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PERFORMANCE OF FIVE ALFALFA-GRASS MIXTURES

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Performance of Five Alfalfa-Grass Mixtures at The BARTAD Project, North Andros Island, Bahamas

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Alfalfa (Medicago sativa) is currently widely used for both pasture and hay in many temperate, sub-tropical and tropical regions of the world. In Australian studies alfalfa has also grown well with several grasses including green panic, Rhodes and buffel. The latter two grasses, however, are said to be more competitive with alfalfa, thus making it more difficult to maintain a satisfactory grass-legume balance with these species.

The value of alfalfa as a tropical and sub-tropical pasture plant when grown in combination with compatible grasses is well established. It provides protein rich grazing and thus enables better use to be made of the lower quality grasses. Also because of its extensive root system and tolerance to cooler temperatures it will make good growth during the winter even when rainfall is limited.

Preliminary observations from an initial trial of alfalfa varieties established at BARTAD, Andros Island, Bahamas, suggested that this species had potential as a productive, high protein legume for both cattle and sheep. Therefore, this study was initiated to determine the performance of alfalfa when grown in combination with several tropical grasses established from seed.

Soils and Weather

Soils at the BARTAD site are composed of oolitic limestone sediments formed during the Pliestocene era. Solution of the limestone by rain and sea water during the ice age resulted in the typical flat topography containing numerous sink holes and solution channels. The water table at the experimental site is approximately 4 feet below the soil surface.

The pH values of the soil in the area range from 7.8 to 8.2. In general phosphorus levels are very low, potasium levels are low to medium, calcium levels are very high and magnesium levels medium. Typical soil levels of several other elements are: aluminum .20 ppm (very low), manganese 3 ppm (very low), iron 10 ppm (low), copper 14 ppm (normal), zinc less than 20 ppm (low) and sodium less than 50 ppm (normal).

Rainfall and temperature data for the period of the study, taken from official BARTAD records, are given in table I. Percipitation at the site is approximately 46-52 inches annually with the dry season beginning in December and ending in May. However, seasonal rainfall from year to year may be highly variable and has a marked influence on total and seasonal crop production.

Species and Varieties

The alfalfa variety chosen for use in this trial was Mex-Son, a variety which has performed well in the early phase of the alfalfa variety study. Mex-Son was developed by the Arizona Experiment Station and resulted from plant selections from a farmer's field of Sonora alfalfa located near Navajoa in the State of Sonora, Mexico. Clones were selected based on resistance or freedom from symptoms of the disease Stemphylium botryosium. Mex-Son has a good level of resistance to several biotypes of pea aphid but a relatively low level of resistance to newer biotypes of spotted alfalfa aphid.

Grasses selected to grow in mixtures with alfalfa are as follows:

Buffelgrass (Cenchrus ciliaris), variety T4464 (USA seed source). Buffelgrass is very variable in growth habit, but is considered a strong perennial bunch grass. It is drought resistant and withstands very heavy grazing once established. It has a large, strong root system, and more of the roots are normally found at deeper soil depths than in the case of species such as Rhodesgrass or green panic. In its main area of adaptation buffelgrass makes much of its growth in summer and is less cold tolerant than plants like green panic. It is adaptable to a wide range of soils and is not as demanding of fertility as many other grasses.

T4464 was selected by Dr. L. C. C. Leibenberg of the agricultural service at Pretoria, Texas from material originally collected in the low rainfall area of South Africa. After extensive testing at many locations in Texas during which its performance was described as outstanding it was increased and officially released as T4464.

Green panicgrass (Panicum maximum var. trichoglume) (Australian seed source). This perennial grass is a botanical variety of guineagrass. It is a tall, relatively shade tolerant, bunch grass with a concentration of fine branched roots near the soil surface. Green panic is adapted to a wide range of soil conditions but is very responsive to fertilization. It is a very palatable grass and careful management is necessary to prevent over grazing. In Australian trials green panic has combined well with alfalfa as well as with viny tropical legumes such as siratro.

Guineagrass (Panicum maximum), variety common (Australian seed source). Guineagrass is a deep, dense and fibrous rooted, perennial bunch grass. It has a typical stool forming habit with the plant crown enlarging by short rootstocks. Leaves are normally long and broad. It has good shade tolerance and is normally highly competitive with other species. Guineagrass is adapted to a wide range of soils and is found growing in many areas on Andros Island. It is known to combine well with viny legumes, but is not commonly grown with alfalfa.

Table 1. Average Temperature and Rainfall Data by Months, Jan, 1975 - June, 1977 (BARTAD)

	1975				1976				1977			
	Rainfall Inches	Temperature F° Avg.	Min.	Max.	Rainfall Inches	Temperature F° Avg.	Min.	Max.	Rainfall Inches	Temperature Avg.	Min.	Max.
January	4.43	70	51	84	.55	64	42	80	.61	63	28	84
February	3.65	70	55	86	3.95	66	44	84	1.80	66	48	89
March	1.42	69	47	88	.16	72	50	86	.46	73	51	88
April	.69	73	51	89	1.14	73	52	87	.66	73	50	90
May	5.63	75	59	90	6.85	77	62	89	14.73	83	62	94
June	6.75	78	63	91	14.35	76	62	86	6.59	78	65	91
July	5.19	79	66	90	.89	79	67	94				
August	2.33	80	63	91	4.30	79	66	92				
September	5.39	80	68	89	7.48	78	64	91				
October	4.41	78	60	88	7.93	76	56	90				
November	6.44	74	50	85	3.78	74	55	91				
December	1.80	68	48	83	2.23	70	42	85				
Total	48.13				53.88							

Rhodesgrass (Chloris gayana), variety common (USA seed source). Rhodesgrass is a moderately drought tolerant, fibrous rooted, tufted, runnering perennial. It is primarily a summer grower but is moderately frost tolerant. Like other grasses included in this study Rhodesgrass is adapted to a fairly wide range of soil conditions but also responds well to improved fertility conditions. It is known to combine well with alfalfa and several viny legumes.

Setaria (Setaria anceps), variety Kazungula (Australian seed source). This species is a highly variable perennial tufted species native to tropical Africa. Kazungula is a vigorous, late flowering variety with a broader crown, broader leaves and somewhat courser stems than Nandi, the originally commercialized variety in Australia. In Australian studies it shows good cold tolerance, succulence and acceptance by stock. Under Australian conditions it is more aggressive than Nandi making it more difficult to maintain companion legumes in the sward.

Land Preparation

The area in which the experiment was established was rough cleared in the fall of 1973, disked several times with a D-8 tractor and Rome disk and then rolled several times with a grid roller. Prior to seeding in the spring of 1974 large rocks were removed by hand, the area was redisked with a small disk, cultipacked, and prepared for seeding.

Fertilization

The over-all fertility program was based on soil samples taken at the time the project was initiated. Approximately 2,600 pounds/A of an 8-18-8 special mix fertilizer containing micronutrients was broadcast by hand and disked in to a depth of approximately 3" prior to seeding.

Sources of the primary plant foods in the fertilizer were sulfate of ammonia, mono-ammonium phosphate, sulfate-potash-magnesium, and ammonium nitrate. Amounts and sources of secondary plant foods were: MgO .75% (sulfate-potash-magnesium), manganese MnO 1.70% (magenese frit), boron B_2O_3 .28% (borax), copper CuO .93% (copper sulfate) and zinc ZnO 1.9% (zinc sulfate).

Forty pounds per acre of K_2O from sulfate-potash-magnesium was broadcast after each harvest (440 pounds K_2O the first year, and 400 pounds the second year) while 200 pounds per acre of P_2O_5 from super phosphate was applied annually.

Establishment

Following fertilization and disking the plot area was cultipacked. Individual 6 x 12 foot plots were broadcast seeded by hand on April 17, 1975. Mex-Son alfalfa was seeded at the rate of 10 pounds/acre for all plots. Individual grasses were over-seeded on the alfalfa at the rate of 3 pounds per acre. The plots were then cultipacked and irrigated. To assure adequate moisture for germination and early emergency, plots were irrigated frequently during the first three weeks after planting.

Harvest Methods

The first seven harvests were made using a tractor drawn forage harvester. Plots harvested for yield were 32" wide by 9' long. The total sample was weighed and a subsample taken for moisture determination.

The remaining harvests were made using a Carter self-propelled flail harvester 36" in width. All other procedures were the same for all harvests. Moisture samples were dried in a fuel-oil heated forced air dryer at 135°F for seven days. After weighing the dry subsamples were composited across replications and ground with a Wiley mill through a 1 mm screen. Ground samples were analyzed for crude protein and IVDMD (in vitro dry matter disappearance) at The Pennsylvania State University.

Results and Discussion

Dry Matter Yields

Dry matter yields by cuttings for the five mixtures by approximately twelve month harvest periods are presented in tables 2 & 3. Total production for the two years is summarized in table 4. As indicated, the first harvest was made June 12, 1975, 56 days after seeding. Cutting intervals during the two year period ranged from a minimum of 20 days to a maximum of 49 days depending on rainfall, temperature, day length and other factors.

Total dry matter yields for the first 12 months harvest season ranged from 8.47 T/A for alfalfa-guineagrass to 10.51 T/A for alfalfa-buffelgrass but were not significantly different. Yields for the second year were somewhat lower but again not significantly different. Total dry matter yields for the two year period (21 harvests) for alfalfa-buffelgrass and alfalfa-setaria were 16.83 T/A and 16.52 T/A respectively but were not significantly higher than the two year total yield of alfalfa-guineagrass (13.79 T/A).

Total two year yields for the top two alfalfa-grass mixtures were similar to the two year total yield of Mex-Son alfalfa alone in another BARTAD study. (Final Report No. 19 "Performance of Five Alfalfa Varieties on North Andros Island, Bahamas.").

Forage Quality

Crude protein and IVDMD percentages for sixteen of the twenty-one harvests are listed in tables 5 & 6. Samples for the remaining harvests were destroyed in a dryer fire on site. The values for both factors varied from mixture to mixture, both within and between cuttings. In general, however, the Rhodesgrass mixture tended to be lowest in both protein and IVDMD while the Kazungula setaria mixture was highest.

Table 2. Dry Matter Yields in Tons Per Acre of Five Alfalfa-Grass Mixtures for the First Approximate 12 Month Harvest Period.

Grass Component	Harvest Date 6/12/75	7/18/75	8/28/75	9/29/75	11/6/75	12/23/75	2/10/76	3/19/76	4/23/76	5/13/76	6/9/76	Total
	D.A. Tons/A											
Buffel	1.93	.91	.85	.92	.53	.61	.44	.99	1.11	1.34	.88	10.51
Setaria	.77	.76	.72	.91	.59	.77	.51	1.14	1.22	1.53	1.05	9.97
Rhodes	2.30	.95	.76	.69	.53	.44	.46	.99	1.18	.96	.80	10.06
Green panic	.87	.85	.78	.80	.54	.58	.41	1.28	1.10	1.16	.94	9.31
Guinea	.51	.83	.59	.90	.48	.49	.46	1.09	1.01	1.19	.92	8.47
L.S.D. .05	.81	.36	.36	.28	.18	.16	.17	.25	.21	.44	.30	2.18

Table 3. Dry Matter Yields in Tons Per Acre of Five Alfalfa-Grass Mixtures for the Second Approximate 12 Month Harvest Period.

Grass Component	Harvest Date 7/20/76	8/17/76	9/21/76	11/2/76	12/14/76	1/25/77	3/3/77	4/1/77	5/4/77	5/25/77	Total
	D.C. Tons/A										
Buffel	1.01	.95	.98	.77	.69	.29	.38	.37	.43	.45	6.32
Setaria	1.13	.86	1.07	.67	.67	.34	.48	.45	.35	.53	6.55
Rhodes	.88	.71	.77	.72	.68	.28	.36	.41	.28	.42	5.51
Green panic	1.04	.71	.99	.64	.65	.34	.41	.44	.36	.45	6.03
Guinea	1.00	.67	.72	.60	.57	.29	.31	.36	.33	.47	5.32
L.S.D. .05	.22	.20	.31	.30	.22	.16	.14	.19	.18	.20	1.37

Table 4. Two Year Total Dry Matter Yields and Average Annual Yields In Tons Per Acre of Five Grass-Alfalfa Mixtures (1).

Mixture	1st year	2nd year	2 year total	Ave/yr.
	DM Tons/A			
Buffelgrass + alfalfa + alfalfa	10.51	6.32	16.83	8.41
Kazungula Setaria + alfalfa	9.97	6.55	16.52	8.26
Rhodesgrass + alfalfa	10.06	5.51	15.57	7.78
Green panicgrass + alfalfa	9.31	6.03	15.34	7.67
Guineagrass + alfalfa	8.47	5.32	13.79	6.89
L.S.D. .05	2.18	1.37	3.18	

(1) The alfalfa variety used in the mixtures was Mex-Son.

Table 5. Percent Protein of Five Alfalfa-Grass Mixtures for an Approximate Two Year Period

Grass Component	Harvest Date 6/12/75	7/19/75	8/29/75	9/29/75	11/6/75	12/23/75	2/10/76	3/19/76	4/23/76	5/13/76	6/9/76
	%										
Buffelgrass	10.02	12.84	13.75	14.00	17.43	17.88	Missing (1)	17.37	Missing (1)	Missing (1)	17.01
Kaz. Setaria	14.87	15.23	14.78	15.26	17.06	17.91		17.53			17.09
Rhodesgrass	8.16	9.12	10.30	12.08	13.11	14.39		19.21			19.11
Green panic-grass	13.00	13.19	12.08	14.34	15.92	17.74		18.21			17.94
Guineagrass	15.66	16.18	13.54	13.01	15.09	16.30		16.02			17.14
Average	12.34	13.31	12.89	13.74	15.72	16.84		17.67			17.66

Grass Component	Harvest Date 7/20/76	8/17/76	9/2/76	11/2/76	12/14/76	1/25/77	3/3/77	4/1/77	5/4/77	5/25/77	Average All Harvests
	%										
Buffelgrass	Missing (1)	16.64	11.55	12.06	13.19	16.21	Missing (1)	16.95	17.42	22.29	15.41
Kaz. Setaria		17.40	13.86	14.88	14.16	18.31		18.43	17.15	20.92	16.55
Rhodesgrass		14.31	-----	10.99	12.63	17.62		18.24	15.89	21.62	14.45
Green panic-grass		13.74	12.86	12.86	14.11	17.25		17.60	17.18	21.00	15.56
Guineagrass		15.97	11.95	12.62	13.61	15.96		16.33	15.39	18.67	15.21
Average		15.61	12.55	12.68	13.54			17.51	16.61	20.90	

(1) Samples burned in dryer fire.

Table 6 Percent IVDMD of Five Alfalfa-Grass Mixtures for an Approximate Two Year Period.

Grass Component	Harvest Date 6/12/75	7/19/75	8/29/75	9/29/75	11/6/75	12/23/75	2/10/76	3/19/76	4/23/76	5/13/76	6/9/76
	%										
Buffelgrass	59.74	65.10	64.20	65.90	68.80	70.15	Missing (1)	66.23	Missing (1)	Missing (1)	60.54
Kaz. Setaria	66.41	63.97	64.97	65.92	65.75	69.31		64.27			58.54
Rhodesgrass	55.38	58.40	59.49	60.44	61.43	64.28		67.09			62.46
Green panic-grass	59.97	64.21	59.98	61.33	66.07	69.67		64.58			61.40
Guineagrass	67.13	63.30	65.21	62.36	67.36	69.72		63.53			59.86
Average	61.73	63.00	62.77	63.19	65.88	68.63		65.14			60.56

Grass Component	Harvest Date 7/20/76	8/17/76	9/2/76	11/2/76	12/14/76	1/25/77	3/3/77	4/1/77	5/4/77	5/25/77	Average All Harvest
	%										
Buffelgrass	Missing (1)	65.39	60.61	60.35	59.24	68.35	Missing (1)	67.05	66.63	69.56	64.86
Kaz. Setaria		67.30	63.60	63.03	59.76	70.55		67.38	66.50	67.71	65.31
Rhodesgrass		65.73	-----	56.47	54.14	69.32		68.29	65.43	66.58	62.33
Green panic-grass		63.63	58.56	61.55	62.59	68.56		68.10	67.22	66.46	63.99
Guineagrass		65.72	60.80	58.72	57.10	68.45		66.79	67.63	64.63	64.27
Average		65.55	48.71	60.02	58.57	69.05		67.52	66.68	66.99	

(1) Samples burned in dryer fires.

Quality in terms of both crude protein and IVDMD is related to the amount of alfalfa present in the mixture. Visual estimates of the amount of alfalfa by weight in the mixtures for fifteen of the twenty-one harvests are reported in table 7. Estimates of botanical composition for the remaining harvests were not recorded. These data verify that the crude protein and IVDMD percentages are directly related to the amount of alfalfa in the mixture. The difference in the amount of alfalfa present at any one harvest was due partly to the increased growth of the grasses during the summer months (table 8), and partly to a reduced growth rate of the alfalfa during the same period.

Stand Persistance

Buffelgrass became established quickly after planting and contributed a large percentage of that yield in the first harvest. After this harvest the alfalfa became better established and the mixture was rated good to excellent. At the end of the experiment the buffelgrass made up approximately 40 percent of the stand.

Kazungula Setaria became established much slower than the buffelgrass. This mixture was rated good. At the end of the experiment the setaria made up approximately 40 percent of the stand.

Rhodesgrass became established very quickly after planting and was so competitive that it shaded out many of the alfalfa seedlings. The alfalfa provided only a very small amount to the first harvest yield. After the first harvest the alfalfa became better established and the mixture was rated good. The Rhodesgrass made up approximately 30 percent of the stand at the end of the experiment.

Green panicgrass grew at almost the same rate as the alfalfa so this mixture was rated good to excellent. At the end of the experiment green panicgrass made up approximately 40 percent of the stand.

Guineagrass was the slowest of the grasses to become established. But when established the mixture was rated good to excellent. The guineagrass made up approximately 50 percent of the stand at the end of the experiment.

Alfalfa stands were beginning to thin out in all of the mixtures by the time of the 17th harvest. However, by the end of the experiment stands still ranged from 44 to 61 percent, table 9.

Insect and Disease Problems

The following insects have been observed damaging both alfalfa plots and field stands at the BARTAD site: fall armyworm, *Spodoptera tragiperda*; yellowstriped armyworm, *Spodoperta ornithogalli*; southern armyworm, granulate cutworm, *Feltia subterranea*; saltmarsh caterpillar, *Estigmene acrea*, and a webworm of possible *Loxostege* species.

Table 7. Estimated Percent Alfalfa by Weight in Five Alfalfa-Grass Mixtures.

Grass Component	Harvest Date 11/ 6/ 75	12/ 23/ 75	2/ 10/ 76	3/ 19/ 76	4/ 23/ 76	5/ 13/ 76	6/ 9/ 76	7/ 20/ 76	8/ 17/ 76	9/ 21/ 76	11/ 2/ 76	12/ 14/ 76	1/ 25/ 77	3/ 3/ 77	4/ 1/ 77	5/ 4/ 77	5/ 25/ 77	6/ 21/ 77
	%																	
Buffelgrass	60	89	98	98		98	98	77	75	77	85			98	89	98	95	70
Kaz. Setaria	71	84	98	98		97	97	76	77	76	85			98	91	93	92	52
Rhodesgrass	26	70	93	94		96	98	81	81	76	61			97	93	92	90	75
Green panic-grass	62	81	97	97		97	98	74	81	74	65			98	86	92	93	64
Guineagrass	52	85	95	96		96	98	71	67	65	56			98	97	94	93	43

Table 8. Average Height of Five Grasses in Inches When Grown in Mixtures with Mex-Son Alfalfa

Grass Component	Harvest Date 7/ 19/ 75	8/ 29/ 75	9/ 29/ 75	11/ 6/ 75	12/ 23/ 75	2/ 10/ 76	3/ 19/ 76	4/ 23/ 76	5/ 13/ 76	6/ 9/ 76	7/ 20/ 76	8/ 17/ 76	9/ 21/ 76	11/ 2/ 76	12/ 14/ 76	1/ 25/ 77	3/ 3/ 77	4/ 1/ 77	5/ 4/ 77	5/ 25/ 77
	Inches																			
Buffelgrass	33	28		19	12	11	12		11	19	26	22	22	15			8	8	9	10
Kaz. Setaria	34	28		23	19	14	16		15	26	30	23	29	18			9	11	14	13
Rhodesgrass	37	31		28	21	19	19		17	25	29	25	33	26			14	17	15	18
Green panic-grass	34	27		22	17	15	17		11	22	25	20	21	18			10	11	9	11
Guineagrass	36	25		23	14	16	19		14	25	27	23	27	20			9	12	11	13

Table 9. Estimated Percent Stand of Alfalfa in Five Alfalfa-Grass Mixtures, Harvests 18 through 21 (Avg of Four Replications).

Variety	3/1/77	4/1/77	5/4/77	5/25/77
Buffelgrass	67	51	52	61
Kazungula Setaria	70	56	59	61
Rhodesgrass	62	47	47	49
Green panicgrass	66	47	46	59
Guineagrass	57	44	35	44

The most damaging of the insects appear to be the armyworms and webworms. These insects have caused severe problems in new seedings of alfalfa which were planted during the period of May through early July 1. Cygon (dimethoate) sprayed at the rate of 1 1/2 pints per acre gave adequate control of these insects if applied before damage became too severe. Webworms attacked established alfalfa stands, but if the alfalfa was grazed or harvested for hay it recovered without spraying.

Several diseases including Alfalfa Rust, Uromyces striatus, var. medicaginis, and Stemphylium Leafspot, Stemphylium botryosum, have been observed in alfalfa plots and in field stands at the BARTAD site. Alfalfa Rust was observed during the period of January-February and disappeared after stands were clipped. Stemphylium Leafspot was observed on both research plots and field stands from February until June. Damage ranged from very light to very severe with nearly 100% of the leaves turning yellow.

What appeared to be Fusarium Wilt was observed in the research plots approximately 1 1/2 years after establishment and over the next 10 months seriously affected stands. Fungi isolated from diseased roots have been tentatively classified by forage pathologists at the U.S. Regional Pasture Research Laboratory as Fusarium (2 species); Cylindrocarpon; Rhizoctonia; an unidentified Phycomycete; and another unidentified fungus that appears to be associated with black, rotted areas on the roots. Further efforts will be made to determine the identification and pathogenicity of the fungi involved in the root rot problem.

Application of Findings to Andros

The results of this study indicate that with adequate fertility and management mixtures of adapted varieties of alfalfa and grass will yield 6 1/2 to 8 1/2 tons of dry matter per acre for at least two and possible three harvest years. From 30 to 50% of this production would occur during the cooler, dryer months of the year.

Of the five mixtures evaluated alfalfa plus T4464 buffelgrass and alfalfa plus kazungula setaria were the highest yielding. Both of these mixtures appear suitable for either grazing or hay making.

Based on initial observations from this trial approximately 160 acres of an alfalfa-buffelgrass mixture were sown on the research station and pilot test farms. At least 60 acres of this total has been in production for one year or longer. These stands have been grazed by cattle or sheep and also harvest for hay.

Observations after 2 years of field plantings indicate that alfalfa or alfalfa-grass mixtures can be established most successfully when seeded during the periods of May-June and September-November. However, during both years there were serious insect problems on seedling alfalfa plants seeded in May and June. Alfalfa seeded in the September-November period was less damaged by insects.

The economics of alfalfa production at BARTAD using information currently available have been developed in other BARTAD reports (see Final Report #15 "Economic Analysis of Beef Production on North Andros Island, Bahamas"). Briefly, based on present data the total per acre cost for establishing an alfalfa-buffelgrass mixture varied from $314 to $371 depending on the management level. Of this cost $200 to $250 was for fertilizer. The annual maintenance costs varied from $150 to $200 again depending on management level.

Thus, initial small plot studies indicate that annual dry matter yields of eight or more tons per acre are possible with adapted alfalfa-grass mixtures seeded at the proper time. However, the economics of growing this crop, either for hay or pasture, have not yet been established.