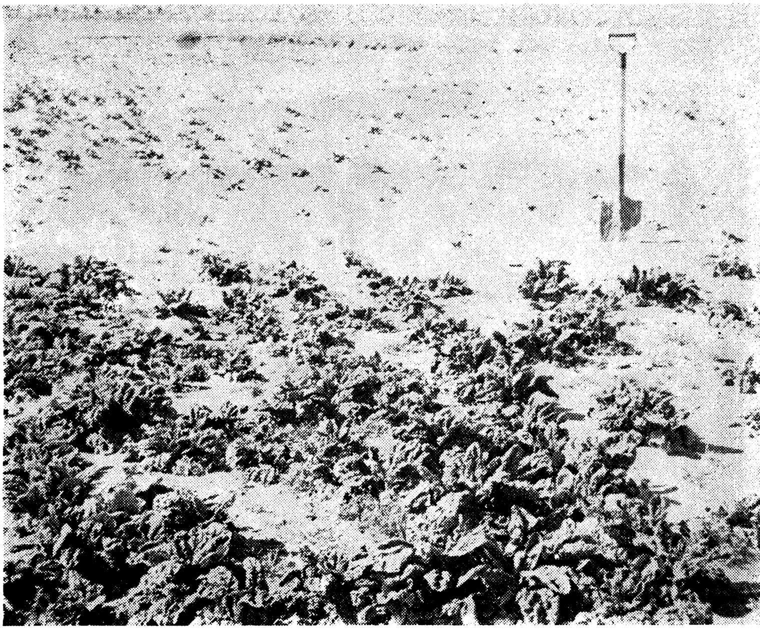

Photo by Ira J. Hollar.

# Improvement of Flood-Damaged Land In Eastern Oklahoma

By

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Oklahoma A. and M. College, Stillwater

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**The Cover Picture**

Deep plowing has been effective in restoring usefulness of silted land where silting was not too deep. The spinach in the foreground of the cover picture is on a mixture of silt and underlying soil made by deep plowing. The area in the background, where spinach failed, was not plowed deeply enough to bring up the more productive soil from beneath the silt.

# THE HIGHLIGHTS

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# IMPROVEMENT OF FLOOD DAMAGED LAND IN EASTERN OKLAHOMA

By HORACE J. HARPER
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A large area of productive land in the Arkansas River Valley between Ft. Gibson, Oklahoma, and Ft. Smith, Arkansas, was severely damaged as a result of two major floods in May, 1943.* Previous major floods have caused severe crop and property damage. Some loss of land has occurred as a result of bank erosion and channel shifting, but no previous flood during the past 110 years caused as much erosion or deposited as much sediment in this area as the floods in May, 1943** The magnitude of these floods was probably responsible for this condition.***

The damaged area was surveyed by representatives of the Oklahoma Agricultural Experiment Station shortly after the flood waters had receded, to determine methods by which the land could be restored to productivity. A preliminary report was distributed to county agents and others in September, 1943. This bulletin contains additional information obtained from physical and chemical analyses of soil samples and from field observations. It also describes the soil treatment required to improve the crop-producing capacity of alluvium deposited on previously productive soils, suggests crops adapted to the present surface conditions, and indicates how cropping systems might be adjusted to reduce future flood damage.

## Nature and Extent of Flood Damage

### AREA AFFECTED BY EROSION

Much of the damage from soil erosion was caused by strong currents flowing against stream banks or across cultivated

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* Flood water of May 22, 1943, at Muskogee, Oklahoma, was 9.9 feet higher than on May 11, 1943, and 11.0 feet higher than the previous maximum flood stage of November, 1941. The crest of the flood at Webbers Falls on May 22, 1943, was one foot higher than on May 11, and 3.2 feet higher than any previous record. At Ft. Smith, Arkansas, the maximum flood stage occurred on May 12, 1943, which was 2.9 feet higher than on May 23, 4.4 feet higher than in November, 1941, and 3.3 feet higher than the previous high water mark of 1833.

** Estimates of the economic loss caused by two major floods occurring in the Arkansas River Valley of Eastern Oklahoma in May, 1943, was obtained from Don McBride of the Oklahoma Planning and Resources Board, State Capitol, Oklahoma City, Oklahoma. The estimated total damage of $5,401,663 was subdivided as follows: Crop loss, $2,781,320; potential land damage, $2,045,223 and loss of farm property, $575,120.

*** The "Hisaw" bottoms at the mouth of the South Canadian River were abondoned following the flood of November, 1941.

**Typical Erosion Damage.**

**Potholes of varying size were formed in many areas where strong currents flowed across sandy ridges and highway grades or around physical barriers such as trees, buildings or farm machinery.**

fields not protected by vegetation. U. S. Army Engineers* estimated that aproximately fifteen hundred acres of land adjacent to the river banks were destroyed by erosion and more than twenty feet of soil and subsoil were removed from these areas.

Severe erosion also occurred where flood water flowed rapidly across high ground adjacent to old stream channels or across sandy land not protected by a vegetative cover. Deep potholes and narrow channels of varying size and depth were formed wherever strong currents developed. Damage from pocket erosion was also severe in many fields.

Individuals who have made a careful study of the area agree that more land was damaged by silting than by soil erosion. Fifteen hundred acres of stream banks eroded to a depth of 20 feet would provide a sufficient quantity of sediment to cover approximately 30,000 acres one foot deep. Potholes and new channels were much deeper than the average deposit of alluvium.** Consequently the total area affected by stream bank or pocket erosion was certainly much smaller than the total land area affected by silting.

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* Information obtained from the Southwestern Division Real Estate Sub-Office of the U. S. Army Engineers in Tulsa, Oklahoma.

** Alluvium is fine material—such as sand, mud or other sediments—deposited on the flood plains of a stream.

### AREA AFFECTED BY SILTING

Deep deposits of coarse textured alluvium have seriously reduced both the immediate and the potential productivity of many good farms in the Arkansas River Valley. However, data in Table 1 show that approximately 40 percent of the total acreage covered by overflow water suffered no immediate damage. A high percentage of the cultivated land which received less than three inches of sediment was plowed as soon as possible after the second flood had subsided, and crops were grown in 1943. Plowing will gradually incorporate the shallow deposit of silt into the surface soil, so it will have no immediate detrimental effect on crop production. Potential damage was caused in some areas where the materials deposited will require nitrogen fertilization sooner than would have been needed by the original soil.

On the approximately 27,000 acres of land covered with silt varying from 3 to 8 inches in depth, fair yields were produced where crops were planted, in spite of limited rainfall between June 1 and October 1, 1943.

On a high percentage of the land which received more than 8 inches of sediment, reduced soil fertility will be an important factor in crop production.

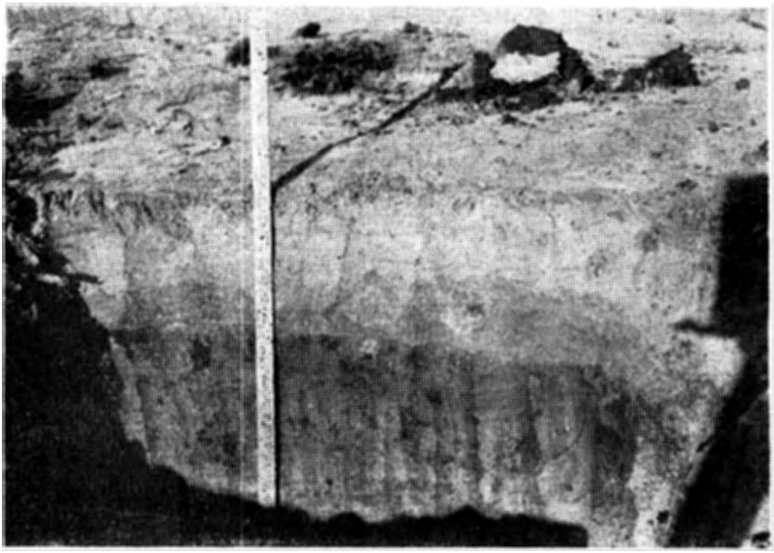
Several areas were observed where strong currents had swept across clay soils occurring inside a bend of the river channel and deposited alluvium varying in texture from

*TABLE 1.—Estimated Acreage Affected by Silt, and Extent of Damage, as Result of Floods in May, 1943; Arkansas River Valley from Mouth of the Verdigris to Arkansas-Oklahoma State Line.**

| Depth of sediment (inches) | Immediate damage to land | Total acres | Estimated area of bottomland in cultivation** |
|---|---|---|---|
| 0 to 3 | None | 60,150 | 45,100 |
| 3 to 8 | Slight | 27,603 | 20,700 |
| 8 to 12 | Moderate | 34,736 | 26,000 |
| 12 to 20 | Severe | 19.154 | 14,300 |
| 20 plus | Very severe | 6,334 | 4,700 |
| | | 147,977 | 110 800 |

* Inormation concerning the approximate acreage of land covered by overflow was obtained from the Tulsa District Office of the U. S. Army Engineers.

** The acreage of cultivated land was calculated from the total area of bottomland inundated, using a weighted average of 75.5 percent obtained from previous surveys which varied from 82 percent of the bottomland in cultivation between the mouth of the Verdigris River and the mouth of the Illinois River; 78 percent from the Illinois River to the bridge near Short Mountain on State Highway 59; and 73.9 percent and 66.1 percent on two areas between Highway 59 and the Arkansas-Oklahoma state line.



**Typical Silting Damage.**

Ten inches of alluvium composed principally of sand and silt were deposited by flood water on this productive soil in the Cache bottom near Spiro. Harmful deposits of similar character covered more than 80,000 acres of land in the Arkansas River Valley between Muskogee, Okla., and Ft. Smith, Ark.

medium sand to fine silt and varying in depth from 3 to 12 inches. These deposits will be beneficial rather than detrimental to these soils as soon as they are mixed with the underlying soils as a result of subsequent tillage.*

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* The pattern of deposition from flood water in May, 1943, was very different in many areas than that of previous floods. The deposition of transported material sorted by water or wind will vary, depending upon the force of the current, from coarse sand, the first material to be deposited, to fine sand, followed by silt, and eventually the clay. Clay particles suspended in flood water are deposited in backwater areas, consequently the texture of the soils in a wide stream valley will normally change gradually from sandy material near the stream bank to sandy loam, loam, silt loam and clay as the distance increases from the point of maximum current velocity.

Soils in bottomland areas gradually develop on the different textures of alluvium as a result of the growth and partial decay of plants and insect activity. A vigorous growth of vegetation and the gradual accumulation of very fine sand and silt will eventually produce a deep soil of high potential productivity. Coarse sand and fine clay will contain very little organic matter and both textures are less favorable for plant development than the medium textured sediments. The organic matter in a thoroughly dispersed soil suspension will settle with the fine silt and coarse clay. Freshly deposited alluvium will produce a good growth of natural vegetation if it contains sufficient organic matter, although it is not technically a soil. The time factor, climatic conditions, the texture of the soil material and rate of deposition have an important influence on the character and productivity of a bottomland soil.

## Comparison of Alluvium and Underlying Soil

*Physical Composition.*—Mechanical analysis of 19 comparisons of alluvium and the underlying soil (Table 2) showed that the present surface contains an average of 19.4 percent more sand and 16.5 percent less clay than the original soil.* Less than 6 percent of clay was found in many samples of alluvium. These areas will be subject to wind erosion when not protected by vegetative cover or crop residues. Under average conditions the deeper deposits of alluvium have a sandier texture than the shallower deposits.

A decrease in the clay content of medium or coarse textured soil reduces the rate at which soil nutrients become available to plants. It also increases the probability of wind erosion during dry, windy weather. Approximately one-half of the recent alluvial samples analyzed did not contain the 6 to 8 percent of clay needed to prevent wind erosion when row crops are planted on the land.

A lowering of the clay content also tends to reduce the moisture-holding capacity of the soil. However, the presence of shallow deposits of sandy material on soils which originally were high in clay content will improve the physical character of these soils as tillage gradually mixes the coarser material into the clay soil beneath. A shallow deposit of sandy material over a less permeable subsurface layer helps absorb rainfall. Soil samples which show this condition were collected from the Reints farm in Pawpaw bottom, Sequoyah County, and the Moore farm in Cache bottom, LeFlore County. (See table 2, samples No. 14 and 17.) Similar conditions were observed in other areas.

*Chemical Composition.*—Chemical analyses of the nineteen comparisons of alluvium and underlying soil show that every sample of alluvium except one contained less organic matter and nitrogen than the original surface soil.** (Table 3.) It

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* Clay is present in some of the coarse deposits of alluvium analyzed because of the stable soil granules which did not disintegrate during the process of erosion and subsequent deposition, but were carried in suspension as if they were grains of sand. The presence of these granules in the sandier deposits will account for a high percentage of the potential fertility occurring in the alluvium.

Soil granules or aggregates are formed principally under the influence of grass vegetation and are composed of sand, silt, clay and organic matter. The mass is held together as a result of weak cementation and does not disintegrate until a high percentage of the organic matter is destroyed as a result of biological activity. They may also be destroyed by tillage operations, the most rapid rate of disintegration occurring when the land is relatively dry.

** In a few areas, such as on the Fite farm in Muskogee County, soil washed from a plowed field was deposited on an adjacent area of alfalfa and not much change in chemical composition occurred. A large deposit of deep alluvium which had a similar physical and chemical composition to the buried soil was observed on the King land in Sequoyah County. The other comparisons indicate that the data obtained from these two locations are an exception to the average condition in most areas

*TABLE 2.—Sand, Silt and Clay Content of the Original Soils and of the Alluvium Deposited on Them by Flood Water in May, 1943; Arkansas River Valley of Eastern Oklahoma.*

| No. | Location | Bottomland area | Name of farm* | Inches of Alluvium | ORIGINAL SOIL Sand % | ORIGINAL SOIL Silt % | ORIGINAL SOIL Clay % | ALLUVIUM Sand % | ALLUVIUM Silt % | ALLUVIUM Clay % |
|---|---|---|---|---|---|---|---|---|---|---|
| **Muskogee County** | | | | | | | | | | |
| 1 | NW¼ Sec. 23, T. 15 N, R19E | Ft. Gibson | Roy Arnold | 3 | 12.8 | 65.6 | 21.6 | 18.8 | 66.0 | 15.2 |
| 2 | SW¼ Sec. 15, T. 15 N, R19E | Ft. Gibson | W. P. Fite | 12 | 41.8 | 41.4 | 16.8 | 37.0 | 56.0 | 7.0 |
| 3 | NE¼ Sec. 26, T. 14 N, R19E | Upper Braggs | Paul Slape | 18 | 63.3 | 23.5 | 13.2 | 60.3 | 33.0 | 6.7 |
| 4 | NE¼ Sec. 2, T. 13 N, R19E | Upper Braggs | W. E. Steele | 12 | 34.4 | 49.7 | 15.9 | 69.9 | 25.2 | 4.9 |
| 5 | NW¼ Sec. 24, T. 13 N, R19E | McLain | W. J. Jones | 12 | 17.6 | 65.6 | 16.8 | 48.8 | 45.6 | 5.6 |
| 6 | SE¼ Sec. 14, T. 13 N, R19E | McLain | W. N. Scott | 20 | 25.6 | 53.6 | 20.8 | 40.1 | 49.4 | 10.5 |
| 7 | NE¼ Sec. 5, T. 11 N, R21E | Webbers Falls | Bill Gibson | 16 | 39.2 | 35.0 | 25.8 | 15.4 | 69.4 | 15.2 |
| 8 | SE¼ Sec. 6, T. 9 N, R20E | Briartown | E. O. Nelson | 7 | 29.5 | 41.5 | 29.0 | 58.3 | 35.4 | 6.3 |
| 9 | SE¼ Sec. 12, T. 9 N, R19E | Briartown | Alliance Trust Co. | 20 | 21.2 | 57.2 | 21.6 | 54.8 | 38.4 | 6.8 |

*TABLE 2.—(Continued).*

| No. | Location | Bottomland Area | Name of farm* | Inches of Alluvium | ORIGINAL SOIL | | | ALLUVIUM | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Sand % | Silt % | Clay % | Sand % | Silt % | Clay % |
| **Sequoyah County** | | | | | | | | | | |
| 10 | NW¼ Sec. 6, T. 10 N, R22E | Vian | E. D. Kendall | 12 | 17.0 | 56.4 | 26.6 | 32.0 | 58.4 | 9.6 |
| 11 | NE¼ Sec. 7, T. 10 N, R23E | Vian | Leba King | 20 | 17.8 | 62.6 | 19.6 | 28.0 | 51.6 | 20.4 |
| 12 | NE¼ Sec. 17, T. 11 N, R22E | Vian | Jim Moody | 14 | 12.8 | 59.8 | 27.4 | 50.6 | 43.2 | 6.2 |
| 13 | SW¼ Sec. 12, T. 10 N, R26E | Pawpaw | Bob Daily | 4 | 15.4 | 39.4 | 45.2 | 16.8 | 65.4 | 17.8 |
| 14 | NW¼ Sec. 19, T. 10 N, R26E | Pawpaw | Neil Reints | 12 | 9.2 | 27.6 | 63.2 | 52.6 | 41.4 | 6.0 |
| **LeFlore County** | | | | | | | | | | |
| 15 | NW¼ Sec. 33, T. 10 N, R23E | Braden | Luke Geren | 10 | 8.8 | 68.8 | 22.4 | 56.1 | 38.1 | 5.8 |
| 16 | SE¼ Sec. 15, T. 10 N, R24W | Cowlington | M. Over-street | 12 | 15.6 | 59.2 | 25.2 | 63.8 | 31.4 | 4.8 |
| 17 | NW¼ Sec. 5, T. 9 N, R25E | Cache | L. R. Moore | 12 | 10.8 | 45.6 | 43.6 | 63.9 | 32.3 | 3.8 |
| 18 | NW¼ Sec. 35, T. 10 N, R25E | Redlands | W. F. Floyd | 18 | 31.2 | 54.2 | 14.2 | 41.3 | 49.3 | 9.4 |
| **Haskell County** | | | | | | | | | | |
| 19 | SE¼ Sec. 9, T. 10 N, R23E | Blaine | Claude Cason | 8 | 83.6 | 7.6 | 8.8 | 67.4 | 29.0 | 3.6 |

* Samples selected are not necessarily representative of all parts of the particular farm named. Instead, they were chosen to represent various post-flood soil conditions existing over a considerable portion of the particular bottomland area from which they were taken.

*TABLE 3.—Chemical Composition of Original Soils and of the Alluvium Deposited on Them by Flood Water in May, 1943; Arkansas River Valley of Eastern Oklahoma.*

| | | | | ORIGINAL SOIL | | | | ALLUVIUM | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample No. | Bottomland area | Name of farm* | Inches of Alluvium | Soil reaction (pH**) | Organic matter (%) | Total Nitrogen (%) | Easily soluble Phos. (p.p m.†) | Soil reaction (pH**) | Organic matter (%) | Total Nitrogen (%) | Easily soluble Phos. (p.p m.†) |
| **Muskogee County** | | | | | | | | | | | |
| 1 | Ft. Gibson | Roy Arnold | 3 | 6.1 | 2.34 | .13 | 190 | 7.3 | 1.14 | .06 | 100 |
| 2 | Ft. Gibson | W. P. Fite | 12 | 6.7 | 1.10 | .07 | 200 | 6.5 | 1.30 | .07 | 100 |
| 3 | Upper Braggs | Paul Slape | 18 | 7.0 | 1.37 | .08 | 160 | 7.6 | .44 | .03 | 200 |
| 4 | Upper Braggs | W. E. Steele | 12 | 6.8 | 2.00 | .10 | 240 | 7.3 | .34 | .04 | 200 |
| 5 | McLain | W. J. Jones | 12 | 7.8 | 1.64 | .09 | 320 | 8.2 | .32 | .03 | 220 |
| 6 | McLain | W. N. Scott | 20 | 7.2 | 1.93 | .09 | 260 | 7.7 | .89 | .05 | 220 |
| 7 | Webber Falls | Bill Gibson†† | 16 | 7.4 | 1.72 | .09 | 200 | 8.0 | .70 | .05 | 80 |
| 8 | Briartown | E. O. Nelson | 7 | 7.8 | 1.83 | .08 | 140 | 8.3 | .34 | .05 | 200 |
| 9 | Briartown | Alliance Trust Co. | 20 | 7.8 | 1.80 | .10 | 130 | 8.2 | .20 | .02 | 100 |
| **Sequoyah County** | | | | | | | | | | | |
| 10 | Vian | E. D. Kendall | 12 | 6.9 | 2.30 | .12 | 100 | 8.0 | .90 | .04 | 200 |
| 11 | Vian | Leba King | 20 | 7.6 | 1.60 | .08 | 35 | 7.8 | 1.40 | .09 | 190 |
| 12 | Vian | Jim Moody | 14 | 7.3 | 2.57 | .13 | 240 | 7.7 | .70 | .04 | 220 |
| 13 | Pawpaw | Bob Daily | 4 | 7.9 | 2.20 | .10 | 200 | 7.9 | 1.40 | .07 | 60 |
| 14 | Pawpaw | Neil Reints | 12 | 7.1 | 2.87 | .15 | 180 | 7.9 | .37 | .03 | 220 |
| **LeFlore County** | | | | | | | | | | | |
| 15 | Braden | Luke Geren | 12 | 7.4 | 1.91 | .10 | 260 | 8.0 | .49 | .03 | 200 |
| 16 | Cowlington | M. Overstreet | 12 | 7.3 | 1.91 | .10 | 280 | 8.0 | .26 | .02 | 200 |
| 17 | Cache | L. R. Moore | 12 | 7.9 | 2.39 | .11 | 220 | 8.1 | .21 | .02 | 200 |
| 18 | Redlands | W. F. Floyd | 18 | 7.8 | 1.24 | .07 | 220 | 7.9 | .89 | .05 | 220 |
| **Haskell County** | | | | | | | | | | | |
| 19 | Blaine | Claude Cason | 8 | 7.5 | 1.42 | .08 | 160 | 8.1 | .27 | .02 | 140 |

* For location in section, township and range see Table 2. Samples are representative of types of damage rather than the particular farm named. See footnote to Table 2.

** A pH value of 7.0 is neutral. Values below 7.0 are acid and above 7.0 are alkaline. The deficiency of basic material in a soil, such as lime, potash and magnesia, increases as the pH value decreases. Neutral and alkaline soils are well supplied with these substances.

† p. p. m. is parts per million.

†† Only the top 13 inches of alluvium collected for this analysis. (See Table 4, sample No. 4).

will be impossible to produce maximum yields of corn and vegetable crops on the deep alluvium unless nitrogen fertilizers are used or legume crops are grown and returned to the soil before these crops are planted.

The average quantity of organic matter in these samples of alluvium was approximately one-third (34.7 percent) of the quantity in the soils on which the sediments were deposited. The total nitrogen in the aluvium averaged 43.3 percent of that in the original surface soils, varying from a minimum of 400 pounds to a maximum of 1800 pounds per acre in the surface layer of soil to a depth of 6⅔ inches. The average cultivated soil in Oklahoma contains slightly more than 1800 pounds.

Many of the samples collected from alluvial deposits contained less than 20 percent as much organic matter as the soil beneath. In several instances the nitrogen content of the original soil was three to five times as high as in the silted materials.

All but two samples were either neutral or slightly alkaline (Tables 3 and 4), and contained an adequate supply of lime for the growth of alfalfa, sweet clover and lime-loving vegetable crops. Two of the samples collected from the Ft. Gibson bottom in Muskogee County were slightly acid.

The quantity of available phosphorus in the alluvium was as high or higher than in the soil samples.*

Only one sample of alluvium deposited by flood water following the storm of May 6 to 11, 1943, was collected in this study. (Table 4, No. 4). This sample was higher in potential fertility and contained more silt, clay and organic matter than material deposited over it by the May 22 flood. Variations in the velocity of the water in this area during these two periods was probably responsible for the differences obtained. (See Table 3, No. 7). This sample was obtained in a backwater area above the mouth of the South Canadian River which discharged a high percentage of the flood water into the Arkansas River during the flood of May 11 and was affected by a stronger current during the flood of May 22.

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* The analyses for soil reaction and easily soluble phosphorus indicate that a relatively small amount of these sediments originated from local upland erosion. The principal source of the material was from stream banks or pocket erosion and scouring of previously deposited silt and sand from the stream channel. Practically all of the bottomland soils in the Arkansas River Valley contain a large quantity of phosphorus soluble in dilute sulfuric acid and are neutral to moderately alkaline in the surface or subsurface layers. The upland soils in eastern Oklahoma are low in available phosphorus and are normally slightly acid to strongly acid.

### Effect of Depth of Deposit

Several samples of alluvial material were collected from different areas to study the relation between depth of deposits and their mechanical and chemical composition. The analyses are given in Table 4.

*Deep Deposits.*—A deep deposit of sand left by previous floods on a portion of the Luke Geren farm in Braden bottom, LeFlore County, was very low in silt and clay content in both surface and subsurface. Both layers were also very low in organic matter and nitrogen. Two plantings of black locust trees have made a rapid growth on this sandy area.

Sandy deposits left by the 1943 floods on the Nichols farm in Goose Neck Bend, Muskogee County and on the Campbell land in Cache bottom, LeFlore County, were similar in mechanical and chemical composition to the soils from the Geren farm.

*Intermediate Depth.*—Samples collected from the Warsop and Short farms in Muskogee County and the Gamble land in LeFlore County are typical of rather deep silt that cannot be improved by plowing unless special equipment is obtained. Alfalfa can be grown on this land to increase the organic matter content of the soil, but competition from crab grass will be more severe than on finer textured soil.

*Shallow.*—Shallow accumulations of alluvium, regardless of mechanical composition, will not have much effect on the growth of deep rooted crops such as alfalfa and spinach. Alfalfa made an excellent growth in the fall of 1943 on the Dickie farm in Sequoyah County where the alluvium was only five inches deep; however, the deposit on this area is a silt loam which was very similar in both physical, and chemical composition to the underlying soil. A good crop of spinach was produced by H. C. Harkey on the Hollis Malone farm in Muskogee County on land where the flood deposit was a silt loam, low in organic matter and about six inches deep. Apparently the spinach crop obtained much of its nitrogen from the underlying soil on this land. Similar observations in other areas indicated that silt accumulations of six to eight inches over good soil did not seriously reduce the production of spinach when proper methods of seedbed preparation were used, although poor crops were obtained on deeper deposits of similar texture.

### Effect of Erosion

The two soils collected from eroded bottomland were typical of many studies which have been made on the chemical composition of eroded soils (Table 4, Nos. 7 and 8). The nitro-

*TABLE 4.—Chemical and Mechanical Composition of Miscellaneous Soil Samples Collected From Silted Areas in the Arkansas River Valley in Eastern Oklahoma.*

| No. | Bottomland area | Name of farm* | Inches of Alluvium | CHEMICAL COMPOSITION: pH | CHEMICAL COMPOSITION: Organic matter % | CHEMICAL COMPOSITION: Total Nitrogen | CHEMICAL COMPOSITION: Easily soluble Phos. p.p.m.* | MECHANICAL ANALYSIS: Sand % | MECHANICAL ANALYSIS: Silt % | MECHANICAL ANALYSIS: Clay % |
|---|---|---|---|---|---|---|---|---|---|---|
| **Muskogee County** | | | | | | | | | | |
| 1 | Goose Neck Bend | J. T. Nichols | 36 | 7.3 | .05 | .01 | 60 | 95.4 | 3.0 | 1.6 |
| 2 | McLain | Ted Scott | 7 | 7.9 | 1.57 | .10 | 240 | 21.2 | 53.4 | 25.4 |
| 3 | Webbers Falls | Roy Warsop | 24 | 8.0 | .21 | .02 | 220 | 70.4 | 25.1 | 4.5 |
| 4 | Webbers Falls | Bill Gibson | 3† | 7.7 | 2.40 | .13 | 170 | 13.4 | 47.0 | 29.6 |
| 5 | Webbers Falls | Hollis Malone | 6 | 7.9 | .80 | .04 | 200 | 18.8 | 66.8 | 14.4 |
| 6 | Webbers Falls | Jim Short | 24 | 8.2 | .25 | .02 | 220 | 54.9 | 41.1 | 4.0 |
| 7 | Webbers Falls | L. M. Thomas | †† | 7.2 | .71 | .06 | 220 | 37.4 | 48.0 | 14.6 |
| 8 | Upper Braggs | W. E. Steele | †† | 6.9 | .78 | .04 | 240 | 44.7 | 41.9 | 13.4 |
| **LeFlore County** | | | | | | | | | | |
| 9 | Braden | Luke Geren | *** | 6.9 | .33 | .02 | 120 | 89.5 | 8.5 | 2.0 |
| 10 | Braden | Luke Geren | *** | 6.8 | .16 | .02 | 120 | 88.4 | 8.5 | 3.1 |
| 11 | Cache | G. C. Gamble | 20 | 8.0 | .50 | .03 | 85 | 64.0 | 30.0 | 6.0 |
| 12 | Cache | J. E. Campbell | 40 | 7.7 | .08 | .01 | 120 | 95.5 | 3.7 | .8 |
| **Sequoyah County** | | | | | | | | | | |
| 13 | Pawpaw | Lindsey Dickie | 5 | 7.4 | 1.20 | .07 | 200 | 34.4 | 56.0 | 9.6 |

* Samples are representative of types of damage rather than of the specific farm where taken. See footnote to Table 2.

* P. p. m. is parts per million. All samples in this table are very high except No. 1, which is high.

† Deposited by flood occurring on May 11, 1943. Second flood of May 22, 1943, covered this material with 13 inches of alluvium, see table 3, sample 7.

†† Samples taken from land where surface soil had been removed by flood water.

*** Alluvium deposited by previous flood. Black locust tres growing on area. Sample 9 was surface soil 0 to 12″ deep and Sample 10 was subsurface soil 12 to 36″ deep.

gen and organic matter content of a normal soil profile decreases with depth, therefore the damage to a bottomland soil having a similar texture in surface and subsurface layers would be proportional to the quantity of top soil removed.

### Miscellaneous Damage

In addition to the damage caused by erosion and silting, Bermuda and Johnson grass were scattered over many cultivated fields not seriously injured by flood deposits. Dense thickets of willow and cottonwood seedlings have also developed on many of the deeply sanded areas which were not cultivated intensively in 1943.

In some areas, the disposal of surface water is an important problem. This is not due entirely to the filling of previously constructed drainage ditches. Sediments deposited across the natural outlets of low lying areas convert them into shallow ponds following overflows or torrential rains.

## Physical Methods of Improving Damaged Land

### Deep Plowing

On areas where the recent deposits of alluvium are much lower in organic matter and clay content than the original soils, deep plowing would increase the potential fertility of the surface layer and thus aid the growth of seedlings and shallow rooted crops. It would also increase the clay content of the surface soil to a point where wind erosion would not be a serious problem.

Moldboard plows which will operate to a depth of sixteen or eighteen inches can be obtained as standard equipment from several farm implement companies.*

Where silt deposits are uneven, it may be necessary to divide a field into different portions and plow each area at a different depth. Deep narrow bars of alluvium should be spread with a grader or bulldozer before the land is plowed.

### Strip Cropping to Control Wind Erosion

Land covered by deep alluvium containing a high percentage of sand and a low percentage of clay will be subject to wind erosion. If the clay content cannot be increased by deep plowing, strips of hairy vetch or cowpeas can be grown with row crops to help prevent crop damage from drifting sand. They will also increase the nitrogen content of the soil.

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* Special plows which will operate from 2 to 4 feet deep can be obtained from Post Brothers, Santa Ana, Calif.

Photo by Ira J. Hollar.

**Deep Plowing Returns Productive Soil to Surface.**
This plow operating at a depth of 14½ inches on the J. L. Short farm southeast of Webbers Falls is returning to the surface some of the productive underlying soil buried by less fertile flood deposits. Analyses showed the flood deposits were generally lower in organic matter and nitrogen and higher in sand than the soil which was covered.

From 16 to 24 rows of each crop should be planted in each strip, depending upon the susceptibility of the land to blowing. A good rotation would be peanuts, cowpeas and cotton with hairy vetch in the fall to be plowed down for a sorghum crop the following spring. The peanuts would follow the sorghum crop in the rotation. Strips should have an east-west direction to protect the land from prevailing winds.

Strips of weeds between watermelon rows should not be plowed until the vines begin to grow. Cowpeas can be planted in the middles during the latter part of June for soil improvement. The watermelons should be planted on the area where the cowpeas were grown the previous year.

### Control of Undesirable Vegetation

Bermuda grass and Johnson grass can be destroyed most conveniently by tilling the land with a one-way disk during the summer months when rainfall is limited. Large sweeps operated about three inches deep are very effective in destroying new growth after the first tillage operation. The land should be cultivated within five or ten days after new growth appears, to prevent the accumulation of root reserves.

Summer tillage can occur between crops of spring and fall spinach, or following a spring crop of green beans, potatoes or small grain. On land where row crops such as corn and cotton were grown prior to the flood, control of undesirable grasses may present a different problem with the present labor shortage unless some change in the cropping system occurs which will permit clean cultivation during July and August.

Exposure of Johnson grass or Bermuda grass roots by shallow plowing during late fall or early winter will kill many plants if severe freezing weather occurs, but this procedure is not as effective as summer tillage.

Willow and cottonwood seedlings are being controlled on a high percentage of the silted areas by plowing the soil and planting row crops. Many small trees are still growing on some fields which were farmed in 1943 and 1944 but will not be farmed in 1945 because of low productivity. Since more hand labor will be required to destroy the trees as they increase in size, it would be cheaper to plow and cultivate the land in 1945 to complete the eradication of this type of vegetation, although the income from crops produced may be relatively low.

### Use of Earth-moving Machinery

Potholes, channels and small sandbars on cultivated land can be eliminated whenever machinery is available. Where the cost of reclaiming such areas would be high in relation to the benefits, pecans or trees for posts could be planted, or the land used for pasture during that part of the season when flood hazards do not occur.

Drainage ditches which have been filled with alluvium will need to be opened; and additional drainage must be provided where water collects behind deposits of deep alluvium during periods of abundant rainfall.

## Restoring Soil Fertility

On silted areas which are too deep to be improved by plowing, crop production can be permanently improved only by growing a large acreage of legumes in the cropping system. Nitrogen fertilizer would profitably increase the yield of veg-

**Nitrate Fertilizer Will Pay on Some Crops.**
Nitrate fertilizer increased spinach production on the W. P. Fite farm in the Ft. Gibson bottom, east of Muskogee. Upper portion, fertilized, 2.9 tons per acre; lower portion, unfertilized, 1.5 tons per acre. Spring spinach crops are more responsive to nitrate fertilization than fall planted spinach on summer fallowed land or following a legume.

etable crops and cotton on much of the silted land until legume rotations can provide nitrogen.

Although some of the deeply silted areas may produce good crops for a few years without fertilizer treatment or the growth of legumes, soil improvement practices will be required at an earlier date on this land as compared with similar land not covered by alluvial material. It is quite probable that as time goes on less nitrogen will be obtained from the underlying soil than was obtained during 1943.*

## Crop Adaptation

The cropping system best adapted to a particular area will depend on the character of the flood deposits and their location with reference to future flood damage. On some sandy land, strip cropping will be needed for protection from wind erosion.

* Stirring the soil increases the rate at which nitrogen is released from soil organic matter. Since a high percentage of the cultivated land in the Arkansas River Valley was plowed and planted before the May, 1943, floods, it was in a loose condition and oxidation proceeded normally during the summer of that year. Crops planted on many sandy areas in 1944 were not as good as similar crops planted on the same areas in 1943. During succeeding years, the underlying soil will not be disturbed by tillage on the deeply silted areas; consequently the major portion of the nutrients will come from the surface deposits which are low in organic matter and nitrogen.

**Black Locust Can Utilize Land Like This.**

Several thousand acres of good bottom land were covered with coarse sand containing very little organic matter. Black locust trees will make a good growth on this type of land because they are a legume and can obtain their nitrogen from the air. A crop of good posts should be produced in ten or twelve years if the subsoil does not contain too much coarse sand.

The fine sand and silt is much more favorable than coarse sand for the growth of shallow-rooted crops because it has a higher water-holding capacity.

*Coarse Textured Alluvium.*—Coarse sandy deposits usually occur near the river bank.* Over a period of years the soil on these areas will gradually increase in organic matter content, but the loose sand should remain out of cultivation.

The Johnson grass and Bermuda grass growing on these sandy areas could be used for pasture in months when the flood hazard is low (See page 27). Hay could be cut on areas where the sand is not too loose or the surface too rough for the operation of farm machinery.

The black locust will make a good growth on low nitrogen soils where non-legume species grow very slowly. Pecans could be planted on deep sand overlying productive soil and a good growth should occur after the young trees develop their root systems into the more fertile soil beneath.

A native legume, trailing wild bean, will grow during the summer months on this sandy soil, but could not be used where Johnson grass must be controlled by summer tillage.

Sweet clover will make a fair growth where the alluvium does not contain too much coarse sand and too little clay. Fall planting about September 15 on a firm seedbed may be more desirable than spring planting about February 15 in many cropping systems.

*Fine Sand and Silt.*—A majority of the areas covered with deep deposits of fine sand and silt will grow alfalfa, and where alfalfa can be grown the problem of soil improvement is easily solved. These soils are well supplied with lime and available phosphorus, and alfalfa will supply nitrogen.** When alfalfa is grown for soil improvement, the land should be plowed at the end of the fourth year and alfalfa seeded on another field for a similar period. Experiments indicate that alfalfa does not add much nitrogen to the soil after the fourth year.

Annual or biennial legumes may be better than alfalfa on farms where a high percentage of the land has been silted, since a long rotation would be required before all of the silted area

* Extensive areas of coarse material were found in Goose Neck Bend, southeast of Fort Gibson and near the southern end of Braggs bottom in Muskogee County; in the upper end of Vian bottom and the western part of Pawpaw bottom in Sequoyah County; in the western part of the Cowlington bottom and limited areas in the Redlands and in the Poteau bottoms of LeFlore County. A rather large area was also covered with deep sand in the northwest and northern part of the Blaine bottom in Haskell County.

** Several seedings of alfalfa on deeply silted areas failed in the fall of 1943 because of the combined effect of a loose seedbed and dry weather. Good stands were obtained on other areas where the silt contained a higher percentage of clay and soil conditions were more favorable for seedling development.

**Shallower Sand Deposits Can Be Worked Into the Underlying Soil.**
Good land was partially covered by sand bars of varying depth and shape in many areas. This spot is in Pawpaw bottom southwest of Moffett. Deposits which are not too deep can be worked into the underlying soil. The deeper bars may need to be spread out before plowing. If the underlying soil contains a high percentage of clay, its physical character will be improved by working the sand into it.

could be planted in alfalfa. Annual or biennial sweet clover could be planted in February and plowed under during August for a fall vegetable crop,* or cowpeas could be planted after spring vegetables and plowed under for a fall crop. Use of cowpeas would permit the growth of two cash crops and a soil improvement crop each year. but would require more labor during the summer to prepare a seedbed and control weeds.

Soybeans and mungbeans are legume cash crops which could be planted on deeply silted areas in place of corn.† However, cowpeas and crotalaria are superior to mungbeans or soybeans for soil improvement.

Yields of corn and cotton can be increased by planting cowpeas or crotalaria in every third row with corn, or planting hairy vetch in cotton middles. Use of small grain or vegetable crops which grow during the spring or fall will permit summer fallowing to control Johnson grass on the more productive areas.

Cowpeas, peanuts, sorghums, rye, sweet potatoes, hairy vetch and watermelons are adapted to sandy soils. Cotton will also make a good growth on this type of land if it is not too low in organic matter. Rye can be grown on deep sandy soil where the flood hazard is not too great.

## Fertilizer Needs of Silted Land**

It is quite probable that more profit will be obtained when nitrogen fertilizers are used to increase the yield of vegetable crops and cotton than when these fertilizers are applied to increase corn production. Good yields of cotton will be obtained on land which will produce only fair to poor crops of corn.

Crops commonly grown in the flooded area may be arranged in order of their fertility requirements as follows: spinach, string beans, Irish potatoes, corn, alfalfa, cotton, watermelon, cowpeas and sweet potatoes.

*Legumes.*—Cowpeas, hairy vetch, alfalfa, peanuts and soybeans are better adapted than non-legumes to the deeply silted land, because they will not need nitrogen fertilizer to increase yields. Alfalfa and soybeans are not as well adapted to the sandier alluvium as are cowpeas, peanuts, hairy vetch or sweet clover. Although peanuts is a legume crop, when the vines

* See Okla. Agri. Exp. Sta. Cir. C-94, *Sweet Clover for Soil Improvement.*

† Adapted varieties of soybeans are Arksoy and Macoupin for oil production and Laredo and Virginia for forage. Chinese mungbeans can be recommended for seed production. Ordinary green mungbeans will produce more seed and less forage than Golden mungbeans, but the seed are not as valuable for sprouting as Indiana Strain No. 12.

** See Oklahoma Agricultural Experiment Station Bulletin B-279, *Commercial Fertilizers for Oklahoma Crops.*


**Corn Yield Quadrupled With Nitrate Fertilizer.**

Corn yield on deeply silted land on the J. L. Short farm southeast of Webbers Falls in 1944 was 9.5 bushels per acre unfertilized, 37.7 bushels where ammonium nitrate was broadcast at the rate of 300 pounds per acre before plowing. The fertilizer cost for the increase in corn yield was approximately 32 cents per bushel. In general, nitrate fertilizers can be used more profitably on vegetable crops than on corn.

and nuts are removed from the soil it must be classed as a soil depleting crop and another legume should be included in the cropping system to increase the nitrogen of the soil. Soybean and hairy vetch seed should be inoculated to insure adequate nodule development.

*Cotton.*—Cotton planted on sandy alluvium containing less than 0.7 percent of organic matter should be fertilized with 100 pounds of ammonium sulfate drilled in the row at the time the seed is planted. Hairy vetch planted between the cotton middles in the fall can be used to increase the nitrogen content of these soils and this crop can be plowed under in the spring before vine crops or sorghums are planted.

*Green Beans.*—Although the silted land contains a good supply of phosphorus and potash, green beans because of their short growing season should be fertilized with nitrogen and phosphorus or a complete fertilizer, such as a 4-12-4 or 5-10-5.

*Spinach*.—On the fine textured soils a crop of cowpeas or summer fallow to increase the quantity of available soil nitrogen, or liberal applications of a nitrate fertilizer, will be needed to produce maximum yields of spinach. Ammonium nitrate should be applied when the seed is planted or after the plants have developed four permanent leaves.

*Melons*.—Hill fertilization with a nitrogen fertilizer is recommended for muskmelons and watermelons. Planting cowpeas between the rows of vine crops for soil improvement will reduce the requirement for commercial nitrogen fertilizers.

### Cropping Systems for Eroded Lands

The important problem on eroded bottomland soils is to increase their organic matter and nitrogen content. Cotton would respond to nitrogen fertilization on the land from which the two eroded samples described in Table 4, Nos. 7 and 8, were obtained.

The physical condition of the eroded land, which is usually a sandy loam or a fine sandy loam, is favorable for the production of alfalfa. Rotating eroded fields on high bottomland in a cropping system with alfalfa should solve the fertility problem on these areas.

Where small grain is grown, sweet clover can be planted between rows of small grain spaced 14 inches apart to provide a more favorable condition for the legume seedlings.*

Corn can be planted and increased yields obtained after a vigorous growth of sweet clover or alfalfa has added nitrogen to these soils.

Cotton should be planted after corn since it does not require as much nitrogen as the corn for maximum yields.

## Cropping Systems to Reduce Flood Damage

On account of the large number of recent major floods,**

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* See Oklahoma Agricultural Experiment Station Circular C-94, *Sweet Clover for Soil Improvement.*

** Seven major floods occurred at Ft. Smith, Ark., during the 54 years from 1883 to 1937, and six during the past six years. At Webbers Falls, Oklahoma, two occured in 38 years from 1899 to 1937, and four during the past six years. At Muskogee, Okla., two occurred in the 14 years from 1923 to 1937, and four in the past six years. Rainfall records show that a major flood in November, 1941, followed a month of rainfall which was higher than any previous October on record. The two floods in May, 1943, followed rainfall which was higher than in any previous May on record. The second group of rains came while the surface soil was wet from previous rain. A high percentage of runoff occurred, and maximum flood stages were also recorded on the Verdigris and Grand Rivers in eastern Oklahoma.

Partial filling of stream channels has increased the flood hazard in some stream valleys in Oklahoma, but is not likely that a reduction in the capacity of the Arkansas River channel from any accumulation of sand could be responsible for the major floods. A fill of several feet in the channel would not have much effect on the total volume of water required to cover an area of bottomland three or four miles wide during a major flood, although it could have some effect on the frequency of minor and moderate floods.

*TABLE 5.—Distribution of Moderate and Major Floods Occurring in the Arkansas River Valley in Eastern Oklahoma, by Months.*

| Location | Time and period in years | FREQUENCY OF FLOODS BY MONTHS* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
| Ft. Smith, Ark.** | 60 (1883-1943) | | | | | | | | | | | | |
| moderate | | | 2 | | 5 | 10 | 6 | | | | 4 | | 3 |
| major | | 1 | 1 | | 3 | 5 | 2 | | | | | 1 | |
| Webbers Falls,*** Oklahoma | 44 (1899-1943) | | | | | | | | | | | | |
| moderate | | | 1 | | 3 | 2 | 6 | | | | 2 | | 1 |
| major | | | | | 2 | 3 | | | | | | 1 | |
| Muskogee, Okla.† | 20 (1923-1943) | | | | | | | | | | | | |
| moderate | | | | | 1 | 2 | 2 | | | | 1 | | |
| major | | | | | 2 | 2 | 1 | | | | | 1 | |

* Data from Daily River Stages, 1907-1941, Weather Bureau, U. S. Department of Commerce, Washington, D. C., and from U. S. Army Engineers Office, Tulsa, Oklahoma.
** moderate flood stage 25 to 30 feet, major flood stage above 30 feet.
*** moderate flood stage 26 to 30 feet, major flood stage above 30 feet.
† moderate flood stage 20 to 32 feet, major flood stage above 32 feet.

residents of the Arkansas River valley in eastern Oklahoma are discussing the possibility of developing cropping systems which will avoid flood damage. Floods will continue to be an important problem in crop production on many of the bottomlands in this area; but more diversification, with emphasis on crops which escape the period of most frequent floods in April, May and June (Table 5), will help to avoid serious crop losses. It is also possible to definitely decide ahead of time what crops will be planted if those on the land are destroyed by flood after it is too late to replant.

In a system designed to reduce flood damage, crops which have a high cash value or are expensive to plant would be grown on the high stream terraces where floods seldom occur. On the low terraces or bottomlands affected by minor and moderate floods, crops would be planted which require a small investment for seed, labor or fertilizer, or which can be planted later in the season after the period of most frequent flood hazard is over.

On low lying areas of sandy land, *cowpeas, peanuts* and *sorghums* can be planted during the latter part of June. Production should not be affected seriously by floods, since the data in Table 5 show that the frequency of fall floods is relatively low. *Rye* will grow on this type of soil but occupies the land during the spring months when flood hazards are great.

*Hairy Vetch* planted for soil improvement in the fall would make much of its growth before serious damage from floods might destroy the crop the following year.

*Sweet Potatoes* can be grown on sandy soil, but should be planted before June 1 to obtain satisfactory yields.

If a soil is not too sandy, corn should be planted late in June in alternate rows with cowpeas as a soil improvement crop. Adapted strains of mung beans and soybeans could be planted between the fifteenth of June and the first of July for the production of seed on the medium textured soils affected by floods.

Cowpeas could be planted after June 15 and plowed under or disked into the soil early in August to prepare the land for *fall spinach* which will be ready to harvest during December, February or March.

*Irish potatoes* and *green beans* are hazardous crops on land subject to overflow because they are planted about the first of March and mature in June. *Spring oats or fall planted grain* maturing in June would be subject to the same hazard, but the cost of planting is low and the consistently good demand for grain in this area might warrant the risk. *Millet* for seed could be planted on the better soils after flood danger is over.

*Watermelons* and *muskmelons* are not expensive crops to plant, consequently crop loss would not be serious. Peanuts, cowpeas or mung beans could be planted on the land if spring floods should destroy the melon crop. *Radishes* planted from September 1 to 15 on the deep sandy soils of the low lying bottomlands would seldom be damaged by flood water.

*Cotton* production is affected by damage from flea hopper, boll weevil and leaf worm if planted late. If it is planted early and floods destroy it, a catch crop of mung beans or cowpeas could be planted and harvested for seed or disked into the soil on the medium and fine textured soils to increase the availablity of soil nitrogen for a fall spinach crop.