur County include the clearing away of brush and trees not needed for shade in woodland pastures, the control of grazing, applications of lime and phosphate and reseedings of poor sod with legume or legume-grass mixtures. Among these various steps, the control of grazing is highly important and should be practiced on all pastures, even those which are in good condition. Furthermore, most pastures over a long period of time can be improved by additions of lime and phosphate and by occasional reseeding. In the pastures which now have a good sod, controlled grazing may be all that is necessary to maintain that sod for a long period of time, whereas steps must be taken to improve the vegetation in pastures which are brushy or are infested with weeds.

The improvement of woodland pastures requires first the clearing away of brush and the trees not needed for shade. These types of vegetation compete with the grasses for water and plant nutrients, thereby reducing the amount of forage produced. Periodic clearing of brush and small trees is necessary on some of the lands in Decatur County, especially on the Lindley and Weller soils. After the brush and necessary trees have been removed, it is commonly desirable to take steps to improve the composition and stand of the remaining vegetation. Some of the steepest areas of Lindley soil are not well adapted for use as pasture land and should be kept under forest cover. These steep areas when kept under forest cover should not be grazed, since they furnish very little forage if they are pastured, and since grazing is detrimental to the growth of trees.

Permanent pastures which are to be improved should be closely grazed the preceding fall or clipped in the spring so that excessive vegetative growth will not be present to interfere with seedbed preparation and with reseeding. The
lime requirements of samples of the soil from different parts of the pasture should be determined and applications of limestone made to correct soil acidity wherever necessary. Most of the soils in Decatur County are acid in reaction. In addition to being acid, many of the soils, particularly those which are light colored and those which occur in rolling or hilly areas, are low in phosphorus available to plants. Applications of superphosphate at rates of 200 to 300 pounds per acre will therefore often be justified by the increased forage yields and returns from the pasture. After the lime and phosphate have been applied, the land is thoroughly disced and is seeded during the early part of the spring. The seeding mixtures to be used have to be adapted to fit the conditions in the particular pasture. Clovers are most satisfactory where at least a scattered stand of grass persists, whereas a mixture of timothy or Kentucky bluegrass with clovers are used where the grass is especially thin. Mixtures recommended for several different soil conditions are as follows:

<table>
<thead>
<tr>
<th>Non-acid soils</th>
<th>Non-acid fertile soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Medium to low fertility)</td>
<td>lbs. per acre</td>
</tr>
<tr>
<td>Sweet clover</td>
<td>5</td>
</tr>
<tr>
<td>Red clover</td>
<td>3</td>
</tr>
<tr>
<td>Alsike clover</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>lbs. per acre</td>
</tr>
<tr>
<td>Sweet clover</td>
<td>4</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>3</td>
</tr>
<tr>
<td>Red clover</td>
<td>2</td>
</tr>
<tr>
<td>Alsike clover</td>
<td>1</td>
</tr>
</tbody>
</table>

**Acid Soils**

<table>
<thead>
<tr>
<th>lbs. per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red clover</td>
</tr>
<tr>
<td>Alsike clover</td>
</tr>
</tbody>
</table>

Korean lespedeza at the rate of 4-6 pounds per acre may be added to the pasture mixture for reseeding areas of Lindley loam and Weller silt loam, especially where those soils have been poorly handled in the past. On the steeper lands which are suitable for pasture but where it is not possible to prepare a satisfactory seedbed, unhulled sweet clover can be broadcast in the early part of the spring at the rate of 15 pounds per acre.

After a pasture has been reseeded, it should not be grazed until the new stand has become well established. Once the seeding has been well established, it is still desirable to practice controlled grazing so as to maintain a good sod of bluegrass with high proportion of clovers. More complete information regarding the improvement and management of pastures is available in the Iowa Agricultural Experiment Station—Agricultural Extension Service Bulletin P8 (New Series).8

**LIMING**

The principal crops of Decatur County make their best growth on soils which are only slightly acid or neutral in reaction. Some crops, such as soybeans, are rather tolerant of acid conditions, but others such as alfalfa and sweet clover, which are of particular importance in a program for maintaining soil fertility, do not thrive on soils which are even moderately acid. Alfalfa and sweet clover, and to a lesser extent other legumes, grow most successfully on soils which are either neutral or slightly acid in reaction. Since many of the soils in humid regions are acid, it is generally necessary to neutralize this acidity before the best crops can be produced. The application of lime, com-

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monly in the form of finely ground limestone, is the usual practice in correcting soil acidity. Applications of lime must be made according to the degree of acidity of the soil, the nature of the crop and the general needs of the farm. More acid soils generally require greater application of lime, and more intensively cultivated areas ordinarily lose lime more rapidly so that more frequent applications are required.

The soils of Decatur County are predominantly acid, ranging from slightly to strongly acid in reaction with but few exceptions. Most of the soil types are acid both in the upper layers of the profile and in the deeper horizons, and this is particularly true of the light-colored soils and those with well-developed claypan horizons. Light-colored soils such as Weller silt loam and the claypan soils such as Edina silt loam are distinctly more acid in reaction than are the dark-colored soils without claypan horizons. Dark-colored soils such as Shelby loam usually are moderately acid in the upper horizons and slightly acid in the deeper layers of the profile. The dark-colored, imperfectly drained soil types, such as Grundy silt loam, are also moderately acid in the surface layers but sometimes approach a neutral reaction in the deeper subsoil. Differences in the degree of acidity, especially in the surface layers, exist within individual areas and between different bodies of most of the soil types. Larger variations and more frequent ones are to be expected in the rolling or hilly soils and in those of the bottomlands than in the soil types on flat uplands and terraces.

Most areas of Shelby loam, steep phase, and Lindley loam are acid in reaction, but occasional ones may be found which are neutral or sometimes even calcareous. The occurrence of neutral or alkaline surface layers in the profiles of Shelby loam or Lindley loam are confined to local spots in regions with steep or hilly topography where lime (calcium carbonate) can be found near the surface of the shallow soil profiles. Such spots are not large, as a general rule, and they seldom occur where the soils are suitable for cultivation. Lime should not be added to soils which are calcareous or neutral, since applications do not benefit crops unless the soils are acid.

Because of local variations in the degree of acidity and in lime requirement, it is generally desirable to determine, in advance of application, the amounts of lime that are needed on the different kinds of soil in a field. Samples should be selected to represent the soil conditions in various parts of a field and the lime requirement of each sample determined. Samples of soil will be tested for their lime requirement by the county agricultural agent, or they can be sent to the Soils Subsection of the Iowa Agricultural Experiment Station. After the tests have been completed, applications of limestone should be made in the amounts needed to neutralize soil acidity in the different parts of the field. Tests of soil samples sometimes indicate that no lime is required on some parts of a field, and applications should not be made in those areas. Very few fields in Decatur County will include soils that are not acid in reaction, however, and most of the soils will be more productive after they have been limed. This is particularly true where legumes are to be grown, but it also applies to other crops and to many of the permanent pastures.

The rate of application of lime is governed chiefly by the acidity of the sur-
face layers of the soil, but consideration should also be given to the lime requirements of the deeper horizons of the profile. Less lime needs to be added to a soil which is acid in the upper layers if the deeper ones are neutral or calcareous. If the soil is distinctly acid throughout its entire profile, enough lime must be added to the upper part of the soil to take care of the needs of the crop to be grown. With the exception of Shelby loam, steep phase, and Lindley loam, the soils in Decatur County can be expected to be acid throughout their entire profiles. Most of the steep Shelby and Lindley areas will also be acid, but some of them are not. The light-colored soils of gently to moderately rolling areas (chiefly Weller silt loam) and the soil types with well-developed claypan horizons (Edina and Chariton) are more strongly acid than are the other soil types of the county. The lime requirements of Weller, Edina and Chariton soils are likely to be somewhat higher than those of Grundy or Shelby soils because of the greater degree of acidity of the former types.

MAINTAINING ORGANIC MATTER

The nature and amounts of organic matter in the soil are important for a number of reasons. Organic matter acts as a storehouse for the nitrogen needed by growing plants, and it contains appreciable quantities of other nutrient elements, particularly phosphorus. It serves as an energy source for microorganisms, and some forms of organic matter have a beneficial effect upon the physical condition (structure, permeability, etc.) of the soil. Because of the numerous ways in which organic matter may improve the nature of the soil, the need for maintaining an adequate supply as a part of a program for the maintenance of long-time production should be readily apparent.

The level and nearly level, dark-colored soils (Grundy, Chariton, Wabash, etc.) in Decatur County contain relatively large quantities of organic matter in their profiles, and they probably contained even more when they were first plowed. The rolling, dark-colored soils (Shelby and Grundy, slope phase) are somewhat lower in their contents of organic matter and humus, but they contain considerably larger amounts than do the light-colored, rolling soil types (Weller and Lindley). The relative differences in the nature and amounts of organic matter present in the soils of the various groups under native vegetation have tended to persist with but minor changes as a result of cultivation.

Under the natural conditions which prevail before the breaking of the prairie and the clearing of forest, there is a balance between the amounts of organic matter added by the native vegetation and that which is decomposed by microorganisms. The quantity of organic matter and humus in the soil, therefore, tends to remain the same after the type has come into equilibrium with its climatic environment. When soils of the grasslands are brought under cultivation, the content of organic matter usually decreases for a number of years. Crops occupy the soils during only part of the growing season instead of the year around as does native vegetation, and part of each crop is removed from the land. Furthermore, the operations of cultivating the soil tend to promote more rapid decay of organic residues. Steps must therefore be taken by the
farmer to replenish the supply of organic matter and humus in the soil, thus keeping it at levels which will allow satisfactory crop production.

Organic matter may be added to the soil by plowing down crop residues, by adding barnyard manure, by using green manure crops and by growing grass-legume mixtures for a period of time in each rotation. All of these different methods of keeping up the supply of humus may be found useful on a single farm, but some one or two will perhaps be utilized more often than the others. The methods followed in maintaining the supply of organic matter in the soils of a farm must be adapted to the nature of the soils and to the organization of the farm unit.

Among the various ways of adding organic matter to the soil, the plowing under of crop residues is perhaps the most common. Although the plowing under of crop residues will not maintain the content of organic matter at desirable levels in the soils of Decatur County, it will help to keep an adequate supply in the soil. Care should therefore be taken to conserve and utilize all crop residues except where diseases or insect pests are present in such residues. Practices such as the burning of cornstalks, for example, are not desirable from the standpoint of soil fertility maintenance and should not be followed except where absolutely necessary. Furthermore, the addition of such types of organic matter as cornstalks is especially helpful in improving the physical condition of heavy-textured soils and in the prevention of erosion.

Barnyard manure is one of the most valuable forms in which organic matter can be added to soils. It supplies larger quantities of nitrogen than do other kinds of organic matter generally available, and it has a number of other beneficial effects. Where considerable quantities of manure are available, as on a livestock farm, the conservation and proper use of barnyard manure is a most important step in maintaining an adequate supply of organic matter in the soil. It often happens, however, that manure is not well handled and thus loses much of its value before it can be applied to the land. The use of large quantities of bedding to absorb the urine, storage of the manure where it will be kept moist but will not be exposed to leaching, and plowing it under as soon as possible after spreading are precautions that should be taken if maximum benefits are to be obtained.

Sufficient quantities of manure to permit necessary applications on all fields are not available on many livestock farms, and even smaller amounts are produced on grain farms where fewer animals are kept. The growing of green manure crops and the use of grasses in long rotations to supplement the organic matter supplied as barnyard manure and crop residues is therefore necessary on most farms. The best green manure crops for general use are the various legumes, though other crops may be more desirable in special cases. Legumes, when they are well inoculated and thrifty, obtain a large proportion of their nitrogen from the air, thus adding considerable quantities to the soil as they are plowed under. The growing of crops such as sweet clover also improves the physical condition of the soil, particularly in the case of soil types such as the Grundy, Edina and Chariton where there is a claypan horizon in each profile. The establishment of good stands of legumes such as sweet clover and alfalfa on most of the soils in Decatur County generally re-
quires prior application of lime. Chances of obtaining good catches of legumes other than sweet clover and alfalfa are also improved by liming.

The use of close-growing plants such as the grasses and legumes, especially the former with their fibrous root systems well distributed through the upper part of the soil mass, helps to maintain the supply of organic matter in the soil. Grasses also seem to have beneficial effects upon the structure of the soil, making it more porous and providing better aeration and water absorption. A more widespread use of grasses, especially when used in grass-legume mixtures, would seem desirable in Decatur County to aid in maintenance of soil fertility.

As has already been suggested, further additions of organic matter would benefit crops on most of the soils in Decatur County at the present time. Such additions are more necessary on the light-colored soil types than on the dark-colored ones, particularly if the latter are imperfectly drained. Soils such as Grundy silt loam and Bremer silt loam contain large quantities of organic matter and nitrogen at the present time; further applications in the form of manure should only be made prior to the growing of corn—not before small grains. Moreover, organic matter can be added to the dark-colored soils of nearly level and level areas by plowing under crop residues and growing green manure crops, thus saving the manure for the light-colored soils and the dark-colored ones of rolling lands. It has already been emphasized that crop residues should be utilized as fully as possible on all of the soil types used for crop production in Decatur County. Attention has also been called to the beneficial effects of green manure crops such as sweet clover on claypan soils such as the Grundy, Edina and Chariton. Since the amount of barnyard manure available on most farms will not be adequate to cover all fields, the supply should be used where it is of most value—on the light-colored soils and on the more rolling dark-colored types. Special emphasis should be given to the importance of further applications of organic matter on soils such as Weller silt loam and Lindley loam, where those types occur on topography that is suitable for cultivation.

**TILLAGE AND EROSION CONTROL**

Questions of tillage problems and erosion control will be discussed together, since the two are rather closely related. Land which is not being cultivated, other conditions being equal, is less susceptible to harmful erosion than land which is being tilled. Some problems of tillage are not related to those of erosion control because of conditions of soil or relief which make special precautions for the control of accelerated erosion unnecessary. On the other hand, the need for preventing erosion may arise in uncultivated areas, as for example, in overgrazed pastures or under thin forest stands. In Decatur County questions of erosion control exist in both the cultivated and uncultivated lands, but those in cultivated fields are more pressing. The harmful erosion in Decatur County is generally due to the action of water; very little has been brought about by the action of wind. Problems of tillage which are not related to the control of accelerated erosion are chiefly concerned with the maintenance of good tilth among the heavy-textured soils with imperfect drainage.
Soils with imperfect or restricted drainage occur on flat uplands, on terraces and in the flood plains, and include the various members of the Grundy, Edina, Chariton, Bremer and Wabash series. Most of the soil types in this group, especially those with silty clay loam textures, can be worked satisfactorily only under a narrow range of moisture conditions. If they are plowed either when they are too wet or too dry, the furrow slice will turn up in large, hard clods which cannot easily be reduced to a good seedbed. The range of moisture conditions under which these soils can be cultivated may be increased somewhat by the addition of coarse, organic residues such as cornstalks or straw and by the growing of crops such as sweet clover. The physical condition of the level, heavy-textured soils can also be improved by occasional fall plowing, thus leaving the furrow slice open to the effects of freezing and thawing throughout the winter and spring. Fall plowing should not be practiced on rolling lands, as a general rule. In addition to the precautions needed to maintain the furrow slice in good tilth, it is also desirable to vary the depth of plowing from time to time so as to avoid the formation of a “plow sole” or compact layer immediately below plow depth.

The need for reducing erosion exists to varying degrees on approximately two-thirds of the land in Decatur County. Slightly more than one-third, 35.4 percent, of the county area consists of level or nearly level lands where erosion does not occur because of the lack of relief. The soils with imperfect drainage, whether in the uplands or in the valleys, are included in this group. Additional areas on which harmful erosion is negligible may be found in gently rolling lands which have been carefully handled either as cropland or pasture. Variable amounts of accelerated erosion have occurred on much of the sloping land which is under cultivation and in numerous areas which are used for pasture. Many cultivated fields, particularly in the more rolling sections of the county, have been affected to some extent by sheet erosion, and others, less widely distributed, have been seriously damaged by a combination of sheet and gully erosion. Damage through erosion and problems of controlling it are more common on light-colored soils such as Weller silt loam and Lindley loam (where the latter is cultivated) than they are on the dark-colored soils found in similar topographic positions.

Among the various practices needed for the control of erosion, measures which have been considered part of a program of good soil management are the most important. Mechanical measures such as terracing are supplementary and cannot be expected to replace such practices as maintenance of organic matter, liming and the use of fertilizers where needed. In a region such as Decatur County, the selection of proper rotations, the application of manure, the growing of green manure crops and the addition of limestone to acid soils are essential to the maintenance of soil fertility, considered from a long-time point of view. These measures are equally important in the control of erosion. Where soils are well farmed, there is less danger of accelerated erosion than in regions where the soils are not well handled. Crops growing on fertile soils are more vigorous; the soils themselves are more permeable to water and less susceptible to movement by water or wind. Where the soils of sloping lands are not well farmed, accelerated erosion often does occur,
and supplementary erosion control practices are necessary in addition to the usual soil management programs. Some of the important supplementary practices for the control of erosion are therefore considered in the following paragraphs.

The land surface in Decatur County is marked by a well-developed network of intermittent streams which have left the landscape generally rolling. Some flat upland divides still remain, and there are also a number of hilly sections. In the rolling landscape which comprises much of the county, measures such as the seeding down of waterways, contour cultivation and strip cropping are helpful supplementary practices in reducing erosion.

The seeding down of waterways and maintaining them in grass is especially important among the various measures for controlling erosion. Grassed waterways prevent the development of deep gullies which may cut up a field and make it much more difficult to farm. It is far simpler to maintain a grassed waterway than it is to control or reclaim a gully. Deep gullies tend to develop readily along many of the intermittent streams in Decatur County.

Contour cultivation is the practice of plowing, planting and cultivating around the slope so as to stay at the same level. In order to cultivate around the slope, contour lines must first be established and this can be done by means of rather simple methods. Contour lines are simply lines drawn through those points on a slope which lie at the same elevation. After contour lines have been established, corn is planted along and parallel to this line and cultivated in the same manner. The practice of contour cultivation helps to restrict water movement and thus reduces erosion in rolling or gently rolling lands where the pattern of drainageways is well developed. Long, relatively unbroken slopes which are a part of the system of distinct ridges and valleys lend themselves well to contour cultivation.

Strip cropping, as the name suggests, is the planting of crops in strips of varying but suitable widths. Alternate strips usually consist of a close-growing crop and an intertilled crop; for example, there may be a strip of hay and a strip of corn, another of hay and another of corn, and so on. Strips are usually laid out to follow the contour, although they are sometimes planted across the general slope of the field. Contour strips are more desirable in Decatur County; field strips are not as well adapted to rolling lands as to lands in which long, smooth slopes make up entire fields. Buffer strips (permanent narrow bands of grass along the contour at intervals across a field) will be more widely useful in Decatur County than alternate strips of corn and hay or of corn and small grain. Buffer strips are simpler, permit the operation of a field as a unit and decrease the possibility of damage from insects. The proper width and arrangement of strips in a field depends upon the type of soil, soil condition, topography and the kinds of crops being grown.

The establishment of a system of strip cropping generally requires the changing of field boundaries and the re-location of fences. When such changes are made, steep or badly eroded areas or land otherwise not suitable

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for cultivation should be left out of the new field and planted to grasses or trees.

Contour cultivation and strip cropping are supplementary measures to aid in the control of erosion on lands which are susceptible to damage or which have been slightly damaged. They are not adequate if the land has been badly damaged, and they may be inadequate on land that, because of relief or the nature of the soil, is highly susceptible to damage from erosion. In either of the latter instances, terraces can be used as additional measures in erosion control, and they will find a place in a number of fields in Decatur County. The building and maintenance of structures, even simple earth structures such as terraces, require some expenditure above that needed for strip cropping and the like. Consideration should therefore be given to the probable benefits of terraces in relation to the costs of construction and maintenance. The kind of terrace commonly used consists of a broad, gently rounded ridge which follows the contour rather closely but has a slight grade downhill. There is a shallow channel along the upper side of the terrace which serves to carry runoff water around the slope to a protected or grassed waterway which can then transfer it to lower levels. Terraces should only be used in conjunction with a program of soil management which provides for maintenance of soil fertility. They cannot be expected to take the place of such measures as additions of organic matter, use of proper rotations or liming and fertilization.

Areas which have been seriously damaged by erosion in Decatur County are marked by occasional or frequent gullies as well as thin or missing surface horizons. Gullies found in the uplands are generally shallow, ranging from a few inches to several feet in depth, whereas the gullies which have developed along the channels of intermittent streams are often quite deep, commonly ranging from 4-8 feet and sometimes exceeding the latter figure. Deep gullies sometimes extend into upland slopes, but they are more common in the drainageways.

Various measures have been used for the control of gullies and for the reclamation of gullied areas. Shallow gullies—less than $1\frac{1}{2}$ feet deep—often can be controlled by changing cultural practices or by plowing in and seeding down the small gullies as grassed waterways. In some cases, diversion terraces are necessary to carry runoff water away from the gullied area. Temporary check dams properly constructed from woven wire, sod bag dams or sod checks are helpful in the control of small gullies and those of intermediate depths. Relatively simple measures are usually sufficient to provide control over small gullies.

In the control of larger and deeper gullies, temporary check dams are sometimes successful, but additional measures are commonly necessary. Deeper gullies which extend into the uplands and which cannot be controlled by means of changes in cultural practices or check dams may need to be planted to trees. Tree plantings, if they are to be successful, must be fenced so that livestock cannot disturb or harm the young trees. Some large gullies, particularly those in the channels of intermittent streams, may

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require permanent structures for their control. Permanent dams, whether of earth or concrete, are expensive, and gullies should be controlled by some other means at an earlier stage of development if at all possible. Various types of dams designed for the control of gullies are illustrated in Iowa Engineering Experiment Station Bulletin 121.12

In the preceding discussions of supplementary measures for the control of erosion, stress has been laid on the need for good soil management to maintain fertility and a favorable physical condition. It might be well to re-emphasize the fact that the important steps in preventing erosion are essentially good farming from a long-time point of view. Cultivating the smoother bodies of land and the more permeable soils while devoting the more rolling and hilly lands to pasture and forest greatly aids in the control of erosion. Soil-management practices such as applications of manure, the use of lime and fertilizer as needed and good crop rotations, all essential for the maintenance of soil fertility, are also necessary for the control of erosion. Measures such as the building of dams and terraces or contour cultivation and strip cropping are means of reducing erosion which are supplementary to good soil management.

**DRAINAGE**

The natural drainage system of Decatur County is well developed (fig. 2). The tributary streams which branch out from the three rivers have penetrated and dissected nearly all of the upland, leaving much of it rolling or hilly and well or excessively drained. There are, however, a number of flat upland divides, co-extensive with the Grundy and Edina soils, which are imperfectly drained. Additional areas which lack adequate natural drainage include most of the terraces and the flood plains along the larger streams. The soils which have restricted natural drainage include Grundy silt loam and Edina silt loam in the uplands, Chariton silt loam and Bremer silt loam on terraces and the loam, silt loam and silty clay loam of the Wabash series in the bottomlands. The total acreage of imperfectly drained soils comprises 35.4 percent of the area of Decatur County.

Crop production can be increased on many of the soils of the flat or nearly level areas by the improvement of drainage. Drainage conditions have therefore been improved in a number of fields by tile drains or open ditches, both of which could be used somewhat more widely than they are at present. In connection with the improvement of natural drainage, particularly where tile drains are used, the practice of care in farming the heavy-textured soils of the flat or level areas is especially important. Steps should be taken to maintain and improve the permeability of the soil itself by the exercise of care in tillage operations, the use of grasses with their fibrous root systems to improve soil structure, applications of manure and other forms of organic matter and the growing of deep-rooted crops such as sweet clover on soils with dense, claypan horizons. Such measures will increase the effectiveness of tile drains and at the same time improve the fertility of the soil.

Tile drains have been used to remove surplus water from a number of areas of imperfectly drained soils in Decatur County. They have not been as

widely used as they have in other parts of the state, chiefly because of differences in the nature of the soils. Tile drainage is most likely to be successful in soils which are friable and relatively porous throughout their entire profiles. Under such conditions tile lines will draw for considerable distances and need not be laid as close together as they must in soils with rather impervious deeper profiles. Tile drains must be laid close together if they are to drain Edina and Chariton soils; consequently, the cost of artificial drainage may more than offset the benefits that will be received. In soils such as Grundy silt loam and Bremer silt loam, the use of tile is more likely to be successful than in the Edina and Chariton soils, because the subsoils of the two former types are slightly more permeable. Tile drainage of the flat uplands and the terraces in Decatur County is generally difficult and rather expensive, however.

Open ditches have been used successfully in improving drainage conditions on some soils, chiefly in the larger bottoms occupied by Wabash silty clay loam along the Thompson River. Shallow ditches have been used to drain some areas of Edina silt loam and others of Chariton silt loam, but the most widespread use of ditches for artificial drainage exists in the flood plains of the larger streams. Flood plains are more difficult to drain, as a rule, than are the terraces and flat uplands because of their slight elevation above the channels of the streams. Furthermore, large volumes of water reach the flood plains from the upland drainageways after heavy rains and such water must be removed in a relatively short time if crops are not to be damaged. Dikes have been used to divert overflow water from fields in the bottomlands, whether that water has come from upland drainageways or from the river channel. The channels of the Thompson and Weldon Rivers have also been deepened and straightened through a part of their respective courses in Decatur County to hasten the removal of runoff water and thus improve the drainage of the soils in the flood plains.

Artificial drainage is generally expensive wherever it is used, but it is necessary if some lands are to be cultivated successfully. Care must be exercised, however, in the selection of lands to be drained so that the soils are productive enough after improvement of drainage to warrant the original cost of the operation. Where large-scale drainage operations are undertaken, as for example, in dredging or straightening river channels, consideration should also be given to the possible effects of such drainage improvement on flood hazards and the utilization of lands farther downstream within the same river basin.

USE OF COMMERCIAL FERTILIZERS

Nitrogen, phosphorus and potassium, among the elements which are essential for plant growth, are used rather heavily in crop production and often become deficient in the soils of humid regions. Where deficiencies arise, both the total yield and the quality of crops are affected adversely. Steps must then be taken to correct the deficiency by adding the element or elements to the soil.

Nitrogen can be added to the soil in large quantities by the application of manure, by the growing and plowing under of green manure crops or by apply-
ing commercial fertilizer. Phosphorus and potassium are present in appreciable quantities in manure, and they can be added to the soil in the form of commercial fertilizers. Nitrogen, phosphorus and potassium are the three principal elements which are generally available in commercial fertilizers. Applications of these three elements to the soils of Decatur County in the past have been limited largely to the nitrogen, phosphorus and potassium in manure and the nitrogen in green manures, with some commercial fertilizers being applied on scattered farms or on special crops. The quantities of commercial fertilizers which have been used in the county have been relatively small.

Actual deficiencies of one or more of the three common fertilizer elements, considered on the basis of needs for successful crop production, occur commonly in the light-colored soils and in the soils of sharply rolling to hilly regions of Decatur County. The more fertile soil types such as Grundy silt loam may also be deficient in one or more plant nutrients in fields which have been improperly handled, but on the whole, deficiencies of plant nutrients are not the limiting factors in plant growth on such soils. In estimating the present need for fertilizer applications on the soils of Decatur County, however, not only the actual deficiencies should be considered. It should be kept in mind that ample supplies of the essential nutrient elements must be present in a soil for the production of good crops of satisfactory quality. Continued satisfactory production depends upon, among other things, the maintenance of adequate supplies of plant nutrient elements in the soil.

Generally speaking, the nitrogen supply in the soils of Decatur County can be maintained economically by the proper use of barnyard manure and the growing of enough legumes in the rotation. Applications of manure and the growing of inoculated and thrifty legumes such as alfalfa and sweet clover also have beneficial effects upon the physical condition of the soil. Such effects are important and desirable, even though the principal reason for using manures would be for the addition of nitrogen. If applications of barnyard manure and the growing of legumes are made a part of regular farm practice, the addition of nitrogen in the form of commercial fertilizer does not seem to be necessary except as side-dressing or top-dressing for special crops.

Applications of phosphate fertilizer would increase crop yields from the soils in many different fields in Decatur County, particularly on those soils which are light-colored and on those which occupy the more rolling lands. Exceptions occur where fields have received unusually large quantities of barnyard manure and have thus received considerable amounts of phosphorus. Crops on such fields would not respond to additional phosphorus fertilization at the present time. The amounts of phosphorus available to plants during the growing season perhaps affects the quality of the crops grown to as great an extent as it influences the total quantity produced. Hence, the application of phosphate fertilizer may have a beneficial effect which could not be readily observed in the growth of the plants in the field. Phosphate fertilizers are also particularly helpful in obtaining stands and satisfactory
growth of legumes such as alfalfa and red clover, crops that are important in keeping up the supply of nitrogen in the soil.

Phosphorus can be applied to soils in a number of different fertilizers, among which superphosphate, rock phosphate and mixed fertilizers (mixtures which usually contain superphosphate as the carrier of phosphorus) are most commonly available. These fertilizers have also been tried in field experiments carried on by the Iowa Agricultural Experiment Station in various parts of the state. Superphosphate and rock phosphate are the more economical forms to apply for the common field crops grown in the region of Decatur County. Rock phosphate contains a larger percentage of phosphorus than some forms of superphosphate, but the phosphorus present is not as available to plants. Heavier applications of fertilizer in the form of rock phosphate than as superphosphate are therefore required. Rock phosphate is generally more satisfactory on acid soils than it is on soils which have been well limed. Superphosphate, however, has given satisfactory results in trials on a number of acid soils and also on others which were neutral or alkaline in reaction. Definite superiority of one form or the other has not always been indicated in the field trials, except where small applications are to be made as in the case of hill or row application with corn. Superphosphate, containing the more soluble forms of phosphorus, should be used in hill or row applications. In the general applications, it has appeared to be more economical. Leaflets giving more complete information as to fertilizer recommendations for various crops and soil conditions can be obtained by writing to the Soils Subsection of the Iowa Agricultural Experiment Station.

Potassium seems to be present in sufficiently available forms and in large enough amounts in most of the soils of Decatur County to satisfy the needs of crop plants for some time to come. General application of potash fertilizers does not seem necessary, though some response to additions of potassium has been obtained on the light-colored and on the claypan soils. It seems evident, however, that potassium is not generally low nor as nearly deficient in the soils of the county as are nitrogen and phosphorus.
The chief purpose of soil surveys is to provide accurate soil maps which can be used to help classify, interpret and apply data regarding agricultural production. In agronomic work, for example, it is not possible to carry out experiments on each different soil in every field in the state; trials can only be made on a limited number of fields. Consequently, there must be some way in which the information obtained from experiments or experience on a given area of a certain soil can be extended to other areas of similar soils. Such means exist when the different kinds of soils and their locations are known; accurate soil maps and descriptions provide this type of information.

Soil maps, if they are to serve their purpose, must show the location and extent of the different kinds of soil with sufficient detail and enough precision to indicate those differences that are important in using the land for the growth of plants. Since the number of important differences in soils is not identical in all landscapes, maps vary as to the detail which is represented. Obviously a map of an irrigation project will have to be much more detailed than will one of grazing country; smaller areas of land and smaller differences in the nature of the soil will have profound effects upon the success or failure of farmers in an irrigation project. The soil map should indicate such differences and others which are important. Briefly, the chief function of a soil map is to help classify and extend knowledge regarding the use-suitabilities of different kinds of soil. In addition to providing a basis for the classification of information gained from experience and experiments with soils, a soil map also provides an inventory of the soil resources. It is helpful in many cases to know the exact acreages of particular kinds of soil, but it is commonly more important to know the location and distribution pattern of soil types.

Soil maps are prepared by means of soil surveys which consist of the examination, classification and mapping of soils in the field. The maps are commonly made for areas of one county, but at times, parts of one or more counties may be selected, as for example, in irrigation projects or in demonstration watersheds.

The first step in the making of a soil survey of an area is the examination of its soils in a number of different locations. Test pits are dug, borings are made, and the soil is studied in available exposures such as road and railroad cuts. Descriptions are obtained of the soil profiles exposed, and samples are often collected for laboratory study. Each horizon of the soil profile, down to and including the parent material, is described as to color, structure, texture, porosity, consistence and the presence of roots, gravel or stones. The reaction (degree of acidity) and the content of lime or other salts is noted in each of the different layers. The relief or lay-of-land and drainage, both internal (through the soil) and external (over its surface), are noted and described. Attention is also given to any observable relationships between the soil and the vegetation.

After the soils have been examined in a number of different locations, they are classified according to the observed characteristics, both internal and external, with special emphasis being given to those features which influence the adaptation of the land for the growing of crop plants, grasses and trees. In the classification of soils in county areas, the most important group is the soil series. A series consists of those soils which have similar genetic horizons, alike in arrangement and important characteristics, and which have developed from a particular type of parent material. The soil profiles within a series consist of horizons that are essentially alike in color, thickness, arrangement, structure, etc. The texture of the upper part of the soil, corresponding to that part which is commonly plowed, may vary significantly within a series, thus giving rise to soil types. Except for the variation in texture in the surface layer, the soils within a series should be essentially alike both in internal characteristics and in such associated external features as drainage and range in relief. Soil series are given place names selected from the geographic regions in which they were first identified and mapped: Shelby, Grundy and Chariton are names of important series in Decatur County.

Soil types are subdivisions within a series, the separations being based on the texture of the surface layers of the profile. The name of each soil type consists of a combination of the series name with that of the class name of the soil texture (sand, sandy loam, loam, clay loam, silty clay, etc.). Thus, Wabash silt loam and Wabash loam are two soil types within one soil series. Except for the differences in the texture of the upper soil layers, the profiles of the two soil types are approximately the same. The soil type is the principal unit used in mapping, and because of its specific character, it is usually the one to which agronomic data are definitely related.

At times, different areas of one soil type may differ in some characteristic that has important practical significance. Features not reflected in the character of the soil but highly important in cultivation, such as stoniness, relief or accelerated erosion, sometimes vary enough within one soil type so that portions are not well suited for cultivation while others are. Such variations are indicated as phases. For example, Shelby loam, steep phase, has been mapped in Decatur County to indicate areas of soil similar to Shelby loam but occurring under conditions of steeper relief.

Mapping units called miscellaneous land types are occasionally used in preparing a soil map of a county. Riverwash, mountainous areas, rough and broken land, sand dunes and peat or muck are generally indicated as miscellaneous land types. A number of areas of rough, broken land were mapped along the valley of the Thompson River in Decatur County.

After a legend has been prepared to indicate and describe the different units which are to be shown on the soil map, a suitable base map must be obtained or prepared before field work can progress. Aerial photographs constitute the most satisfactory base map and are used wherever they are available. Geological survey quadrangles are also good base maps. In a number of areas or parts of areas, satisfactory base maps are not available, and the soil surveyor must prepare one. Base maps, after they have been
obtained or prepared, should be carefully checked against the land survey, especially in sectionized regions.

When both the legend and the base map are ready, the boundaries of the different soil types, phases, etc., can be located and indicated on the map by means of symbols. In locating the boundaries of the mapping units, the surveyor traverses the landscape at intervals of \( \frac{1}{4} \) mile, \( \frac{1}{2} \) mile or whatever interval will allow him to observe each boundary throughout its entire course. It is sometimes necessary to go out from the line of traverse to make sure of the location of a boundary, but it is seldom necessary to follow a boundary through its entire course to see where it is located. After the field sheets for the map are completed, they show the location of the soils and miscellaneous land types with respect to houses, roads, railroads, streams, lakes, section and township lines and other natural and cultural features of the landscape.

Field work in the soil survey of Iowa has been carried on cooperatively between the Bureau of Chemistry and Soils of the United States Department of Agriculture and the Soils Subsection of the Iowa Agricultural Experiment Station. After the field work is completed for an individual county, a colored map on a scale of 1 inch to the mile is prepared by the Bureau of Chemistry and Soils. An accompanying text to describe the soils, agriculture and other important features of the county area is also prepared, and this is published together with the colored map as a report of the survey.