B-993

SEPTEMBER 1962

Influence of Cropping Systems On Cotton and Corn Yields On the Gulf Coast Prairie

THE AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
TEXAS AGRICULTURAL EXPERIMENT STATION

R. D. LEWIS, DIRECTOR, COLLEGE STATION, TEXAS

SUMMARY

Experiments were conducted during 1953-58 on (1) the influence of cropping systems on the Gulf Coast Prairie on crop yields, soil improvement and conservation; (2) the influence of nitrogen fertilizer on crop yields and (3) fertilizer tests on continuous and rotated cotton.

Cropping systems producing the highest forage yields, with and without nitrogen fertilizer, were those which contained a legume.

A 2-year system, the first-year oats and Sudangrass and the second-year cotton, produced the lowest forage yield of any system tested and showed little effect on soil improvement.

High forage yields were obtained from all cropping systems containing Hubam. A 3-year system of first-year oats-Hubam, Sudan; second-year Hubam, Sudan and third-year cotton provided forage over a long period of time. The year this system was in cotton, the land was easier to work, there were not as many weeds and better stands of cotton were obtained. The main disadvantage of this system was that two planting operations a year were required.

Cropping systems containing Dallisgrass and White clover are more highly recommended than all other systems tested. These forage crops furnished year-round grazing and required only one planting operation per cycle of the cropping system. The disadvantages of these forage crops are: (1) a good seedbed is necessary to obtain a good stand of Dallisgrass; (2) White clover can cause bloat in cattle; (3) 2 years are needed to obtain high forage yields and (4) it is difficult to obtain a good seedbed for corn or cotton when the land goes out of forage production.

Dallisgrass and White clover produced higher forage yields and were better able to utilize nitrogen fertilizer following cotton than when following corn.

Fescuegrass, in a 5-year cropping system of 3 years fescuegrass and 2 years cotton, produced winter and spring grazing, high forage yields the first year in the system when treated with nitrogen fertilizer, and required only one planting operation. This system, however, was the most unsatisfactory system tested, because it was difficult to maintain a good stand of fescuegrass and low yields were produced without nitrogen fertilizer. In preparing the land for cotton, the plots coming out of fescuegrass were more difficult to work, and poorer stands of cotton were obtained than in any other system tested.

Statistical analysis showed that there were no significant differences in cotton yields because of the treatments in 1953. In 1954 nitrogen fertilizer produced a highly significant difference in the increase in yields and in 1955 a significant difference was caused by the interaction of nitrogen and crop rotation. In 1956 the effects of cropping systems became apparent in increased yields. In 1956-57 there was a highly significant increase in yields because of crop rotation, and in 1957 a highly significant increase in yields because of nitrogen fertilizer.

The three cropping systems recommended for the Gulf Coast Prairie are: (1) a 5-year system of 3 years Dallisgrass-White clover and 2 years cotton; (2) a 3-year system of first year oats, Hubam, Sudan; second year Hubam, Sudan and third year cotton; (3) a 2-year system of first year Hubam, Sudan and second year cotton.

Applications of 60 pounds of nitrogen per acre per year produced an average increase in cotton yields in all systems tested.

In comparing the fertilizer tests on continuous cotton and cotton rotated with Dallisgrass and White clover, the nonfertilized, rotated cotton produced an average yield increase of 550 pounds of seed cotton per acre per year more than the nonfertilized continuous cotton.

In the fertilizer test on continuous cotton, the highest average increase in yield was produced by the 90-30-60 treatment. This treatment produced 380 pounds of seed cotton per acre more than the nonfertilized cotton. The second highest increase was obtained from a 45-0-0 treatment, which produced an average increase of 190 pounds of seed cotton per acre.

In the fertilizer tests there was a larger increase in yield of rotated cotton with fertilizer than in the continuous cotton. In the fertilizer test on rotated cotton, nitrogen was the most effective element and phosphorus the next in increasing cotton yields. Fertilizer applications of 90-30-0 and 45-30-0 produced the highest yields with an average of 1,430 and 1,390 pounds of seed cotton per acre per year, respectively.

A 5-year system of 3 years Dallisgrass and White clover and 2 years corn increased first and second year corn yields 42 and 56 percent more than the continuous corn. When nitrogen fertilizer was applied, there was an increase in yields of 21 and 12 percent more than the fertilized, continuous corn. The application of 60 pounds of nitrogen increased continuous corn yields 60 percent. Combinations of crop rotation and nitrogen increased first and second year corn yields 96 and 88 percent more than the nonfertilized continuous corn.

Cropping systems of Dallisgrass and White clover are recommended as soil improvement crops for corn as well as cotton.

A deficiency of soil moisture was a major limiting factor in cotton and corn yields during this experimental period.

Contents

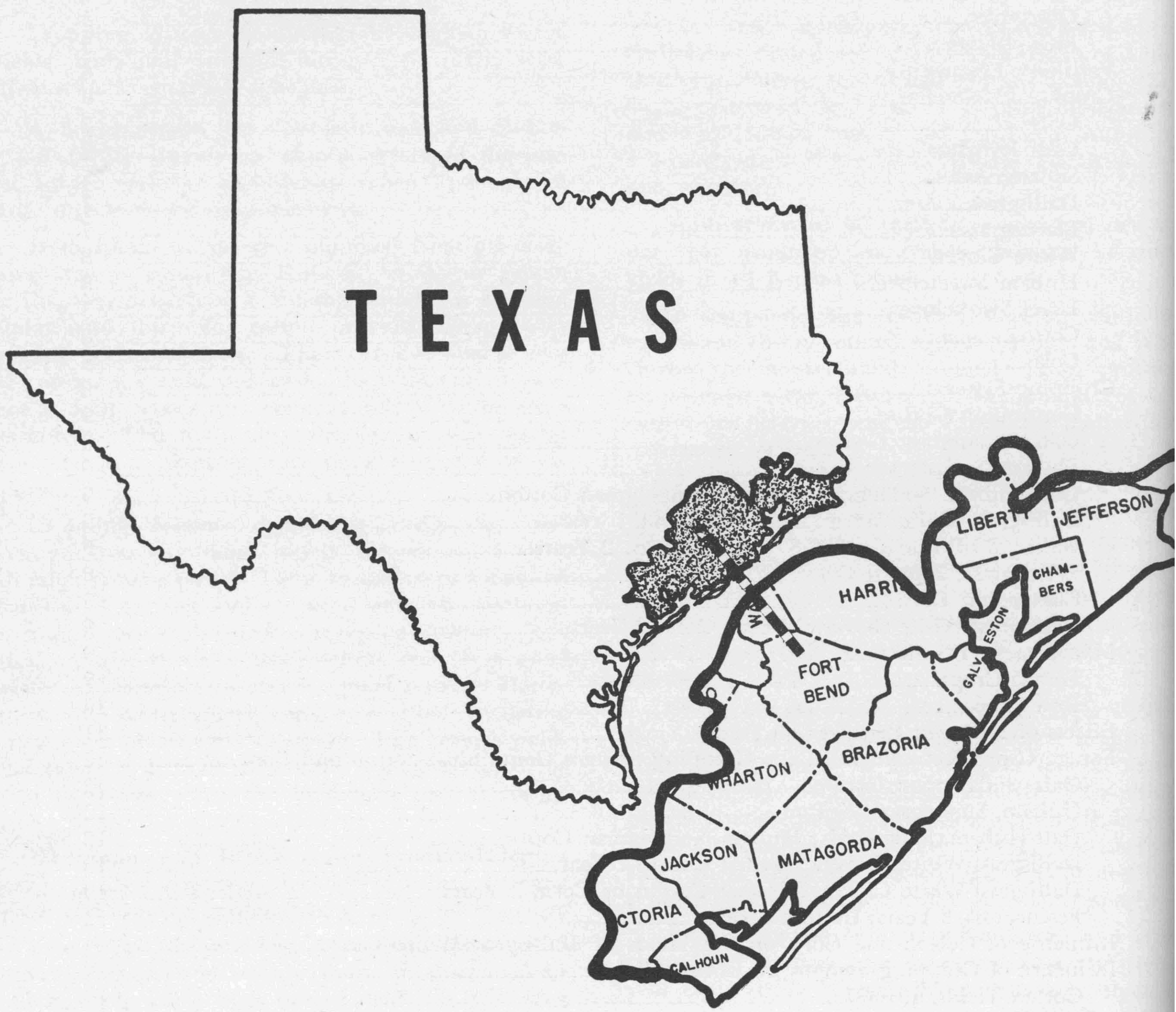

Figure 1. The Gulf Coast Prairie Region of Texas.

Influence of Cropping Systems on Cotton and Corn Yields on the Gulf Coast Prairie

B. E. Jeter, J. C. Smith and E. L. Whiteley*

In recent years rotation, one of the oldest fundamentals of crop production, has been challenged by many crop specialists and farmers. Rotation, according to some workers, has become a liability instead of an asset. Members of this group contend that if the farmer wants to get maximum economic production from his land, he must plant the maximum of high value crops every year. This idea has some justification, since a single set of soil management practices can be applied to the land. These management practices require less farm machinery and lower crop production costs. With the expanded use of fertilizers, yields have been maintained at a fairly high level.

Unfortunately with the passage of time, crop yields have shown a gradual decline. This decline shows that no single system of soil management will fit all soils and produce economic returns to farmers. Because of crop surpluses, acreage controls and declining yields, farmers and research workers have taken a closer and more critical look at rotations. The need for additional cash income has led to the introduction of the beef cattle enterprise into the farming systems on the Gulf Coast Prairie of Texas, Figure 1. This has led to the problem of finding cropping systems which will produce the most economical returns by increasing cash crop yields and producing adequate forage yields for beef cattle production.

CLIMATE AND RAINFALL

The Gulf Coast Prairie is generally favored with relatively low summer temperatures and abundant rainfall. The average annual rainfall at Angleton for a 45-year period, 1914-58, is 47.46 inches, Table 1. Rainfall is fairly uniform throughout the year, although it may be quite variable within any given year. The rate of evaporation varies considerably, and the climate is characterized by wet winters and by drouth during the summer. The average growing season from the last killing frost in the spring, February 22, to the first killing frost in the fall, December 2, is 282 days.

*Respectively, assistant agronomist and superintendent, Substation No. 3, Angleton, Texas; and associate professor, Department of Soil and Crop Sciences, College Station, Texas.

SOIL TYPE

The Gulf Coast Prairie includes some 8 million acres of dark colored soils with black to gray clays and some sandy loams. The main soil series are Lake Charles, Beaumont, Harris, Hockley, Katy and Edna (4).

The Lake Charles clay was selected for this study because it is the most extensive and important soil in the area. It is a dark ashy-gray or black clay, which is slowly permeable to rainfall. Drainage is poor, and planting is retarded sometimes by excessive rains during the spring. The soil is very sticky when wet, but when dry, the soil in cultivated fields crumbles and in uncultivated areas cracks deeply.

Normally, the soil pH is neutral with a range of 6.5 to 6.8; native soils are medium to high in nitrogen, low to very low in phosphorus and medium to high in potassium (4).

EXPERIMENTAL PLAN

This bulletin is a report on an experiment begun in 1953 on the influence of cropping systems on the Gulf Coast Prairie on crop yields, soil improvement and conservation. The research was conducted at Substation No. 3, Angleton.

Objectives

The main objectives of the project were (1) to determine the effects of certain cropping systems on soil productivity on Lake Charles clay; (2) to obtain information which can be used in formulating good cropping systems; (3) to derive methods whereby soil productivity may be maintained for given soil and land conditions; (4) to determine the effects of good cropping systems on soil structure and air-water relationships and (5) to determine the combined effects of known positive practices on crop production.

Field Design

This test was conducted on an area of Lake Charles clay soil that had been in cultivation for at least 50 years.

The experimental design was a split plot randomized block, replicated three times. The cropping

TABLE 1. MONTHLY AND ANNUAL PRECIPITATION AT ANGLETON, 1953-58 AND THE 45-YEAR AVERAGE, 1914-58

Month	1953	1954	1955	1956	1957	1958	Average 1953-58	Average 45-year
January	0.65	0.98	4.42	3.26	1.93	7.05	3.05	3.49
February	4.96	0.18	5.47	4.05	3.24	4.37	3.71	3.17
March	0.08	1.05	0.36	1.36	10.23	1.51	2.43	3.31
April	0.52	1.91	5.06	2.76	4.54	2.01	2.80	3.23
May	10.08	2.25	4.84	1.73	2.62	3.39	4.15	3.96
June	4.88	2.73	2.55	1.15	7.29	0.25	3.14	3.78
July	3.82	1.73	3.40	2.23	0.16	3.56	2.48	5.02
August	13.58	1.11	6.00	1.50	2.33	3.81	4.72	4.52
September	0.80	1.84	3.60	0.58	9.97	19.49	6.05	5.07
October	3.69	3.81	0.32	4.24	5.09	2.21	3.23	3.76
November	5.68	1.71	0.56	1.82	7.90	1.33	3.17	3.70
December	3.90	2.46	3.45	5.05	1.94	3.16	3.33	4.42
Total rainfall	52.64	21.76	40.03	29.73	57.24	52.14		
Average annual rainfall	48.37	47.72	47.54	47.13	47.36	47.46		
Departure from average	+ 4.27	— 25.96	— 7.51	— 17.40	+ 9.88	+ 4.68		

systems used in this study were selected to give the maximum range in soil improving practices, Table 2. Cotton and corn were used as index crops to measure the effects of the different practices included in the tests. The selection of grasses and clovers used in the cropping systems was based on experiments conducted since 1914 at the Angleton station. These earlier tests indicate that oats, Sudan, fescue and Dallisgrass are the best grasses for the area and that Hubam and Louisiana S-1 White clover are the best legumes. Each crop in each system appeared every year during the study.

An additional 3 x 2 factorial fertilizer test with three replications was carried out at the same time as the major test. The test included two cropping systems, one of continuous cotton and the other a 3-year cropping system of 2 years of Dallisgrass and White clover and 1 year of cotton. The general management of this test was the same as in the major test.

All of the forage crops produced in both tests were cut and baled for hay; none was used as green manure crops.

TABLE 2. CROPPING SYSTEMS USED IN THE TEST AT ANGLETON, 1953-58

System no.	Year in system	Cropping system
1.		Continuous cotton
2.	1st	Oats, Sudan
	2nd	Cotton
3.	1st	Hubam, Sudan
	2nd	Cotton
4.	1st	Oats-Hubam, Sudan
	2nd	Hubam, Sudan
	3rd	Cotton
5.	1st	Dallisgrass-White clover
	2nd	Dallisgrass-White clover
	3rd	Cotton
6.	1st	Dallisgrass-White clover
	2nd	Dallisgrass-White clover
	3rd	Dallisgrass-White clover
	4th	Cotton
	5th	Cotton
7.	1st	Fescuegrass
	2nd	Fescuegrass
	3rd	Fescuegrass
	4th	Cotton
	5th	Cotton
8.		Continuous corn
9.	1st	Dallisgrass-White clover
	2nd	Dallisgrass-White clover
	3rd	Dallisgrass-White clover
	4th	Corn
	5th	Corn

Fertilizer Treatments

The fertilizer treatments used in this test were based on previously conducted experiments at Angleton station (10). In the main test each plot received an average of 30 pounds of available phosphorus (P_2O_5) per acre per year. Where a legume appeared in the cropping system, all of the phosphorus was applied at the beginning of the sequence when the legume was planted. Two levels of nitrogen were used in the main test. One-half of each plot received 60 pounds of nitrogen per acre per year and the other half of the plot received no nitrogen.

The supplemental fertilizer test included three rates of nitrogen, 0, 45 and 90 pounds per acre per year, and two rates of available phosphorus (P_2O_5), 0 and 30 pounds per acre per year. All of the phosphorus was applied to the legume at the beginning of the cropping sequence. Two extra treatments were added to each replication of the test so that potassium (K_2O) could be tested at two levels, 90-30-30 (90 pounds of nitrogen, 30 pounds phosphorus as P_2O_5, and 30 pounds of potassium as K_2O) and 90-30-60 pounds per acre per year.

Crops

The selection of a cropping system should be based on the individual farmer's needs. All the forage crops used in this study fit in well with Gulf Coast Prairie farming and ranching enterprises.

OATS

Oats, *Avena sativa,* are the most popular small grain crop produced for forage on the Gulf Coast Prairie. They are winter annual grasses which produce forage of high quality from December to May, a season when green forage is limited. Good stands are easy to obtain with little seedbed preparation. To obtain high yields, however, a well-drained and reasonably fertile soil is required. They produce numerous small fibrous roots which penetrate the soil several feet.

Oats are used for grazing, hay, silage and as a soiling crop. They are an ideal crop when grown in pure stands or as a companion crop with Hubam clover. The varieties, Mustang, Alamo and Goliad, have been the most consistent in performance in this area (7).

Oats were recommended over all other temporary winter pasture grasses until 1956 when they lost their popularity because of Helminthosporium blight and other plant diseases such as smut, crown rust and stem rust (1) which seriously affect forage yields. Few oats will be planted in the area until new blight and disease-resistant varieties are developed.

GULF RYEGRASS

Gulf ryegrass, *Lolium multiflorum,* is a ryegrass variety released in 1958 by the Texas Agricultural Experiment Station and the Agricultural Research Service, USDA. It is becoming the most popular temporary annual winter pasture grass on the Gulf Coast Prairie. Most of the acreage which has previously been planted in oats has been replaced by Gulf ryegrass. Under normal conditions it can be planted as early as September 15 and will provide grazing from November to June. Good stands can be obtained with little seedbed preparation. It grows well on wet land, but forage yields are low if drainage is poor. It produces a very small, fibrous, shallow root system.

Gulf ryegrass is used for grazing, hay and silage. It is superior to the already popular Italian ryegrass because it is more disease resistant, produces forage over a longer period of time, produces a higher yield of seed and reseeds itself (11).

SUDANGRASS

Sudangrass, *Sorghum vulgare sudanense,* is one of the most valuable summer annual temporary pasture grasses grown on the Gulf Coast Prairie. It can be planted as late as June 1, makes rapid growth and is drouth tolerant. Good stands and high yields have been obtained by drilling in 20-inch rows with a pasture dream planter following oats, ryegrass and Hubam clover without any additional seedbed preparation. Sudangrass is a fibrous-rooted plant which grows in clumps. It produces good yields on soils ranging from light sands to heavy clays. Highest yields are obtained from soils high in organic matter and fertility. It responds readily to nitrogen fertilizer.

Sudangrass is used for grazing, hay and silage. It produces an abundance of leaves and sweet juicy stems that are readily eaten by livestock. The varieties most commonly grown in the area are Sudex and Sweet Sudangrass. Sudex is more palatable, produces a nonshattering seed and is more disease resistant than most other Sudangrass varieties.

DALLISGRASS

Dallisgrass, *Paspalum dilatatum,* is one of the most desirable perennial warm-season grasses produced on the Gulf Coast Prairie. It grows in clumps and produces most of its leaves near the base of the plant. The plants normally grow 2 to 4 feet tall and produce forage of excellent quality. One of its most favorable characteristics is its deep, strong root system.

Dallisgrass grows well on soils ranging from clays to sandy loams. It is very well adapted to Lake Charles clay which is found so extensively on the Gulf Coast Prairie. It requires a medium to high fertility level for good forage production (6).

Dallisgrass is one of the first warm-season grasses to begin growth in the spring and one of the last to cease growing in the fall. In some years it remains green throughout the winter. A low of 26° F. on October 6, 1959, at the Angleton station, had no effect on Dallisgrass, while all other warm-season grasses showed severe damage.

Its characteristic of growing in clumps makes it an ideal companion crop to be grown with Bermudagrass and White clover. The mixture of Dallisgrass and Louisiana S-1 White clover is very desirable.

The forage produced by Dallisgrass is primarily used for grazing. It produces hay of high quality, but is not recommended as a hay crop because its leaves are produced near the soil surface and many of them cannot be harvested.

The main disadvantages of Dallisgrass are the difficulty encountered in establishing a good stand, which is a result of poor seed quality and the low forage yields which are to be expected the first year after planting.

FESCUEGRASS

Ky 31 fescuegrass, *Festuca arundinacea,* is the best perennial cool-season grass grown on the Gulf Coast Prairie. It provides forage from late fall until early summer. Fescue roots are numerous and coarse and normally penetrate several feet through dense subsoils. Stands are easy to establish and high yields can be expected the first year if it is planted on a fertile, moist soil and proper management practices be disked to break up the larger clods and harrowed to level the seedbed. Levelling the seedbed is essential on the Gulf Coast Prairie to obtain the best possible surface drainage. If the seedbed is not level, poor stands will result from excessive moisture in the low spots in the field. If the seedbed is loose, it should be rolled before planting.

SEEDING—On the Gulf Coast Prairie the best time to plant grasses, legumes and small grains for grazing *is between October 15 and December 1. Plantings made earlier will suffer from attacks of diseases, and* the young seedlings from later plantings may be killed by frost.

The best stands of Hubam, Louisiana S-1 White clover and Dallisgrass were obtained when the seed were broadcast on the surface of a well-prepared seedbed and rolled with a corrugated roller or culti-packer. Oats and fescue were drilled in 10-inch rows before seeding the small seeded grasses and legumes. The legume seed were inoculated with the proper strain of bacteria. Sudangrass was planted in 20-inch rows about May 1.

FERTILIZERS—Since phosphorus does not move freely in the soil profile, it was broadcast on the surface and disked into the soil or was drilled into the soil in 10-inch bands before planting (8). Thirty pounds of phosphorus (P_2O_5) per acre per year were applied at the time of planting the forage crops. All of the phosphorus to be applied to the cropping system was applied to the forage crops. Thus, the 1, 2, 3 and 5-year systems would receive the equivalent of 30, 60, 90 and 150 pounds of phosphorus (P_2O_5) per acre when the forage crops were established.

Each plot was split. One-half received the equivalent of 60 pounds of nitrogen fertilizer per acre per year, and the other half received no nitrogen fertilizer. The nitrogen fertilizer was broadcast annually on the various cropping systems in the following manner:

Oats, Sudangrass

The 60 pounds of nitrogen were divided equally between the oats and the Sudangrass, 30 pounds applied in the fall at the time of planting the oats and 30 pounds applied in the spring at the time of planting the Sudangrass.

Hubam, Sudangrass

The 60 pounds of nitrogen were applied to the Sudangrass and none to the Hubam clover.

Oats-Hubam, Sudangrass; Hubam, Sudan

The 60 pounds of nitrogen were divided equally between the oats-Hubam and Sudangrass the first year. When Sudangrass followed Hubam the second year, Sudangrass received all the nitrogen.

Dallisgrass-White Clover

In those cropping systems containing Dallisgrass and White clover, 15 pounds of nitrogen per acre were applied in the fall to enhance the establishment of Dallisgrass. The remaining 45 pounds were applied in the spring at the time White clover goes into its period of minimum production and at the time Dallisgrass is beginning its period of maximum production.

Ky 31 Fescuegrass

Fescuegrass received 30 pounds of nitrogen per acre at planting time or at the time it began its growth in the fall. The remaining 30 pounds were distributed as growth warranted.

CROP UTILIZATION—The forage crops in the various cropping systems were selected in order to furnish year-round grazing as near as possible. Because of the design of the experiment, it was impossible to graze the various forage crops, so the forage was removed as hay.

ROW CROPS

LAND PREPARATION—Cotton and corn received the same seedbed preparation. Land going out of forage production and into row crops was disked in the fall as close to October as possible; around December the land was bedded and in early spring was row disked. If land was used for continuous cotton and corn, or row crops had followed row crops in the sequence, the row crops were shredded as soon after harvest as possible. The land was then bedded and rebedded in December when possible and was disked lightly before planting. Early preparation of the seedbed is important from the standpoint of insuring enough soil moisture for germination and early seeding growth.

SEEDING—Deltapine 15 cotton was planted April 1 or as soon after that time as weather conditions were favorable. The seed were planted 1 to 2 inches deep on top of the beds, at a rate of 20 to 30 pounds of seed per acre. The final stand was thinned to three to four plants per foot of row.

Corn on the Gulf Coast Prairie should be planted as close to March 15 as possible. Texas Hybrid 34 is the corn hybrid recommended for the area. Under dryland conditions 18-inch spacing between plants in 40-inch rows, or 8,500 to 9,000 plants per acre, has given the highest yields at the Angleton station. Under irrigation, spacing of 12 to 9 inches in 40-inch rows, or 12,000 to 16,000 plants per acre, is recommended for highest yields.

FERTILIZERS—The continuous cotton and corn received the equivalent of 30 pounds of available phosphorus (P_2O_5) per acre at the time of planting. All of the row crops received two levels of nitrogen ferused extensively throughout the area. Texas hybrids 34, 30 and 28 are the most productive yellow hybrids, and Texas 17W and Asgrow 101W are the most popular white hybrids (3).

Cropping Systems

The nine cropping systems tested during this study consisted of cotton and corn, grown continuously and rotated with the forage crops best adapted to the Gulf Coast Prairie.

CONTINUOUS COTTON

Continuous cotton was planted on the same land year after year. This is the most common practice througout the area. It is one of the main reasons for the Gulf Coast Prairie's low average cotton yields.

OATS, SUDANGRASS; COTTON

In this 2-year cropping system with the first year planted to oats and Sudangrass followed by cotton the second year, the oats were planted in the fall for winter forage and the Sudangrass was planted in the spring for summer forage. These crops were tested to determine their value as a temporary pasture crop and the value of a cropping system containing only grasses as a soil improvement practice.

HUBAM, SUDANGRASS; COTTON

This is also a 2-year cropping system. The first year, Hubam was planted in the fall and Sudangrass in the spring. Cotton was planted the second year. This cropping system was tested to determine the value of Hubam clover as a temporary pasture crop and to determine the value of having a legume in a 2-year cropping system as compared with a 2-year system containing only grasses.

OATS-HUBAM, SUDANGRASS; HUBAM, SUDANGRASS; COTTON

In this 3-year cropping system, oats and Hubam were planted in the fall of the first year followed by a late-spring planting of Sudangrass. In the second year, Hubam was fall planted, followed by Sudangrass in the spring. Cotton was planted in the third year.

This system was tested to evaluate the effect of 2 years of temporary pasture containing both grasses and a legume as a soil improvement practice.

DALLISGRASS-WHITE CLOVER, 2 YEARS; COTTON, 1 YEAR

A 3-year cropping system of 2 years of Dallisgrass and White clover followed by one year of cotton was tested to determine the value of a permanent type pasture mixture of a grass and a legume upon soil improvement and to determine the merits of a permanent type pasture versus temporary pasture crops.

DALLISGRASS-WHITE CLOVER, 3 YEARS; COTTON, 2 YEARS

A 5-year cropping system of 3 years of a Dallisgrass and White clover pasture mixture followed by 2 years of cotton was tested. This test was used to determine the merits of a long-time cropping system containing a permanent type pasture mixture of a grass and a legume, as compared with a short-time system having temporary pasture crops. The test was also used to determine the effect of having cotton in the system more than 1 year.

FESCUEGRASS, 3 YEARS; COTTON, 2 YEARS

A 5-year cropping system of 3 years of fescuegrass followed by 2 years of cotton was tested to determine the merits of a long-time cropping system containing only grasses as compared with a system having a grass and a legume. It was also tested to determine the merits of fescuegrass as a permanent type pasture grass for winter forage production and as a soil improvement crop.

CONTINUOUS CORN

Corn was planted year after year on the same land, which is the cropping system most commonly used by corn farmers in the area. This system was used to determine the effects of continuously planted corn as compared with corn rotated with a grass and a legume. It also helped in determining the effects of continuous cotton versus continuous corn.

DALLISGRASS-WHITE CLOVER, 3 YEARS; CORN, 2 YEARS

A 5-year cropping system of 3 years of Dallisgrass and White clover and 2 years of corn was tested to determine the value of these forage crops as soil improvement crops when rotated with corn. This system also was used to determine the influence of corn and cotton on the yields of Dallisgrass and White clover.

Management Practices

FORAGE CROPS

LAND PREPARATION—All of the forage crops tested, except Sudangrass, received the same seedbed preparation. Sudangrass was planted in oats and Hubam stubble after they had been harvested for hay.

Seedbed preparation is the most important single factor in the establishment of small seeded grasses and legumes. Good seedbeds result in good stands, a good balance between grass and legume plants, good weed control and early grazing. Well-prepared seedbeds will help in the control of insects and diseases.

When small seeded grasses and legumes are to be planted following row crops, the crop residue should be shredded as soon after harvest as possible. The residue should be plowed under, and the land should be disked to break up the larger clods and harrowed to level the seedbed. Levelling the seedbed is essential on the Gulf Coast Prairie to obtain the best possible surface drainage. If the seedbed is not level, poor stands will result from excessive moisture in the low spots in the field. If the seedbed is loose, it should be rolled before planting.

SEEDING—On the Gulf Coast Prairie the best time to plant grasses, legumes and small grains for grazing is between October 15 and December 1. Plantings made earlier will suffer from attacks of diseases, and the young seedlings from later plantings may be killed by frost.

The best stands of Hubam, Louisiana S-1 White clover and Dallisgrass were obtained when the seed were broadcast on the surface of a well-prepared seedbed and rolled with a corrugated roller or culti-packer. Oats and fescue were drilled in 10-inch rows before seeding the small seeded grasses and legumes. The legume seed were inoculated with the proper strain of bacteria. Sudangrass was planted in 20-inch rows about May 1.

FERTILIZERS—Since phosphorus does not move freely in the soil profile, it was broadcast on the surface and disked into the soil or was drilled into the soil in 10-inch bands before planting (8). Thirty pounds of phosphorus (P_2O_5) per acre per year were applied at the time of planting the forage crops. All of the phosphorus to be applied to the cropping system was applied to the forage crops. Thus, the 1, 2, 3 and 5-year systems would receive the equivalent of 30, 60, 90 and 150 pounds of phosphorus (P_2O_5) per acre when the forage crops were established.

Each plot was split. One-half received the equivalent of 60 pounds of nitrogen fertilizer per acre per year, and the other half received no nitrogen fertilizer. The nitrogen fertilizer was broadcast annually on the various cropping systems in the following manner:

Oats, Sudangrass

The 60 pounds of nitrogen were divided equally between the oats and the Sudangrass, 30 pounds applied in the fall at the time of planting the oats and 30 pounds applied in the spring at the time of planting the Sudangrass.

Hubam, Sudangrass

The 60 pounds of nitrogen were applied to the Sudangrass and none to the Hubam clover.

Oats-Hubam, Sudangrass; Hubam, Sudan

The 60 pounds of nitrogen were divided equally between the oats-Hubam and Sudangrass the first year. When Sudangrass followed Hubam the second year, Sudangrass received all the nitrogen.

Dallisgrass-White Clover

In those cropping systems containing Dallisgrass and White clover, 15 pounds of nitrogen per acre were applied in the fall to enhance the establishment of Dallisgrass. The remaining 45 pounds were applied in the spring at the time White clover goes into its period of minimum production and at the time Dallisgrass is beginning its period of maximum production.

Ky 31 Fescuegrass

Fescuegrass received 30 pounds of nitrogen per acre at planting time or at the time it began its growth in the fall. The remaining 30 pounds were distributed as growth warranted.

CROP UTILIZATION—The forage crops in the various cropping systems were selected in order to furnish year-round grazing as near as possible. Because of the design of the experiment, it was impossible to graze the various forage crops, so the forage was removed as hay.

ROW CROPS

LAND PREPARATION—Cotton and corn received the same seedbed preparation. Land going out of forage production and into row crops was disked in the fall as close to October as possible; around December the land was bedded and in early spring was row disked. If land was used for continuous cotton and corn, or row crops had followed row crops in the sequence, the row crops were shredded as soon after harvest as possible. The land was then bedded and rebedded in December when possible and was disked lightly before planting. Early preparation of the seedbed is important from the standpoint of insuring enough soil moisture for germination and early seedling growth.

SEEDING—Deltapine 15 cotton was planted April 1 or as soon after that time as weather conditions were favorable. The seed were planted 1 to 2 inches deep on top of the beds, at a rate of 20 to 30 pounds of seed per acre. The final stand was thinned to three to four plants per foot of row.

Corn on the Gulf Coast Prairie should be planted as close to March 15 as possible. Texas Hybrid 34 is the corn hybrid recommended for the area. Under dryland conditions 18-inch spacing between plants in 40-inch rows, or 8,500 to 9,000 plants per acre, has given the highest yields at the Angleton station. Under irrigation, spacing of 12 to 9 inches in 40-inch rows, or 12,000 to 16,000 plants per acre, is recommended for highest yields.

FERTILIZERS—The continuous cotton and corn received the equivalent of 30 pounds of available phosphorus (P_2O_5) per acre at the time of planting. All of the row crops received two levels of nitrogen fertilizer. One-half of the plot received 60 pounds of nitrogen per acre and the other half received no nitrogen. The nitrogen was applied at planting. The fertilizers were applied in bands 4 to 5 inches to the side and at about the same depth at which the seed were planted.

CULTIVATION—Good cultivating practices were carried out during the test. Standard planting equipment was used at the time of planting. A rotary hoe attachment was used for the first cultivation after the plants were up. The remaining cultivations were kept to a minimum and were used only to control weeds. All cultivations were shallow in order to conserve moisture and to prevent as much root damage as possible.

There should be no cultivation for any reason except to control weeds which compete with row crops for nutrients and soil moisture. A large number of farmers reduce their cotton and corn yields by deep cultivation, which dries out the Lake Charles clay soil to the depth at which it is cultivated and destroys or injures many roots, thus weakening the cotton and corn plants.

INSECT CONTROL—During the experiment, insecticide control measures recommended by Texas Agricultural Extension Service Leaflet 218, "Texas Guide for Controlling Cotton Insects," were carried out. No insecticides were used for controlling corn insects.

EFFECTS OF NITROGEN FERTILIZER ON FORAGE YIELDS

All of the forage crops receiving nitrogen fertilizer produced higher yields than those receiving no nitrogen, Table 3. Those cropping systems containing a legume produced the highest yields both with and without nitrogen fertilizer. The three cropping systems producing the highest forage yields with 60 pounds of nitrogen per acre per year were: (1) Hubam, Sudan—10,880 pounds per acre; (2) oats-Hubam, Sudan—10,100 pounds per acre; (3) Dallisgrass-White clover—9,960 pounds per acre. Without nitrogen the yields were: (1) Hubam,Sudan—8,350 pounds per acre; (2) oats-Hubam, Sudan—8,840 pounds per acre; and (3) Dallisgrass-White clover—8,530 pounds per acre.

The cropping systems which showed the greatest response to nitrogen fertilizer were those which did not contain a legume. Fescuegrass produced greatest yield increases due to nitrogen. Based on 3-year averages and compared with nonfertilized fescuegrass,

TABLE 3. THE INFLUENCE OF CROPPING SYSTEMS AND NITROGEN FERTILIZER ON FORAGE YIELDS

Year in system	Crop	1956 60	1956 None	1957 60	1957 None	1958[1] 90	1958[1] 15	Average 1956-58 60	Average 1956-58 None
		Pounds of air-dry forage per acre							
		Continuous cotton							
1st	Oats,	3950	1520	1780	1740	5150	2480	3630	1910
	Sudan	4670	4300	[2]	[2]	3920	3370	4290	3830
2nd	Cotton								
1st	Hubam,	5530	4630	3060	3240	5530	5900	5710	4590
	Sudan	4830	2770	[2]	[2]	5510	4750	5170	3760
2nd	Cotton								
1st	Oats-Hubam,	5350	3690	1400	2700	8440	5070	5060	3820
	Sudan	5200	4700	[2]	[2]	4880	4630	5040	4660
2nd	Hubam,	5490	5640	2620	2870	4050	4690	4050	4400
	Sudan	6170	2330	[2]	[2]	5100	4080	5640	3210
3rd	Cotton								
1st	Dallisgrass-White clover	4190	2480	3120	3020	6440	5860	4580	3790
2nd	Dallisgrass-White clover	6850	5660	8640	6660	7210	9730	7570	7350
3rd	Cotton								
1st	Dallisgrass-White clover	4170	2470	2850	2980	6580	6340	4530	3930
2nd	Dallisgrass-White clover	7100	6890	9760	8260	8410	8380	8420	7840
3rd	Dallisgrass-White clover	5860	5260	12810	10680	11210	9660	9960	8530
4th	Cotton								
5th	Cotton								
1st	Fescuegrass	3460	1610	14990	3200	6030	2530	8160	2450
2nd	Fescuegrass	5500	3850	12000	3280	9950	5230	9150	4120
3rd	Fescuegrass	2620	1880	5700	5170	10870	5770	6400	4270
4th	Cotton								
5th	Cotton								
		Continuous corn							
1st	Dallisgrass-White clover	2740	2290	2740	2840	5930	6030	3800	3720
2nd	Dallisgrass-White clover	5230	6010	5250	4830	8720	7870	6400	6240
3rd	Dallisgrass-White clover	5140	5250	9740	8600	9680	10100	8190	7680
4th	Corn								
5th	Corn								

Nitrogen per acre, pounds

[1]In 1958 the nitrogen fertilizer treatments were increased from 60 pounds per acre to 90 pounds, and the no-nitrogen treatment to 15 pounds per acre.

[2]Unable to obtain a stand of Sudangrass in 1957 due to lack of moisture.

nitrogen increased the yield of first-year stands 233 percent; second-year stands, 122 percent; and third-year stands, 50 percent. Nitrogen applied to oats at the rate of 60 pounds per acre gave a 90 percent increase in yield over nonfertilized oats.

It was difficult to maintain a good stand of grass in the cropping systems receiving no nitrogen fertilizer. When nitrogen was applied, stands were easily maintained.

FORAGE CROPS RECOMMENDED FOR CROPPING SYSTEMS CONTAINING COTTON AND CORN

The high forage yields obtained from all the cropping systems more than offset the cost of establishing the forage crops, and a good income was obtained from the land when it was in forage production. The cropping system with the lowest yield produced a 3-year average of 2 tons of air-dry forage per acre per year. The system with the highest yield produced an average of 5 tons of air-dry forage per acre per year. These yields would have been higher, in all probability, if normal rainfall had occurred in 1956. The rainfall for 1956 was 17.4 inches below the 45-year average at the Angleton station, Table 1.

Oats, Sudangrass; Cotton

A 2-year system of first-year oats and Sudangrass and second-year cotton produced lower forage yields than any other system tested, Table 3. It also showed little effect upon soil improvement. Oats planted alone required nitrogen fertilizer to obtain high yields. Nonfertilized oats produced an average of 1,910 pounds of air-dry forage per acre. When 60 pounds of nitrogen were applied, yields were increased 90 percent. Pure stands of oats provide grazing for a short time when it is most needed on the Gulf Coast Prairie.

Oats were recommended over all other temporary winter pasture grasses until 1956. They have now lost their popularity due to Helminthosporium blight and other plant diseases found on the humid coastal prairie. These diseases were the cause of the low forage yields produced by this cropping system. Until new disease-resistant varieties are developed, oats are not recommended for the area.

Gulf ryegrass, a variety released in 1958, is now recommended instead of oats. Gulf ryegrass, as compared with oats, is more disease resistant, produces higher forage yields over a longer time and is able to reseed itself.

Gulf ryegrass replaced oats in this study in 1960. During that year Gulf ryegrass, receiving 15 and 90 pounds of nitrogen per acre, produced 4,290 and 7,120 pounds of air-dry forage per acre, respectively. It was easy to obtain stands of Sudangrass following oats and Gulf ryegrass.

Hubam, Sudangrass; Cotton

A 2-year system of first-year Hubam and Sudangrass and second-year cotton produced a yearly total of 8,350 pounds of air-dry forage per acre. This was one of the higher forage yields obtained from the cropping systems receiving no nitrogen fertilizer. Hubam clover produces the majority of its forage in the late spring when the summer grasses are in production and normally the forage is not needed.

It is believed that Sudangrass in the systems containing Hubam reduced forage yields. In preparing the land for planting Sudangrass, it was necessary to remove the Hubam clover at the time it was beginning to make its maximum production. It was difficult to obtain a good stand of Sudangrass following Hubam because of the lack of moisture.

Israel sweetclover, (*Melilotus alba* var. *annua*, Coe) is a new variety of annual sweetclover released in 1958. This clover has good possibilities of replacing Hubam on the Gulf Coast Prairie. It could fit in well in the cropping systems. Because of its late maturity, Sudangrass could be dropped from the system, and high forage yields over a long period could still be obtained.

Oats-Hubam, Sudangrass; Hubam, Sudangrass; Cotton

High forage yields were obtained from a 3-year system of first-year oats-Hubam, Sudangrass; second-year Hubam, Sudangrass and third-year cotton. This system fits in well in the area and is recommended over the two systems containing oats or Hubam. This system has several advantages other than producing higher forage yields. When oats and Hubam were planted together, they provided grazing over a longer period than when the two crops were planted separately. It was observed that when this system was in cotton there were not so many weeds, the land was easier to work and better stands of cotton were obtained.

The disadvantage of this 3-year system, which also applied to the systems of pure stands of oats and Hubam followed by Sudangrass, is that it requires two planting operations a year. The fall planting in October of oats and Hubam, and spring planting of Sudangrass occurs when the farmer is either harvesting or planting his row crops. Another disadvantage is that livestock must be kept off the land until the crops are large enough to graze.

Field observations in 1957-59 indicate that in all the plots planted to cropping systems containing Hubam clover, the "workability" of the soil was improved over all other systems and better stands of cotton were obtained. It also appeared that after heavy rains cropping systems containing Hubam clover showed better moisture penetration.

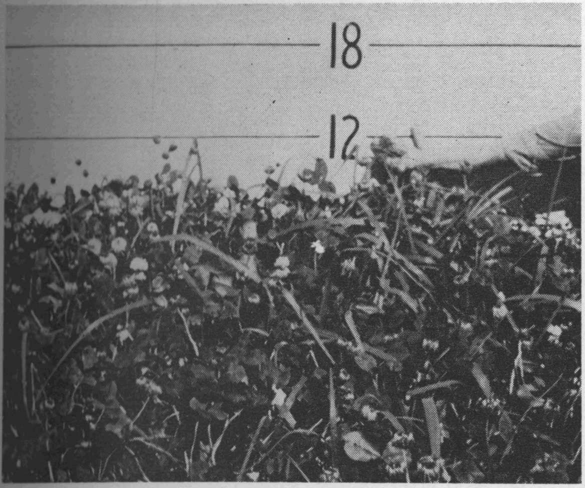

Figure 2. Dallisgrass and La. S-1 White clover is the most highly recommended pasture mixture for the Gulf Coast Prairie. This picture taken in March 1957 shows a good balance of grass and legume which is necessary to keep down the possibility of bloat in cattle.

Dallisgrass-White Clover, 2 Years; Cotton, 1 Year

Dallisgrass and White clover have many advantages as a grass and clover pasture combination. Grown together, these two furnish almost year-round grazing, Figures 2 and 3. One of the main advantages of having Dallisgrass and White clover in a cropping system is that only one planting operation is required for the time the system is in forage production.

There are some disadvantages of having these forage crops in a cropping system. A very good seedbed must be obtained to insure a good stand of Dallisgrass, while a stand of White clover is easy to obtain even on a poor seedbed. A good stand of both Dallisgrass and White clover is necessary to keep down the possibility of bloat in cattle which could occur on a pure stand of White clover. Another disadvantage is that 2 to 3 years are necessary to obtain high forage yields of Dallisgrass. The 3-year average taken from Table 3 shows an 86-percent increase in forage yields in second-year yields over first-year yields, and an 18-percent increase in third-year forage yields over the second-year yields. Still another disadvantage of a Dallisgrass and White clover pasture is the difficulty encountered in obtaining a good seedbed for cash crops of cotton and corn. Even with these disadvantages, cropping systems containing Dallisgrass and White clover are recommended over all other systems.

Dallisgrass-White Clover, 3 Years; Cotton or Corn, 2 Years

Of the nine cropping systems used in this test, the 5-year system containing 3 years of Dallisgrass and Louisiana S-1 White clover followed by 2 years of cotton or corn is the one most recommended over

Figure 3. A third-year stand of Dallisgrass and White clover produced an average of 12,810 pounds of air-dry forage per acre in 1957. This picture taken in August shows the growth habits and seeding characteristics of Dallisgrass. La. S-1 White clover (bottom of the picture) is still making active growth.

the other systems. It conforms well with the livestock program throughout the area, and Dallisgrass and White clover pastures are the most productive pastures in the area. They also increase the yields of the chief cash crops, cotton, corn and rice.

Cropping systems containing 3 years of Dallisgrass and White clover are recommended over 2-year systems because of the increased forage yields obtained from third-year systems over second-year systems, and the high cost of establishment of a good Dallisgrass and White clover pasture.

Fescuegrass, 3 Years; Cotton, 2 Years

This 5-year system has several advantages on the Gulf Coast Prairie. Fescuegrass provides forage over a long growing season from late fall until early summer. It requires only one planting operation during its duration in the system and with the addition of nitrogen fertilizer, high forage yields can be expected the first year it is in the system.

Fescuegrass has several disadvantages which have made it unpopular at the Angleton station. It is difficult to maintain a good stand of fescuegrass, and it is necessary to keep stock off the land during the summer months. The stock should be taken off early enough to allow the fescuegrass to produce seed. Low

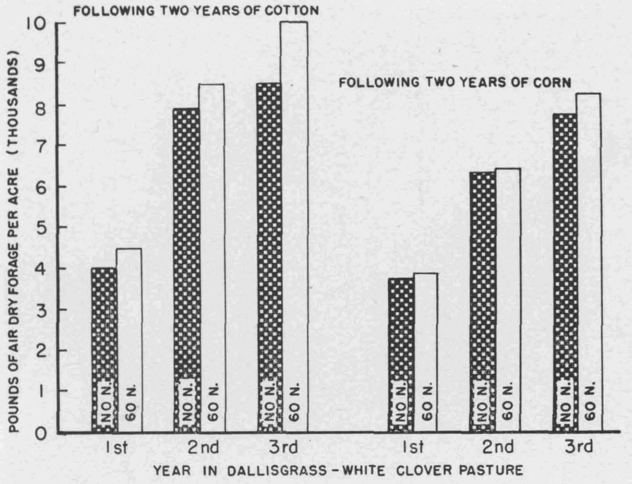

Figure 4. The influence of cotton and corn on the yields of Dallisgrass-White clover.

yields are to be expected without the use of nitrogen fertilizer. First, second and third-year stands of fescuegrass produced 8,160, 9,150 and 6,400 pounds of air-dry forage per acre, respectively, with applications of 60 pounds of nitrogen per acre per year. Where no nitrogen was applied, 2,450, 4,120 and 4,270 pounds of forage was produced in the first, second and third years, respectively, Table 3. Even when high yields are obtained by using nitrogen fertilizer, production was poor when considered on an annual basis.

In preparing the land for cotton, the plots coming out of fescuegrass were harder to work that the plots in any other system, and the poorest stands of cotton were obtained on these plots.

The growing season in 1957 was very favorable for fescuegrass. The plots fertilized with 60 pounds of nitrogen per acre produced average yields for first, second and third-year stands of 14,900, 12,000 and 5,700 pounds of air-dry forage per acre, respectively. The nonfertilized plots produced an average of only 3,200, 3,280 and 5,170 pounds of air-dry forage per acre in the first, second and third-year stands, respectively.

Cropping systems containing pure stands of fescuegrass are not recommended for the Gulf Coast Prairie without the use of high rates of nitrogen fertilizer.

INFLUENCE OF COTTON AND CORN ON THE YIELDS OF DALLISGRASS-WHITE CLOVER

The influence of cropping systems containing cotton and corn on the yields of Dallisgrass and White clover is shown in Figure 4. These two forage crops following cotton produced higher yields than when following corn. Nitrogen fertilizer was more significant in increasing forage yields of Dallisgrass and White clover following cotton than when these forage crops followed corn.

INFLUENCE OF CROPPING SYSTEMS ON COTTON YIELDS

Cotton Yields, 1953-57

The yields of cotton obtained from various cropping systems without nitrogen and with 60 pounds of nitrogen per acre per year for 1953-57 are given in Table 4.

Weather conditions were unfavorable for high cotton yields during the 5 years in which the test was conducted. Yields were extremely low in 1953 and 1955 because of the lack of moisture necessary to germinate seed to a good stand, and insufficient

TABLE 4. THE INFLUENCE OF CROPPING SYSTEMS AND NITROGEN FERTILIZER ON COTTON YIELDS, 1953-57

Year in system	Cropping system	Pounds of seed cotton per acre									
		No nitrogen					60 pounds of nitrogen per acre				
		1953	1954	1955	1956	1957	1953	1954	1955	1956	1957
Continuous	Continuous cotton	380	1480	360	970	1280	340	1660	620	1010	1230
1st	Oats, Sudan										
1st	Cotton	540	1470	430	1010	1170	410	1560	430	1070	1240
1st	Hubam, Sudan										
1st	Cotton	650	1580	460	1220	1200	550	1620	310	1200	1320
1st	Oats-Hubam, Sudan										
2nd	Hubam, Sudan										
1st	Cotton	470	1470	350	1170	1310	500	1660	370	1190	1460
1st	Dallisgrass-White clover										
2nd	Dallisgrass-White clover										
1st	Cotton	410	1360	710	1130	1130	640	1850	600	1250	1340
1st	Dallisgrass-White clover										
2nd	Dallisgrass-White clover										
3rd	Dallisgrass-White clover										
1st	Cotton	380	1420	430	1210	1250	500	1660	350	1230	1250
2nd	Cotton	530	1360	390	1220	1200	580	1830	580	1230	1400
1st	Fescuegrass										
2nd	Fescuegrass										
3rd	Fescuegrass										
1st	Cotton	400	1290	360	820	860	480	1650	510	840	1070
2nd	Cotton	570	1420	340	970	1180	700	1800	590	1100	1410

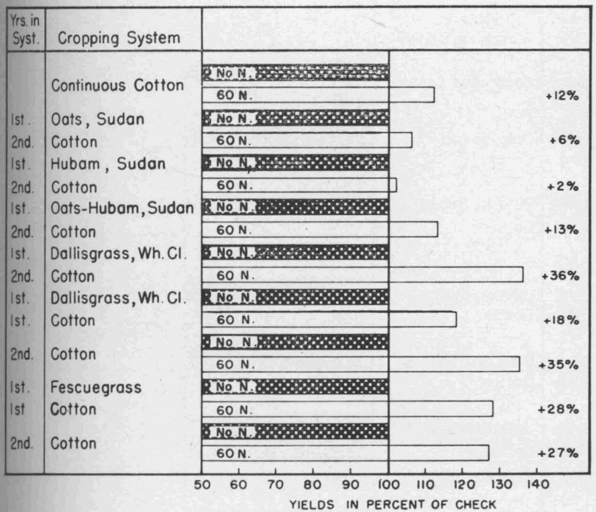

Figure 5. The effect of 60 pounds of nitrogen per acre on the yields of cotton in various cropping systems, 1954.

rainfall during the growing season prevented the cotton plants from maturing a normal crop of bolls, Table 1. Under normal conditions, the Angleton station produces 1½ bales of cotton per acre without supplemental irrigation.

In 1953 the cotton was planted on land that had been in row crops of cotton or corn for 50 years. The cotton yields showed no significant difference due to crop rotation or nitrogen fertilizer.

In 1954 none of the cotton had been preceded by a soil-improving crop for more than 1 year. There was no significant difference in cotton yields due to crop rotation. The rainfall during the growing season was favorable for the use of nitrogen fertilizer. Applications of 60 pounds of nitrogen per acre produced from 2 to 36-percent increases in cotton yields in all of the cropping systems tested, Figure 5.

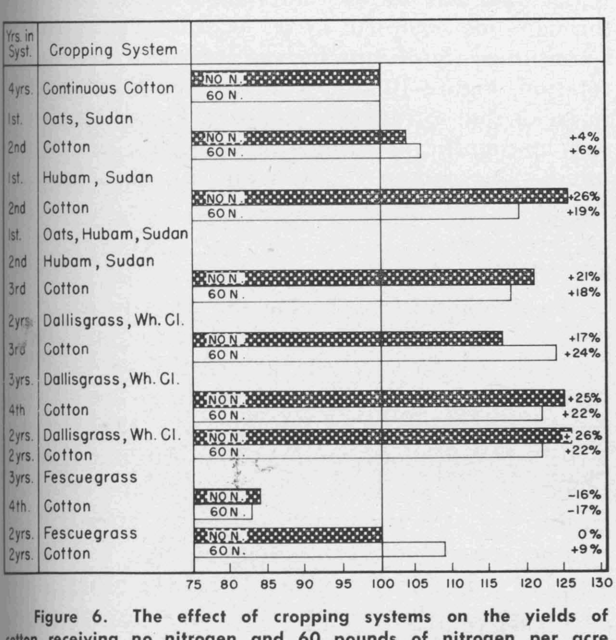

Figure 6. The effect of cropping systems on the yields of cotton receiving no nitrogen and 60 pounds of nitrogen per acre per year, 1956.

Figure 7. Continuous cotton receiving yearly fertilizer treatments of 0-30-0 produced only 970 pounds of seed cotton per acre in 1956. Note the short height of plants (18 inches) and few number of blooms.

In 1955, as in 1953, cotton yields were extremely low due to lack of moisture. All of the cropping systems, except the 5-year systems, had gone through a complete cycle. Crop rotation and nitrogen fertilizer caused no significant increase in yields.

In 1956 it became apparent that cotton yields were being increased by rotation. Four of the seven cropping systems tested in this experiment produced a highly significant increase in yields of rotated cotton over continuous cotton, Figure 6.

The cropping systems containing a legume produced the highest percentage increase in yields. Nonfertilized cotton following 1 year of Hubam, Sudan

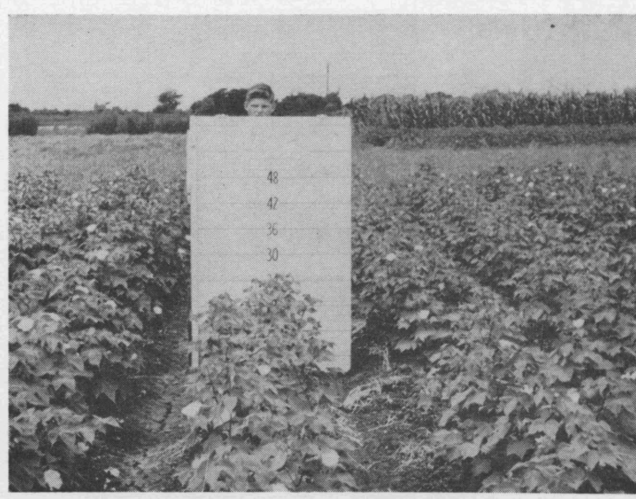

Figure 8. Cotton rotated with Dallisgrass and White clover and receiving a yearly fertilizer treatment of 0-30-0 produced 1,220 pounds of seed cotton per acre in 1956. This gave a 26 percent increase in yields over continuous cotton receiving the same fertilizer treatments. Note height (26 inches) and increase in number of blooms even during drouth period as shown by cracking of soil between cotton rows.

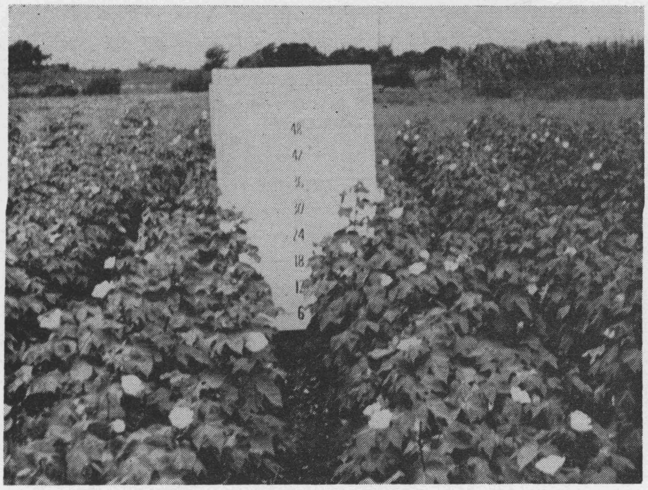

Figure 9. In 1957 cotton rotated with Dallisgrass and White clover and receiving a yearly fertilizer treatment of 60-30-0 per acre produced only 1,230 pounds of seed cotton per acre. The 60 pounds of nitrogen only increased cotton yields 10 pounds per acre. Note height of plant (36 inches) and large number of blooms as compared with Figures 7 and 8. If normal rainfall had occurred, probably there would have been a high increase in yields due to nitrogen fertilizer as well as crop rotation.

and second-year cotton following 2 years of Dallisgrass and White clover produced 26-percent increases in yields over continuous nonfertilized cotton, Figures 7 and 8. In the same systems cotton with 60 pounds of nitrogen produced 19 and 22-percent increases in yields, respectively.

Continuous cotton was better than cropping systems that did not contain a legume. Cotton following 1 year of oats, Sudan with and without nitrogen produced 6 and 4-percent increases in yields, respectively, over continuous cotton receiving the same fertilizer treatments. First-year cotton following 3 years of fescuegrass with and without nitrogen fertilizer produced 17 and 16-percent decreases in cotton yields, respectively.

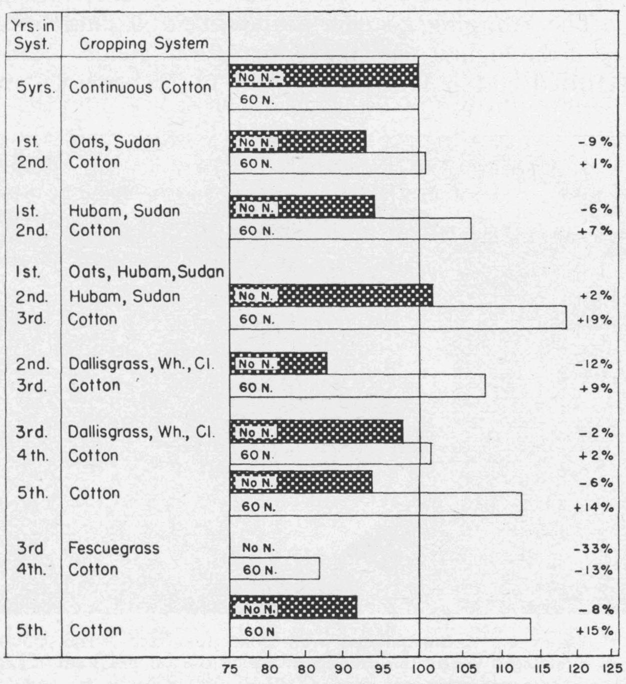

Figure 10. The effect of cropping systems on the yields of cotton receiving no nitrogen and 60 pounds of nitrogen per acre per year, 1957.

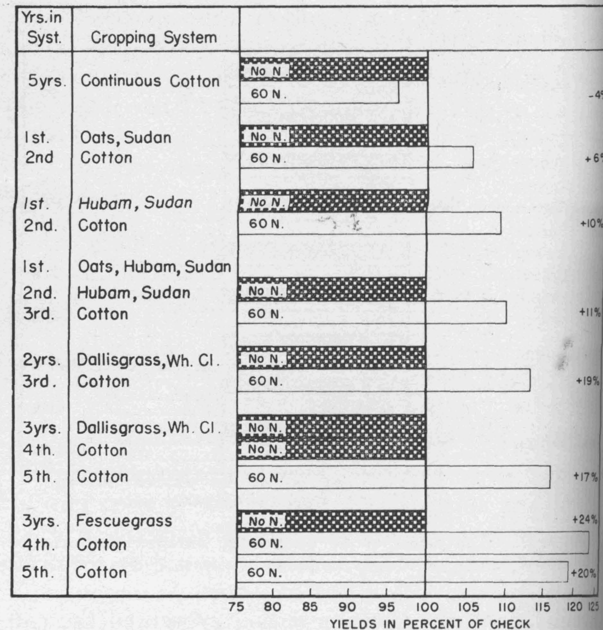

Figure 11. The effect of 60 pounds of nitrogen per acre on the yield of cotton in various cropping systems, 1957.

In the nonfertilized cotton, crop rotation was as effective in increasing cotton yields as a fertilizer application of 60 pounds of nitrogen per acre, Figure 9.

In 1957 all of the cropping systems had gone through one complete cycle. Cotton yields showed a continued significant increase in yields due to crop rotation, Figure 10, and a highly significant increase in yields due to nitrogen fertilizer, Figure 11. There was no significant difference in yields, due to the interaction of crop rotation and nitrogen fertilizer, Figure 12.

NO NITROGEN

Field observations during the years in which the test was conducted have shown that continuous nonfertilized cotton reached maturity 3 weeks earlier than rotated cotton and cotton receiving nitrogen fertilizer. This was an advantage in 1957 for nonfertilized continuous cotton. The continuous cotton bloomed and set bolls while the rotated fertilized cotton was still producing vegetative growth. The weather turned dry, and the test area had only a trace of rain for 6 weeks. The Lake Charles clay dried and cracked deeply, and the late cotton was unable to set a normal crop of bolls.

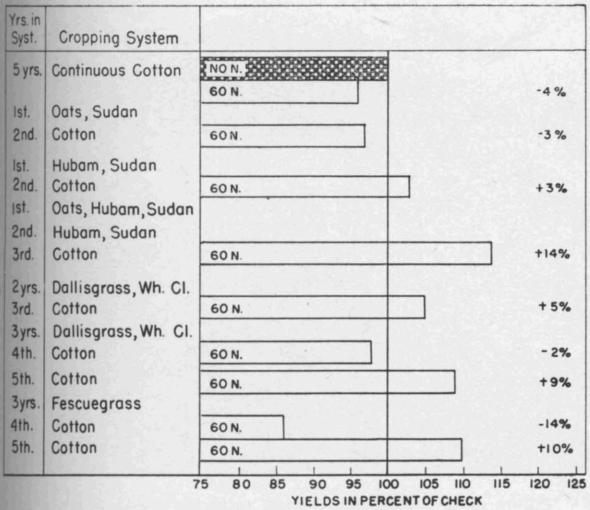

Figure 12. The effect of cropping systems and nitrogen on the yield of cotton, 1957.

The use of 60 pounds of nitrogen per acre on continuous cotton caused a decrease in yields as compared to the nonfertilized continuous cotton.

Continuous nonfertilized cotton produced higher yields than cotton in six of the seven cropping systems tested in 1957. The effect of cropping systems on nonfertilized cotton is presented in Figure 10. The decrease in yields ran from 2 percent for cotton following Dallisgrass and White clover to 33 percent for cotton following fescuegrass. The only increase in yields obtained from nonfertilized cotton was in a cropping system containing 2 years of Hubam clover. The results obtained from nonfertilized cotton in 1957 were the opposite of those obtained in 1956. More emphasis should be placed on the 1956 data than the 1957, as the weather conditions occurring in 1957 were very unusual for the Gulf Coast Prairie.

NITROGEN

The effects of cropping systems on cotton yields receiving 60 pounds of nitrogen per acre for 1957 is shown in Figure 10. There was an increase in yields in six of the seven cropping systems tested. The highest increase in yields was obtained from cropping systems containing a legume.

Cotton in a 2-year cropping system of first-year Hubam, Sudan and second-year cotton, and a 3-year system of first-year oats-Hubam, Sudan; second-year Hubam, Sudan and third-year cotton produced a 7 and 19-percent increase in yields, respectively, over continuous cotton. The two systems which contained Dallisgrass and White clover (a 3-year system of 2 years of Dallisgrass and White clover and 1 year cotton, and a 5-year system of 3 years of Dallisgrass-White clover followed by 2 years of cotton) produced 9, 2 and 14-percent increases in yields, respectively. Cotton in a 2-year system of 1 year oats, Sudan and 1 year cotton made only a 1-percent increase in yields. In a 5-year system of 3 years of fescuegrass and 2 years cotton, first-year cotton produced a 13-percent decrease in yields and second-year cotton produced a 15-percent increase in yields.

The effects of nitrogen fertilizer on the yields of cotton in 1957 are presented in Figure 11. The applications of 60 pounds of nitrogen per acre applied at planting produced a highly significant increase in cotton yields in six of the eight cropping systems tested. The two systems in which nitrogen fertilizer did not produce an increase in yields were continuous cotton and first-year cotton following 3 years of Dallisgrass and White clover. The system producing the highest increase in yields because of nitrogen was first and second-year cotton following 3 years of fescuegrass. This system showed an increase in yields of 24 and 20 percent, respectively.

The increase in yields caused by nitrogen was very apparent in field observation. The cotton which had received nitrogen withstood drouth better than the nonfertilized cotton. Since the fertilized cotton maintained a good color, did not shed its leaves and was able to resume growth and set cotton bolls, it made a late cotton crop. The cotton which did not receive fertilizer and the fertilized continuous cotton did not recover after the drouth.

Effects of Nitrogen on Cotton Yields

Nitrogen fertilizer applied at the rate of 60 pounds per acre per year increased the yields of cotton in all the cropping systems in 1954, 1956 and 1957, Figure 13. The greatest increase in yields due to nitrogen was in the 3-year system of 2 years of Dallisgrass-White clover and 1 year of cotton. This system produced a 22-percent increase in yields over cotton in the same system which did not receive nitrogen.

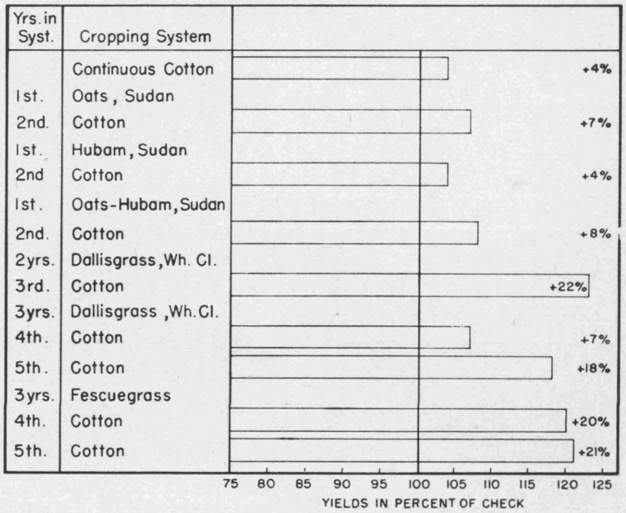

Figure 13. The effect of 60 pounds of nitrogen per acre per year on the average yields of cotton in various cropping systems, 1954, 1956 and 1957.

TABLE 5. AVERAGE YIELDS OF SEED COTTON PER ACRE AS INFLUENCED BY FERTILIZER AND CROP ROTATION, 1954-57

Fertilizer	Average yields of seed cotton per acre 1954	1955	1956	1957	1954-57
Continuous cotton					
0-0-0	1550	680	830	810	970
0-30-0	1360	840	930	800	980
45-0-0	1640	830	980	1070	1130
45-30-0	1900	600	1120	1040	1170
90-0-0	1740	670	940	1010	1090
90-30-0	1670	650	1000	1000	1080
90-30-30	1620	860	1000	980	1120
90-30-60	1980	950	1390	1120	1360
Cotton in a 3-year cropping system of 2 years Dallisgrass-White clover; 1 year cotton					
0-0-0	1590[1]	1310	1090	690	1170
0-30-0	1660	1610	1230	820	1330
45-0-0	1760	1600	1250	990	1400
45-30-0	1760	1910	1210	1060	1490
90-0-0	1680	1080	1160	1000	1230
90-30-0	1740	1950	1290	1040	1510
90-30-30	1920	1660	1130	1100	1450
90-30-60	2150	1760	1210	1110	1560

[1]The cotton in 1954 followed only 1 year of Dallisgrass-White clover.

The smallest increase in yields caused by nitrogen was produced by continuous cotton and cotton in a 2-year system of Hubam, Sudan and cotton. These systems produced an increase of 4 percent over the same systems which did not receive nitrogen.

Statistical analysis of the cotton yields shows that there was no significant difference in yields due to any of the treatments in 1953. In 1954 there was a highly significant difference in the increase of yields because of nitrogen fertilizer. In 1955 there was a significant difference because of the interaction of nitrogen and crop rotation. In 1956 the effect of cropping systems became apparent in increasing yields. In 1956 and 1957 there was a highly significant increase in yields because of the crop rotation and nitrogen fertilizer.

Cropping Systems Recommended for Cotton

Based on the information obtained from this study, a cropping system of continuous cotton is better than cotton rotated in systems containing only grasses. Cotton rotated with fescuegrass caused a

Figure 14. Continuous cotton receiving no fertilizer produced a 3-year average of 770 pounds of seed cotton per acre.

decrease in yields over continuous cotton in practically all cases.

All of the cropping systems containing a legume produced higher cotton yields than continuous cotton.

The cropping system most recommended for the Gulf Coast Prairie is a 5-year system of 3 years of Dallisgrass and White clover followed by 2 years of cotton. This cropping system not only produced a high increase in cotton yields but also fits in well with the livestock program throughout the Gulf Coast Prairie.

A 3-year cropping system of first-year oats-Hubam and Sudan, second-year Hubam and Sudan and third-year cotton produced higher cotton yields than any of the systems tested, but because of the difficulty encountered in the establishment of the forage crops this system is not recommended as highly as the cropping systems containing Dallisgrass and White clover.

A 2-year cropping system of first-year Hubam-Sudan followed by second-year cotton is the third choice cropping system recommended for the area.

The type of cropping system used must be based on the individual farmer's needs and the acres he has

TABLE 6. INCREASE IN YIELDS OF SEED COTTON PER ACRE DUE TO FERTILIZER AND CROP ROTATION

Fertilizer	Average yields of seed cotton per acre, 1955-57: Continuous cotton	Rotated[1] cotton	Fertilizer: Continuous	Fertilizer: Rotated	Increase in yields due to: Crop rotation	Fertilizer and Crop rotation
0-0-0	770	1030			260	260
45-0-0	960	1280	190	240	320	510
90-0-0	870	1080	100	50	210	310
0-30-0	860	1220	90	190	360	450
45-30-0	920	1390	150	360	470	620
90-30-0	880	1430	110	400	550	660
90-30-30	950	1300	180	270	350	530
90-30-60	1150	1360	380	330	210	590

[1]Cotton in a 3-year cropping system of 2 years Dallisgrass-White clover, 1 year cotton.

available for crop rotation. A 5-year cropping system of a 3:2 ratio requires 3 acres of pasture for every 2 acres of row crops. A 3-year cropping system of 2:1 ratio requires 2 acres of pasture for every 1 acre of row crops, and a 2-year system of 1:1 ratio requires 1 acre of pasture for every 1 acre of row crops.

Cotton Fertilizer Tests

An additional 3 x 2 factorial fertilizer test with three replications was carried out at the same time as the major test. This test used two cropping systems—one of continuous cotton, and the other a 3-year cropping system of 2 years Dallisgrass-White clover and 1 year cotton.

Rainfall during the years in which the test was conducted was low and in all probability the response to fertilizer treatments and cropping systems was lower than could be expected under normal conditions. This was especially true in 1957, Table 1.

Deltapine 15 cotton was planted during the test, and general management was the same as in the major test.

The test was started in 1953 and had been in production for 5 years by 1957. The first cycle of the 3-year cropping system was not completed until 1955. The cotton test was lost in 1953, and no yields were obtained for that year. The yields obtained from 1954-57 are given in Table 5.

CONTINUOUS COTTON

The results given in Table 5 show that very low yields were obtained from continuous cotton receiving no fertilizer. The average yield was only 770 pounds of seed cotton per acre for the 3-year period 1955-57, Figure 14. Yields were almost doubled when cotton was rotated with 2 years of Dallisgrass-White clover and received fertilizer treatments of 90-30-0 per acre. There was a 550-pound-per-acre increase in cotton yields because of the cropping system, and an additional 110 pounds because of the fertilizer.

Of more interest are the relative effects of nitrogen, phosphorus and potassium. In continuously grown cotton, potassium was the most effective element in increasing yields, Table 6. Nitrogen was the second most effective element in increasing yields and phosphorus, third. A fertilizer application of 90-30-60 per acre resulted in an average increase of 380 pounds of seed cotton per acre, Figure 15. The fertilizer treatment of 90-30-30 resulted in only a 180-pound increase in yields.

The high increase in yields caused by potassium is unusual on Lake Charles clay soil as it is medium to high in native potassium. For the past 50 years, however, the area in which the test was conducted

Figure 15. Continuous cotton receiving a yearly fertilizer treatment of 90-30-60 produced a 3-year-average increase in yields of 380 pounds of seed cotton per acre over nonfertilized continuous cotton. There was a 270-pound increase in yields due to the 60 pounds of potassium (K_2O) compared with the cotton receiving a fertilizer treatment of 90-30-0.

has been planted in row crops. It is believed this is the reason continuous cotton responded so well to potassium.

The response to nitrogen was not as pronounced as the response to potassium. The application of 45 pounds of nitrogen produced 190 pounds of seed cotton per acre more than the nonfertilized cotton, Figure 16. This represents the production of 4 pounds of seed cotton for each pound of nitrogen applied. The 90-0-0 treatment produced only 100 pounds of seed cotton per acre more than the check treatment. However, the cotton in the plots receiving this treatment was taller, produced more foliage and maintained a greener color than the other plots. But these plants did not set a majority of the cotton bolls.

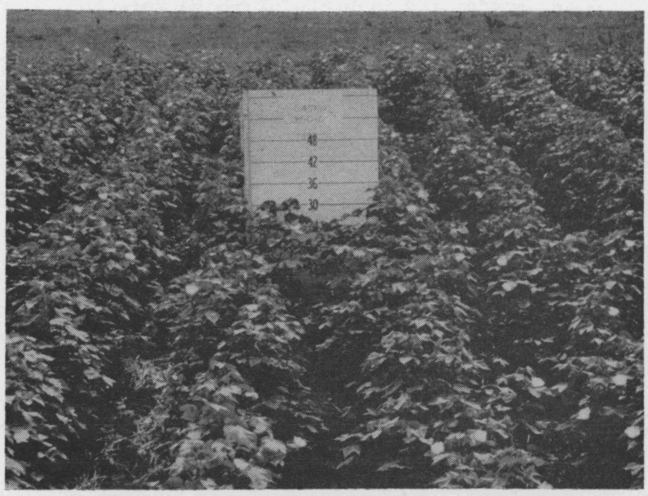

Figure 16. Continuous cotton receiving fertilizer treatments of 45-0-0 per acre per year produced a 3-year-average increase in yields of 190 pounds of seed cotton over continuous nonfertilized cotton. This fertilizer treatment was the most economical in the continuous cotton fertilizer test.

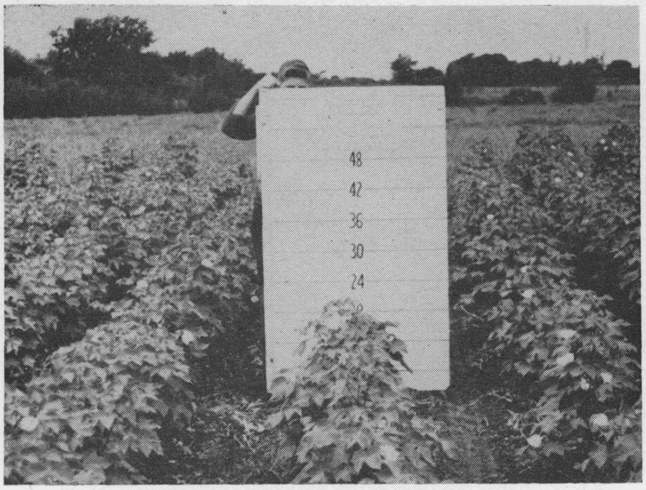

Figure 17. Cotton rotated with Dallisgrass and White clover receiving no fertilizer produced a 3-year average of 1,030 pounds of seed cotton. This represented a 34-percent increase in yields over continuous nonfertilized cotton. All of the rotated cotton plots withstood drouth periods better, were better able to set cotton bolls and were later in maturing than were continuous cotton plots.

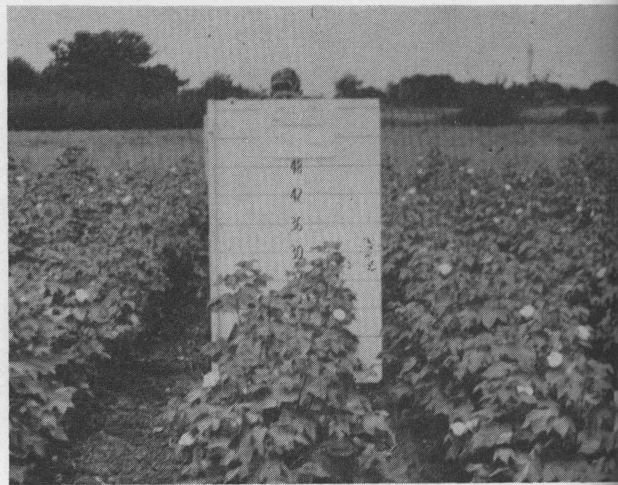

Figure 18. Cotton rotated with Dallisgrass and White clover fertilized yearly with 90-30-0 produced a 3-year average of 1,430 pounds of seed cotton per acre. This yield represented a 400-pound increase in yields due to fertilizer as compared with rotated cotton receiving no fertilizer; a 550-pound increase in yields due to crop rotation as compared with continuous cotton receiving the same fertilizer treatment; and a 620-pound increase due to fertilizer and crop rotation as compared with continuous nonfertilized cotton.

An application of 30 pounds of phosphorus (P_2O_5) per acre resulted in an average increase of 90 pounds of seed cotton per acre. When phosphorus (P_2O_5) was applied in fertilizer treatments of 45-30-0 and 90-30-0 per acre, an average increase of 150 and 110 pounds of seed cotton was produced, respectively.

The results of the test show that a complete fertilizer of 90-30-60 should be applied to obtain the highest yields of cotton under similar conditions to those which prevailed during this experiment, especially when the land has been in row crops for several years. The second highest yields produced by continuous cotton were made with a fertilizer treatment of 45-0-0 per acre per year.

ROTATED COTTON

The increase in yields caused by fertilizer was much higher in cotton following Dallisgrass and White clover than in continuous cotton, Table 6. Nitrogen was more effective in increasing yields than phosphorus. Potassium did not increase cotton yields in rotated cotton. Fertilizer applications of 90-30-30 and 90-30-60 decreased yields 130 and 70 pounds of seed cotton per acre, respectively, over cotton receiving fertilizer treatments of 90-30-0. The same amount of potassium (K_2O) applied to continuous cotton increased yields 200 and 270 pounds per acre, respectively.

Nitrogen and phosphorus gave the highest returns in cotton yields when they were applied together. Applications of 90-30-0 produced the highest average yield obtained in the test, producing 1,430 pounds of seed cotton per acre. The second highest yield was obtained from a fertilizer treatment of 45-30-0 which produced 1,390 pounds of cotton. This gave increases of 400 and 360 pounds of seed cotton per acre, respectively, over rotated cotton receiving no

TABLE 7. THE INFLUENCE OF CROPPING SYSTEMS ON CORN YIELDS

Treatment number	Years in system	Cropping system	Bushels of shelled corn per acre 1953	1954	1955	1956	1957	Average
			No nitrogen					
8	Continuous	Continuous corn	10.9	25.8	30.9	18.8	32.5	23.8
9	1st	Dallisgrass-White clover						
	2nd	Dallisgrass-White clover						
	3rd	Dallisgrass-White clover						
	1st	Corn	9.6	27.9	25.0	29.1	43.9	27.1
	2nd	Corn	8.7	19.9	34.4	32.2	47.6	28.6
			60 pounds nitrogen per acre					
8	Continuous	Continuous corn	15.9	37.2	38.8	30.3	52.8	35.0
9	1st	Dallisgrass-White clover						
	2nd	Dallisgrass-White clover						
	3rd	Dallisgrass-White clover						
	1st	Corn	8.9	37.2	47.8	33.1	67.2	38.8
	2nd	Corn	12.6	37.5	38.0	36.2	60.0	36.9

fertilizer, and an increase of 660 and 620 pounds of cotton over the continuous, nonfertilized cotton, Figures 17 and 18. These two treatments coincide well with the fertilizers used in the major test and the cotton fertilizer recommendation for the Gulf Coast Prairie of 60-30-0 per acre per year.

Cotton in rotation with Dallisgrass and White clover made considerably higher yields than continuous cotton, Table 6. The increase in yields varied from 18 to 62 percent. The continuous nonfertilized cotton produced an average of 770 pounds of seed cotton per acre, while the cotton in the rotation system receiving no fertilizer produced 1,030 pounds of seed cotton. This represented a 34-percent increase in cotton yields due to the cropping system.

The increase in yields caused by the cropping systems was much higher in those systems receiving phosphorus fertilizer than those receiving only nitrogen. This is believed to be due to two factors: (1) the removal of phosphorus from the soil by the White clover and (2) the nitrogen fixed in the soil by the legume. The addition of 30 pounds of phosphorus (P_2O_5) per acre to the cropping system of 2 years of Dallisgrass-White clover and 1 year of cotton produced 360 pounds more seed cotton per acre than the same treatment produced on continuous cotton.

The highest increase in yields caused by the cropping system was in the plots receiving fertilizer treatments of 90-30-0 and 45-30-0, which produced an increase of 550 and 470 pounds, respectively, of seed cotton per acre over continuous cotton receiving the same fertilizer treatments, Figure 18. The lowest increase was obtained from plots receiving fertilizer treatments of 90-30-60. The high increase in yields caused by crop rotation is partly due to the large amounts of high quality organic residues produced by Dallisgrass and White clover, while continuous cotton tillage practices offer little opportunity for the return of residues of organic material to the soil.

These fertilizer recommendations should not be used except in locations where the soil and climatic conditions are similar to those which prevailed during this experiment.

The Texas Agricultural Extension Service Leaflet 224 "General Fertilizer Recommendations for the Gulf Coast Prairie and Coastal Marsh" can be used successfully for making fertilizer recommendations in the area, but because of the wide variation in nutrient levels, soil tests should be made to obtain more definite and economical fertilizer recommendations.

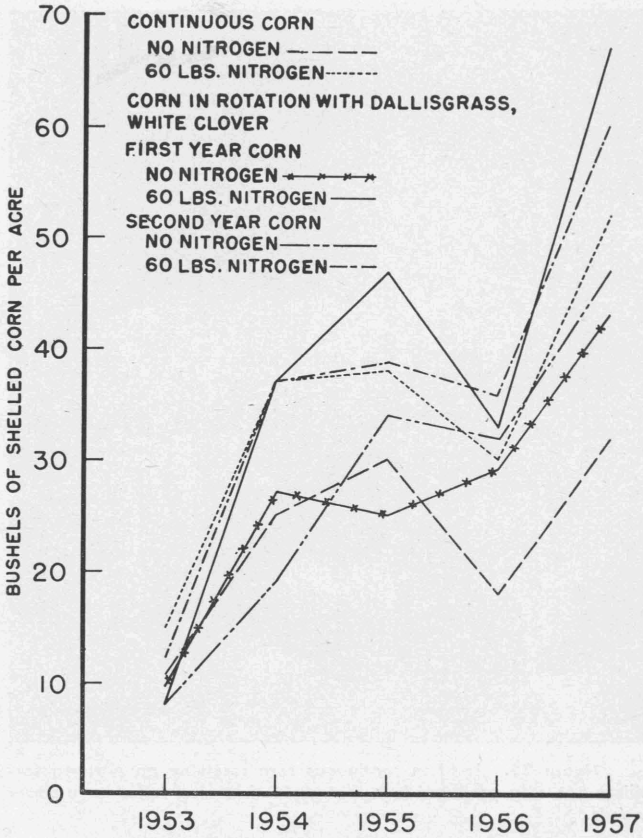

Figure 19. The influence of cropping systems of Dallisgrass, White clover and nitrogen on corn yields.

INFLUENCE OF DALLISGRASS-WHITE CLOVER AND NITROGEN FERTILIZER ON CORN YIELDS

Corn Yields

The corn yields obtained during the 5 years of the experiment are shown in Table 7 and Figure 19. Because of insufficient or poor distribution of rainfall and unavoidable lateness of planting or replant-

TABLE 8. EFFECTS OF CROPPING SYSTEM OF DALLISGRASS-WHITE CLOVER ON YIELDS OF CORN RECEIVING NO NITROGEN AND 60 POUNDS OF NITROGEN PER ACRE PER YEAR

Cropping system	Nitrogen per acre, pounds					
	1956		1957		Average	
	None	60	None	60	None	60
	Bushels of shelled corn per acre					
Continuous corn	18.8	30.3	32.5	52.8	25.6	41.6
First-year corn following 3 years Dallisgrass-White clover	29.1	33.1	43.9	67.2	36.5	50.2
Second-year corn following 3 years Dallisgrass-White clover	32.2[1]	36.2[1]	47.6	60.0	39.9	48.1

[1]Second-year corn in 1956 followed 2 years of Dallisgrass-White clover.

Figure 20. Land in continuous corn receiving no nitrogen fertilizer not only produced low corn yields but also failed to produce weeds.

Figure 21. Land in continuous corn receiving 60 pounds of nitrogen produced 18½ pounds of grain per acre for every pound of nitrogen applied over continuous corn receiving no nitrogen.

ing necessitated by bird damage, low to medium yields were obtained during the 5 years of this test.

High infestations of sugarcane borers and earworms caused considerable reductions in yields for 1953-56. During this time Texas Hybrid 30 corn was planted. In 1957 Texas Hybrid 34 corn was planted. In that year there was no loss caused by earworms and relatively little damage caused by sugarcane borers. The high yields obtained in 1957 as shown in Table 7 are believed to be partly due to Texas 34 corn which is a new yellow corn hybrid developed particularly for the Gulf Coast Prairie (13). Prior to 1957 Texas Hybrid 30 was the recommended corn hybrid for the area (3).

The cropping systems tested containing corn were continuous corn and a 5-year system of 3 years of Dallisgrass and White clover and 2 years of corn. These systems received the same management practices as those used in the cropping systems containing cotton. One-half of each plot was fertilized each year with 60 pounds of nitrogen per acre and the other half received no nitrogen. All the plots received a total of 30 pounds of phosphorus (P_2O_5) per acre per year.

The 5-year cropping system of Dallisgrass and White clover completed its first cycle in 1957. From 1953-55 Dallisgrass and White clover showed little effect upon increasing corn yields over continuous corn, Table 7.

CROP ROTATION

In 1956-57 the effect of crop rotation became apparent in increasing corn yields, Table 8. In plots receiving no nitrogen fertilizer, the crop rotation increased corn yields 42 percent for first-year corn and 56 percent for second-year corn following Dallisgrass and White clover over continuous corn. The plots receiving 60 pounds of nitrogen per acre produced an average increase in corn yields of 21 and 13 percent, respectively.

NITROGEN FERTILIZER

Applications of 60 pounds of nitrogen per acre increased continuous corn yields 62 percent, Figures 20 and 21, and first-year corn and second-year corn following Dallisgrass and White clover 38 and 20 percent, respectively.

The combination of crop rotation and nitrogen fertilizer was more effective in increasing corn yields than either Dallisgrass and White clover or nitrogen fertilizer alone. First and second-year corn following Dallisgrass and White clover that had received nitrogen fertilizer produced an average increase in yields of 96 and 88 percent, respectively, over the nonfertilized continuous corn.

Recommendations for Gulf Coast Prairie

Dallisgrass and White clover are recommended as a soil improvement crop for corn as well as for cotton. Field observations showed an improvement in the

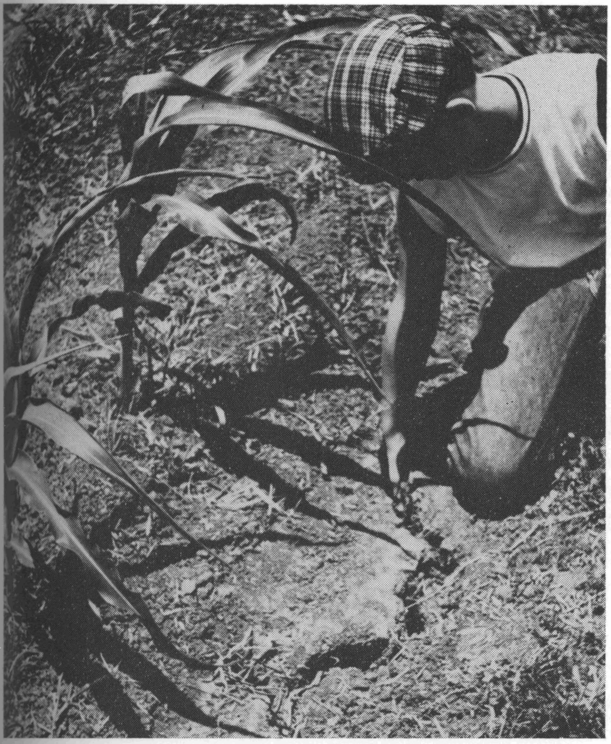

Figure 22. Severe cracking of Lake Charles clay soil in continuous corn plots caused by drouth. Cracks measured 6 feet deep. There was relatively little cracking in corn plots which had been rotated with Dallisgrass and White clover. The rotated corn plants showed no stress because of lack of moisture as continuous corn plots showed.

physical condition of the soil in the plots with Dallisgrass and White clover in the system as compared to the continuous corn plots. The moisture holding capacity of the soil appeared to be better in corn plots following Dallisgrass and White clover than in the continuous corn plots. There was not so much cracking during drouth periods, and the corn did not show nearly the stress due to lack of moisture as in the continuous corn plots. Infiltration also seemed to be improved, Figure 22.

LITERATURE CITED

1. Atkins, I. M., Gardenhire, J. H. and Porter, K. B. Oats for grain, winter pasture and other uses. Texas Agr. Exp. Sta. Bul. 929. 1959.
2. Bonnen, C. A. Cotton statistics for Texas, 1947-57. Texas Agr. Ext. Ser.; Texas Agr. Exp. Sta. M.P. 144. 1957.
3. Bockholt, A. J., Rogers, J. S. and Collier, J. W. Corn hybrids for Texas. Texas Agr. Exp. Sta. Bul. 878. 1957.
4. Carter, W. T. The soils of Texas. Texas Agr. Exp. Sta. Bul. 431. 1931.
5. Cheaney, R. L., Weihing, R. M. and Ford, R. F. The effect of various rates and frequencies of application of rock and super-phosphate on the yield and composition of forage on a Lake Charles clay loam soil. Soil Science Society of America Proceedings Vol. 20, No. 1. Jan., 1956.
6. Holt, E. C. Dallisgrass. Texas Agr. Exp. Sta. Bul. 829. 1956.
7. Holt, E. C. Small grains for forage. Texas Agr. Exp. Sta. Bul. 944. 1959.
8. Thornton, M. K. Fertilizers and their use. Texas Agr. Ext. Ser. Bul. 167.
9. Reynolds, E. B. Cotton production in Texas. Texas Agr. Exp. Sta. Bul. 938. 1959.
10. Riewe, M. E. and Smith, J. C. Effect of fertilizer placement on perennial pastures. Texas Agr. Exp. Sta. Bul. 805. 1955.
11. Gulf ryegrass. Texas Agr. Exp. Sta. L. 407. 1958.
12. Israel sweetclover. Texas Agr. Exp. Sta. L. 399. 1958.
13. Texas 34, a new hybrid for the Gulf Coast. Texas Agr. Exp. Sta. L. 313. 1956.

ACKNOWLEDGMENTS

Acknowledgment is made to M. J. Norris, associate agronomist, Substation No. 23, McGregor, project leader for Project H-719; E. R. Cozart, former junior agronomist, Substation No. 3, Angleton, who assisted in conducting the tests in 1953-55; and to the Phillips Petroleum Company, which furnished the ammonium sulfate fertilizer used in this test.

Location of field research units of the Texas Agricultural Experiment Station and cooperating agencies

State-wide Research

★

The Texas Agricultural Experiment Station is the public agricultural research agency of the State of Texas, and is one of the parts of the A&M College of Texas.

OPERATION

IN THE MAIN STATION, with headquarters at College Station, are 13 subject-matter departments, 3 service departments, 3 regulatory services and the administrative staff. Located out in the major agricultural areas of Texas are 20 substations and 10 field laboratories. In addition, there are 13 cooperating stations owned by other agencies. Cooperating agencies include the Texas Forest Service, Game and Fish Commission of Texas, Texas Prison System, U. S. Department of Agriculture, University of Texas, Texas Technological College, Texas College of Arts and Industries and the King Ranch. Some experiments are conducted on farms and ranches and in rural homes.

ORGANIZATION

THE TEXAS STATION is conducting about 450 active research projects, grouped in 25 programs, which include all phases of agriculture in Texas. Among these are:

- Conservation and improvement of soil
- Conservation and use of water
- Grasses and legumes
- Grain crops
- Cotton and other fiber crops
- Vegetable crops
- Citrus and other subtropical fruits
- Fruits and nuts
- Oil seed crops
- Ornamental plants
- Brush and weeds
- Insects
- Beef cattle
- Dairy cattle
- Sheep and goats
- Swine
- Chickens and turkeys
- Animal diseases and parasites
- Fish and game
- Farm and ranch engineering
- Farm and ranch business
- Marketing agricultural products
- Rural home economics
- Rural agricultural economics
- Plant diseases

Two additional programs are maintenance and upkeep, and central services.

Research results are carried to Texas farmers, ranchmen and homemakers by county agents and specialists of the Texas Agricultural Extension Service

AGRICULTURAL RESEARCH seeks the WHATS, the WHYS, the WHENS, the WHERES and the HOWS of hundreds of problems which confront operators of farms and ranches, and the many industries depending on or serving agriculture. Workers of the Main Station and the field units of the Texas Agricultural Experiment Station seek diligently to find solutions to these problems.

Today's Research Is Tomorrow's Progress