EVALUATION OF QUALITY FACTORS FOR EIGHT ANNUAL FORAGE GRASSES

By

JAMES EDWARD STROIKE

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1964

Submitted to the faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
May, 1967

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EIGHT ANNUAL FORAGE GRASSES

Thesis Approved:

Charles E. Denman
Thesis Adviser

David A. Sands

O. M. Durham
Dean of the Graduate College

ACKNOWLEDGMENT

The author wishes to take this opportunity to express his sincere appreciation to his major adviser, Professor C. E. Denman, for his guidance and encouragement throughout the course of this study. Also I would like to extend my thanks to Dr. David A. Sander, Dr. Billy Tucker, and Dr. Robert Noble for their assistance while serving on my graduate committee. A special thanks to Dr. James E. Webster for his guidance and help in making the facilities available for use for the protein evaluation in this study. I would also like to thank my co-workers, Kenneth Richardson, Jack Lollar, and Wesley Thurman for their help in the field work involved in this study.

The author wishes to also thank his wife, Janet, for her help and patience during this study.

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CHAPTER I

INTRODUCTION

Sudangrass is a rapid growing annual forage species, originally introduced from Africa as a result of a search directed by C. V. Piper for a sorghum that lacked the aggressive rootstocks of johnsongrass (25). The crop is best suited to warm climates. Its short growing season and tolerance to drought makes it a valuable summer supplemental crop for pasture, hay, or silage.

Extensive research has been done on the management factors that affect forage quality. Only a limited amount of research has been done concerning the chemical composition of individual parts of the plant, and their relationship to each other.

As the livestock producer becomes more concerned about the quality of forage fed, it becomes increasingly more important to know the feeding value of forage crops that might be used.

Forage grasses such as pearl millet and sudangrass are very useful as supplemental forage crops because their maximum growth occurs during the late summer months when many perennial grasses produce poorly.

This study was initiated to evaluate the forage quality of Lahoma sweet sudangrass, sorghum-sudangrass hybrids, varieties SX-11 and SX-12, a sorgo-sudangrass hybrid, variety Sweet Sioux and a true sudangrass hybrid, variety Trudan II. Also included were a Piper Sudangrass X *Sorghum propinquim* cross, variety PxP, and an improved pearl millet,

variety Gahi-1.

CHAPTER II

REVIEW OF LITERATURE

The stems and leaves of forages differ considerably in their chemical composition. Hostermann (19) analyzed parts of the timothy plant at different stages of maturity and found the leaves were the greater part of the plant at the early bloom stage and contained the larger percent of protein. The heads contained a higher percent of protein as the plant matured. Griffith (15) determined a leaf-stem ratio of six annual forage grasses in 1963 and found approximately 75% of the total plant protein was found in the leaves. He concluded that, in general, the percentage of protein followed the same pattern as the percentage of leaves. Craigmiles (8) found the average total digestible nutrients for Starr, Browntop, and Common millet forage stems and leaves to be 61.3% and 60.4% respectively, and Tift and Common sudangrass stems and leaves 62.3% and 65.0% respectively. Craigmiles concluded that the percent protein varies with the maturity of the plant as well as between parts of the plant.

Sotola (28) made a chemical analysis of alfalfa and presented the following results of the percentage of digestible nutrients in the stems, whole hay and leaves: stems, 4.17% digestible crude protein and 41.55% total digestible nutrients; whole hay, 9.77% digestible crude protein and 48.43% total digestible nutrients; and leaves 14.87% digestible crude protein and 57.81% total digestible nutrients. Baker (1) in a study of

the consumption of sudangrass by dairy cows found that the intake of nutrients by grazing cows was quite variable, but was usually sufficient to support a level of milk production of about 35 pounds of 4% FCM (Fat-corrected milk) without supplementation with concentrates. Denman (11) made a leaf-stem ratio analysis of Lahoma, Piper, and Tift sudangrasses, and found Lahoma produced more leaves which indicates higher quality forage, because grazing animals prefer leaves to stems, and leaves contain more digestible nutrients. In an analysis of tropical grasses Dirven (12) found crude protein and fats were considerably higher in leaves, and crude fiber was usually higher in stems. This correlation between crude fiber and crude protein has been reported by others (6, 8, 19).

Sullivan (33) stated that the stage of growth is undoubtedly the most important factor influencing the composition of grasses. Stallcup (29) conducted an approximate analysis for three stages of growth of Piper Sudangrass (18-24 inches in height; 36-48 inches in height; and boot to early-head stage) and obtained the following results in the order listed: crude protein, 16.8%, 12.8%, and 9,7%; crude fiber, 24.1%, 31.1%, and 34.7%. Rusoff (27) reported the percentage of crude protein declined significantly at each successive stage of cutting in sudan and millet forages. The mean value dropped from 13.1 to 5.9% at the first and last cuttings, respectively. He also found that lignin progressively increased with plant maturity. Jung (20) stated that yields increased and digestibility decreased with advancement in maturity of sudangrass. From a study of the chemical composition of some forage grasses, Phillips (24) found that during the progress of maturation, the grasses underwent continuous decreases in protein, acid-soluble ash, and ether extract,

and continuous increase in lignin. In general many studies (9, 13, 17, 18, 39) have shown significant negative correlation coefficients between crude protein and crude fiber as related to plant maturity.

The real objective in any study of the chemical composition of forages is to obtain an indication of their nutritive value. The chemical changes resulting from maturation are greater than those arising from any other factors. Louw (22) has found such changes to be associated, at least partly, with changes in feeding value in that they are accompanied by a lowering of digestibility. Digestibility and intake data were determined on chopped, green sudangrass fed to sheep at various stages of maturity by Reid (26). He found the feeding value decreased markedly with increasing maturity. Stallcup (30) showed there was a highly significant negative correlation between the lignin content of the hay and the percent removal of lignin, ash, and protein from the rumen in 12 hours. This indicates the importance of lignin content in hay because of its influence on the digestibility of the forage, and because it slows up the passage of nutrients through the rumen, thus reducing the physical capacity of the animal for more roughage at the next feeding. In a study of three systems of summer management of late fall in Situ utilization of sudangrass and forage sorghum, Burns (5) found a linear increase in percent crude fiber within each system of management after frost.

Crude protein and crude fiber fractions have generally been used as criteria for forage quality. Crampton and Maynard (10) proposed that lignin is not only unavoidable to the ruminant but also has an adverse effect on the availability of other constituents.

The proper management of forage grasses throughout its growing

season will provide for an ultimate increase in forage quality and quantity. Many studies have been made on forage grass management practices. The effect of management practices in the production of Blue Panicgrass studied by Wright (39) suggest the desirability of harvesting at the early stage of maturity, leaving a minimum stubble height of 12 inches, and applying 500 to 700 pounds of nitrogen per acre. After a study of the effect of cutting height on sudangrass, Thurman (37) found varietal differences within the same species, and that proper cutting height should be determined for each variety and type. Mays and Washko (23) found by chemical analysis that forage harvested at six to eight inches was somewhat higher in protein and TDN and lower in fiber than that harvested at two to four inches in height. But the forage removed at six and eight inches was not sufficiently superior in nutritional value to offset the yield advantage from two inch and four inch harvests.

Burger (4) found that drilled sudangrass produced higher original stand counts, smaller original stem diameter, and more herbage than when broadcast. Also, he found that row width or seeding rate had no significant effect on herbage yields. In contrast, Sumner (36) found the production from sudangrass pastures can be increased by more than 20% when row widths are changed from 12 to 18 inches. Row widths greater than 18 inches resulted in lowered yields.

Koller and Clark (21) found that the quality of sudangrass forage at the initial harvest decreased as plant population increased under pasture management. At the second harvest, forage quality improved as plant density increased due to depression of regrowth in the dense population.

Studies by Broyles and Fribourg (3) on fertilization and cutting

management of sudangrass and millet have shown that as cutting intensities decreased and the height of grasses increased, there was a general decrease of percent nitrogen in the harvested forage. With increases in nitrogen fertilizer applications from zero to 120 pounds of nitrogen per acre, there was a corresponding increase in dry matter yields, nitrogen yields, and nitrogen percentages of the harvested forage. A study with Piper sudangrass by Sumner (35) showed that 200 pounds of nitrogen is about the optimum amount to apply to sudangrass to be used for pasture or greenchop when considering total dry matter, protein yield, and efficiency of utilization. A split application might be more desirable in that dry matter and protein yields would tend to be more uniformly distributed throughout the season. A study of different fertilizer treatments on sudangrass by Chinwala (7) indicated there were significant differences in yield among varieties and among treatments of fertilizer, but there was no interaction between variety and treatment. He found that the application of 60 pounds of nitrogen and 30 pounds of phosphorus at seeding time, with or without potassium, and 60 pounds of nitrogen after each cutting, significantly increased the yields of all varieties.

The sorghum-sudangrass hybrids, sudangrass varieties, and millet varieties differ considerably in yield. Staten and Holt (31) found that in general the sorghum-sudangrass hybrids produced the greatest forage yields, averaging 20% to 50% greater production than the standard sudangrass varieties. They also noted that sorghum-sudangrass hybrids tended to have a lower leaf percentage than standard sudangrasses. This yield advantage between sorghum-sudangrass hybrids and sudangrass has been found in other studies (13, 14, 16).

Burton (6) found that the young leaf blades from the top of heading

CHAPTER III

METHODS AND MATERIALS

In the summer of 1964 a study was initiated to evaluate quality factors of annual forage grasses. Six varieties were used in 1964, and two varieties were substituted in 1965. Thus eight annual forage grass varieties (Table I) were tested during the two year period. The study was conducted at the Agronomy Research Farm, Perkins, Oklahoma, on a Vanoss silt loam soil.

The purpose of this study was to evaluate the relative percentages of leaves and stems for each variety of annual forage grass harvested at three stages of maturity; namely, the pasture stage (24 inches in height), the hay stage (early boot), and the mature stage (95% flowering). Harvests were made at these stages initially and each time regrowth on the respective plots reached the proper stage. Leaf and stem separations were made and crude protein determinations were conducted by the Kjeldhahl procedure on both leaves and stems for each variety at each harvest.

The field layout consisted of a randomized block design with four replications. Each plot consisted of five rows, 12 inches apart and 12 feet long. The nine foot area remaining after one and one-half foot borders were removed from each end of the plot was the main plot. This was then divided into three sub-plots for the three treatments.

All varieties were seeded with a one-row hand operated Planet

TABLE I

VARIETIES OF EIGHT ANNUAL FORAGE GRASSES ENTERED
IN A FORAGE QUALITY EVALUATION STUDY

Variety		Type
Piper	Sorghum sudanense, Hitchc.	Common Sudangrass
PxP	Sorghum sudanense, Hitchc. x Sorghum propinquim	Piper x Sorghum propinquim
Lahoma	Sorghum sudanense, Hitchc.	Sweet Sudangrass
SX-11	Sorghum vulgare, Pers. x Sorghum sudanense, Hitchc.	Sorghum-Sudangrass hybrid
SX-12	Sorghum vulgare, Pers. x Sorghum sudanense, Hitchc.	Sorghum-Sudangrass hybrid
Trudan II	Sorghum sudanense, Hitchc. x Sorghum sudanense, Hitchc.	Sudangrass hybrid
Sweet Sioux	Sorghum vulgare, Pers. x Sorghum sudanense, Hitchc.	Sorgo-Sudangrass hybrid
Gahi-1	Pennisetum glaucum, R. Br.	Hybrid Pearl millet

Junior garden planter. Piper, Lahoma, PxP, and Trudan II were seeded at 15 pounds per acre. Sweet Sioux, SX-11, and SX-12 were seeded at the rate of 20 pounds per acre. Gahi-I Pearl Millet was seeded at the rate of eight pounds per acre. Fertilization consisted of 100 pounds of 33.5-0-0 per acre applied after each harvest. The first application was made with a Gandy spreader. The remaining applications were broadcasted by hand.

Supplemental water was used periodically during June, July, and August of 1964, applying approximately eight inches of water by five applications with sprinkler irrigation. In 1965 flood irrigation was necessary to maintain the plots during the extreme drought of July and August. Two applications were made supplying a total of approximately two inches of water.

A varying number of cuttings were made depending on the stage of harvest. In 1964, four harvests were made at the pasture stage, three harvests at the hay stage, and one harvest at the mature stage. In 1965, three harvests were made at the pasture and hay stages, and one harvest at the mature stage.

On each harvest date the forage from the three middle rows was cut with a hand sickle at a height of approximately three inches. The forage was then separated into leaves and stems. Green weight measurements were taken from each plot. The entire plot yield was then oven-dried in a forced air oven at approximately 150 degrees Fahrenheit for 72 hours. After dry weights were recorded, a random sample of leaves and stems was collected for protein determination.

In 1964 the sample collected for crude protein determinations represented each variety for each cutting. Thus the four replications

were bulked before sampling.

Statistical analysis of the data collected was conducted as outlined by Steele and Torrie (32). The results are not reported since significant differences were found for all treatments.

CHAPTER IV

RESULTS AND DISCUSSION - 1964

The percentages of leaves and stems for the six annual forage grass varieties grown in 1964 are shown in Table II according to harvesting stages. In the pasture stage Lahoma had the highest percent leaves with 77%, and the lowest percent stems with 23%. All other varieties were similar, ranging from 58% to 66% leaves. In the hay stage Gahi-1 had the highest percent leaves with 64%, and the lowest stem percentage with 36%. Lahoma was second highest in leaf percentage at 60%. Sweet Sioux had the lowest leaf percentage with 49%. All leaf percentages were low in the mature stage, with Lahoma again having the best leaf-stem ratio with 44% leaves and 56% stems. Sweet Sioux was lowest in leaf percentage and highest in stem percentage with 28% leaves and 72% stems in the mature stage.

Adequate moisture and optimum growing conditions prior to the first harvest is evident in the comparison of leaf yields from the first to the fourth harvest of the pasture stage as shown in Table III. Leaf production was generally higher in the first and second cuttings than in the third and fourth cuttings. Varieties SX-11, Sweet Sioux, and Gahi-1 produced the best leaf yields in the first harvest, but Gahi-1 was the only variety that maintained high leaf forage yields throughout the season. For the pasture stage, Lahoma was consistently low in stem yield for all cuttings, whereas Gahi-1 was more variable, with low yield

TABLE II

LEAF AND STEM PERCENTAGES OF SIX ANNUAL FORAGE GRASS VARIETIES ON A DRY WEIGHT BASIS, PERKINS, OKLAHOMA, 1964

Varieties	Pasture State		Hay Stage		Mature Stage	
	% Leaves	% Stems	% Leaves	% Stems	% Leaves	% Stems
Piper	62	38	52	48	33	67
PxP	66	34	53	47	33	67
Gahi-1	65	35	64	36	35	65
Sweet Sioux	58	42	49	51	28	72
Lahoma	77	23	60	40	44	56
SX-11	63	37	53	47	27	73

TABLE III

LEAF AND STEM FORAGE YIELD OF SIX ANNUAL FORAGE GRASS VARIETIES AT THE PASTURE STAGE, PERKINS, OKLAHOMA, 1964 (GRAMS OF DRY WEIGHT)

Variety	Cutting							
	1		2		3		4	
	Leaves	Stems	Leaves	Stems	Leaves	Stems	Leaves	Stems
Piper	98	69	93	55	90	49	68	39
PxP	94	42	99	57	94	51	100	47
Gahi-1	143	21	147	80	139	74	126	122
Sweet Sioux	153	108	89	53	99	71	101	85
Lahoma	108	35	79	23	83	24	38	11
SX-11	169	84	113	65	114	90	98	56

in the first cutting and high yield in the last cutting.

The leaf percentages in the pasture stage, Table IV, are quite different from that of the leaf forage yields. Lahoma maintains a more consistently higher percentage of leaves, whereas Gahi-1 has the highest percent leaves in the first cutting but the lowest percent leaves in the last cutting.

TABLE IV

LEAF AND STEM PERCENTAGES OF SIX ANNUAL FORAGE GRASS VARIETIES AT THE PASTURE STAGE, PERKINS, OKLAHOMA, 1964

	Cutting							
	1		2		3		4	
Variety	Leaves	Stems	Leaves	Stems	Leaves	Stems	Leaves	Stems
Piper	59	41	63	37	65	35	63	37
PxP	69	31	64	36	65	35	68	32
Gahi-1	87	13	65	35	65	35	51	49
Sweet Sioux	59	41	63	37	58	42	54	46
Lahoma	75	25	77	23	78	22	77	23
SX-11	67	33	63	37	56	44	64	36

Leaf yields in the hay stage were reduced greatly as the season progressed (Table V). Gahi-1, Sweet Sioux, and SX-11 varieties were the most pronounced in this decrease of leaf production. Stem forage yield was high for Sweet Sioux and SX-11 varieties, while Gahi-1 produced lower than the average stem yield.

With the exception of Gahi-1, all varieties produced a higher percentage of leaves as the season progressed in the hay state (Table VI). Gahi-1 again had the highest percent leaves in the first harvest and the lowest percent leaves in the last harvest. Lahoma showed the greatest

increase of leaf percentage throughout the forage season.

TABLE V

LEAF AND STEM FORAGE YIELD OF SIX ANNUAL FORAGE GRASS VARIETIES AT THE HAY STAGE, PERKINS, OKLAHOMA, 1964 (GRAMS OF DRY WEIGHT)

	Cutting					
	1		2		3	
Variety	Leaves	Stems	Leaves	Stems	Leaves	Stems
Piper	144	154	108	91	53	42
PxP	133	138	98	79	60	41
Gahi-1	286	127	108	61	77	76
Sweet Sioux	234	310	99	79	122	92
Lahoma	171	123	91	58	27	9
SX-11	220	229	102	73	108	79

TABLE VI

LEAF AND STEM PERCENTAGES OF SIX ANNUAL FORAGE GRASS VARIETIES AT THE HAY STAGE, PERKINS, OKLAHOMA, 1964

	Cutting					
	1		2		3	
Variety	Leaves	Stems	Leaves	Stems	Leaves	Stems
Piper	48	52	54	46	56	44
PxP	49	51	55	45	59	41
Gahi-1	69	31	64	36	50	50
Sweet Sioux	43	57	55	45	57	43
Lahoma	58	42	61	39	76	24
SX-11	49	51	58	42	58	42

In the mature stage (95% flowering) Gahi-1 produced the most total forage, with the highest yield of both leaves and stems (Figure 1).

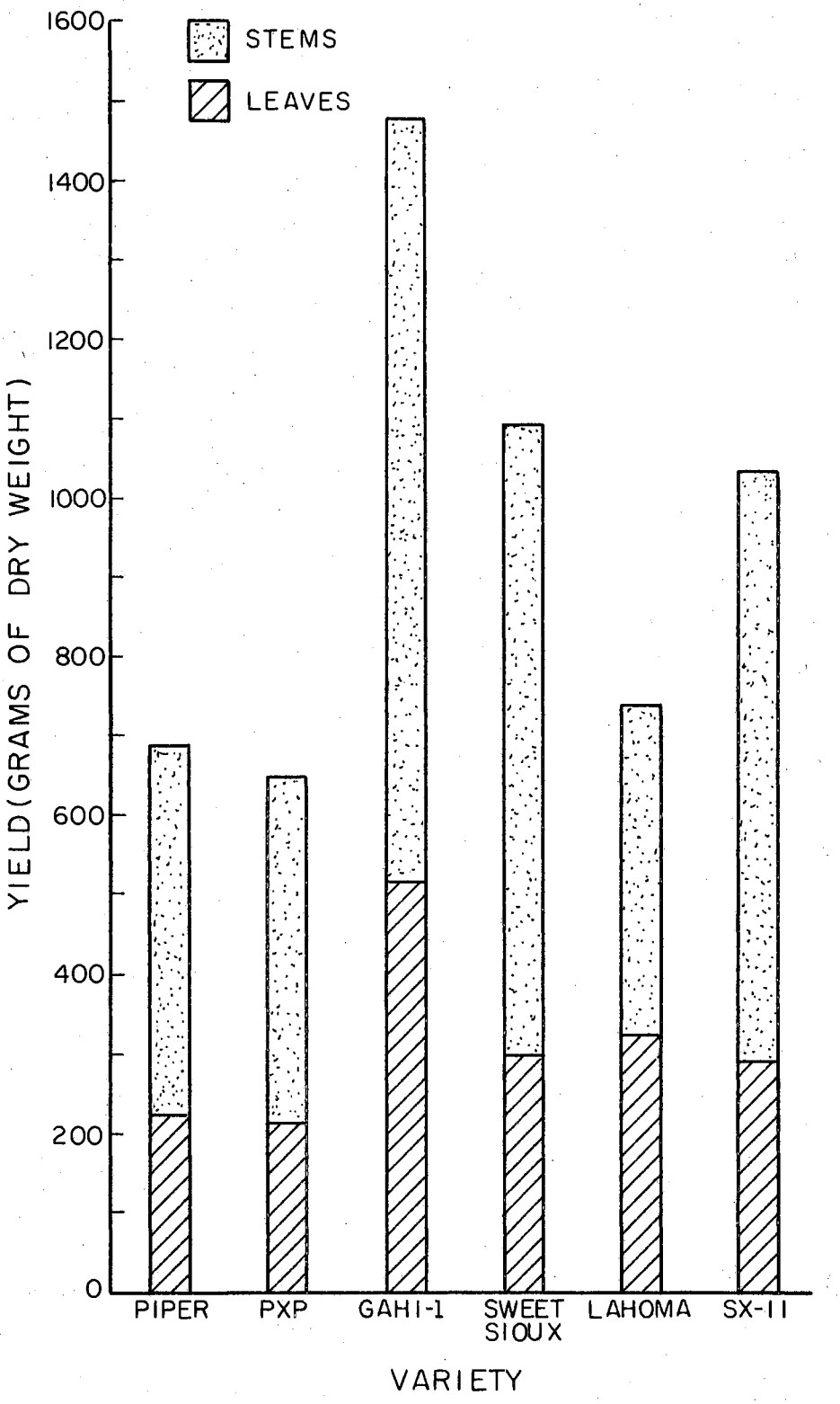

Figure 1. Leaf and Stem Forage Yield of Six Annual Forage Grass Varieties at the Mature Stage, Perkins, Oklahoma, 1964.

Lahoma, however, had the best ratio of leaves and stems with 44% leaves and 56% stems (Figure 2).

Sweet Sioux, Gahi-1, and SX-11 all produced high total forage yields. Gahi-1 was highest in both the pasture and mature stages as shown in Table VII. Sweet Sioux had the highest total yield in the hay stage. These three varieties also had the highest stem percentages, which accounts for their high total forage yields.

TABLE VII

TOTAL YIELD IN POUNDS OF FORAGE PER ACRE OF SIX ANNUAL FORAGE GRASS VARIETIES, PERKINS, OKLAHOMA, 1964

Variety	Pasture Stage			Hay Stage			Mature Stage		
	Leaves	Stems	Total	Leaves	Stems	Total	Leaves	Stems	Total
Piper	3715	2249	5964	3251	3057	6308	2388	4893	7281
PxP	4115	2089	6204	3091	2750	5841	2303	4626	6929
Lahoma	3251	981	4232	3070	2015	5085	3475	4413	7888
Sweet Sioux	4712	3369	8081	4840	5127	9967	3219	8411	11,630
Gahi-1	5906	3795	9701	5010	2804	7814	5565	10,234	15,799
SX-11	5255	3134	8389	4584	4051	8635	3027	8038	11,065

Table VIII shows the total protein production based on total forage for the six varieties tested at the various stages of harvests for 1964. SX-11 had the highest protein yield in the pasture stage, with Gahi-1 following closely. Both varieties produced a high percent of protein in leaves. Sweet Sioux was the best producer of protein in the hay stage, while Gahi-1 was the best in the mature stage. Figures 3, 4, and 5 graphically illustrate the percent of protein found in the leaves and stems of each variety for each stage of harvest.

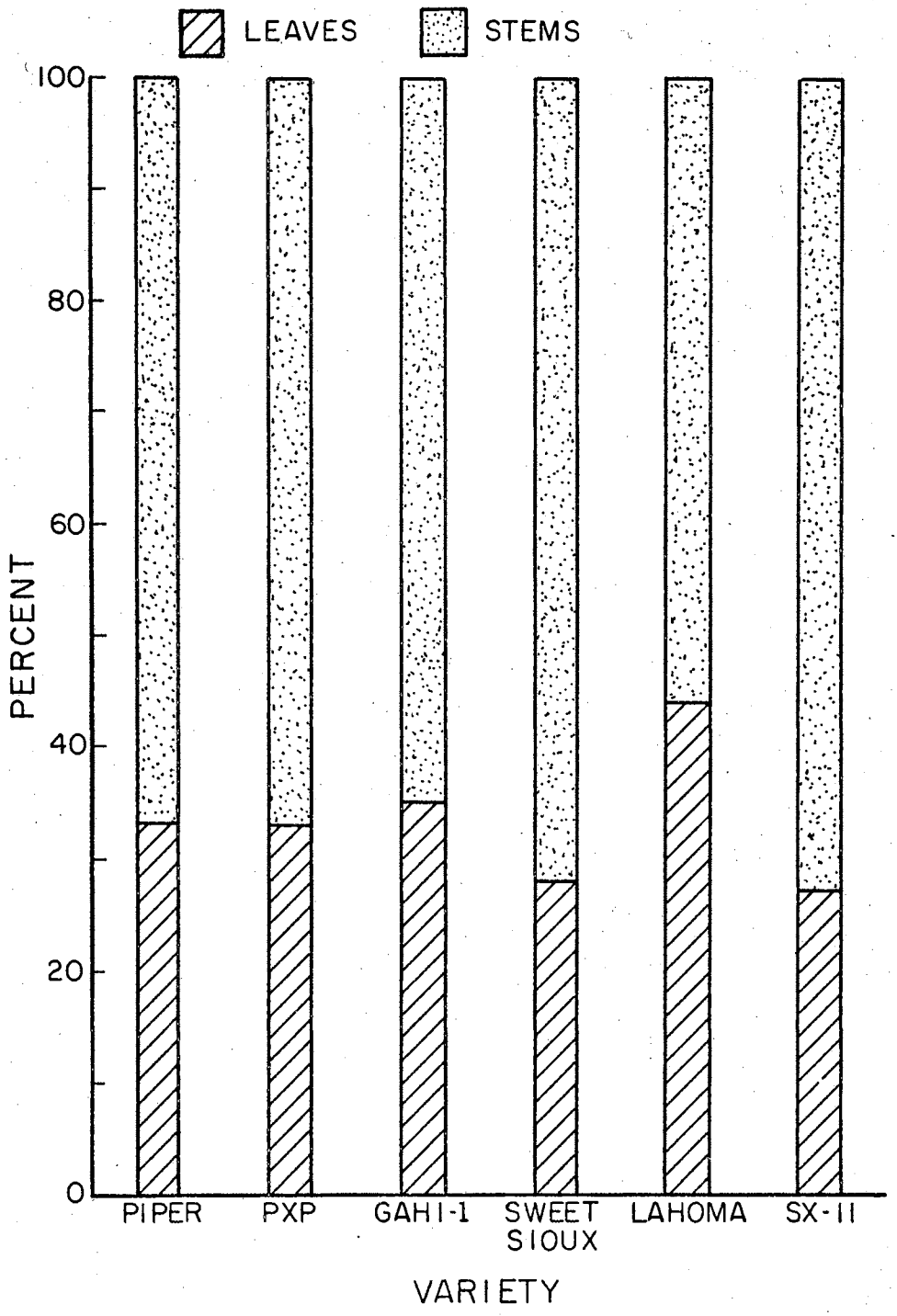

Figure 2. Leaf and Stem Percentages of Six Annual Forage Grass Varieties at the Mature Stage, Perkins, Oklahoma, 1964.

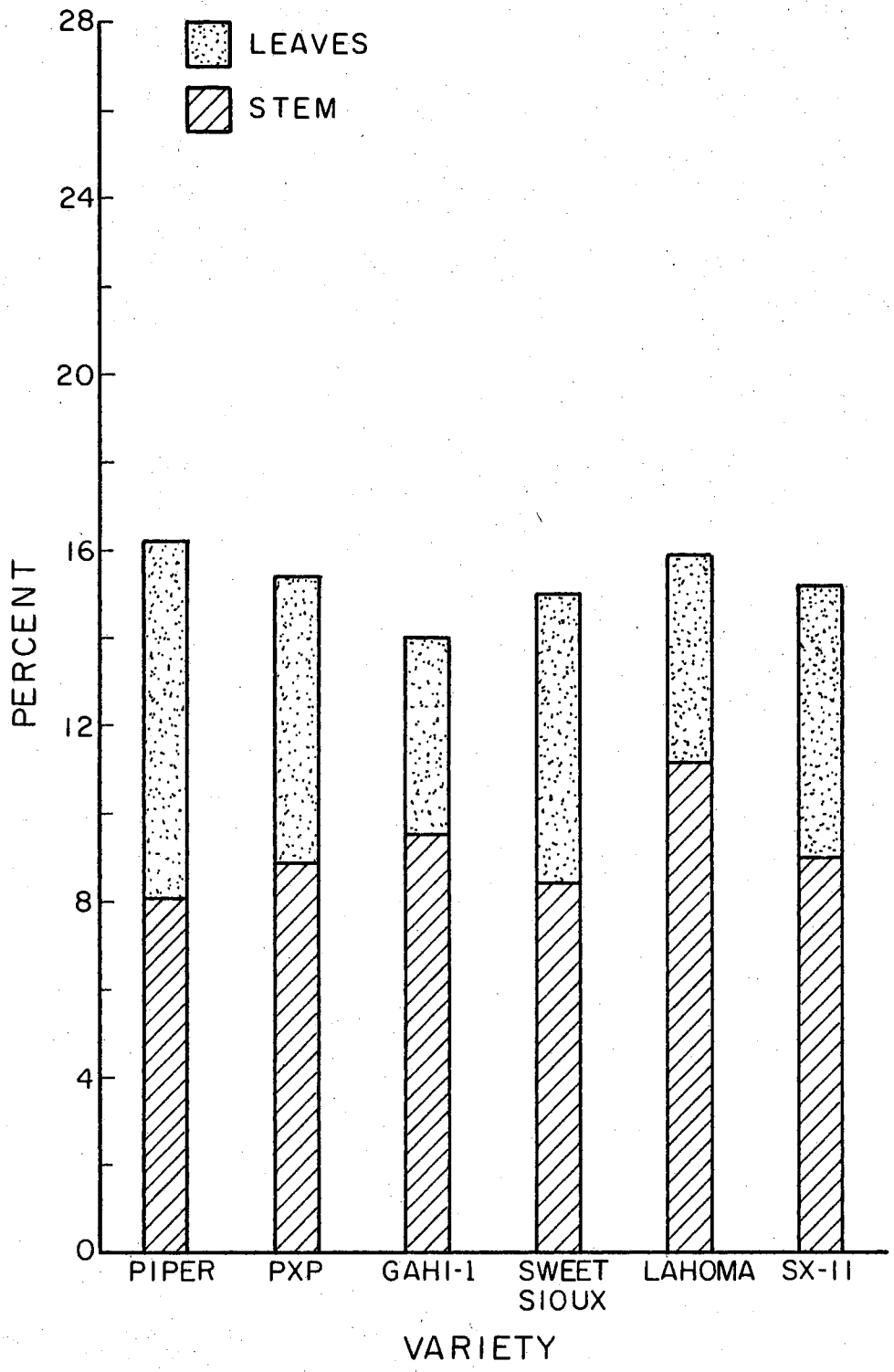

Figure 3. Percent Protein in Leaves and Stems of Six Annual Forage Grass Varieties at the Pasture Stage, Perkins, Oklahoma, 1964.

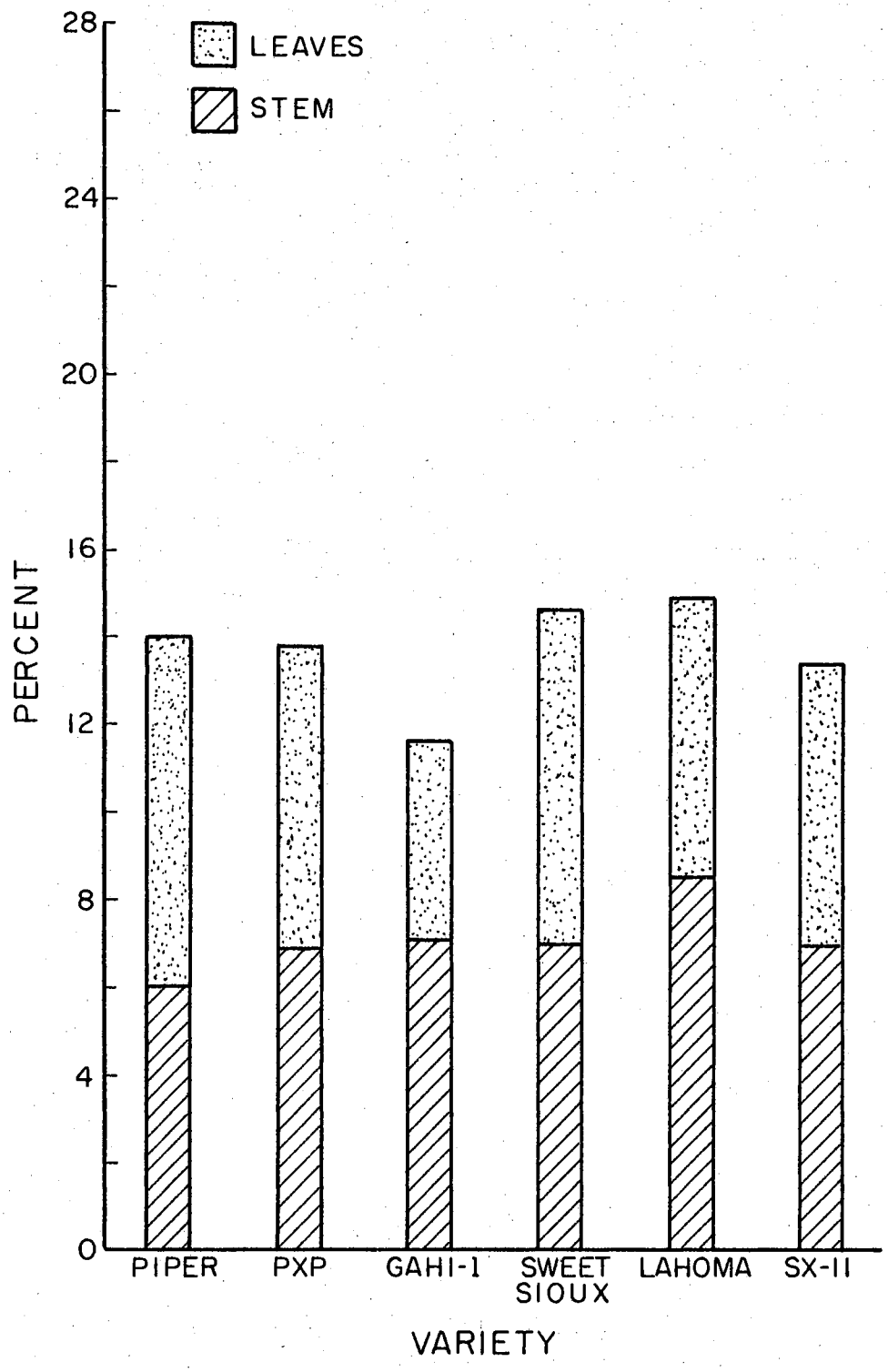

Figure 4. Percent Protein in Leaves and Stems of Six Annual Forage Grass Varieties at the Hay Stage, Perkins, Oklahoma, 1964.

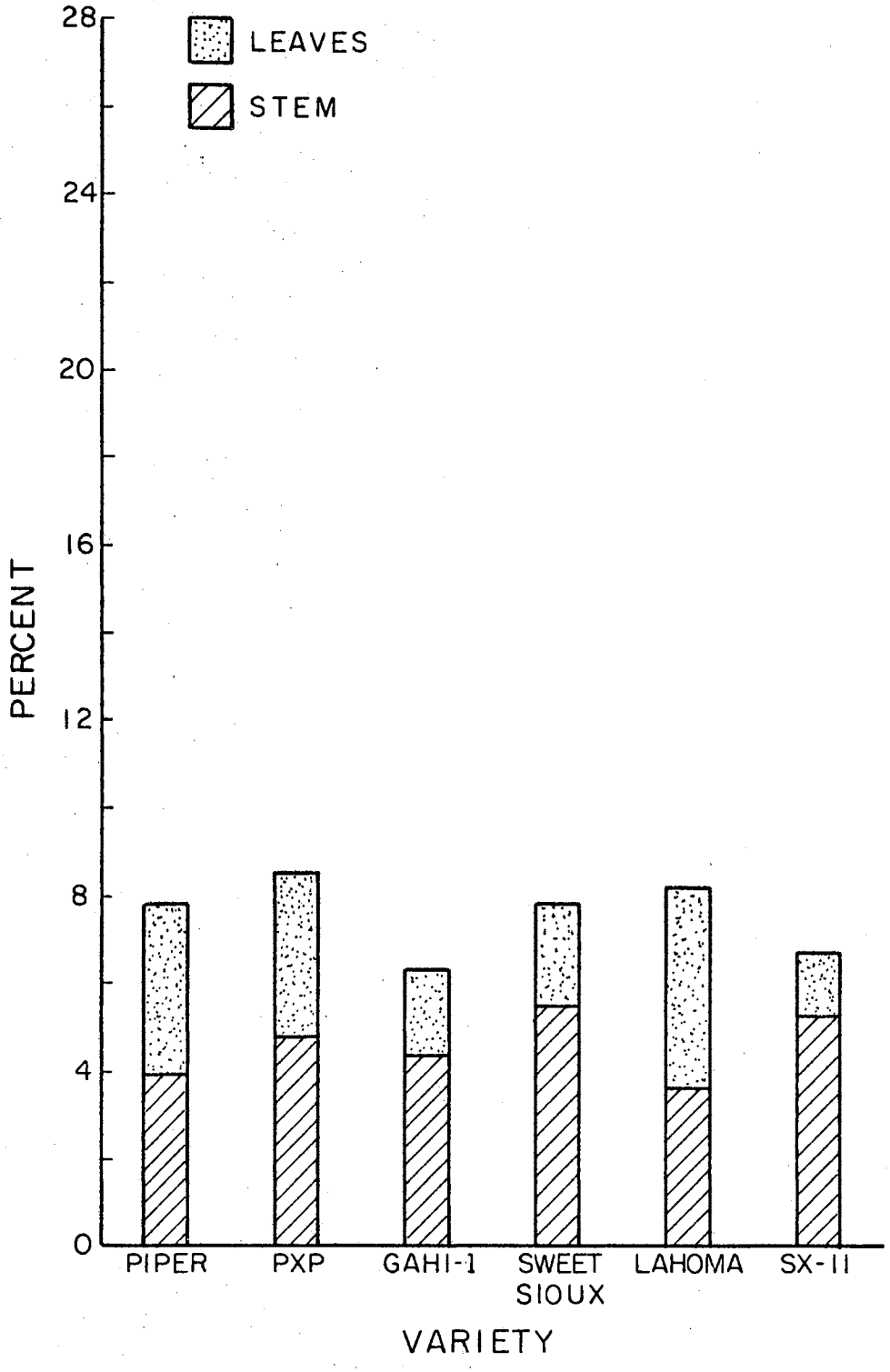

Figure 5. Percent Protein in Leaves and Stems of Six Annual Forage Grass Varieties at the Mature Stage, Perkins, Oklahoma, 1964.

TABLE VIII

PROTEIN YIELD IN POUNDS PER ACRE OF SIX ANNUAL FORAGE GRASS VARIETIES, PERKINS, OKLAHOMA, 1964

Variety	Pasture Stage			Hay Stage			Mature Stage		
	Leaves	Stems	Total	Leaves	Stems	Total	Leaves	Stems	Total
Piper	600	183	783	456	186	642	187	190	377
PxP	633	184	817	426	189	615	196	214	410
Lahoma	490	82	572	447	142	589	271	240	511
Sweet Sioux	717	301	1018	648	347	995	215	447	662
Gahi-1	940	424	1364	747	237	984	456	358	814
SX-11	737	296	1033	533	289	822	189	352	541

Figure 6 shows the decreasing trend in percent of protein production for all varieties from the pasture stage to the mature stage. Lahoma was either highest or near the highest in total protein production at all stages. Gahi-1 was consistently the lowest producer of protein in all stages of harvest. Rusoff et. al (27) observed that the advancement in maturity of sudangrass is characterized by rapid elongation of the stem during the period immediately preceding bloom. The high percentage of stems compared to leaves and low protein percentages in stems would account for this sharp decrease in protein production from the pasture stage to the mature stage.

Table IX shows the harvesting dates for each variety at each cutting for 1964. All varieties were harvested on the same date in the pasture and hay stages, but only when it reached 95% flowering in the mature stage.

Based upon the 1964 data only the following summarizations could be made:

Piper was the best variety in the pasture stage for quality forage with the highest amount of protein produced. Gahi-1 was the best variety for total yield without regard to protein yield. SX-11 was the best variety for the combination of forage and protein yield.

Lahoma was the best variety in the hay stage for quality forage with the highest amount of protein produced. Sweet Sioux was the best variety for total yield without regard to protein yield. Sweet Sioux was also the best variety for the combination of forage and protein yield.

PxP was the best variety in the mature stage for quality forage with the highest amount of protein produced. Gahi-1 was the best variety for total yield without regard to protein yield. Sweet Sioux was the best variety for the combination of forage and protein yield.

TABLE IX

DATES OF HARVEST FOR SIX ANNUAL FORAGE GRASS VARIETIES, PERKINS, OKLAHOMA, 1964*

	Pasture Stage	Hay Stage	Mature Stage
First Harvest	July 10	July 23	Sept. 5 - SX-11
Second Harvest	Aug. 4	Aug. 25	Sept. 5 - Sweet Sioux
Third Harvest	Sept. 1	Oct. 23	Sept. 15 - Gahi-1
Fourth Harvest	Oct. 23		Sept. 19 - Piper
			Sept. 19 - PxP
			Sept. 19 - Lahoma

*All varieties were harvested on the same date in the pasture and hay stages. Each variety was harvested when it reached 95% flowering in the mature stage.

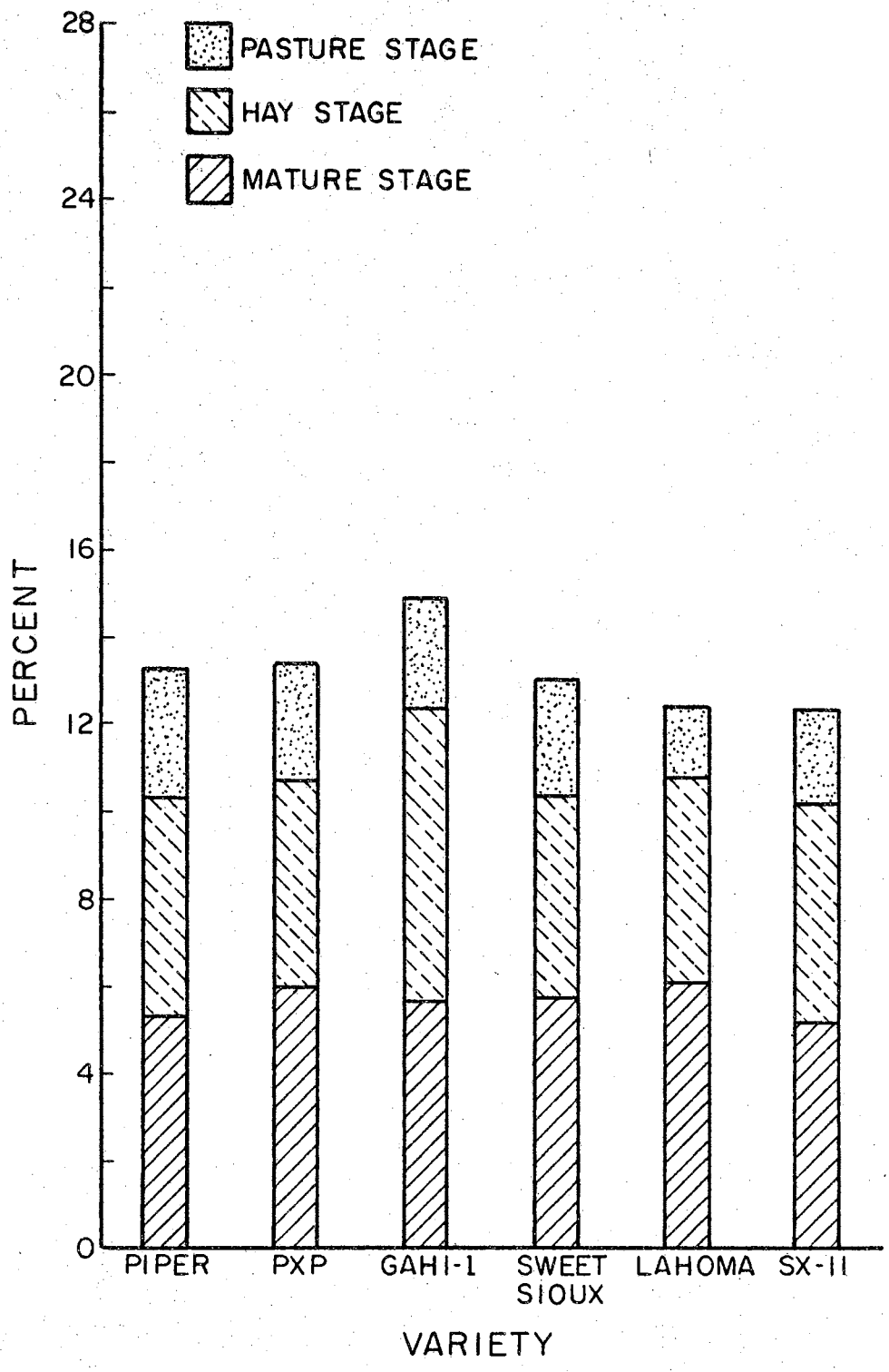

Figure 6. Percent Protein in the Total Plant of Six Annual Forage Grass Varieties at the Pasture, Hay and Mature Stages, Perkins, Oklahoma, 1964.

RESULTS AND DISCUSSION - 1965

The percentages of leaves and stems for the six annual forage grass varieties grown in 1965 are shown in Table X according to harvesting stages. Gahi-1 had the best ratio of leaves and stems with 63.3% leaves and 36.7% stems in the pasture stage. All other varieties were similar, ranging from 53.1% to 59.6% leaves. In the hay stage Gahi-1 was again the best producer of leaves with 67.3%. Lahoma had 53.9% leaves to be the next best in leaf-stem ratio. In the mature stage Gahi-1 had the best ratio of leaves and stems with 40.7% leaves and 59.3% stems. Lahoma was second best with 36.1% leaves and 63.9% stems.

TABLE X

LEAF AND STEM PERCENTAGES OF SIX ANNUAL FORAGE GRASS VARIETIES ON A DRY WEIGHT BASIS, PERKINS, OKLAHOMA, 1965

Varieties	Pasture Stage		Hay Stage		Mature Stage	
	% Leaves	% Stems	% Leaves	% Stems	% Leaves	% Stems
Piper	53.7	46.3	46.4	53.6	30.7	69.3
Trudan II	53.1	46.9	46.3	53.7	27.1	72.9
Gahi-1	63.3	36.7	67.3	32.7	40.7	59.3
Sweet Sioux	56.6	43.4	49.9	51.1	28.5	71.5
Lahoma	57.3	42.7	53.9	46.1	36.1	63.9
SX-12	59.6	40.4	50.6	49.4	30.4	69.6

Table XI shows the yield of each variety for the pasture stage of harvest with three cuttings. With the exception of Lahoma, all varieties produced about equally well from the first harvest to the second harvest, but the effect of the extremely dry summer was shown by the decrease in yield for the third cutting. Lahoma did not recover suffi-

ciently for another cutting after the second harvest. Gahi-1 was definitely the best producer of leaf forage in the pasture stage. It produced the least amount of stems the first cutting, but produced the most stem forage in the last two cuttings.

TABLE XI

LEAF AND STEM FORAGE YIELD OF SIX ANNUAL FORAGE GRASS VARIETIES AT THE PASTURE STAGE, PERKINS, OKLAHOMA, 1965 (GRAMS OF DRY WEIGHT)

	Cutting					
	1		2		3	
Variety	Leaves	Stems	Leaves	Stems	Leaves	Stems
Piper	107	106	112	91	65	49
Trudan II	109	80	110	115	92	80
Gahi-1	195	42	192	147	100	94
Sweet Sioux	132	106	143	104	80	62
Lahoma	161	127	125	87	*	*
SX-12	142	83	145	108	89	65

*Insufficient recovery for harvest.

Table XII shows Gahi-1 produced an exceptionally high percentage of leaves in the first cutting of the pasture stage, however, leaf production declined rapidly, resulting in the lowest percent of leaves in the last cutting. This vividly illustrates the tendency of forage grass to produce more fiber, due to increased percentages of stems as the plant matures. Leaf percentages for all other varieties were within a small range from 50% to 63% in the pasture stage.

In the hay stage the yields of leaf production showed almost a linear decrease from the first to the last cutting. Gahi-1 had the highest leaf forage yield in the first cutting, but the lowest leaf

forage yield in the second cutting as shown by Table XIII. Trudan II had the highest yield of stem production for the hay stage and Gahi-1 the least. Gahi-1 and Lahoma were harvested later in the first two cuttings, and did not recover sufficiently for a third cutting as shown by Table XIV.

TABLE XII

LEAF AND STEM PERCENTAGES OF SIX ANNUAL FORAGE GRASS VARIETIES AT THE PASTURE STAGE, PERKINS, OKLAHOMA, 1965 (MEAN OF FOUR REPS.)

	Cutting					
	1		2		3	
Variety	Leaves	Stems	Leaves	Stems	Leaves	Stems
Piper	50	50	55	45	57	43
Trudan II	58	42	49	51	54	46
Gahi-1	82	18	57	43	52	48
Sweet Sioux	55	45	58	42	56	44
Lahoma	56	44	59	41	*	*
SX-12	63	37	57	43	58	42

*Insufficient recovery for harvest.

Harvesting procedures for 1965 differed from those of 1964 in that each variety was harvested when it reached the appropriate height instead of harvesting each replication when all varieties were near the appropriate height. Thus Gahi-1 and Lahoma were harvested later for all stages. In both the pasture and hay stages Gahi-1 did not recover for a third cutting. Lahoma did not recover for a third cutting in the hay stage.

In the mature stage Sweet Sioux produced the most total forage (Figure 7). The leaf forage production was high for this variety at this

TABLE XIII

LEAF AND STEM FORAGE YIELD OF SIX ANNUAL FORAGE GRASS VARIETIES AT THE HAY STAGE, PERKINS, OKLAHOMA, 1965 (GRAMS OF DRY WEIGHT)

	Cutting					
	1		2		3	
Variety	Leaves	Stems	Leaves	Stems	Leaves	Stems
Piper	150	238	104	118	22	19
Trudan II	189	274	132	195	69	51
Gahi-1	287	114	94	55	*	*
Sweet Sioux	205	257	140	153	74	55
Lahoma	160	166	104	74	*	*
SX-12	203	227	125	156	64	42

*Insufficient recovery for harvest.

TABLE XIV

DATES OF HARVEST FOR SIX ANNUAL FORAGE GRASS VARIETIES, PERKINS, OKLAHOMA, 1965[1]

	Pasture Stage			Hay Stage			Mature
Variety	First	Second	Third	First	Second	Third	First
Piper	July 1	Aug. 11	Sept. 17	July 16	Sept. 7	Oct. 28	Sept. 27
Trudan II	July 1	Aug. 6	Sept. 10	July 16	Sept. 7	Oct. 28	Sept. 27
Gahi-1	July 15	Sept. 14	Oct. 7	Aug. 11	Sept. 27	-----[2]	Oct. 28
Sweet Sioux	July 1	Aug. 11	Sept. 24	July 16	Sept. 7	Oct. 28	Sept. 27
Lahoma	July 15	Sept. 14	-----[2]	Aug. 2	Oct. 21	-----[2]	Oct. 21
SX-12	July 1	Aug. 11	Sept. 24	July 16	Sept. 7	Oct. 28	Sept. 27

[1] Each variety was harvested when it reached the appropriate maturity as designated for each harvest stage.

[2] Indicates no harvest; insufficient recovery.

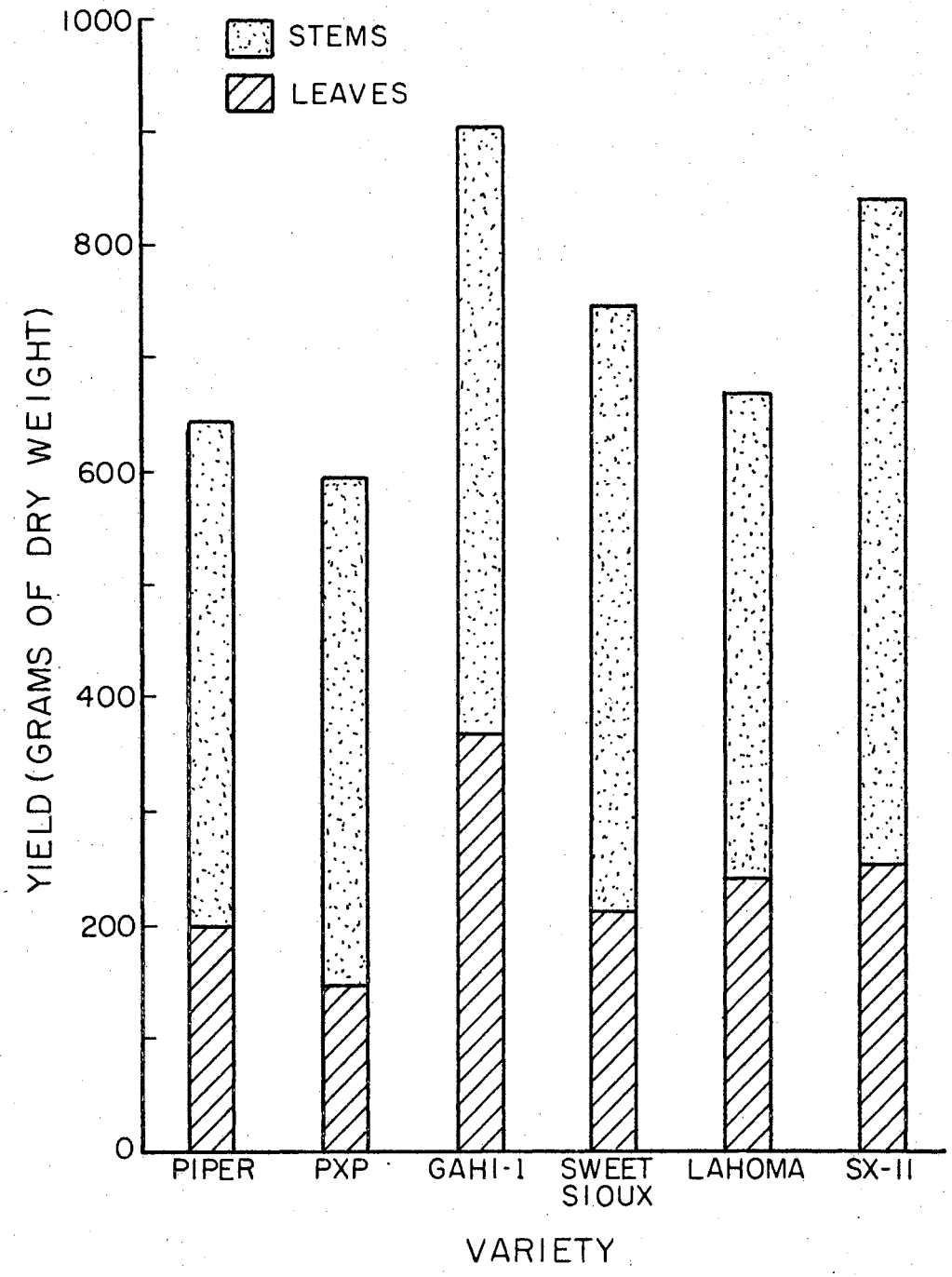

Figure 7. Leaf and Stem Forage Yield of Six Annual Forage Grass Varieties at the Mature Stage, Perkins, Oklahoma, 1965.

stage. The highest percentage of leaves produced in the mature stage was 41% by Gahi-1 pearl millet. Lahoma was next best in leaf-stem ratio with 36% leaves and 64% stems (Figure 8).

Table XV shows Gahi-1 had the best percentage of leaves for the first two cuttings of the hay stage. Piper, Trudan II, Sweet Sioux, and SX-12 all increased in leaf percentage as the season progressed. These four varieties all produced nearly the same total forage yield, and leaf and stem percentages.

TABLE XV

LEAF AND STEM PERCENTAGES OF SIX ANNUAL FORAGE GRASS VARIETIES AT THE HAY STAGE, PERKINS, OKLAHOMA, 1965

	Cutting					
	1		2		3	
Variety	Leaves	Stems	Leaves	Stems	Leaves	Stems
Piper	39	61	47	53	54	46
Trudan II	41	59	40	60	58	42
Gahi-1	72	28	63	37	*	*
Sweet Sioux	44	56	48	52	57	43
Lahoma	49	51	59	41	*	*
SX-12	47	53	95	55	60	40

*Insufficient recovery for harvest.

In total forage production Gahi-1 had the highest yields in the pasture and mature stages, with Trudan II highest in the hay stage as indicated by Table XVI. Sweet Sioux and SX-12 both had good yields at all stages of harvest.

Protein percentages for both leaves and stems revealed a somewhat different picture than that of yield percentages for the pasture stage. Table XVII shows that Piper was the most consistent variety from one

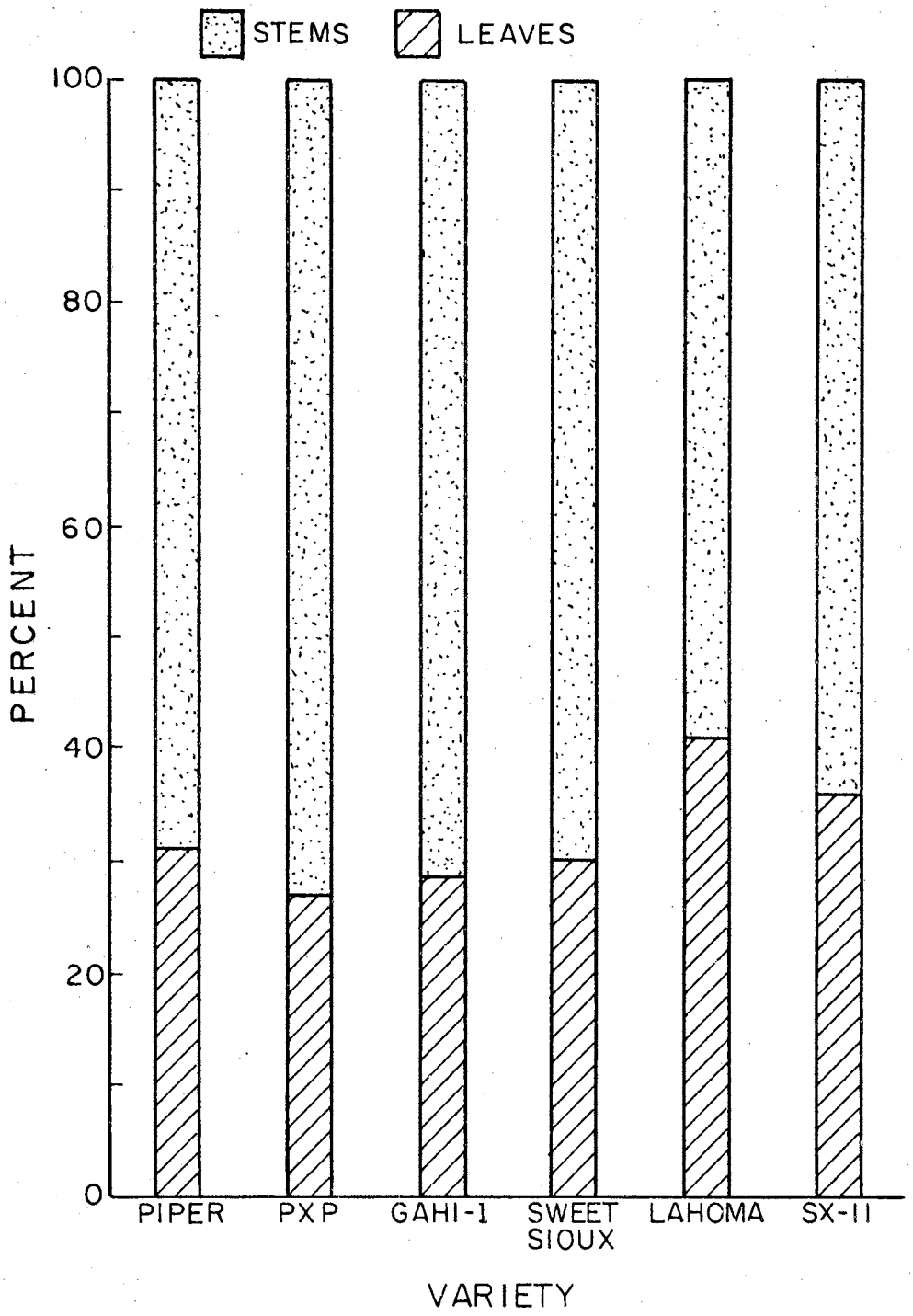

Figure 8. Leaf and Stem Percentages of Six Annual Forage Grass Varieties at the Mature Stage, Perkins, Oklahoma, 1965.

cutting to another in leaf protein percentage for the pasture stage. Gahi-1 was about average for the second harvest, but had the lowest percent leaf protein in the first and last cutting. The protein percentage in Gahi-1 stems was the highest or near the highest for all cuttings. Gahi-1 stem production was low and did not provide much benefit from its high stem protein percentage.

TABLE XVI

TOTAL YIELD IN POUNDS OF FORAGE PER ACRE OF SIX ANNUAL FORAGE GRASS VARIETIES, PERKINS, OKLAHOMA, 1965

Variety	Pasture Stage			Hay Stage			Mature Stage		
	Leaves	Stems	Total	Leaves	Stems	Total	Leaves	Stems	Total
Piper	3027	2622	5649	2942	3998	6940	2111	4754	6865
Trudan II	3315	2932	6247	4157	5543	9700	1716	4605	6321
Gahi-1	5191	3017	8208	4061	1802	5863	3934	5746	9680
Sweet Sioux	3784	2900	6684	4467	4957	9424	2303	5788	8091
Lahoma	3049	2281	5330	2814	2558	5372	2569	4552	7121
SX-12	4008	2729	6737	4179	4531	8710	2718	6225	8943

By combining the yield with the protein percentage, Sweet Sioux and SX-12 produced the best combinations for quality forage in the pasture stage of harvest.

In Table XVIII the percent protein found in the leaves for the hay stage was highest for Piper, Gahi-1, and Sweet Sioux. The protein in stems was definitely highest for Gahi-1, with all other varieties within a small range.

The percent protein of the total plant comparing three stages of harvest are shown in Table XIX. All six varieties were within a very

TABLE XVII

PERCENT PROTEIN IN LEAVES AND STEMS OF SIX ANNUAL FORAGE GRASS VARIETIES AT THE PASTURE STAGE, PERKINS, OKLAHOMA, 1965

Variety	Cutting 1		2		3	
	Leaves	Stems	Leaves	Stems	Leaves	Stems
Piper	17.2	6.5	18.3	10.9	18.8	11.4
Trudan II	17.5	7.9	16.2	8.8	17.3	11.3
Gahi-1	11.5	6.6	18.1	11.4	16.6	12.8
Sweet Sioux	15.8	6.6	17.7	10.4	18.4	11.5
Lahoma	13.7	6.1	17.6	11.0	*	*
SX-12	15.3	7.4	19.4	11.2	17.2	12.1

* Insufficient recovery for harvest.

TABLE XVIII

PERCENT PROTEIN IN LEAVES AND STEMS OF SIX ANNUAL FORAGE GRASS VARIETIES AT THE HAY STAGE, PERKINS, OKLAHOMA, 1965

Variety	Cutting 1		2		3	
	Leaves	Stems	Leaves	Stems	Leaves	Stems
Piper	13.4	4.8	17.1	8.5	19.8	11.5
Trudan II	14.5	5.3	15.9	8.3	17.0	10.4
Gahi-1	12.9	8.6	18.4	13.6	*	*
Sweet Sioux	12.2	3.9	16.6	7.8	17.6	11.2
Lahoma	10.9	5.7	14.3	8.6	*	*
SX-12	12.0	4.8	16.9	8.3	16.6	10.8

* Insufficient recovery for harvest.

small range from 12.6 to 14.4% in the pasture stage. SX-12 had the highest percent protein and Lahoma had the lowest percent protein in the

pasture stage. In the hay stage Gahi-1 had the highest, and Lahoma again had the lowest percent protein. In the mature stage the range of total protein was from 5.5% to 6.9%. SX-12 had the highest percent protein and Trudan II had the lowest percent protein.

TABLE XIX

PERCENT PROTEIN IN TOTAL PLANT OF SIX ANNUAL FORAGE GRASS VARIETIES AT THE PASTURE, HAY, AND MATURE STAGES OF GROWTH, PERKINS, OKLAHOMA, 1965

Variety	Stage of Harvest		
	Pasture	Hay	Mature
Piper	14.1	11.9	6.2
Trudan II	13.4	11.3	5.5
Gahi-1	13.5	14.3	6.4
Sweet Sioux	13.9	11.4	6.1
Lahoma	12.6	10.0	5.9
SX-12	14.4	11.4	6.9

Table XX shows the total protein based on total forage for the six varieties of annual forage grasses at the various stages of harvest for 1965.

Based upon the 1965 data the following summarizations were made:

Gahi-1 was the best variety in the pasture stage for quality forage with the highest amount of protein produced, for total yield without regard to protein yield, and for the combination of forage and protein yield.

Trudan II and Sweet Sioux were the best varieties in the hay stage for quality forage with the highest amount of protein produced, for total yield without regard to protein yield, and for the combination of

forage and protein yield.

Gahi-1 was the best variety in the mature stage for quality forage with the highest amount of protein produced, for total yield without regard to protein yield, and for the combination of forage and protein yield.

TABLE XX

PROTEIN YIELD IN POUNDS PER ACRE OF SIX ANNUAL FORAGE GRASS VARIETIES, PERKINS, OKLAHOMA, 1965

Variety	Pasture Stage			Hay Stage			Mature Stage		
	Leaves	Stems	Total	Leaves	Stems	Total	Leaves	Stems	Total
Piper	548	251	799	493	331	824	173	253	426
Trudan II	564	273	837	656	443	1099	137	210	347
Gahi-1	799	310	1109	636	200	836	260	362	622
Sweet Sioux	656	275	931	692	379	1071	177	315	492
Lahoma	477	194	671	355	183	538	235	182	417
SX-12	692	280	972	635	360	995	213	406	619

CHAPTER V

SUMMARY AND CONCLUSIONS

An evaluation of quality factors for eight annual forage grass varieties was conducted on a Vanoss silt loam soil at the Agronomy Research Farm, Perkins, Oklahoma. The varieties grown were Piper common sudangrass; Lahoma sweet sudangrass; a sorgo-sudangrass hybrid, variety Sweet Sioux; and sorghum-sudangrass hybrids, varieties SX-11 and SX-12. Also included were an improved pearl millet, variety Gahi-1; a Piper sudangrass x Sorghum propinquim cross, variety PxP; and a true sudangrass hybrid, variety Trudan II.

Yield data and crude protein determinations were made for leaves and stems of each variety at three stages of maturity. Harvests were made as each variety reached the appropriate maturity; namely, pasture stage, 24-36 inches in height; hay stage, early boot; and mature stage, 95% flowering.

The results of this study show forage grass leaves to be superior in protein content as compared to stems. Thus a variety with a high percentage of leaves and high yield should be superior in feeding value.

In 1964, Gahi-1 and SX-11 in the pasture stage combined high leaf yields with high protein percentages. With these criteria, these varieties in the pasture stage produced the highest quality forage of all varieties studied. Sweet Sioux produced a high yield in the hay stage, but was not the best producer of protein. The mature stage was mostly stem

forage with very low protein percentage.

In 1965, Gahi-1 in the pasture stage combined high leaf yield and protein production to be the best variety for high quality forage production. Trudan II, Sweet Sioux, and SX-12 varieties had high yields in the hay stage, but their high percentage of stems lowered total protein production. These varieties were about equal with each other in the hay stage, and with Gahi-1 in the pasture stage for total yield and total protein production. As in 1964, the mature stage produced high percentages of stems and low percentages of protein.

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VITA

James Edward Stroike

Candidate for the Degree of

Master of Science

Thesis: EVALUATION OF QUALITY FACTORS FOR EIGHT ANNUAL FORAGE GRASSES

Major Field: Agronomy

Biographical:

Personal Data: Born near Carrier, Oklahoma, May 1, 1942, the son of Edward J. and Alta Stroike.

Education: Attended elementary school in Carrier, Oklahoma; graduated from Lamont High School in 1960; received the Bachelor of Science degree from Oklahoma State University, with a major in Agronomy, in May, 1964. Attended Graduate School at Oklahoma State University 1964 to 1967.

Professional Experience: Born and raised on a farm through high school. Employed by the Agronomy Department, Oklahoma State University, as a student employee 1961-1964, as a Graduate Assistant 1964-1966. Employed as Associate Secretary-Treasurer of the Oklahoma Crop Improvement Association January, 1966 to present.

Professional Organizations: O. S. U. Agronomy Club, American Society of Agronomy.