

Kikuyu Grass: *Pennisetum clandestinum*.
Hochst ex Chiov and its value in the
montane region of Ceylon

2. Nutritive value and animal production aspects

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INTRODUCTION

In the first section of this paper, the agronomic aspects of growing kikuyu grass have been dealt with, and it was pointed out that kikuyu is a productive grass which can easily be established and grown in the montane region of Ceylon. This part of the paper deals with the value of kikuyu for animal production.

The nutritive value of a forage is determined not only by characteristics of the forage, but also by other factors such as management and environment. We are thus concerned with a number of related problems. How much forage will the animal consume? How efficiently is the grass utilised? What factors affect this utilization? What are the levels of production that can be obtained from cows fed kikuyu and what supplementation with concentrates is necessary? These are the questions that we hope to discuss.

REVIEW OF LITERATURE

Several reports have appeared in the literature on the use of kikuyu for milk and meat production (17,315 and 13). Yields of 1000 gallons of milk per acre from kikuyu pastures were reported as early as 1941 by Taylor (17). These results were obtained in a 7 month season with only 34 inches of rainfall with an application of about 500 lbs. of Ammonium Sulphate per acre per year. Colman (3) has shown similar results in his stocking rate trials. He obtained 300 lbs of butterfat (8000 lbs of 4 per cent milk) per acre, applying about 350 lbs Nitrogen, with 65 inches of rainfall. These pastures were being stocked at the rate

of 1.3 cows per acre. Beef cattle also appear to do well on kikuyu. In one report (13), steers gained up to 4.4 lbs per acre per day, and these irrigated pasture were stocked at 2 steers per acre. While these and other reports indicate that kikuyu pastures show promise as a crop for animal production, there is scant information on the nutritive value and animal production potential of the grass.

FORAGE INTAKE

Intake is, no doubt, one of the most critical consideration in assessing the nutritive value of a feed. It is generally agreed that dairy animals and cattle, in general, will consume feed at varying rates depending on a number of factors related to the feed itself and to the management of the feeding programme (12). The maximum limit for temperate cattle is usually at about 3.5 lb of Dry Matter intake per 100 lbs live body weight; this occurred when concentrates were fed liberally. The values reported for forage intake in the tropics are much lower and very often are less than half those reported for animals in temperate regions (10).

Harrison has reviewed the literature on intake of tropical forages and has pointed out some of the problems (8,9). He notes that low dry matter intake is often thought to be due to the high moisture content of the herbage during the rainy season. This however, has not been demonstrated with Napier grass. Harrison (10) obtained very low intake values of about 1.5 per cent; and was able to increase this intake by 60 per cent in a separate trial by wilting the grass from 20 per cent. to 30 per cent. dry matter. In the temperate regions however, it was found (9) that low dry matter forage produced by high nitrogen fertilisation, was consumed at the same rate of dry matter intake, as the same forage of higher dry matter content. The consumption was around 2 per cent. body weight. Todd (16), in Kenya, has noted that the dry matter intake of kikuyu by sheep was over 3.0 per cent. live weight. The grass that he used for feeding was wilted overnight, the original moisture content being very high (over 85 per cent.)

TABLE 1.—Intake of fresh kikuyu by cattle and sheep under stall-fed conditions

Description of Forage	Animals used	Intake of dry Matter (% of live weight)	Dry Matter (% of grass)
30-day growth ..	3, mature heifers	2.4	15.0
30-day growth ..	3 milking cows	2.7	14.8
30-day growth ..	4, mature rams	1.9	17.4
30-day growth cut from 30 day rotationally grazed paddock	4, mature rams	2.0	18.8
Average ..		2.25	16.5

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The data obtained from trials conducted by the Authors at the Ambawela station in Ceylon, are listed in Table I. In these trials, the animals were stall-fed with fresh, kikuyu grass. A wide range of dry matter intakes have been noted (1.9 to 2.7 per cent.) which do not seem to bear any relationship to the moisture content of the grass. In certain isolated instances, the daily dry matter intake was reduced with an increase in the moisture content of the grass. During the rainy season, the moisture content of the grass was very high, upto 90 per cent. and at these levels there is probably a physical limitation to the quantity of dry matter the animal can ingest. From the data collected over the year, it seems that a dry matter intake of between 2 and 2½ per cent. live weight could be expected. Hardison (8) has found about the same level of intake for other tropical forages

DIGESTIBILITY AND NUTRITIVE VALUE

In the assessment of any forage, the intake and the digestibility are closely related. As a general rule, as the intake increase, there is a tendency for the digestibility to decrease due to lowered microbiological efficiency of the fuller rumen. On the other hand, as the digestibility of a forage increases due to its character, the rate of passage of intake increased with digestibility from 2.5 to 3.3 per 100 lbs. intake. When three qualities of hay were fed to sheep (1), their digestibilities ranged from 46 to 76 per cent. The corresponding rates of intake increased with digestibility from 2.5 to 3.3 lbs. per 100 lbs. live weight per day. Thus it is important to provide a forage that is highly digestible so that in turn it will be consumed readily.

A. Effect of species and stage of growth

The nutritive value of forages vary widely between species and between stages of growth within the same species. In order to illustrate some of these effects, table II shows the digestible crude protein (DCP) and total digestible nutrients (TDN) obtained from several trials. Fescue and cocksfoot have been included in the list of grasses because these two temperate grasses are generally considered to be good grasses and when young, have high digestible crude protein and total digestible nutrient content. Pangola grass is somewhat lower in protein, but in its early stages of growth, has TDN values comparable to the temperate grasses. In comparison, kikuyu in its early stages of growth, is even higher in DCP and TDN than these other grasses; and it seems therefore that kikuyu grass is equal and superior to these other species in this respect.

Dry Matter
% of
grass

15.0
14.8
17.4
18.8
16.5

TABLE II.—Digestible crude protein and total digestible nutrient values of kikuyu and other grasses compared

<i>Grass sp. and stage of growth</i>	<i>Animals used</i>	<i>DCP</i>	<i>TDN</i>	<i>References</i>
TALL FESCUE				
Young pasture ..	..	12.8 ..	71.2 ..	11
COCKSFOOT				
Young pasture ..	..	13.4 ..	66.5 ..	11
PANGOLA HAY				
3 week ..	.. Sheep	9.8 ..	64.2 ..	14
6 week ..	..	3.3 ..	68.2 ..	
6 week ..	..	1.3 ..	67.3 ..	
KIKUYU HAY				
3 week ..	.. Sheep	9.6 ..	56.3 ..	
8 week ..	..	8.4 ..	56.5 ..	14
9 week ..	..	4.7 ..	57.0 ..	
KIKUYU GRASS				
3 inch ..	.. Sheep	18.3 ..	68.9 ..	16
12 inch ..	..	15.7 ..	53.2 ..	
KIKUYU GRASS*				
young ..	..	20.0 ..	68.4 ..	
12 to-20 inch ..	..	8.8 ..	58.7 ..	4
leaf ..	..	—	—	—
stem ..	..	7.6 ..	45.5 ..	
Old ..	..	2.0 ..	56.0 ..	
KIKUYU HAY				
18 week ..	.. Sheep	1.7 ..	48.5 ..	2
KIKUYU*				
young ..	...	11.9 ...	62.0 ...	7
KIKUYU GRASS				
5 inch ..	.. Sheep	9.3 ..	60.5 ..	15
KIKUYU GRASS				
30 day, cut ..	.. Sheep	18.1 ..	73.2 ..	
30 day, grazed ..	..	12.8 ..	69.9 ..	authors
30 day, cut ..				
fed 100 lb/day ..	.. mature heifers	18.6 ..	73.0 ..	authors
fed 120 lb/day ..	..	19.0 ..	74.5 ..	

*calculated from prediction equation (6).

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It is well known that the nutritive value of temperate grasses declines with extended growth and maturity. Sherrod and Ishisaki (14) found that the nutritive value of pangola and kikuyu also decline with maturity. As noted in Table II, the DCP content declined from almost 10 per cent at 3 weeks to about 5 per cent at 9 weeks after cutting. Campbell (2) reported to DCP level of only 1.7 at 19 weeks of age. While the TDN levels also show a similar trend, they appear to be much less variable than the DCP levels. Todd (16) noted a decline in both DCP and TDN when 3 inch kikuyu was compared with 9-12 inch kikuyu. Sherrod observed only a slight decline in TDN values of kikuyu and pangola upto 9 weeks. Costzee (4) found a dramatic difference in digestible nutrients of the grass between the three stages of growth. Sherrod in addition, noted that TDN had declined to 57.3 and 37 per cent. for pangola and kikuyu respectively at 24 weeks after cutting. The nutritive value of kikuyu leaves is also somewhat higher than that of the stems (4). At Ambawela we have found DCP values ranging from 12.8 to 19.0 and TDN values 69.9 to 74.5 in 30 day rotationally cut or grazed grass. From published reports and our feeding trials it appears that the higher nutritive value in kikuyu grass is obtained when it is cut or grazed once in 20 to 30 days.

B. Effect of fertilisation

In addition to the effects of fertilizer application on the growth and yield of grass, it also changes the nutrient content. Webster (15) reviewed a number of reports which have shown that application of fertilizer, particularly nitrogen compounds, have increased crude protein content as much as 3 to 4 per cent. Phosphate values were increased when phosphates were applied as fertilizers. In one trial conducted by Fernando and Andrew (5) at Ambawela, the effects of nitrogen fertilizer applications on kikuyu grass composition was studied. They found that the crude protein level in the grass was increased at all levels of nitrogen application; rising as much as 7.2 per cent. when 600 lbs. of nitrogen was applied per acre. Of this increase, nearly half was in the form of soluble nitrogen, when sampling was undertaken a few weeks after the fertiliser applied. A large portion of this soluble nitrogen was in the form of nitrate. Although the nitrate levels were higher than those usually considered

safe, there have been no indications of nitrate toxicity in animals grazed on the pastures fertilized at recommended levels. Some soluble forms of nitrogen can be utilized by the ruminant provided an adequate supply of energy is provided in the total ration.

C. Effects of Rainfall and Season

It was pointed out in the first section of this paper that the growth of grass varied greatly during the year due to the different climatic conditions. These variations may be as much as 50 per cent. above or below the average growth rate. Along with the variation in growth rate the composition of the grass also varies, affecting the intake and nutritive value. Hardison (8) noted that the dry matter contents of tropical grasses generally vary inversely with the rainfall. During the dry season, at Ambawela, mature kikuyu may contain 35 per cent. dry matter, while in the wet monsoon season, it has been noted to drop as low as 10 per cent. During the dry seasons, grazing animals should be able to obtain their requirements, but during the wet season, as pointed out by Todd, the animal may not be able to consume its full dry matter requirement due to the high moisture content and extreme bulk of this grass.

Hardison (8) notes that the reports in regard to the effects of rainfall and season on forage constituents are conflicting, with the exception of the dry matter content. However, in trials that the author has conducted, the crude protein content (10 per cent. dry matter) in kikuyu is about 4 per cent. higher in the wet season than in the dry season, while the other constituents such as crude fibre, ash and ether extract appear to alter only slightly. These values were obtained from grass of the same age and may not reflect some of the changes that usually occur in the grass due to the rapid growth in the wet season and the tendency for it to mature more quickly.

The primary effect of rainfall and season appears to be on the growth and dry matter content. At Ambawela during the first few months of the year it is cold and dry, and although the dry matter content is high, the growth of grass is inadequate. During the monsoon seasons although grass is abundant, the high moisture content appears to limit an animals intake.

TABLE III

Milk production potential per cow per day from kikuyu and estimated effects of concentrate feed supplementation

Feeding Programme	Intake of dry matter lbs per 100 lb. BW		Predicted milk production (pints)		Feed cost (Rs/pint)	Return over feed cost (2) Rs.
	Forage	Forage plus conc.	Protein	TDN	(1)	
<i>Ad lib</i> kikuyu grass pasture without any concentrates	2.0 ..	2.0 ..	35.0 ..	6.0 ..	0.213 ..	1.12
	2.5 ..	2.5 ..	57.0 ..	14.1 ..	0.113 ..	4.05
	3.0 ..	3.0 ..	71.0 ..	21.6 ..	0.089 ..	6.73
	3.3a ..	3.3 ..	88.0c ..	27.0c ..	0.076 ..	8.74
<i>Ad lib</i> kikuyu grass pasture plus 7 lbs concentrate per day	2.0 ..	2.8 ..	65.0 ..	20.6 ..	0.130 ..	5.56
	2.5 ..	3.3a ..	79.0c ..	28.0c ..	0.107 ..	8.20
	3.0b ..	— ..	— ..	— ..	— ..	—
	3.3b ..	— ..	— ..	— ..	— ..	—
<i>Ad lib</i> kikuyu grass pasture plus 12 lbs concentrate/day	2.0 ..	3.3a ..	88.0c ..	30.6c ..	0.117 ..	8.50
	2.5b ..	— ..	— ..	— ..	— ..	—
	3.0b ..	— ..	— ..	— ..	— ..	—
	3.3b ..	— ..	— ..	— ..	— ..	—

(1) Feed cost assumed —grass Rs. 0.08 per lb. dry matter
Conc. Rs. 0.20 per lb.

(2) Milk valued at Rs. 0.40 per pint.

a Maximum expected intake when given excellent quality forage and concentrates.

b Above intake capacity.

c These levels may not be reached due to limited intake capacity.

MILK PRODUCTION POTENTIAL AND CONCENTRATE SUPPLEMENTATION

From the data presented above some generalizations could be made about quality and nutritive value of kikuyu, from which the milk production potential can be predicted. Table III presents some of these estimates for levels of intake of grass and concentrates. For the purpose of these calculations it has been assumed that cows on pasture require 40 per cent. more nutrients than those under stall fed conditions, and the maintenance requirements have been revised upwards by this factor. The requirements have been taken from Morrison and Morrison (11) for an 800 lb. cow producing 4 per cent. milk. 20 to 30 day rotationally grazed kikuyu is estimated to contain 18 per cent. DCP and 70 per cent. TDN, while the concentrate available is estimated to contain 16 per cent. DCP and 75 per cent. TDN. The nutrient requirement for milk production is taken as 0.04 lbs of DCP and 0.3 lbs. of TDN per lb. of 4 per cent. milk. The milk production potential was determined by the excess nutrient intake over that required for body maintenance.

It can be seen that in all cases the DCP level is more than adequate and would support more milk production than the levels of energy. While there is sufficient protein to support the production of 35 pints of milk at the 2 per cent. level of forage dry matter intake, there is sufficient energy for only 6 pints. It becomes obvious that the concentrate fed should contain less protein and more energy. However, in Ceylon, the major ingredient available for concentrates is coconut poonac and since this contains 20 per cent. protein, it would be expensive to formulate a low protein, high energy concentrates. This is further aggravated by the lack of energy supplements such as high energy cereals.

It will be noted that as the rate of forage intake increases from the 2 per cent. level to 3.3 per cent. level, the cost of milk production decreases and return over feedcost increases significantly. Since the results of trials conducted show that the level of intake would lie between 2.0 and 2.5 per cent. milk production levels of 6 to 14 pints could be expected from 800 lb. cows on grass alone. With 7 lbs of concentrates, the expected production level is increased to about 20 pints, with a forage intake of 2.0 per cent. Higher levels of concentrate feeding may depress the forage dry matter intake. Therefore a moderate level of concentrate feeding with an attempt to maximize the forage intake is recommended. The best returns over feed cost would lie in the range of 2.0 per cent dry matter intake and a moderate concentrate supplementation of 5 to 10 lbs. of concentrate. This is

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in agreement with Hardison's (8) estimates for tropical forages. For supplementation of kikuyu grass with the presently available concentrate, the following general recommendation can be made; for cows producing over 6 pints of milk per day, provide adequate kikuyu grass pasture, free choice mineral lick and water, and feed concentrate at the rate of 1 lb. per 2 lbs. milk produced. Thus a cow producing 20 pints of milk would receive 7 lbs. of concentrate.

MINERAL AND VITAMIN CONTENT

Fernando (5) found that kikuyu would provide potassium, calcium and phosphorus in sufficient quantities to meet the maintenance and production requirements of the lactating cow. Apart from these, it seems that kikuyu when growing in fertile soil and under normal conditions, is similar to other grasses and would provide all necessary minerals except sodium and chlorine. It must be noted, however, that deficiencies of the minor elements in the soil would be reflected in the grass. To meet the above requirements and possible deficiencies, the concentrate fed should include a 3 per cent. mineral mixture. In addition a mineral lick could be provided free choice. A simple mixture such as 1 part mineralized salt mixed with 4 parts of defluorinated dicalcium phosphate will usually provide any deficient elements.

Under grazing conditions green pastures will provide adequate quantities of vitamin A and D. Silage made with wilted or fresh kikuyu would also be abundant in carotene. For stall-fed cows, however, may require supplements of vitamin D. The level of vitamin D required is still in question, but current estimates (12) indicate that about 3,000 iu. of vitamin D per day per 1 lb. cow is adequate. The B complex vitamins are available in the feed and in addition are synthesised by the rumen microorganisms, so that no supplementation is required.

CONSERVATION OF KIKUYU GRASS

It is desirable to conserve some of the grass during the rainy season so that it can be fed out to supplement the poor growth during the dry season. In the montane area of Ceylon, during the rainy season the conditions are too wet for hay making, but good results have been obtained with preservation as silage. The chief drawbacks to making silage have been the high moisture content of the grass and the lack of energy. This was overcome by the addition of 5 to 10 per cent. concentrate. When this silage was fed to 4 sheep, it was found to contain 15 per cent. crude protein of which 45 per cent. was digestible. with a TDN value of 49.5 per cent. Since much of this grass was over

mature these values are somewhat lower than that could be expected if good quality grass is ensiled. However, when 30 lbs. of this silage was fed to milking cows, to supplement poor pasture during the dry season, these cows were able to maintain their milk production at about the same level as those that had night pasturing. It is therefore recommended that any surplus grass available in the peak periods of growth be ensiled either by wilting to about 70 per cent. moisture content or by adding 5 to 10 per cent. concentrate, wheat bran, rice bran or any other dry, fermentible material. The grass should be chopped if possible and well packed in the silo.

SUMMARY

A review of the information available on the nutritive value of kikuyu grass is presented, including some of the results obtained with kikuyu at the Ambawela station in Ceylon. No information is available on the grazing intake of kikuyu, but under stall-fed conditions, a dry matter intake of about 2.25 per cent live weight could be expected. The high moisture content of the grass, especially during the monsoon period, appears to limit the dry matter intake. Kikuyu grass is very well utilized being especially high in digestible crude protein. The nutritive ratio is narrow and indicates a need for supplementation of kikuyu with an energy concentrate. Milk production levels obtainable from different levels of intake of kikuyu and concentrate presently available in Ceylon, are predicted and the costs compared. The mineral and vitamin supplementation that is required when feeding kikuyu is also discussed. A note is included on the successful conservation of kikuyu grass as silage.

REFERENCES

1. APPADURAI, R. R. (1970). Pasture Improvement for the future. Symposium proceedings: The Development of the Cattle Industry in Ceylon. Ed. by R. R. Appadurai. Department of Animal Husbandry, University of Ceylon, Peradeniya. pp. 40-41.
2. CAMPBELL, C. M. SHERROD, L. B. and ISHIZAKI, S. M. (1969). Effect of supplemental protein and energy levels on the utilization of kikuyu grass (*Pennisetum Clandestinum*). *J. Ani. Sci.* 29: 634-637.
3. COLMAN, R. L. and HOLDER, J. M. (1968). Effect of stocking rate on butter-fat production of dairy cows grazing kikuyu grass pastures fertilized with nitrogen. *Proc. Australian Society of Animal Production* 7: 129-132.
4. COSTZEE, P. J. S. (1948). The *Pennisetum* grasses. *Farming in South Africa* 23: 811-814.
5. FERNANDO, W. and ANDREW, W. Unpublished data (1969).

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6. GLOVER, J., DUTHIE, D. W. and DOUGALL, H. W. (1960). The total digestible nutrients and grass digestible energy of ruminant feeds. *J. Agric. Sci.* 55 : 403-408.
7. GLOVER, J. and DOUGALL, H. W. (1961). Milk production from pasture. *J. Agric. Sci.* 56 : 261-264.
8. HARDISON, W. A. (1966). Chemical composition, nutrient content, and potential milk producing capacity of fresh tropical herbage. Tech. Bull. No. 1, Dairy Training and Research Institute, University of the Philippines, Laguna. Philippines.
9. HARDISON, W. A. (1967-1968). Grass and Livestock production in the tropics. *Philippine J. An. Sci.* 4 and 5. 43-65.
10. HARRISON, E. (1942). Digestibility trials on green fodders. *Trop. Agric.* 19 : 147.
11. MORRISON, F. B. (1956). Feeds and Feeding. 22nd ed. The Morrison Publishing Co., Clinton, Iowa.
12. REAVES, P. M. and HENDERSON, H. O. (1963). Dairy Cattle Feeding and Management. 5th ed. John Wiley & Sons. Inc. New York.
13. ROWLAND, J. W. (1958). Henderson Research Station Research on Pastures, Ep. Soc. Fed. Minist. Agric. Rhod. and Nyasld. pp. 42-44.
14. SHERROD, L. B. and ISHIZAKI, S. M. (1966). Effects of stage and season of regrowth upon the nutritive value of kikuyu and pangola grass. *J. An. Sci.* 25 : 597.
15. SQUIBB, R. L. RIVERA, C. and JARQUIN, R. (1958). Comparison of chromogen method with standard digestion trial for determination of the digestible nutrient content of kikuyu grass and ramie forage with sheep. *J. An. Sci.* 17 : 318-321.
16. TODD, J. R. (1956). Investigations into the Chemical composition and nutritive value of certain forage plants at medium altitudes in the tropics. II. The digestibility and nutritive value of three grasses at different stages of growth. *J. Agric. Sci.* 47 : 35-40.
17. TAYLOR, A. J. (1941). The composition of kikuyu grass under intensive grazing and fertilizing. Bull. 203. Govt. Printers, S. Africa.
18. WEBSTER, C. C. and WILSON, P. N. (1966). Agriculture in the Tropics. English Language Book Society and Longmans, Green, and Co. Ltd., London.