NUTRITIVE VALUE OF BRACHIARIA DECUMBENS AND NATIVE PASTURE AT VARIOUS STAGES OF MATURITY[1]

P.B. O'DONOVAN[2], VALÉRIA P.B. EUCLIDES and JOSÉ MARQUES DA SILVA[3]

ABSTRACT - In five indoor digestion trials, Nellore steers (140-230 kg live-weight) were fed with *Brachiaria decumbens* (BD) and native pasture (NP), cut at different maturity stages and made into hay: in a sixth experiment poor quality native hay was given with and without 0.5 kg of cottonseed meal (CSM) per steer daily. Digestibility and intake of BD were for the most part significantly greater than NP and the differences increased with plant maturity. Supplementing poor quality native hay with 0.5 kg CSM per steer daily resulted in a significant increase in total feed intake. Significant correlation coefficients were found between digestibility of feed dry and organic matter and nitrogen content of feed and faeces; r values, relating digestibility to intake, ranged from 0.40 (NP) to 0.77 (BD) and for faecal nitrogen (FN) and digestible organic matter (DOM) were 0.71 or 0.79 (BD, with and without dry season herbage) and 0.66 for NP. Approximately similar figures were calculted for FN and organic matter intake. Within BD, r values of 0.98 (each case) were found between percentage of leaves and both digestibility and intake of organic matter.

Index terms: intake, digestibility, faecal nitrogen, percentage of leaves.

VALOR NUTRITIVO DE BRACHIARIA DECUMBENS E PASTOS NATIVOS EM VÁRIOS ESTÁDIOS DE MATURAÇÃO

RESUMO - Em cinco ensaios de digestibilidade, novilhos nelore (140-230 kg de peso vivo) foram alimentados com *Brachiaria decumbens* (BD) e pastagem nativa (PN), cortadas em vários estádios de crescimento e fornecidas sob a forma de feno; em um sexto experimento, o feno de pastagem nativa de baixa qualidade foi fornecido suplementado ou não com 0,5 kg de farelo de sementes de algodão por novilho por dia. Os dados de digestibilidade e consumo de BD foram, na maioria das vezes, significativamente superiores aos obtidos com PN, e as diferenças aumentaram com a maturidade das plantas. A suplementação de feno de PN de baixa qualidade com 0,5 kg de farelo de sementes de algodão/novilho/dia resultou em aumento significativo no total de alimento consumido. Coeficientes de correlação significativos foram encontrados entre as digestibilidades de matéria seca e da matéria orgânica e os conteúdos de nitrogênio dos alimentos e das fezes; os valores de r, relacionando digestibilidade e consumo, variaram de 0,40 (PN) a 0,77 (BD) e, para nitrogênio fecal (NF) e matéria orgânica digestível (MOD), foram de 0,71 e 0,79 (BD, com e sem os dados da estação seca) e 0,66 para PN. Resultados similares foram obtidos quando se relacionou NF e consumo de matéria orgânica. Para BD, valores de r de 0,98 (para ambos os casos) foram encontrados quando a percentagem de folhas foi relacionada à digestibilidade e ao consumo de matéria orgânica.

Termos para indexação: estádios de crescimento, consumo, digestibilidade, nitrogênio fecal, percentagem de folhas.

INTRODUCTION

Although native pasture, containing a wide variety of low productive and poor quality species, occupies large areas of South American grasslands, there is little research completed on its potential for livestock production (Paladines 1975). The latter has, based on research conducted principally in Africa and Australia, pointed to the low rates of live-weight gains which are tradicionally obtained on these pastures. Native pasture is found over extensive areas of Brazil, particularly the west-central region, and O'Donovan (1979) has highligted some of the problems and possibilities with respect to its use in cattle problems systems.

Among the improved grass species investigated at this centre, *Brachiaria decumbens* was found to establish and produce well under the prevailing soil types and fertility conditions. The species has given high dry matter yields in cutting experiments in Columbia (Crowder et al. 1970) and Sarawak (Ng 1972) while, in experiments in Trinidad

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2 Engº Agrº, Ph.D., FAO Animal Nutrition Officer, FAO/UNDP Project BRA 75/023.

3 Engº Agrº, M.Sc., Centro Nacional de Pesquisa de Gado de Corte (CNPGC) - EMBRAPA, Caixa Postal 154, CEP 79100 - Campo Grande, MS.

(Grieve & Osbourn 1965), it was consumed in greater amounts than was observed for a number of other improved grass species.

The two foregoing pastures, representing extremes in quality, provide the major part of the cattle feed in west-central Brazil; *Brachiaria decumbens*, when available, tends to be reserved for categories of cattle with higher nutritional requirements. Initial work reported here was confined to indoor digestibility and intake trials; the latter are simultaneously and subsequently supported by similar type studies under grazing conditions. In addition, some data were collected on the effect of supplementing animals, receiving low quality native pasture, with a small amount of protein. Simulataneously investigated was the possible relationship existing between faecal nitrogen and herbage digestibility, with a view to its further application in estimating the digestibility of similar type grazed pastures.

MATERIAL AND METHODS

A series of six indoor digestion trials were conducted utilizing both native pasture and *Brachiaria decumbens* cv. Australian. Each pasture was cut at different maturity stages, with the harvesting dates shown in Table 1. In all, both pastures were evaluated on five ocasions: in the second trial Brachiaria only was studied in the absence of a suitable area of native pasture; in the sixth experiment, Brachiaria was not included and it afforded the opportunity to study the effect of feeding native pasture only and supplemented with 0.5 kg of cottonseed meal (containing 30.11% crude protein in the dry matter) per steer daily.

Pastures. With the exception of experiment 5, all the Brachiaria was cut from the same general area. Different areas, according to availability, were utilized for the native pasture. For all experiments, unfertilised pastures were mowed about 10 cm above ground level. When drying conditions were favourable, field drying was adopted; during the rainy season, the cut material was transported near to the digestion house and sun-dried on canvasses, thereby allowing intermittent withdrawal under cover as the rains came. When suitably dry, it was stored as hay either in the baled of loose form.

Prior to mowing, 20 0.25 m^2 quadrat samples of Brachiaria were randomly taken throughout the area. The yields of four quadrats were pooled giving five samples altogether. These samples were separated into leaves, stems and dead matter and, following drying, the percentage of each were calculated (Table 1). Fresh and dry matter yields per hectare were also determined.

Throughout the native pasture 16 0.25 m^2 quadrat samples were previously handcut at random. The yields of four quadrats were pooled, giving four samples finally; the fresh and dry matter yields per hectare were calculated from the data obtained on these samples Immediately prior to cutting the fresh native pasture contained within

TABLE 1. Harvesting dates, yields and ratios of plant parts for the various experiments.

Pasture types (Experiment nº)	Mean harvesting dates	DM yields per ha kg	% (DM basis) Leaves	Stems	Dead matter
Brachiaria					
1	01/07/78	808	33.5	27.2	39.3
2	17/09/78	1706	15.8	19.0	65.2
3	30/10/78	740	63.8	21.0	15.3
4	12/12/78	1528	51.0	40.3	8.7
5	21/02/79	7200	25.9	56.7	17.4
Native pasture[a]					
1	04/07/78	3248	-	-	-
2	-	-	-	-	-
3	10/10/78	832	-	-	-
4	29/12/78	1990	-	-	-
5	16/03/79	2798	-	-	-
6	20/06/79	Not determned	-	-	-

[a] Native pasture samples were not separated into the various components, as for Brachiaria.

each quadrat, an attempt was made in experiment 1, 3 and 4 to identify the major genera, as well as the extent of weed infestation.

Animals. Nellore steers, with mean live-weights ranging from about 140 to 230 kg during the course of the studies, were selected from a total available number of twenty. They were about 10 months of age at the commencement of experiment 1. Five steers were allotted at random to each of the two treatments, after they were stratified into subgroups of two in descending order of live-weight; a limited amount of native hay for experiment 3 necessitated a reduction to four on this experiment.

During the adjustment phase of each experiment and again at the end of the experiment, live-weights were recorded between 08.00 and 10.00 hours and prior to receiving their morning feed. The average of the two weights was used in calculating metabolic size. Steers were maintained in individual pens during each experiment.

Feeding and management. Brachiaria and native hays were given in the unchopped form, after the daily amount for each steer was weighed into sacks. In experiment 1, 25% Brachiaria hay in excess of appetite was offered; because of the low quality native hay, it was considered desirable to offer about 100% over appetite. In experiments 2 to 5 the respective excesses were 10 and 20%, while 30% native hay over appetite was offered in experiment 6. In the latter, five steers each received 0.5 kg of cottonseed meal (449 g dry matter) supplement once daily at 08:00 hours. A complete mineral mixture was made available in the feed troughs daily. Within each pen, there was a feed trough and a water container.

Steers were adjusted to feed for 10-14 days. This was followed by a faecal collection phase of either 7 (experiments 1 and 2) or 5 days. A time lag of 48 hours was allowed for feed to pass through the digestive tract. Approximately one half the total daily feed for each steer was given at 07.30-08.00 hours and the remainder at 15.00 hours, approximately. Feed refused was first collected each morning, weighed and recorded.

Three samples of hay fed were collected daily during 5 or 7 days. The total in each was oven-dried at 70°C, ground and conserved for laboratory analyses. An aliquot was taken from the feed refused by each steer daily over 5 or 7 days, the aliquots were composited, from which two subsamples were taken, dried (70°C), ground and retained for analyses.

Collection and processing of faeces. Total faeces produced were collected directly by the aid of harnesses and canvass bags containing plastic liners. Faeces were collected from individual steers twice daily at 07.30-08.00 hours and again at 15.00 hours aprox. The faeces were weighed, well mixed and a 10% subsample taken; this procedure adopted twice daily during the 5 or 7 days of collection and the subsamples were meanwhile maintained in a freezer. At the end of each experiment, all the subsamples were pooled according to animal number, defrosted, well mixed, and two samples were taken for nitrogen determination on the fresh material. The remainder was divided into two parts, ovendried at 65°C for about 72 hours and these dried samples were ground (1 mm sieve) and retained for laboratory analyses.

Laboratory and statistical analyses. Results are expressed in terms of both dry and organic matter after these determinations were made on samples of feed offered, feed refused and faeces voided. Nitrogen was determined by the Kjeldahl procedure (Horwitz 1970); samples of fresh faeces were analysed and nitrogen percentage were expressed on both dry matter and organic matter bases. Neutral and acid detergent fibre and lignin procedures were those described by Soest & Wine (1967).

Test of significance between the two treatments in each of the six experiments were performed according to the standard t procedure.

RESULTS

The results of Brachiaria plant separations (Table 1) indicate that the highest quality was obtained in experiment 3, with a high ratio of leaves to stems and dead matter, followed by experiments 4 and 1. This order was confirmed by the crude protein percentages in Table 2. Both the Brachiaria hays fed in experiment 2 and 5 had both a low ratio of leaves and a reduced crude protein level. Similar separations were not made with native pasture because of both the time factor involved and the likely less clearcut relationship between plant parts within this pasture type. The dry matter yield of Brachiaria was low during the early part of the rainy season (30/10) but the yield was approximately doubled for the next harvest (12/12); the herbage cut for experiment 5 was on purpose allowed to mature for about 5 grass growing months, thus the high dry matter yield. Although good yields were observed during the drier months (experiments 1 and 2) of the year, there was a considerable proportion of dead matter present.

Within native pasture, the respective percentage contributions (visual estimates) of *Andropogon*, *Paspalum*, *Piptochecium* and broad leaved species were 26, 45, 14, 13; 10, 58, 0, 32; 20, 27, 34, 18 for experiments 1, 3 and 4, respectively. The considerable percentages of the latter, particularly in experiments 3 and 4, necessitated the manual separation of pure herbage. Despite considerable variation between experiments, there was a tend-

TABLE 2. Composition of *Brachiaria decumbens* and native pasture in the different experiments.

Exp. nº	Pasture type[a]	Dry matter (DM) %	Organic matter (OM) % of DM	Crude protein (% of DM)		Fibre, % of DM				NDF dig., %	CP dig., %
				Hay as fed	Samples taken in field	Neutral detergent fibre (NDF)	Acid detergent fibre (ADF)	Hemi-cellulose	Lignin		
1	BD	90.6	92.2	6.9	6.6	69.4	40.2	29.2	6.9	56.0	57.0
	NP	91.0	94.0	3.3	-	73.7	45.8	27.9	11.5	51.9	-4.8
2	BD	91.6	93.0	4.7	4.6	73.7	45.4	28.4	7.7	52.2	19.3
	-	-	-	-	-	-	-	-	-	-	-
3	BD	85.6	90.7	9.8	9.6	66.6	34.4	32.2	4.6	65.5	57.5
	NP	88.6	94.4	9.8	8.1	72.7	39.8	32.9	6.6	64.3	49.5
4	BD	89.6	91.2	7.6	7.2	71.5	38.9	32.6	5.5	65.0	46.3
	NP	90.6	94.5	4.6	4.4	78.0	42.5	35.5	7.2	58.0	34.0
5	BD	90.0	93.4	4.4	4.3	74.8	45.5	29.4	6.6	61.1	33.6
	NP	89.5	94.0	3.7	3.7	76.5	46.2	30.3	8.1	57.1	20.0
6	-	-	-	-	-	-	-	-	-	-	-
	NP	87.4	93.9	3.8	-	74.7	47.1	27.6	10.7	44.9	12.6

[a] *Brachiaria decumbens* and native pasture, respectively.

ency for *Andropogon* and *Paspalum* spp. combined to contribute from slightly less than half to over two-thirds of the total, with small contributions from other species, notably species of Ciperaceae and Panicum. The subjective natural of the assessment must be stressed as well as a future need to more accurately identify the variety of species present. Dry matter yields of native pasture (Table 1) increased successively during the rainy season (experiments 3 to 5 inclusive) while a high yield in the dry season (experiment 1) was the result of accumulated herbage from the previous rainy months.

The composition of Brachiaria and native hays grazed, shown in Table 2, indicates that, with the exception in experiment 2, native hay had a somewhat higher organic matter content, ranging from 0.6 in experiment 5 to 3.6 percentage units in experiment 3. With only one exception, there was good agreement between the crude protein percentages of hay grazed and those derived from representative field samples taken before harvesting. With regard to fibre analyses (NDF and ADF), Brachiaria had at all stages lower percentages than native pasture. There was a tendency for differences in digestible protein and digestible NDF to become greater, in favour of Brachiaria, with increasing maturity (Table 2). Hemicellulose percentages, calculated as the difference between NDF and ADF, did not reveal any consistent trend and were rather similar for the two pasture types. Crude lignin values were lower for *Brachiaria decumbens* versus native pasture at all times; their respective crude lignin percentages ranged from 4.6 - 7.7 and 6.6 - 11.5.

Digestibility (Table 3) expressed in terms of both dry matter and organic matter was significantly ($P < 0.01$) higher for *Brachiaria decumbens* in experiments 1, 3 and 4. Peak digestibilities for both pasture types were obtained with good quality material harvested during the early part of the rainy season (October) and declined progressively thereafter. Digestibility differences were small, in favour of Brachiaria, during the initial stages of the rainy season and widened steadily thereafter; digestibility of native pasture declined much more rapidly than that of Brachiaria.

Feed intake and digestible feed consumption per steer daily (Table 3) is expressed in kilograms and g/W $kg^{0.75}$ of dry and organic matter. In all experiments with all measures of intake, those of Brachiaria were significantly (P either < 0.01 or 0.05) greater than those of native pasture. As for digestibility, intakes were highest and differences between pasture types were least for good quality herbage harvested during the early part of the rainy season (October) but the differences became progressively greater with increasing plant maturity. Intake of native pasture declined much more rapidly than that of Brachiaria.

A criterion of much importance in determining the likely animal grains is the intake of digestible dry matter (DDMI) or organic matter (DOMI), derived from the product of feed digestibility and intake. Both measures were significantly ($P <$ 0.01 or 0.05) higher for Brachiaria than native pasture. In terms of kilograms of DDMI per steer daily, the difference ranged from about 35% (October harvest) to more than 135% with poor quality material harvested in July.

From the digestibility and intake data in Table 3, certain relationships were developed:

a. **Relationship between digestible dry matter (DDM) and digestible organic matter (DOM) (Fig. 1).**

Brachiaria: $Y = 8.72 + 0.89\,X$

$n = 24 \quad r^2 = 0.96 \quad r = 0.98^{**} \quad S_{y.x} = 0.94$

Native pasture: $Y = 1.55 + 1.03\,X$

$n = 24 \quad r^2 = 0.99 \quad r = 0.99^{**} \quad S_{y.x} = 0.72$

Brachiaria and native pasture (combined):

$$Y = 3.79 + 9.99\,X$$

$n = 48 \quad r^2 = 0.98 \quad r = 0.99^{**} \quad S_{y.x} = 0.91$

where Y = digestible organic matter (DOM) and X = digestible dry matter (DDM), %. Substituting a DDM value of 60 in each of the foregoing yields DOM figures of 62.12, 63.35 and 63.19, respectively, and significant ($P < 0.01$) r values were found with a relatively low error estimate (Fig. 1).

b. **Relationship between digestible dry matter (DDM) and dry matter intake (DMI) (Fig. 2):**

Brachiaria: $Y = -29.73 + 1.66X$

$n = 24 \quad r^2 = 0.60 \quad r = 0.77^{**} \quad S_{y.x} = 7.21$

TABLE 3. Mean digestibilities and intake values of *Brachiaria decumbens* and native pasture for the various experiments[a].

Exp. nº	Pasture type	Dig. % DM	Dig. % OM	Feed intake/animal/day DM kg	Feed intake/animal/day DM g/W kg$^{0.75}$	Feed intake/animal/day OM kg	Feed intake/animal/day OM g/W kg$^{0.75}$	Intake dig. DM kg	Intake dig. DM g/W kg$^{0.75}$	Intake dig. OM kg	Intake dig. OM g/W kg$^{0.75}$
1	BD	55.6**	57.2**	2.44**	59.3**	2.22**	54.1**	1.35**	33.0**	1.27**	30.9**
		(2.2)	(1.3)	(0.10)	(2.2)	(0.09)	(2.0)	(0.04)	(1.2)	(0.04)	(1.1)
	NP	44.4	46.6	1.29	32.0	1.21	29.9	0.57	14.1	0.56	13.8
		(2.3)	(2.2)	(0.06)	(1.6)	(0.08)	(1.4)	(0.02)	(0.6)	(0.02)	(0.5)
2	BD	44.4	48.6	1.75	44.6	1.62	41.4	0.78	19.8	0.79	20.1
		(0.3)	(0.4)	(0.12)	(2.2)	(0.1)	(2.1)	(0.05)	(0.9)	(0.05)	(0.9)
	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-
3	BD	57.1**	60.7*	3.29*	70.1*	2.98*	63.5*	1.82**	38.6**	1.75*	37.3**
		(0.7)	(0.8)	(0.14)	(2.6)	(0.13)	(2.4)	(0.08)	(1.2)	(0.07)	(1.1)
	NP	53.1	57.1	2.52	54.6	2.38	51.5	1.34	29.0	1.35	29.3
		(0.6)	(0.7)	(0.18)	(3.8)	(0.17)	(3.6)	(0.08)	(1.7)	(0.08)	(1.7)
4	BD	56.2**	59.2**	3.49**	69.1**	3.17**	62.8**	1.96**	38.8**	1.88**	37.2**
		(0.8)	(0.7)	(0.19)	(1.8)	(0.17)	(1.7)	(0.11)	(1.1)	(0.10)	(1.0)
	NP	50.9	53.7	2.11	43.9	2.00	41.5	1.07	22.4	1.07	22.3
		(0.8)	(0.8)	(0.13)	(3.0)	(0.12)	(2.8)	(0.07)	(1.5)	(0.06)	(1.5)
5	BD	50.6	54.1	2.89**	49.0*	2.70**	45.7*	1.46**	24.8**	1.46**	24.7**
		(1.0)	(1.0)	(0.17)	(3.6)	(0.16)	(3.3)	(0.10)	(1.9)	(0.10)	(1.8)
	NP	47.8	51.6	1.81	31.7	1.70	29.7	0.86	15.0	0.87	15.2
		(1.2)	(1.4)	(0.24)	(3.8)	(0.22)	(3.5)	(0.10)	(1.6)	(0.10)	(1.5)
6	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-
	NP	37.0	40.0	2.00	35.6	1.87	33.4	0.75	13.2	0.76	13.4
		(1.7)	(1.6)	(0.12)	(1.4)	(0.11)	(1.4)	(0.07)	(1.0)	(0.07)	(1.0)

[a] Standard errors are shown in parentheses.

* $P < 0.05$ ** $P < 0.01$

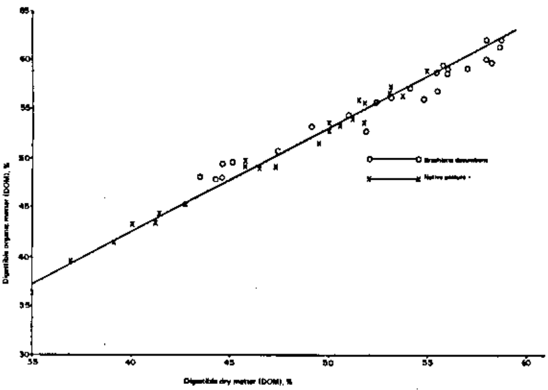

FIG. 1. Relationship between DDM and DOM for *Brachiaria decumbens* and native pasture.

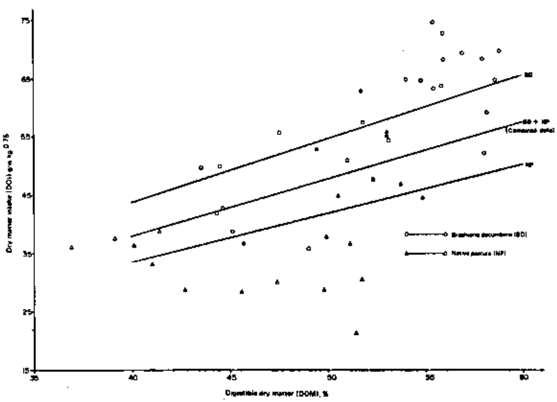

FIG. 2. Relationship between DDM and DMI for *Brachiaria decumbens* and native pasture.

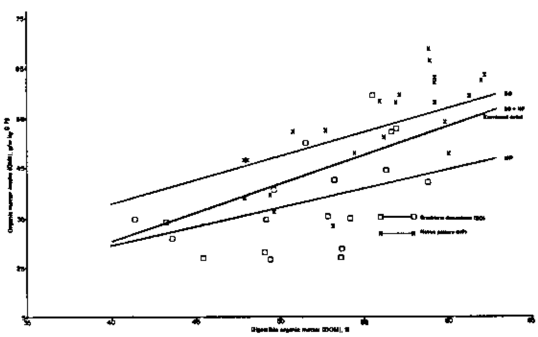

FIG. 3. Relationship between DOM and OMI for *Brachiaria decumbens* and native pasture.

Native pasture: $Y = 9.25 + 0{,}64\ X$

$n = 24 \quad r^2 = 0.16 \quad r = 0.40^{*} \quad S_{y.x} = 9.54$

Brachiaria and native pasture (combined):

$Y = -25.22 + 1.48\ X$

$n = 48 \quad r^2 = 0.48 \quad r = 0.69 \quad S_{y.x} = 10.33$

where Y = dry matter intake (DMI) g/W $kg^{0.75}$ and X = digestible dry matter (DDM), %.

A considerable 'spread' was in evidence (Fig. 2) when attempts were made to relate these two criteria. There was less variation in the case of Brachiaria and the correlation coefficient of 0.77 ($P < 0.01$) was superior to the r value of 0.40 ($P < 0.05$) for native pasture.

c. Relationship between digestible organic matter (DOM) and organic matter intake (OMI) (Fig. 3):

Brachiaria: $Y = -33.63 + 1.55\ X$

$n = 24 \quad r^2 = 0{,}57 \quad r = 0.75^{**} \quad S_{y.x} = 6.55$

Native pasture: $Y = 7.17 + 0.59\ X$

$n = 24 \quad r^2 = 0.17 \quad r = 0.41^{*} \quad S_{y.x} = 9.04$

Brachiaria and native pasture (combined):

$Y = -23.72 + 1.30\ X$

$n = 48 \quad r^2 = 0.46 \quad r = 0.68 \quad S_{y.x} = 9.38$

where Y = organic matter intake (OMI), g/W $kg^{0.75}$ and X = digestible organic matter (DDM), %.

Apart from a small reduction in the error of estimate, the trend and r values were very similar to those noted for dry matter.

d. Relationship between feed nitrogen and faecal nitrogen (means):

Since only mean values for feed nitrogen were available, it was possible only to relate these to similar data for faecal nitrogen to give the following results:

Brachiaria: $Y = 0.54 + 1.13\ X$

$n = 5 \quad r^2 = 0.92 \quad r = 0.96^{**} \quad S_{y.x} = 1.41$

Native pasture: $Y = -0.38 + 1.03\ X$

$n = 5 \quad r^2 = 0{,}97 \quad r = 0.98^{**} \quad S_{y.x} = 0.38$

where Y = % N in feed organic matter and X = % N faecal organic matter.

Although significant correlation coefficients were obtained for each pasture type, the error of estimate was higher for Brachiaria. Substituting a value of 1% faecal N in both yielded feed nitrogen and crude protein percentages of 1.67, 0.67; 10.44, 4.06, for Brachiaria and native pasture, respectively. It becomes imperative, therefore, to utilize individual equations for the appropriate pasture.

The intake of metabolizable energy (Mcal/steer/day) was obtained by multiplying digestible organic matter intake in kilograms by a factor of 3.60 (Smith & Arnold 1972). The relation of both metabolizable energy and digestible protein intakes to requirements for maintenance and production was made according to the National Research Council (1976). In experiment 3, during which high native Brachiaria and native pasture were fed, there was sufficient of both nutrients for maintenance in the case of the former and a slight deficiency for native pasture. In experiment 4, the intake of energy from Brachiaria was slightly in excess of maintenance while the digestible protein intake was slightly deficient. In all other cases, nutrient intake was below maintenance and the estimated live-weight losses reflected the quality and consumption of the feed offered. Because of the fact that steer live-weight changes were recorded only during the short duration of the trials, it was considered invalid to attempt to relate actual with estimated live-weight changes. The maximum estimated mean live-weight loss was 486 g per steer daily fed with native hay in experiment 1. Losses were in all instances greater in native versus Brachiaria hay.

Supplementation with as little as 0.5 kg of cottonseed meal (CSM), which contained 30.1% crude protein in the dry matter, was instrumental in increasing both dry and organic matter digestibility non-significantly (Table 4). Both feed intake and digestible feed intake were increased significantly ($P < 0.01$). When OMI is expressed as $g/W\ kg^{0.75}$, an increase of 60.8% was recorded; the corresponding figure for DOMI was 68.7%. Because of this, both metabolizable energy and digestible protein intakes were significantly improved as a result of protein supplementation. The estimates of live-weight changes revealed that additional protein resulted in a reduction in live-weight losses from - 451 g/steer/daily to - 279 g, on the basis of energy, and from - 470 to - 231 g, on the basis of protein.

Mean faecal nitrogen percentages of the organic matter are shown in Table 5, as well as the corresponding values for DOM and OMI. Highest faecal nitrogen percentages for both Brachiaria and native pasture, resulted from the highest quality hays fed in experiment 3 and were identical at 1.95. While there was a gradual decrease in faecal nitrogen commensurate with the decline in Brachiaria digestibility, there occurred a disproportionate and rapid decrease in faecal nitrogen resulting from reductions in native hay digestibility. The highest OMI values for both types in experiment 3 were reflected in the greatest faecal nitrogen concentrations.

Regression equations were computed relating faecal nitrogen, as percent of organic matter, to DOM.

1. Brachiaria (Fig. 4):

$Y = 40.28 + 10.35\ X$ (5 experiments)

$n = 24\quad r^2 = 0.50\quad r = 0.71^{**}\quad S_{y.x} = 3.40$

$Y = 46.01 + 7.51\ X$ (4 experiments, excluding dry season's herbage)

$n = 19\quad r^2 = 0.63\quad r = 0.79^{**}\quad S_{y.x} = 2.03$

where Y = digestible organic matter, % and X = faecal nitrogen, % of organic matter

2. Native pasture (Fig. 5):

$Y = 35.99 + 11.68\ X$ (5 experiments)

$n = 24\quad r^2 = 0.43\quad r = 0.66^{**}\quad S_{y.x} = 5.16$

Although there was considerable variation observed in relating faecal nitrogen to Brachiaria digestibility, the error of estimate was not excessive (3.40 digestibility units), with a significant ($P < < 0.01$) correlation coefficient of 0.71; the values were improved to 2.03 and 0.79 when material harvested during the dry season (experiment 2) was not considered. With regard to native hay the error of estimate reached 5.16 digestibility units with a siginificant ($P < 0.01$) r value of 0.66. The high faecal nitrogen results of experiment 3, relative to DOM, did not conform to the faecal nitrogen/DOM relationships of other experiments. In simple terms, for a relatively moderate reduction in DOM between experiments 3 and 4 there occurred a very marked decline in faecal nitrogen percentage; thereafter there were only small

TABLE 4. The effect of protein supplementation on the digestibility and intake of poor quality native hay[a], Experiment 6.

	Native pasture only	Native pasture + 0.5 kg cottonseed meal (CSM)
Digestibility %		
Dry matter (DM)	30.0 (1.7)	39.8 (1.4)
Organic matter (OM)	40.0 (1.6)	42.4 (1.4)
Feed intake/animal/day:		
DM:		
kg	2.00 (0.12)	3.28** (0.17)
$g/W\ kg^{0.75}$	35.6 (1.4)	57.1** (2.7)
OM:		
kg	1.87 (0.11)	3.09** (0.16)
$g/W\ kg^{0.75}$	33.4 (1.3)	53.7** (2.6)
Intake of digestible feed		
DM:		
kg	0.75 (0.07)	1.30** (0.06)
$g/W\ kg^{0.75}$	13.2 (1.0)	22.6** (0.8)
OM:		
kg	0.76 (0.07)	1.30** (0.05)
$g/W\ kg^{0.75}$	13.4 (1.0)	22.6** (0.7)
Energy intake/steer/day:		
Mcals ME	2.74	4.68
Maintenance req., Mcals	7.34	7.53
Remainder for prod. ±	- 4.60	- 2.85
Est. gain or loss, l.w., g.	- 451	- 279
Protein intake/steer/day:		
Protein dig. (±), %	12.6	43.1
Dig. protein intake, g.	9.2	100.2
Maintenance req., g.	178.5	183.3
Remainder for prod. ±	- 169.3	- 83.1
Est. gain or loss, l.w., g.	- 470	- 231

[a] Standard errors are shown in parentheses.

** $P < 0.01$

changes in faecal nitrogen values over the various maturity stages (Fig. 5).

In view of the possible correlation between faecal nitrogen and DOM, and the correlation of the latter with OMI, it was of interest to determine the relationship between faecal nitrogen and OMI.

Brachiaria: $Y = 16.79 + 24.25\ X$

$n = 25 \quad r^2 = 0.60 \quad r = 0.78^{**} \quad S_{y.x} = 6.63$

Native Pasture: $Y = 16.53 + 17.38\ X$

$n = 24 \quad r^2 = 0.46 \quad r = 0.68^{**} \quad S_{y.x} = 7.30$

where Y = OMI $g/W\ kg^{0.75}$ and X = faecal nitrogen, % of organic matter.

The significant ($P < 0.01$) correlation coefficients of 0.78 and 0.68 are slightly superior to those obtained earlier in correlating faecal nitrogen with DOM (0.71 and 0.66). In contrast with the earlier results, the error of estimate for native hay was only slightly inferior to that of Brachiaria (7.30 vs. 6.63, respectively). Although the intercepts for both pasture types were very similar, there was a significant difference in the slope which invalidates any attempt to utilize a combined regression for both pastures.

The separation of Brachiaria plant samples, collected before each harvest, into percentages (dry matter basis) of leaves, stems and dead matter permitted the development of regression equations relating both the percentages of leaves and green matter (leaves plus stems) with DOM and OMI (Fig. 6). Although good correlation coefficients were obtained with linear, quadratic, exponential and logarithmic equations, the latter proved slightly superior and are, therefore, shown here.

TABLE 5. Faecal nitrogen percentages (of organic matter) relative to digestibility and intake of *Brachiaria decumbens* and native pasture.

	Faecal N (% of organic matter)	Digestible org. matter (DOM) %	Organic matter intake (OMI) g/W $kg^{0.75}$
Experiment 1:			
Brachiaria	1.44	57.2	54.1
Native pasture	0.99	46.6	29.9
Experiment 2:			
Brachiaria	1.30	48.6	41.4
Native pasture	-	-	-
Experiment 3:			
Brachiaria	1.95	60.7	63.5
Native pasture	1.95	57.1	51.5
Experiment 4:			
Brachiaria	1.78	59.2	62.8
Native pasture	1.11	53.7	41.5
Experiment 5:			
Brachiaria	1.11	54.1	45.7
Native pasture	1.03	51.6	29.7
Experiment 6:			
Brachiaria	-	-	-
Native pastue	0.86	40.0	33.4

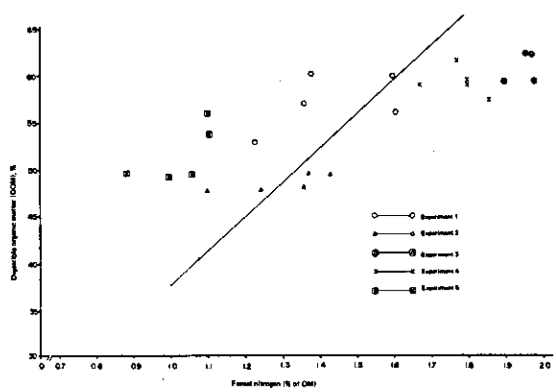

FIG. 4. Relationship between faecal nitrogen and digestibility of *Brachiaria decumbens*.

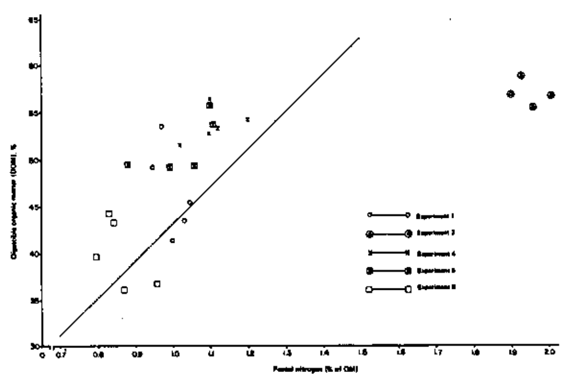

FIG. 5. Relationship between faecal nitrogen and digestibility of native pasture.

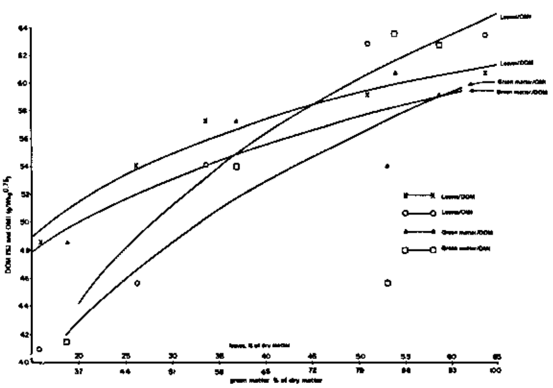

FIG. 6. Relationship between percentages of leaves and green matter in *Brachiaria decumbens* and DOM and OMI.

$Y = 25.80 + 8.56 \ln X \quad r^2 = 0.97 \quad r = 0.98^{**}$
where Y = DOM % and X = % leaves
$Y = -8.46 + 17.58 \ln X \quad r^2 = 0.95 \quad r = 0.98^{**}$
where Y = OMI, g/W $kg^{0.75}$ and X = % leaves
$Y = 13.68 + 10.05 \ln X \quad r^2 = 0.70 \quad r = 0.84^{**}$
where Y = DOM % and X = % green matter
$Y = -21.66 + 17.87 \ln X \quad r^2 = 0.52 \quad r = 0.72$
where Y = OMI, g/W $kg^{0.75}$ and X = % green matter

It can be seen that highly significant correlation coefficients were in evidence when percentages of leaves were related to DOM and OMI, r being 0.98 in each case. Thus, within *Brachiaria decumbens* at least, both digestibility and intake of organic matter can be reliably predicted from the percentages of green leaves present in the feed offered. The combination of leaves plus stems (green matter) resulted in a deterioration of the relationship, as shown by the lower r values. It should be borne in mind that only five mean values (one for each experiment) are used in developing the regression equations, a similar procedure to that described earlier for the feed and faecal nitrogen relationship.

DISCUSSION

Although there is on average some rain during every month of the year, there is a season (October - March/April approx.) during which most rainfalls occurs; the driest months of the year are generally June to September inclusively. This rainfall pattern had a marked effect on the nutritive value of the pastures which were tested here; the highest quality grasses are those grazed or harvested during the early part of the heavy rains (October/November), with a rather rapid decline in quality following the end of the rains to a minimum during the period June to September. This applies particularly to native pasture since Brachiaria grows well, even if at a much reduced rate, to support low stocking rates during the dry months (Empresa Brasileira de Pesquisa Agropecuária 1979).

The Brachiaria plant separations indicated that the highest quality herbage, reflected by a crude protein content of 9.8% in experiment 3 (6 weeks growth, approx.), had a high leaf: stem ratio with a small amount of dead matter; a decrease to 7.6% protein in experiment 4 resulted mainly from a higher proportion of stems, since there was no significant change in the dead matter fraction. Subsequent protein decreases, noted in the other experiments, stemmed from an increase in either the stem or dead matter fraction or both. Grieve & Osbourn (1965) found that 5 week *Brachiaria decumbens* regrowth contained 9.1% crude protein, having declined from 13.1% and 11.9% at 3 and 4 weeks, respectivelt; lower values at similar stages were reported by Hunkar (1965). The decrease in protein content of Brachiaria with maturity is in accordance with observations of Bredon & Horrell (1961), Johnson & Pezo (1975) and Reid et al. (1973). On the other hand, the rapid decline noted in protein content of native pasture (Paladines 1975) approximates that of the present trials and of data collected at this centre (Boock 1979)[4].

There seems to be no plausible explanation for the tendency of native pasture to have a higher organic matter content. There may not be any significance attached to the fact that the difference was greatest for experiments 3 and 4 corresponding to harvests (October and December) during the wettest part of the year. The consistently higher

[4] Personal communication.

NDF, ADF and crude lignin content of native pasture was in accordance with expectations.

Limited information is available concerning the nutritive value of native pasture at various maturity stages, so as to relate it to the observed low rates of gain per animal and per hectare in large areas of the tropics (Paladines 1975). Highly significant intake differences were found in all experiments between Brachiaria and native pasture and although; it most cases, significant differences were also recorded for digestibility; the latter contributed much less than the former towards increasing the intake of digestible dry and organic matter; these latter criteria are highly correlated with rates of live-weight gain (Minson et al. 1976). The wide variability in species comprising different native pastures, renders it difficult to make realistic comparisons within the latter. Langlands & Bowles (1974), working with predominantly *Poa labillardieri* native and *Phalaris tuberosa* improved pastures under grazing, found an average DOM difference (January to October) of 10.9 units in favour of improved pasture. Seasonal variation in the intake and nutritive value was greater on native pasture. Engels et al. (1974), in studying native pastures in which *Themeda triandra* comprised 70% of the total, reported "in vitro" organic matter digestibilities of 61-67% with daily OMI (g/W $kg^{0.75}$) of 132-185 for lactating cows.

Efforts made to relate ME and digestible protein intakes to maintenance and production requirements (Table 6) must be treated with caution. The assumption that ME intakes from both pasture types are utilized with the same degree of efficiency for live-weight gains may not be correct. Langlands & Bowles (1974) found that for wool production DOMI (from which ME is calculated) utilization was greater on improved versus native pasture to the extent of about 15%. The estimated live-weight changes varied from slightly above maintenance for Brachiaria in experiment 3 to varying rates of live-weight losses; for native pasture, losses range from 108 g initially to a mean high of 486 g. Experience obtained under grazing at this centre indicates that Brachiaria is capable of supporting daily gains of 400 - 500 g throughout the rainy season and 200 - 250 g during the dry season, at a much reduced stocking rate; daily gains on native pasture can approach 400 - 500 g during the early months of the rainy season decreasing to maintenance and below during the latter part of the rainy season and dry season, respectively.

While it is difficult to offer an explanation for the foregoing discrepancies, two possibilities come to mind. Under grazing, there is much better scope for animals to select a higher proportion of the leafy more digestible herbage and, because digestibility and intake are positively correlated, DOMI is higher. It is quite conceivable that the resulting increase in ME intake will significantly reduce this discrepancy. The second possibility concerns the maintenance and production requirements adopted. Those employed were developed largely from studies made with temperate climate species and may overestimate the needs of tropical livestock breeds but sufficient factual data for this latter point are, however, not yet available. It is interesting to note that irrespectively of whether requirements are expressed in terms of energy or protein, the estimated rates of gain do not, in general, differ widely.

The significantly high correlation coefficients ($r = 0,98$ and 0.99) and low errors of estimate, between DDM and DOM, for Brachiaria and native pasture, respectively, are in agreement with published results (Fig. 1). Substituting a DDM value of 60% in each equation yields DOM figures of 62.1 and 63.3% for Brachiaria and native pasture, respectively.

Although digestibility and intake figures were also correlated positively (Fig. 2 and 3), the **r** values were lower and the error estimates considerably higher than between DDM and DOM. Equations for Brachiaria differ from those of native pasture in both intercept and slope, thus a separate equation must be employed for each pasture type to avoid biased results. Substituting a DDM value of 60% in each of the two equations yields DMI of 69.9 and 47.6 for Brachiaria and native pasture, respectively. Animal variability in intake was generally much more pronounced for native pasture, thereby accounting for the low **r** and high errors of estimate for the digestibility/intake relationships. The significantly high correlations ($r = 0,96$ and 0,98 for Brachiaria and native pasture) between

TABLE 6. Relating mean values for metabolizable energy (ME) and digestible protein intakes to requirements for maintenance and production.

Experiment nº	1		2		3		4		5		6	
Pasture type[a]	BD	NP	BD	NP	BD	NP	BD	NP	BD	NP	BD	NP
Mean liveweight (kg)	142.1	138.3	132.8	-	169.3	165.8	186.3	175.4	230.7	220.0	-	222.3
($g/W^{0.75}$)	(41.2)	(40.3)	(39.1)	-	(46.9)	(46.2)	(50.4)	(48.2)	(59.2)	(57.1)	-	(57.6)
Dig. org. matter intake (DOMI), kg	1.27	0.56	0.79	-	1.75	1.35	1.88	1.07	1.46	0.87	-	0.76
Energy intake/steer/day:												
Mcals ME	4.57	2.02	2.84	-	6.30	4.86	6.77	3.85	5.26	3.13	-	2.74
Maintenance req., Mcals	5.38	5.27	5.12	-	6.14	6.04	6.62	6.31	7.86	7.56	-	7.62
Ramainder for prod. ±	- 0.81	- 3.25	- 2.28	-	0.16	- 1.18	0.15	- 2.46	- 2.60	- 4.43	-	- 4.88
Est. gain or loss, l.w., g.	- 139	- 560	- 393	-	20	- 151	16	- 289	- 230	- 392	-	- 432
Protein intake/steer/day:												
Protein dig. (±) %	57.0	- 4.8	19.3	-	57.5	49.5	46.3	34.0	33.6	20.0	-	12.6
Dig. prot. intake, g.	112.4	- 0.9	16.3	-	187.3	121.5	125.0	33.3	43.7	13.7	-	9.2
Maintenance req., g.	125.3	123.0	119.7	-	145.4	142.6	159.0	150.3	188.4	182.0	-	183.4
Remainder for prod. ±	- 12.9	- 123.9	- 103.4	-	41.9	- 21.1	- 34.0	- 117.0	- 144.7	- 168.3	-	- 174.2
Est. gain or loss, 1.w., g.	- 40	- 413	- 345	-	130	- 66	- 100	- 355	- 391	- 455	-	- 471
Mean estimated gain or loss, g. ±	- 90	- 486	- 369	-	75	- 108	- 42	- 322	- 310	- 424	-	- 452

[a] BD = *Brachiaria decumbens*
NP = Native pasture

mean feed and faecal nitrogen values point to the usefulness in particular situations of predicting the former form the latter.

Supplementing steers, fed with native hay containing 3.8% crude protein, with 135 g of crude protein daily (449 g cottonseed meal dry matter, containing 30.1% protein) was intrumental in significantly increasing feed intake and reducing live-weight losses (Table 4). The crude protein of the ration consumed was increased from 3.8 to 7.4%; Milford & Manson (1966) found this latter level to be critical below which intake responses are manifested to protein supplementation. Langlands & Bowles (1976) also reported that supplementing heifers on native pasture with molasses/urea and linseed meal reduced the rate of live-weight losses compared to unsupplemented heifers. The significant increases in OMI and DOMI have widespread implications for dry season supplementation of cattle grazing poor quality native pasture. By providing protein, animals are, therefore, capable of satisfying some or practically all of their energy needs through the increased pasture intake, an observation also made by Niekerk (1975). While both energy and protein are limiting nutrients with poor quality roughage diets, protein may be more restrictive at low responses i.e. up to maintenance and slightly above. With higher rates of gain, energy may become progressively more important. With the few available mean values, the trend observed by Milfor & Minson (1966), of intake increasing up to about 7% dietary protein, was also in evidence here for both pasture types. At selected herbage protein percentages a consistent and uniformly higher intake was in evidence for Brachiaria.

The use of faecal nitrogen to predict digestibility was used successfully by O'Donovan et al. (1967) working with various clones of *Phalaris arundinacea*. Correlation coefficients of a similar magnitude (0.94 and 0.97) with error estimates of 1.1 to 1.5 were obtained by Thomas & Campling (1976) on ryegrass pastures. On the other hand, Canadian work has shown little relationship between these parameters for certain plant species (Pigden & Minson 1969). Milford (1957) reported a negative correlation between faecal nitrogen and digestibility for some tropical species. Later work (Minson & Milford 1967), with two varieties of *Chloris gayana*, produced high correlation coefficient (0.96 and 0.97) with moderately low standard errors of estimate of 1.7 and 2.6 digestibility units, respectively. A recognized prerequisite is that the local regression equations to be applied under grazing must be developed with similar type herbage fed indoor (Minson & Raymond 1958).

If satisfactory 'local' regressions could be developed (although of secondary importance in these studies) it would dispense with the collection of representative herbage samples, using oesophageal fistulated animals or other established procedures. Results obtained (Table 5, Fig. 4 and 5) indicate that a considerably better relationship was obtained for Brachiaria than for native pasture. There was an improvement in the r value (0.79 vs. 0.71) by disregarding data obtained with low-quality herbage (containing much dead matter) in experiment 2, as well as a reduction in the error estimated from 3.4 to 2.0. Thus, the relationship may apply more to herbage produced during the rainy season and containing a high proportion of green matter. The poorer relationship, in the case of native pasture (r, 0.66; $S_{y.x}$, 5.2) stemmed mainly from the disproportionate decline in faecal nitrogen, relative to digestibility, with plant maturity.

Had the experiments been designed with the express purpose of studying the faecal nitrogen/digestibility relationship, certain modifications might have effected an improvement. More frequent harvests, in particular, would have provided more points on the graph over a wide range of digestibilities. Nevertheless, certain other factors also need to be borne in mind. Lambourne & Reardon (1962) have found different regression equations for leaves and stems of grasses, demonstrating that the greater selectivity of leaves, generally occurring under grazing, will affect the slope of the faecal index/digestibility regression. Minson & Milford (1967) reported that two varieties of *Chloris gayana* gave rise to significantly ($P < 0.01$) different intercepts which, for a given nitrogen percentage, yielded DDM values of 55.8 and 49.4; it may be invalid therefore, to utilize the results obtained with *Brachiaria decumbens* for other species such as *B. himidicola* and *B. ruziziensis*. The problems tend to be compounded when dealing with native pasture comprising a wide variety of species. Wherever possible, therefore, the use of oesophageal-fistulated animals may be more reliable than faecal nitrogen to estimate the digestibility of grazed herbage (Scales et al. 1974), although Engels et al. (1975) found good agreement with the two techniques. The correlation coefficients between faecal nitrogen and organic matter intake (0.78 and 0.68), for Brachiaria and native pasture, respectively, were about the same magnitude as those relating faecal nitrogen to digestibility.

Little data exist in the literature comparisons of the latter value of *Brachiaria decumbens* (Loch 1977) or comparisons of the latter with native pasture. The trials reported here provide preliminary information under indoor controlled conditions and no attempt is made to speculate what differences might be found under grazing where the wide scope for selectivity generally exists. Simultaneous grazing trials were conducted with native pasture, and will shortly be extended to include *Brachiaria decumbens*. It is envisaged that, when results from these latter experiments are considered jointly with animal performance figures, more comprehensive proposals can be made concerning the nutritive value of the two pasture types for grass-based animal production systems.

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