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STUDIES ON GRASS SILAGE FROM PREDOMINANTLY *PASPALUM DILATATUM* PASTURES IN SOUTH-EASTERN QUEENSLAND

3. INFLUENCE OF FERTILIZATION WITH NITROGEN AND METHOD OF HARVESTING ON SILAGES WITH AND WITHOUT THE ADDITION OF MOLASSES

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SUMMARY

Experimental tower silos of 0·75 ton capacity were used in a comparison of five silage treatments: (1) pasture top-dressed with 65 lb N per acre, harvested by cutter-bar and ensiled without molasses; (2) as for silage treatment 1, but ensiled with the addition of molasses at the rate of 40 lb per ton of green matter; (3) pasture from an unfertilized area, harvested by cutter-bar and ensiled without molasses; (4) pasture top-dressed with 65 lb N per ac, harvested by flail and ensiled without molasses; and (5) as for silage treatment 4, but ensiled with the addition of molasses at the rate of 40 lb per ton of green matter.

Top-dressing with one application of ammonium sulphate almost doubled the pasture dry-matter yield at harvesting, over untreated pasture. Crude protein content on a dry-matter basis was 11 per cent., compared with 9 per cent. in pasture from the unfertilized area. Digestibility was significantly increased.

The experimental procedure of rapid filling and maximum compaction resulted in low-temperature silages in all treatments. Fermentation losses were comparable and low, ranging from 8 to 14 per cent. Effluent occurred only in one treatment, the dry matter of which was 20 per cent.

Optimum silage quality was not obtained in any treatment. An improved product as shown by lower pH, higher lactic acid content, lower butyric acid level and lower concentration of volatile bases resulted from the inclusion of molasses. The method of harvesting was also important, the best product coming from material harvested by cutter-bar and ensiled with the addition of molasses.

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The ensiling process resulted in a decrease in the digestibility of most components. The addition of molasses significantly increased the dry-matter digestibility, due largely to a marked increase in the digestibility of the nitrogen-free-extract. Harvesting method also influenced digestibility. The product harvested by cutter-bar and ensiled with the addition of molasses showed a digestibility of all components which was significantly higher than that of the product harvested by flail and ensiled with a similar quantity of molasses.

All silages were eaten readily by sheep. With free choice of all products, sheep favoured the silage from the unfertilized area and the silage from the nitrogen-fertilized area harvested by cutter-bar and ensiled with the addition of molasses.

I. INTRODUCTION

The grazing management studies of Harvey, Beames, Hegarty, and O'Bryan (1963) indicate the wide seasonal variation in pasture productivity in south-eastern Queensland and emphasize the need to include conservation in the control of pasture for optimum animal productivity in this environment. In any conservation programme it is desirable that both yield and quality of pasture should be at their economic maximum at the time of conservation. Henzell (1963) has shown that in the coastal areas of south-eastern Queensland large increases in pasture yield can be obtained from the application of nitrogenous fertilizers. Further, if the rate of nitrogen application exceeds requirement for maximum growth, there will be an increase in the nitrogen content of the pasture.

Previous papers in this series (Levitt, Taylor, and Hegarty 1962; Levitt, Hegarty, and Radel 1964) have evaluated the influence of additives and harvesting methods on the quality of silage made from predominantly paspalum pastures. In the absence of nitrogen fertilization the protein content on a dry-matter basis of the pasture at ensiling was low, ranging from 8·6 per cent. in January 1957 to 8·3 per cent. in February 1959 to 6·9 per cent. in December 1959. Under these conditions the best silage resulted from the use of the cutter-bar type of harvester and the addition of molasses at the time of ensiling.

In general, crops of high protein content contain relatively small quantities of easily fermentable carbohydrate and are more difficult to ensile (Watson and Nash 1960). In the study now reported the predominantly paspalum pasture was harvested from an untreated area and from a comparable area which had been top-dressed with nitrogen. Two methods of harvesting were compared on the product from the nitrogen-treated area. The use of molasses as an additive to improve silage quality was also evaluated.

II. METHODS AND MATERIALS

Experimental Area.—An experimental area of approximately 2 ac was selected at the Animal Husbandry Research Farm at Rocklea, near Brisbane. The pasture consisted of *Paspalum dilatatum* almost exclusively. The area was first mown and cleared of dung patches. One acre was fertilized with ammonium sulphate at the rate of 65 lb nitrogen per ac.

Pasture Yield Measurements.—Estimation of pasture yield was carried out by the quadrat procedure previously described (Levitt, Taylor, and Hegarty 1962).

Harvesting Procedure.—A commercial cutter-bar type harvester giving a produce chopped in 1-2-in. lengths was used to cut enough pasture from the fertilized area to fill two experimental silos each with a capacity of 0·75 ton. It was also used to cut 0·75 ton of pasture from the untreated area.

A commercial flail-type harvester giving a product varying in length from 6 to 12 in. was used to cut a further 1·5 tons of pasture from the fertilized area. All the harvested pasture was transported approximately two miles to the experimental silos and ensiled immediately.

Experimental Silos and Filling Procedure.—These were essentially the same as previously described by Levitt, Taylor, and Hegarty (1962). Where treatments involved the use of molasses it was added at the rate of 40 lb per ton of green material. To facilitate handling, the molasses was diluted with an equal volume of water just prior to use, the correct proportion being sprinkled after the addition of each 50 lb of pasture to the silo.

Temperature of each silage treatment was determined by the introduction of thermocouples located at top, middle and bottom positions when each silo was being filled. Readings were taken by coupling the thermocouple leads to a previously calibrated potentiometer.

Silage quality tests were essentially those of Barnett (1954). Fatty acids were determined in aqueous extracts by the technique of Emery and Koerner (1961).

Stock-food analyses were by the methods of the Association of Official Agricultural Chemists (1955). Total sugar in pasture and silage was by the method of Wiseman, Mallack, and Jacobson (1960).

Digestibility was determined on pasture from each area collected at the time of ensiling and on a representative sample of the material from each silage treatment. Unlike the previous studies in this series, a latin square design was not followed, each silo being evaluated in sequence.

Comparative palatability was determined by giving six sheep access to all silages simultaneously and recording daily dry-matter consumption of each product. Sheep were housed in pairs and had access to the silages for three days in succession.

III. EXPERIMENTAL

This experiment was carried out during the summer of 1961. The area selected was mown and raked on January 12, 1961. Approximately half the area (1 ac) was fertilized with ammonium sulphate at the rate of 65 lb nitrogen per ac on January 17, 1961. In the absence of rain, pasture yield measurements from treated and untreated areas did not commence until February 28, 1961; they continued until March 23, 1961.

Digestibility measurements on pasture cut from both areas commenced on March 13, 1961. After a 7-day preliminary period, the collection period was from March 19 to March 25 inclusive.

The pasture was harvested for silage on March 21 and 22, 1961.

The silage treatments were:—

Silo 1: Pasture cut from the treated area with the cutter-bar type harvester and ensiled without molasses (harvested March 21).

Silo 2: Pasture cut from the treated area with the cutter-bar type harvester and ensiled with molasses at the rate of 40 lb per ton of green material (harvested March 22).

Silo 3: Pasture cut from the untreated area with the cutter-bar type harvester and ensiled without molasses (harvested March 21).

Silo 4: Pasture cut from the treated area with the flail-type harvester and ensiled without molasses (harvested March 21).

Silo 5: Pasture cut from the treated area with the flail-type harvester and ensiled with molasses at the rate of 40 lb per ton of green material (harvested March 22).

The experimental towers were opened for digestibility and palatability studies in the following order:—

August 5, 1961—Silo 3 and Silo 5

August 15, 1961—Silo 1 and Silo 4

August 29, 1961—Silo 2.

IV. RESULTS

Rainfall data and the yield and crude protein content of pasture from both the treated and untreated areas on a dry-matter basis are shown in Figure 1. The yield from the fertilized area showed a threefold increase in the 20 days prior to ensiling, while the protein level fell from 16·0 per cent. to 11·0 per cent. on a dry-matter basis. During this period the untreated area showed a fivefold increase in yield but the final yield at ensiling was only about half the final yield from the fertilized area. The protein content of the treated pasture at ensiling was about two percentage units above that from the untreated area. There was a slight change in yield and protein content of pasture from both areas during the period when digestibility was being determined.

Proximate analyses are recorded in Table 1 for pasture collected from both areas. These include samples taken by quadrat cuts at approximately 7-day intervals, representative samples of material fed during the digestibility trials and

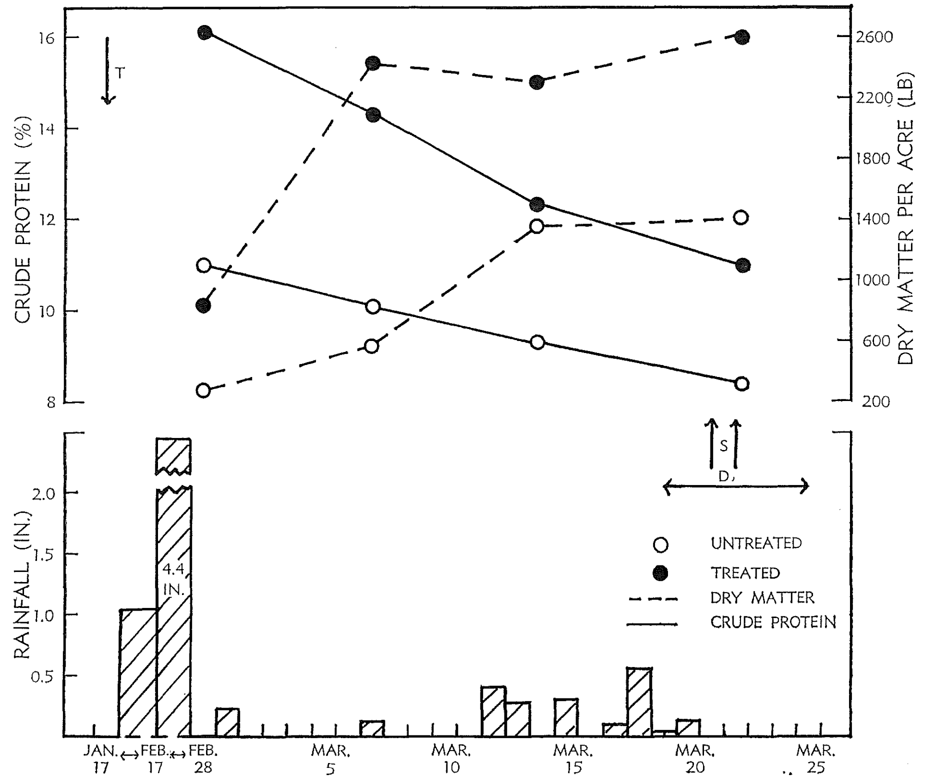

Fig. 1.—Rainfall data and the dry-matter yield and protein content of pasture from treated and untreated areas.

↓ T Date of top-dressing of treated area with 65 lb nitrogen per ac

↑S↑ Time of harvesting for silage

D ⟵⟶ Period of digestibility measurement

representative samples of material at ensiling. At all sampling times the pasture from the treated area had a lower dry-matter content and a higher protein level than the pasture from the unfertilized area. In both areas the increase in pasture growth resulted in a decrease in the level of protein and an increase in the fibre content. For each area, the representative sample of pasture from the digestibility trial was of similar chemical composition to that of pasture harvested for ensiling.

The maximum temperatures recorded at the three levels in each silo are shown in Table 2. All silos had reached a maximum by the third day after filling. The highest temperature was recorded in the middle of each silo. The temperature recorded near the bottom varied from 2 to 5°C below the temperature recorded in the middle, but the temperature recorded near the top was only slightly below that in the middle. All silos had returned to atmospheric temperature at about 10 days after filling.

TABLE 1

COMPOSITION OF PASTURE

Sample	Dry Matter (%)	Percentage on Dry Matter							
		Protein	Fat	Fibre	N.F.E.	Ash	Calcium (Ca)	Phosphorus (P)	Sugar
Untreated area									
Quadrats cut 28.ii.61	30·6	11·1	2·7	30·1	47·3	8·8	0·26	0·20	3·01
Quadrats cut 7.iii.61	28·4	10·1	2·7	31·3	45·9	10·0	0·27	0·22	3·74
Quadrats cut 14.iii.61	28·8	9·3	2·3	32·3	45·4	10·7	0·21	0·21	3·92
Quadrats cut 23.iii.61	24·0	8·4	2·4	33·6	46·6	9·0	0·20	0·20	
Representative sample from digestibility trial 19.iii.61 to 25.iii.61	22·9	8·5	2·4	34·2	46·3	8·6	0·18	0·25	
Representative sample harvested by cutter-bar at ensiling 21.iii.61	28·0	9·0	2·2	33·4	46·2	9·2	0·21	0·25	2·71
Treated area									
Quadrats cut 28.ii.61	20·8	16·1	3·5	28·2	42·0	10·2	0·23	0·24	3·31
Quadrats cut 7.iii.61	20·9	14·3	3·0	29·5	42·8	10·4	0·23	0·27	3·73
Quadrats cut 14.iii.61	22·5	12·3	2·8	31·8	43·7	9·4	0·22	0·23	3·82
Quadrats cut 23.iii.61	20·8	10·8	2·6	33·9	43·6	9·1	0·20	0·22	
Representative sample from digestibility trial 19.iii.61 to 25.iii.61	19·6	11·0	2·6	33·4	44·1	8·9	0·19	0·25	
Representative sample harvested by cutter-bar at ensiling on 21.iii.61	23·5	10·8	2·7	32·0	44·9	9·6	0·17	0·24	3·36
Representative sample harvested by flail at ensiling on 21.iii.61	23·6	11·0	2·3	33·1	44·2	10·1	0·23	0·25	3·13
Representative sample harvested by cutter-bar at ensiling on 22.iii.61	19·8	11·1	2·8	33·0	43·9	9·2	0·17	0·26	3·73
Representative sample harvested by flail at ensiling on 22.iii.61	24·0	10·9	2·3	32·5	44·2	10·1	0·23	0·25	3·08

TABLE 2

MAXIMUM TEMPERATURES (°C) RECORDED IN EACH SILO

Silo No.	Atmospheric Temperature	Bottom	Middle	Top
Silo 1 (cutter-bar, treated area, no additive)	27·0	28·8	31·8	31·7
Silo 2 (cutter-bar, treated area, 40 lb molasses/ton)	28·0	25·8	29·7	29·2
Silo 3 (cutter-bar, untreated area, no additive)	27·0	27·1	31·2	30·5
Silo 4 (flail, treated area, no additive) ..	27·0	30·9	35·8	34·6
Silo 5 (flail, treated area, 40 lb molasses/ton)	28·0	29·7	31·2	30·6

Maximum recorded 3 days after filling in Silos 1, 2, 3 and 5; 2 days after filling in Silo 4.

Fermentation losses for each silage treatment are shown in Table 3. Losses were of the order of 10 per cent. in all silages except Silo 2, in which a loss of 14 per cent. was recorded. Effluent was produced only in Silo 2, and this probably accounts for the higher fermentation loss in this treatment. Composition of the effluent is shown in Table 4.

TABLE 3

FERMENTATION LOSSES

Treatment	Amount Ensiled (lb)	Additive (lb)	Amount Recovered (lb)	Amount of Effluent (lb)	Fermentation Loss (%)
Silo 1 (cutter-bar, treated area, no additive) ..	1,825 (429)*	..	1,753 (393)	..	8
Silo 2 (cutter-bar, treated area, 40 lb molasses/ton)	2,300 (455)	41·1 (31·4)	2,077 (416)	138·9 (6·4)	14
Silo 3 (cutter-bar, untreated area, no additive) ..	1,525 (427)	..	1,469 (388)	..	9
Silo 4 (flail, treated area, no additive)	1,750 (413)	..	1,683 (370)	..	10
Silo 5 (flail, treated area, 40 lb molasses/ton) ..	1,600 (384)	28·6 (21·8)	1,611 (366)	..	10

* Values in parentheses are expressed on a dry-matter basis.

TABLE 4

COMPOSITION OF EFFLUENT FROM SILO 2

(Treatment: cutter-bar, treated area, 40 lb molasses/ton)

Total Volume (l)	pH	Dry Matter (%)	Nitrogen (%N)	Volatile Acids (% acetic acid)	Residual Acids (% lactic acid)
63	5·24	4·6	0·15	0·95	0·27

TABLE 5

SILAGE QUALITY TESTS

Silo No.	pH	Dry Matter (%)	Volatile Acidity* (% acetic acid)	Residual Acidity* (% lactic acid)	Acetic Acid* (%)	Butyric Acid* (%)	Nitrogen (%N)*			Comments
							Total	Amino Acid	Volatile Base	
Silo 1 (cutter-bar, treated area, no additive)	4·86	22·40	5·09	2·01	2·24	2·93	1·83	0·26	0·43	Mid-brown leaves; light-brown stems; some seed-head; sweet odour with acetic acid smell
Silo 2 (cutter-bar, treated area, molasses 40 lb/ton)	4·54	20·05	4·44	2·44	2·01	2·69	1·77	0·24	0·24	Mid-brown leaves and stems, changing to dark-brown on exposure; very sweet smell
Silo 3 (cutter-bar, untreated area, no additive)	4·85	26·42	2·91	2·38	1·37	1·49	1·55	0·25	0·26	Light-brown leaves and stems; stemmy with much seed-head; sweet odour but not strong
Silo 4 (flail, treated area, no additive)	4·88	21·97	4·32	1·82	1·54	2·83	1·87	0·28	0·35	Light-midbrown leaves; yellow stems; sweet odour with some acetic acid detectable
Silo 5 (flail, treated area, 40 lb molasses/ton)	4·64	22·69	4·71	3·17	1·91	2·70	1·83	0·26	0·26	Light-brown leaves and stems; very sweet smell

* Values expressed on a dry-matter basis.

Silage quality findings are tabulated in Tables 5 and 6. Optimal silage quality was not obtained in any silage although the addition of molasses resulted in an increased level of lactic acid and a lowered pH. Butyric acid was present in appreciable quantities in all silages. The total volatile acidity was lowest in the product conserved from the untreated area. No marked differences in quality could be attributed to the method of harvesting.

TABLE 6

GAS CHROMATOGRAPHY OF LOWER FATTY ACIDS EXPRESSED AS MOLES (%)

Silo No.	Acetic Acid	Propionic Acid	Isobutyric Acid	Butyric Acid	Isovaleric Acid	Valeric Acid	Caproic Acid	Not Identified
1	44·1	6·8	4·7	39·2	1·6	0·9	2·5	..
2	45·4	4·6	2·5	41·2	1·2	0·6	3·7	0·7
3	46·7	6·3	6·1	34·7	1·4	1·4	3·4	..
4	35·7	8·7	5·8	44·8	1·9	1·9	1·7	0·4
5	40·4	14·0	3·2	38·9	1·6	1·6	1·3	0·5

The proximate analyses of the five silages are shown in Table 7. The protein on a dry-matter basis was higher and the nitrogen-free-extract lower in all silages than in the representative samples of pasture prior to ensiling.

TABLE 7

COMPOSITION OF SILAGES

Treatment	Dry Matter (%)	Percentage on Dry Matter					
		Protein	Fat	Fibre	N.F.E.	Ash	Sugar
Silo 1 (cutter-bar, treated area, no additive)	22·4	11·5	3·0	33·9	40·2	11·4	0·80
Silo 2 (cutter-bar, treated area, 40 lb molasses/ton) ..	20·1	11·0	3·1	33·9	41·7	10·3	1·20
Silo 3 (cutter-bar, untreated area, no additive)	26·4	9·7	2·7	36·9	41·2	9·5	0·60
Silo 4 (flail, treated area, no additive)	22·0	11·7	3·1	33·7	40·8	10·7	0·76
Silo 5 (flail, treated area, 40 lb molasses/ton)	22·7	11·5	2·7	32·9	40·2	12·7	1·12

Digestibility data on the pasture from both areas prior to ensiling and on the five silage treatments are shown in Tables 8 and 9. The results have been analysed statistically, using the multiple range test.

TABLE 8

MEAN DIGESTIBILITY COEFFICIENTS, APPROXIMATE STANDARD ERRORS AND SIGNIFICANCE OF TREATMENT DIFFERENCES

Treatment	Dry Matter (%)	Organic Matter (%)	Protein (%)	Fat (%)	Fibre (%)	N.F.E. (%)
(a) Pasture from untreated area ..	54·83	57·49	54·57	51·81	62·59	54·26
(b) Pasture from treated area ..	59·52	61·66	64·69	40·64	66·71	58·81
(c) Silo 1 (cutter-bar, treated area, no additive)	50·98	53·91	61·52	53·34	62·15	43·34
(d) Silo 2 (cutter-bar, treated area, molasses at 40 lb/ton) ..	56·95	58·72	62·56	56·73	65·03	52·63
(e) Silo 3 (cutter-bar, untreated area, no additive)	52·03	54·57	57·71	48·73	63·91	45·73
(f) Silo 4 (flail, treated area, no additive)	51·56	53·58	61·34	52·94	62·18	44·28
(g) Silo 5 (flail, treated area, molasses at 40 lb/ton) ..	53·04	55·36	59·19	52·22	63·12	48·15
S.E. of treatment means (approx.)	± 0·55	± 0·63	± 0·75	± 1·08	± 0·74	± 0·06
Significance:						
Effect of nitrogen—						
(i) on pasture	b> a***	b> a***	b> a***	b< a***	b> a**	b> a***
(ii) on silage	N.S.	N.S.	c> e***	c> e**	N.S.	c< e**
Effect of ensiling—						
(i) cutter-bar, untreated area	e< a**	e< a**	e> a**	N.S.	N.S.	e< a***
(ii) cutter-bar, treated area ..	c< b***	c< b**	c< b*	c> b***	c< b***	c< b**
(iii) flail, treated area ..	f< b***	f< b***	f< b*	f> b***	f< b**	f< b***
Effect of harvesting method—						
(i) with no additive ..	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
(ii) with addtive	g< d***	g< d***	g< d**	g< d**	g< d*	g< d***
Effect of additives—						
(i) cutter-bar	d> c***	d> c***	N.S.	N.S.	d> c*	d> c***
(ii) flail	g> f*	g> f*	g< f*	N.S.	N.S.	g> f***

N.S. = No significant differences among treatments
* = Significant at 5% level
** = Significant at 1% level
*** = Significant at 0·1% level

Top-dressing with nitrogen not only increased the yield and protein content of the pasture but also markedly increased the digestibility of all components in this pasture. This improvement in digestibility was much less apparent in the silages made from these pastures. For all components other than fat, the ensiling processes resulted in a reduction in digestibility.

With both the flail and cutter-bar types of harvester the addition of molasses resulted in more digestible products, the improvement being more marked in the product harvested by the cutter-bar type of commercial harvester. The product of maximum digestibility resulted from harvesting by cutter-bar and the addition of molasses. In the absence of molasses, differences due to harvesting method did not attain significance.

TABLE 9

DIGESTIBLE PROTEIN, TOTAL DIGESTIBLE NUTRIENTS, METABOLIZABLE ENERGY AND STARCH EQUIVALENT PER 100 LB OF MOISTURE-FREE MATERIAL

Sample	Digestible Protein (lb)	Total Digestible Nutrients (lb)	Metabolizable Energy (therms)	Starch Equivalent (lb)
Pasture (untreated area)	4·6	54·0	84·8	33·5
Pasture (treated area)	7·1	57·7	90·4	37·8
Silo 1 (cutter-bar, treated area, no additive)	7·0	49·2	73·0	28·5
Silo 2 (cutter-bar, treated area, molasses 40 lb/ton)	6·9	54·8	81·9	34·1
Silo 3 (cutter-bar, untreated area, no additive)	5·6	51·0	75·5	28·7
Silo 4 (flail, treated area, no additive) ..	7·2	49·9	74·3	29·2
Silo 5 (flail, treated area, molasses 40 lb/ton)	6·8	50·1	75·1	30·0

The comparative palatability of the five silages is shown in Table 10. With free access to all silages, sheep showed a preference for two products—the material harvested from the untreated area and ensiled without molasses (Silo 3) and the material harvested by the cutter-bar type of commercial harvester and ensiled with molasses (Silo 2). There were no marked differences in the comparative palatability of the other silages but there was an indication that the next product in order of palatability was the material harvested by the flail type of commercial harvester and ensiled with molasses (Silo 5). All silages were eaten readily when fed without choice.

TABLE 10

COMPARATIVE PALATABILITY OF SILAGES

Sheep Nos.	Day	Percentage of Daily Diet Selected from each Silage				
		Silo 1	Silo 2	Silo 3	Silo 4	Silo 5
201 & 252	1	10·3	22·3	28·9	15·4	23·1
,,	2	12·2	30·7	38·7	4·8	13·6
,,	3	11·3	25·1	32·3	16·3	15·0
249 & 256	1	10·9	22·6	29·9	23·4	13·2
,,	2	18·7	33·6	27·9	3·6	16·2
,,	3	21·9	30·7	23·3	9·9	14·2
233 & 246	1	12·3	28·9	32·3	9·5	17·0
,,	2	6·3	35·0	33·6	11·0	14·1
,,	3	6·2	26·5	36·4	15·7	15·2
Mean		12·3	28·4	31·4	12·2	15·7

V. DISCUSSION

In this experiment the unexpectedly dry conditions in the 30 days following the application of nitrogen undoubtedly influenced pasture growth. These conditions may also have limited the response to nitrogen in terms of pasture growth. A measurable increase in yield resulted only with the advent of effective rain and it was two months from the time of top-dressing before the amount of pasture was considered sufficient for conservation. At this stage the yield of pasture in the treated area was approximately twice that in the untreated area. There was also a marked improvement in quality, pasture from the treated area having a higher moisture content and higher protein and lower fibre on a dry-matter basis. This increase in quantity and quality following nitrogen fertilization is in keeping with the findings of Henzell (1963) for pastures in south-eastern Queensland.

A number of workers have investigated the influence of nitrogen fertilization on the quality of the pasture or crop conserved as silage. Gordon *et al.* (1962), from experiments with pasture top-dressed with 400 lb ammonium nitrate per ac 2-3 weeks before harvesting, concluded that nitrogen fertilization resulted in a marked increase in protein content but could lead to a silage of poorer chemical quality and lower feeding value than silage prepared from unfertilized control forage. Wieringa (1962) reported that top-dressing herbage with nitrogen increased the protein and decreased the dry-matter and sugar contents and resulted in a silage of lowered quality. In our experiment there was also a lowered chemical quality in silage from pasture top-dressed with nitrogen. A direct comparison is possible between silages prepared from pasture from treated and untreated areas, harvested by the cutter-bar type of commercial harvester and ensiled without additive. Using chemical indices of quality (Barnett 1954), the silage from the treated pasture had a higher butyric acid level (2·24 compared with 1·37 per cent.), a lower lactic acid content (2·01 compared with 2·38 per cent.), a poorer ratio of lactic acid to acetic acid (0·4:1 compared with 0·8:1), and a poorer ratio of amino acids to volatile bases (0·6:1 compared with 1:1). However, in both silages the pH was undesirably high. This may be related to the low sugar content of 3·4 and 2·7 per cent. in pasture from the treated and untreated areas. Wieringa (1962) stated that 8 per cent. soluble sugar in pasture is necessary for the production of a good quality silage. The findings of Murdoch (1961) suggest that some improvement in silage quality may have resulted had the pasture from both areas been allowed to wilt before ensiling.

The present investigation permitted an extension of the earlier findings on the influence of harvesting method and additives on silage quality (Levitt, Taylor, and Hegarty 1962; Levitt, Hegarty, and Radel 1964). In the earlier studies the protein content of pasture on a dry-matter basis ranged from 6·6 to 8·6 per cent. In the present study the protein level in pasture from the nitrogen-treated area was 11 per cent. at the time of ensiling. In all experiments the procedure of rapid filling and maximum compaction in small concrete towers of 0·75-ton capacity resulted in low fermentation losses and the production of silages which would be classed as low-temperature products (Watson and Ferguson 1937).

In the present investigation considerable care was taken to adjust the cutting height of both harvesters to the same level and this is reflected in the marked similarity in chemical composition of representative samples of both products at ensiling. The cutter-bar type of harvester gave a product in lengths of 1-2 in. The flail-harvested material varied in length from 6 to 12 in. and contrary to the previous experiment (Levitt, Hegarty, and Radel 1964) showed considerable laceration. This has been attributed to the more succulent and less fibrous nature of this pasture. Even so, the flail-harvested material was more difficult to compact than the finely chopped product from the cutter-bar type of harvester. However, under the experimental conditions, which allowed maximum compaction, there was no marked evidence of improved silage quality attributable to fine chopping. As suggested by Murdoch (1961), this could be due to the greater measure of control which can be exercised when only small quantities of silage are made. In large-scale silage production the obviously greater ease of compaction of the finely chopped pasture certainly favours the use of a harvester which will give this type of product.

An improvement in silage quality was again evident following the addition of molasses at the rate of 40 lb per ton of green matter. This is reflected in the lowered pH, increased lactic acid, better ratio of lactic to acetic acid, improved ratio of amino acids to volatile bases and enhanced physical characteristics of colour and smell. However, this level of molasses did not result in a silage of pH below the minimum level of 4·2 required for a stable product (Barnett 1954). Levitt, Taylor, and Hegarty (1962) reported an additional response in the quality of paspalum silage from the use of molasses at the rate of 80 lb per ton. Studies now in progress with pastures showing an even lower sugar content (unpublished data) indicate a further response in silage quality from molasses at the rate of 120 lb per ton.

A number of conclusions are evident from the measurements of apparent digestibility on treated and untreated pasture prior to and after ensiling. Top-dressing with nitrogen significantly increased the digestibility coefficients for protein, fibre and nitrogen-free-extract. As in previous experiments in this series, the digestibility of most components fell as a result of the ensiling process. The influence of harvesting method was similar to that recorded by Levitt, Hegarty, and Radel (1964), a more digestible product being obtained from silage made from pasture harvested by the cutter-bar type of commercial harvester. Contrary to the findings of Levitt, Hegarty, and Radel (1964) but in keeping with earlier findings (Levitt, Taylor, and Hegarty 1962), the addition of molasses increased the overall digestibility, the increase being most marked in the silage made from pasture harvested by the cutter-bar type of harvester. Failure to obtain a digestibility response to molasses in the experiment reported in 1964 may be related to the low digestibility of all components in pasture at the time. The digestible protein level was particularly low—2·3 per cent., compared with 7·1 per cent. for pasture in the present study.

An indication of comparative palatability was obtained by giving each animal access to all silages simultaneously. This procedure differed from that used previously, when each animal had access to no more than two silage products at the one time. In general, results tended to be less conclusive. However, there was some indication of a preference for silage from pasture from the untreated area harvested by cutter-bar and ensiled without molasses, and also for silage from pasture from the treated area harvested by cutter-bar and ensiled with molasses.

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