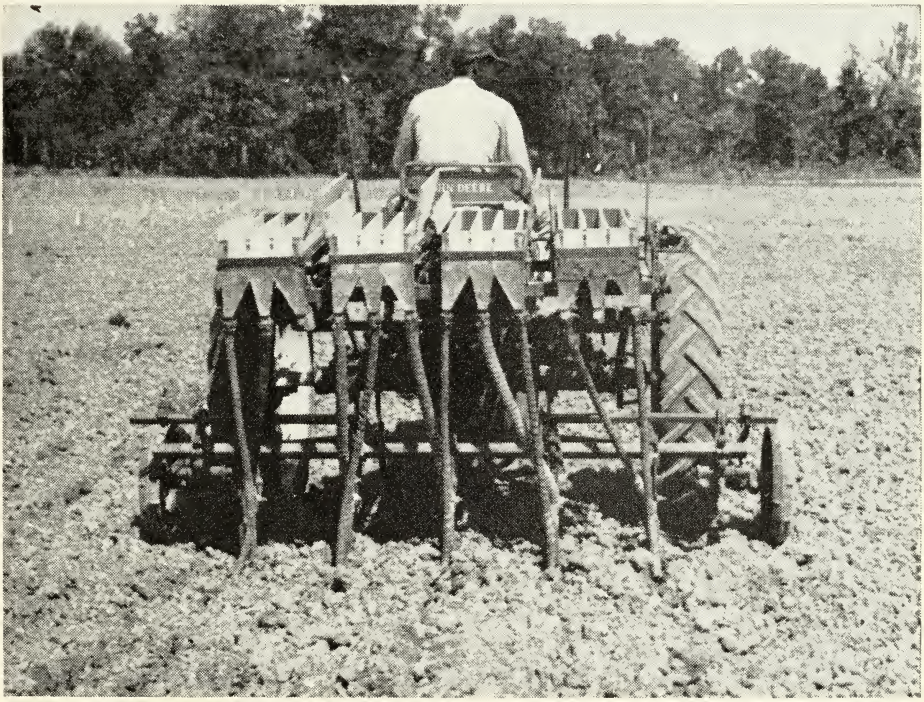
Higher Forage Yields With Closer Row Spacing



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Summary

The closer row spacings produced higher yields with all forages. Data indicate that the closer the spacing the greater the yield.

Narrow row spacings present a problem with equipment for seeding, cultivating, and harvesting forage. By proper use of chemicals, cultivating may be greatly reduced or eliminated.

Seeding may be accomplished with equipment now available if the row spacing is not less than 16 inches. However, harvesting presents a problem which requires additional research.

On the cover:
Figure 1. Machine for accurate seeding and fertilizer application of experimental field plots.

HIGHER FORAGE YIELDS WITH CLOSER ROW SPACING

BY T. N. JONES

An increase in production of quantity and quality forage is desirable to meet the demands of the growing livestock in dustry in this area. Since production of livestock will continue to be highly competitive, the economical production of quality forage is of great importance. It is generally recognized and accepted that the utilization of home grown forage is the cheapest source of energy and protein for ruminant animals.

Crop row spacings narrower than 40 inches have interested researchers for many years. Most of the research work pertaining to narrow rows has been con ducted in the corn belt with corn. Recent experiments show that by reducing the row width for forage crops in general from 40 to about 20 inches and doubling the distance between each plant in the row, an increase in yield may be expected. Today, 18 to 20 thousand plants per acre are recommended or twice the number previously used. This doubling of population means that twice as many plants are squeezed into the row. In other words, with 40-inch rows and 20 thousand plants or more per acre, the plants may be crowded in the row. One way to reduce crowding between plants in the row and make better use of the space between rows without changing population-per-acre is to decrease row width.

Equipment for Seeding Field Plots

In 1962, a study was initiated using four selected forages and seven row spacings to determine the influence on yield of the narrow row spacings.

It became evident early in the studies that the commercial equipment available was not accurate enough for applying seed and fertilizer for the field plot work. An experimental machine was built for this work. It consists of four endless belt hoppers, a toolbar with g a u g e wheels, permitting wide variations in row spacing. Each hopper is divided into three equal troughs. This permits using up to six boots or applicators at one time. This provides a trough for seed and one for fertilizer for each of the six applicators. The four hoppers are driven from a shaft which has a hand clutch built into the drive. Each belt is equipped with adjusting screws to assure continuous drive of all belts.

The experimental machine is set up to turn the endless belts one-half round in 21 feet of forward movement, by the tractor on the ground, thus dumping all seed and fertilizer from the belts in this distance. For experimental procedure, an 18' plot is harvested, cutting off 18 inches on each end of the plots, eliminating any drag in the equipment. The only human element left in the machine is that of placing the seed and fertilizer evenly on the belts. The upper part of the hopper is made of clear plastic materials, so the operation of the machine, seed and fertilizer is visible at all times.

The material from each trough falls into a separate flexible hose and is carried directly to the applicators. The applicators may be spaced at any desired row width on the toolbar.

In planting test plots, accuracy is the major objective. At the same time speed is desirable. To maintain accuracy and still obtain fair speed the following method of measuring the amount of seed and fertilizer has been found satisfactory. Determine by weight the amount of seed and fertilizer to be placed per row. Then make or cut a cylinder or container which will hold this exact amount when filled and leveled off across the top. These containers must

be marked to identify them readily with the material with which they will be used. In a test of row spacing of four forages, seven row spacings and two seeding and fertilization rates were used. This test replicated eight times, just under 600 plots, required detailed planning not only for planting and producing but also for obtaining data during production and harvesting.

This machine has many possible uses in research, such as studies on fertilizer placement, rate, and seeding of crops. The endless belts will handle any type of seed, fertilizer, or combination of the two.

Four Forages Tested

The objectives of these tests with four forage crops was to determine if the narrow row spacing would significantly increase the yield of forage per acre. If increases were obtained by the narrow row spacing, then a major machinery problem of harvesting was involved and agricultural engineering research could be directed to this problem.

Two other factors were incorporated in the test, namely rate of seeding and fertilization. Row spacings were 16, 20, 24, 28, 32, 36, and 40 inches. The forages selected for the test were grain sorghums RS-610 and FS-1A, sorghum Dekalb 50B, and corn Pioneer. Each row spacing combination received two treatments as follows: Treatment 1, a given amount of seed and fertilizer per acre and Treatment 2, a given amount of seed and fertilizer per row regardless of row spacing.

The test was laid out in a standard lattice design with each treatment having seven replications. The two grain sorghums and the sorghum produced two crops each year from one seeding, while corn produced only one.

Each year after the plots were seeded, a chemical for weed control was applied broadcast as a spray. None of the plots received any cultivation or additional fertilizer.

Results Row Spacing Test 1962-65

Grain Sorghum RS-610: Table 1 shows results obtained with this crop. Row spacing is the only variable in Treatment 1. By reducing the spacing from 40

Table 1. Yield of RS-610 grain sorghum in row spacing test at State College, Mississippi.

Row space	1962	1963	1964	1965	Average	Percent increase over 40"
			Pounds of dry matter per acre			
Treatment 1: Set amount of seed and fertilizer per acre						
16"	16,662	14,701	17,968	12,277	15,402	70
20"	15,290	14,767	12,545	11,853	13,614	50
24"	13,504	13,939	13,286	8,668	12,349	36
28"	12,975	12,228	12,881	8,704	11,697	29
32"	12,415	11,189	9,311	6,158	9,768	14
36"	10,817	11,689	8,712	6,230	9,362	3.0
40"	10,781	10,781	9,017	5,798	9,094	----
Double rows		12,153	5,750	------	8,951	2.0
Treatment 2: Set amount of seed and fertilizer per row						
16"	20,092	17,642	20,582	12,839	17,789	94
20"	16,858	18,034	13,329	11,104	14,831	62
24"	16,226	14,157	12,850	8,382	12,904	41
28"	13,908	13,161	13,815	7,711	12,149	33
32"	13,313	11,598	9,474	5,827	10,053	10
36"	10,600	12,387	8,567	6,516	9,518	4.0
40"	11,042	10,912	9,017	5,653	9,156	----
Double rows		14,375	6,403	------	10,389	13

Figure 2. Good weed control was obtained by broadcast chemical treatments immediately after planting.

inches to 16 inches, the yield of forage was increased 6,308 lbs. dry matter per acre, or 70 percent. One of the big increases in yield, 21 percent, is between 32- and 28-inch spacing. The other big increase, 20 percent, is from 20- to 16-inch spacing. It may be observed that the yield increased progressively as the row spacing was reduced.

The statement for the two treatments must be understood before these data become of any value. For **Treatment 1,** the statement is as follows: "Set amount of seed and fertilizer per acre". For **Treatment 2,** the statement reads, "Set amount of seed and fertilizer per row regardless of spacing", which means fertilizer (13-13-13) as follows: 40- and 36-inch rows, 400 lbs.; 32- and 28-inch spacing, 800 lbs.; and 16-inch, 1000 lbs. per acre.

The increase in yield for **Treatment 2** using RS-610 was from 9,518 lbs. on 40-inch spacing to 17,789 lbs. on 16-inch spacing or 94 percent. How much of this was due to row spacing, and how much to increase in fertilizer? The 40-inch spacings for the two treatments should theoretically be the same and in this test they were close: therefore, by subtracting percent increases, it is found that a 250 percent increase in fertilizer gave 24 percent increase in yield. The $22.50 invested in fertilizer gave a return of 2,387 lbs. of dry forage worth $24.35. Costs of seedbed preparation, cultivation, and chemicals do not change, regardless of yield. With higher yields, less acres would be needed to produce the required forage.

Grain Sorghum FS-1A: Yields of this crop are shown in Table II. In Treatment 1 reduction of row spacing from 40 inches to 16 inches gave the following yields: for 40 inches, 14,374 lbs.; for 16 inches, 21,510 lbs. or an increase of 50

Table 2. Yield of FS-1A grain sorghum in row spacing test at State College, Mississippi.

Row space	1962	1963	1964	1965	Average	Percent increase over 40"
			Pounds of dry matter per acre			
Treatment 1: Set amount of seed and fertilizer per acre						
16"	22,542	17,478	22,689	23,332	21,510	50
20"	22,085	15,682	19,602	22,922	20,073	40
24"	21,018	15,028	18,295	25,771	20,028	39
28"	17,082	11,948	16,802	19,630	16,366	14
32"	18,050	12,170	13,558	17,305	15,271	6.0
36"	17,206	12,342	13,213	18,834	15,399	7.0
40"	16,531	11,761	16,074	13,211	14,394	---
Double rows		13,852	12,153	------	13,002	10
Treatment 2: Set amount of seed and fertilizer per row						
16"	33,977	18,132	26,136	24,354	25,650	84
20"	29,664	17,250	21,693	20,182	22,197	59
24"	23,522	13,177	20,255	23,074	20,007	43
28'	23,896	13,068	17,735	15,144	17,461	25
32"	19,602	12,170	15,355	16,987	16,028	15
36"	20,328	12,124	15,827	15,803	16,020	15
40"	17,576	10,781	15,812	11,759	13,982	
Double rows		14,898	10,454	...	12,676	9.0

Table 3. Yield of Dekalb sorghum in row spacing test at State College, Mississippi.

Row space	1962	1963	1964	1965	Average	Percent increase over 40"
			Pounds of dry matter per acre			
Treatment 1: Set amount of seed and fertilizer per acre						
16"	18,459	20,255	16,988	10,184	16,472	69
20"	16,988	17,199	13,852	7,599	13,890	42
24"	18,186	15,899	11,761	7,062	13,277	35
28"	15,961	16,055	10,641	6,090	12,187	25
32"	14,456	12,496	9,801	5,118	10,468	7.0
36"	14,230	13,576	7,986	5,616	10,452	6.0
40"	12,153	13,656	8,625	4,654	9,772	----
Double rows		18,557	7,187	------	12,872	32
Treatment 2: Set amount of seed and fertilizer per row						
16"	24,829	21,889	17,315	9,585	18,404	85
20"	20,517	18,557	14,113	7,675	15,216	54
24"	17,860	16,988	11,326	7,789	14,491	37
28"	17,082	14,281	12,135	4,490	11,997	21
32"	17,723	12,088	8,821	4,029	10,665	8.0
36"	13,576	13,576	10,164	4,527	10,461	6.0
40"	15,028	13,460	7,710	4,343	9,885	....
Double rows		18,577	6,403	------	12,490	26

percent. This forage was the highest producer in the test so far as tons are concerned, but it would not be the best forage for many producers (because of its low grain to stover ratio.) It is least affected by the narrow row spacing of the forages in the test, with only 50 percent increase in yield resulting from reducing the row spacing from 40 inches to 16 inches.

In Treatment 2, 40-inch rows produced 13,982 lbs., and the 16-inch rows produced 25,650 lbs. an increase of 84 percent. Since FS-1A was the highest yielding forage in the test, this was the largest increase in the entire test.

Sorghum-Dekalb: Table III shows results with this crop. In Treatment 1 the

Table 4. Yield of corn (Pioneer) in row spacing test at State College, Mississippi.

Row space	1962	1963	1964	1965	Average	Percent increase over 40"
			Pounds of dry matter per acre			
Treatment 1: Set amount of seed and fertilizer per acre						
16"	3,104	12,088	13,068	14,770	10,758	80
20"	3,136	10,062	9,670	12,216	8,771	48
24"	3,267	11,108	9,148	10,783	8,576	44
28"	2,053	9,241	10,641	8,209	7,536	27
32"	2,450	9,066	7,024	6,311	6,213	5.0
36"	2,468	9,220	6,824	6,269	5,945	----
40"	2,483	8,494	6,795	5,997	5,942	----
Double rows		9,932	4,966	------	7,449	25
Treatment 2: Set amount of seed and fertilizer per row						
16"	3,757	12,905	15,028	15,270	11,740	95
20"	3,267	13,983	10,977	12,778	16,251	70
24"	3,267	11,761	8,712	10,297	8,509	41
28"	2,250	11,201	9,894	8,324	7,917	32
32"	2,777	10,699	7,514	7,004	6,998	16
36"	2,323	10,600	7,841	5,224	6,497	8.0
40"	2,287	8,364	7,449	6,027	6,032	----
Double rows		11,108	5,096	------	8,102	34

increase in yield from 9,772 to 16,472 lbs. for the 40- to 16-inch spacing was 69 percent. The increase in yield from increased use of seed and fertilizer was less with silage sorghum than any other forage in the test. Since this is a large growing forage, water might cause such a limited difference.

In Treatment 2 the 40-inch rows produced 9,885 lbs., as compared to 18,404 lbs. for the 16-inch rows, or an increase of 85 percent. This is only 16 percent increase in forage for an increase of 50 percent in seed and fertilizer as compared to the 16-inch spacing in Treatment 1

Corn-Pioneer; This forage (Table IV) produced only one crop per seeding in comparison of two crops for the other three forages. If corn is to be grown for silage, the plants per acre must be high, along with proper fertilization and water application. An increase in yield of 80 percent was obtained between 40- and 16-inch row spacings in Treatment 1.

There are two interesting results from treatment 2. One is the big increase of 34 percent of double rows. This is important because the present equipment will harvest this type of row spacing (two rows 7 inches apart on each bed) with 40-inch centers on beds. The other interesting factor concerns water and fertility. The 1962 results definitely point out lack of moisture, and the other three years' results point out that fertility without water will not produce corn for forage where the plant population is high The only difference in the double rows and 20-inch spacing on this treatment is the spacing, both receiving the same amount of seed and fertilizer. Yet, the 1964 yield was more than doubled on the 20-inch spacing.

Four Crops Compared: Summarized data presented in Table V is the average of four years' work of seven row spacings, using two treatments on four selected forage crops.

These data clearly show that narrow row spacing increases the yield per acre and permits the farmer to produce greater quantities of quality feed on fewer acres.

Results of row spacing studies using different rates of seeding and fertilization show that the yield of certain forages may be increased 63 percent by 16-inch

row spacing instead of 40 inches. (Same seeding and fertilization rates per acre.) An additional 25 percent yield increase may be obtained with optimum seeding and fertilization.

The significant difference in yield of corn and the other forages may be observed in Table V. These data also show that the increase in yield as the row spacing is decreased forms almost a perfect regression curve.

It is generally agreed that corn is the best crop now available for forage or silage. However, due to soils and weather, some areas cannot produce a satisfactory corn crop every year without supplemental water. Therefore, other crops such as grain sorghum, sweet sorghums, and sorghum-sudan hybrids are grown in many areas of the South for forage, the reason being that these crops will produce more forage with less water. They have the ability to withstand the short droughts and make a quick recovery.

This is the main reason that corn is not used more extensively for silage. Attention is invited to Table IV for a look at the spread in yield for the four years. One does not have to go to the weather records to know that 1962 was very dry at a critical time for the growth of corn. The increase in yield of the four forages (Table V) was affected more by row spacing than any other factor. The type of forage had little or no effect.

To obtain the desired results with a forage program, a particular forage or forages must be selected that will meet the needs of a producer. The dairy and beef producers both want a quality forage but may not need the same grain-stover ratio. Generally, the stage of maturity of the forage may determine to a large extent the quality. In planning a forage program, the planting dates should be scheduled so that any one planting can be harvested within a period of one week. Sometimes two varieties of forage with different number of days to maturity will solve this problem.

Other research work concerning row spacing, seeding rates, and varieties of forages conducted by the Agronomy Department of Mississippi State University show results similar to those given in this report.

The close row spacing presents a machinery problem in production and harvesting of forage for silage. This is the area in which we hope to adapt, design and construct some equipment in order that the farmer may take full advantage of these important yield increases.

Table 5. Comparison of forage yields, in dry matter per acre, for four crops used in row spacing study, 4-year averages.

Row spacing	Corn	RS-610	FS-1A	Dekalb-50A	Average	Percent increase over 40"
			Pounds of dry matter per acre			
Treatment 1: Set amount of seed and fertilizer per acre.						
16"	10,728	15,402	21,555	16,472	16,039	63
20"	8,771	13,614	20,073	13,890	14,087	44
24"	8,576	12,349	20,008	13,227	13,540	38
28"	7,536	11,697	16,366	12,187	11,946	23
32"	6,213	9,768	15,271	10,468	10,630	8.0
36"	5,945	9,362	15,399	10,352	10,264	5.0
40"	5,942	9,094	14,394	9,772	9,800	—
Treatment 2: Set amount of seed and fertilizer per row.						
16"	11,740	17,789	25,650	18,404	18,395	88
20"	10,251	14,831	22,197	15,216	15,623	60
24"	8,509	12,094	20,007	13,491	13,728	41
28"	7,985	12,149	17,461	12,110	12,426	27
32"	6,998	10,053	16,028	10,665	10,936	12
36"	6,497	9,542	16,020	10,461	10,630	9.0
40"	6,032	9,156	13,982	9,885	9,763	—