THE EFFECTS OF STOCKING RATE ON LIVEWEIGHT GAIN OF DORPER WETHERS

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN ANIMAL PRODUCTION IN THE FACULTY OF AGRICULTURE, UNIVERSITY OF NAIROBI

1981.

DECLARATION

(a) This thesis is my original work and has not been presented for a degree in any other University.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

APPENDIX NUMBER		PAGE

ABSTRACT

An experiment on the effects of stocking rate on liveweight gain of Dorper wethers was conducted at Kabete, in Kenya from 23rd February to 13th July, 1981. The wethers were continuously grazed on natural pasture predominantly composed of Kikuyu grass (*Pennisetum clandestinum*).

The experimental design was completely randomized. Each plot was set stocked with 3 wethers and there were 4 replicates. There were 3 sizes of plots, approximately 0.087, 0.0650 and 0.0433 hectares, corresponding to stocking rates of 34.6, 51.8 and 69.1 sheep per hectare.

Results showed that the overall weight gain per head was 7.15, 5.54 and 3.8 kg at the low, medium and high stocking rates respectively. In the dry period (5 weeks), the wethers lost a mean weight of 0.54 kg per head at the high and medium stocking rates. However, the wethers at the low stocking rate gained a mean weight of 0.54 kg per head. In the wet period (15 weeks), the wethers gained a mean weight of 6.67, 6.10 and 4.33 kg per head at the low, medium and high stocking rates respectively. The differences in weight changes between the different stocking rates for each period were only significantly different in the overall period, ($P < 0.05$). An evaluation of the finishing stage showed that 50, 25 and 8% of the sheep at the low, medium and high stocking rates respectively, were ready for slaughter at the end of the experiment.

The overall mean weight gain per hectare was 248.69, 288.14 and 262.00 kg at the low, medium and high stocking rates respectively. In the dry period, there was mean weight loss of 28.06 and 37.43 kg per hectare at the medium and high stocking rates respectively. However, there was mean weight gain of 18.75 kg at the low stocking rate. In the wet period, there was mean weight gain of 229.95, 319.84 and 299.43 kg per hectare at the low, medium and high stocking rates respectively. However, there were no significant differences in weight changes between stocking rates for any of the periods ($P > 0.05$).

There was an increased emergence of herbs and forbs at the high stocking rate in the wet period. Changes in foliage cover showed that Kikuyu grass was tolerant to heavy grazing but there were signs of overgrazing at the high stocking rate.

It was concluded that the medium stocking rate could be suitable but with caution because it was unable to finish off 80% of the sheep. Continuous rainfall was required if overgrazing had to be averted at the high stocking rate.

ACKNOWLEDGEMENTS

I am greatly indebted to many individuals who helped me conduct the experiment successfully. Those whom I wish especially to thank for their help are Drs. A.B. Carles and T. Njoka for their constructive criticisms and suggestions from the early stages of the experiment to the writing up of this thesis; Dr. Van Eijnsbergen for his advice on the design of the experiment and analysis of liveweight data; Mr. P. Chege for taking care of the animals throughout the experiment; Miss S. Mainja and Mr. J. Gitau for typing draft and final copies of the thesis, respectively.

This work was made possible with a scholarship generously offered to the Malawi Government by the Food and Agriculture Organization (F.A.O) of the United Nations, whom I wish to give special thanks.

DEDICATED TO MY PARENTS

Dedicated to Anuos Family.

1. INTRODUCTION

The importance of animal protein in human nutrition cannot be over emphasized. It provides essential amino acids which are normally deficient in food stuffs of plant origin. Mc Gillivray (1967) stated that in the event of beef becoming in short supply in East Africa as had been projected by the East African Livestock Survey, prospects for the production of small stock were bright. Relative to cattle, it takes much shorter periods of time to increase numbers and the annual off-take can be 60% or above.

However, the productivity of many tropical sheep breeds appears to be lower than that of temperate breeds. Williamson and Payne (1974) stated that tropical sheep breeds responded poorly to good feeding and on their normal grazing, grew comparatively slowly. Although the productivity of temperate sheep breeds is superior to that of tropical breeds, they cannot be raised successfully under most tropical conditions due to the seasonal scarcity of feed, high ambient temperatures and solar radiation among other factors.

The performance of cross breds of temperate and tropical parents have shown that they are well adapted to the tropical environment and have higher productivity than pure tropical breeds. Williamson et al. (1974) stated that the carcass quality of cross bred sheep is better than that of pure indigenous sheep and although the crossbred may be smaller, it could be finished for slaughter at an earlier age.

One of the cross breds that was bred for arid environment, typical of many tropical countries such as Kenya, Somalia, Botswana, Mali and Chad among other countries, is the Dorper. The Dorper was first bred in South Africa from Dorset Horn and Blackhead Persian parents. The Dorper possesses the hardiness of the Blackhead Persian to live in arid environment where few other improved breeds if any would survive, Williamson et al. (1974).

However, there appears to be no reports on the productivity of the Dorper when grazed on Kikuyu grass pasture growing in its natural habitat. Kikuyu grass is indigenous to the East African Highlands which includes Kenya, Tanzania, Zaire, Uganda and Ethiopia. Edwards (1943) showed that Kikuyu grass is more nutritious than other tropical grass species. Said (1970) found that the crude protein content of Kikuyu grass in 5 weeks regrowth samples was 23.7%. Kikuyu grass was also shown to be more tolerant to heavy grazing than other tropical grass species, Edwards, (1943). In light of the superiority of Kikuyu grass, it appears as if it has the potential of increasing animal production without the application of inorganic fertilizers and supplementary feeding of the grazing animals.

However, previous experiments have shown that stocking rate is one of the most important factors that affect animal production from pastures, Mc Meekan and Walshe (1963) and Stobbs (1969). Newton and Young (1974) were able to show that liveweight gain per sheep declined with increasing stocking rate while liveweight gain per hectare increased with increasing stocking rate.

Therefore, the primary objective of this experiment was to investigate the effects of stocking rate on the performance of the Dorper when continuously grazed on Kikuyu grass. The secondary objective of this study was to investigate botanical changes of the sward species in response to different stocking rates.

2. LITERATURE REVIEW

Previous workers have shown that stocking rate is one of the most important factors that affect animal production from pastures. A wide range of stocking rates have been used and results of the performance of both sheep and cattle are similar.

The response of the stoloniferous and rhizometous pastures to several years of defoliation showed a high degree of tolerance.

1. ANIMAL RESPONSE AT DIFFERENT STOCKING RATES

Most of the studies in sheep responses, especially in the area of stocking rate, have been done in Australia more than in any other country under tropical climatic conditions. This may perhaps be due to the leading role that Australia plays in wool production.

Wright (1974) used 24.69 wethers per hectare to compare grazing systems. He found that set stocking coupled with a 6 month drought period resulted in liveweight loss of 11.21 kg per head. During the wet period, from December, 1968 to April, 1969 the wethers gained 13 kg per head. The experiment which was conducted on Kikuyu grass/ white clover pasture showed that continous grazing system was unable to carry 24.69 wethers per hectare throughout the experimental period.

Robinson and Simpson (1975) compared grazing systems by using Merino wethers stocked at 10, 20 and 30 per hectare. The wethers were grazed on pasture composed of Phalaris tuberosa, Trifolium repens and perrennial ryegrass. Wool production per head was significantly higher at 10 than at 20 and 30 wethers per hectare, but more wool per hectare was produced at 20 wethers per hectare.

Simpson and Robinson (1978) used Merino wethers stocked at 10, 20 and 30 per hectare to compare grazing systems. The wethers were grazed on pasture sward composed of phalaris, cockfoot, perennial ryegrass and white clover. Results showed that under continous grazing system, supplementary feeds were necessary for weight gain at 20 and 30 wethers per hectare. However, no supplements were required at 10 wethers per hectare thoughtout the 3 year experimental period.

Birrel, Bishop, Tew and Plowright (1978) used 3 year old Polworth X Corriedale wethers to compare grazing systems. The highest grazing pressure led to production of high quality herbage but also led to reduced productivity, low feed intake and liveweight loss.

Brownlee (1973) conducted two grazing experiments from 1965 to 1969. Medicago truncatula c.v., jemalong pasture was set stocked with Merino wethers at 3, 1, 4.1

and 6.2 per hectare. In both experiments, the pasture regenerated successfully each year.

Southwood and Robards (1975) compared grazing systems by using Merino ewes stocked at 5 and 10 hectare. Stocking rate was the only factor to affect ewe liveweight and wool production, both of which were higher at 5 than 10 ewes per hectare.

Although the foregoing review discusses sheep experiments conducted in Australia, which has similar tropical ecological features to East Africa, a similar relationship between stocking rate and output per head was also observed under temperate ecological conditions. This contrast is important because it shows that results obtained from experiments done under temperate conditions, may be useful and applicable under tropical conditions, especially in those areas where little or no information is available.

In Ireland, Nolan (1975) conducted experiments in 1970 and 1971 lasting 2½ and 1¾ months respectively, at stocking rates of 29.7, 44.6 and 59.4 sheep per hectare, on a 4 year old perennial ryegrass/white clove pasture. In 1970, liveweight gains during the specified period were 9.46, 6.36 and 2.36 kg per lamb for the low, medium and high stocking rates, respectively. Similar liveweight gains per lamb were obtained in 1971.

In Britain, Newton and Young (1974) used weaned down breeds, Dorset Down X Finnish Blackface among others to compare performance when grazed on S24 perennial ryegrass. The lambs were set stocked at 43.5, 60.0 and 87.0 per hectare. Results showed that increasing stocking rate decreased growth rate.

Results obtained by previous workers show that the response of sheep at a wide spectrum of stocking rates gave similar results, that increasing stocking rate decreased production per head but increased production per hectare. However, it appears as if there are no reported studies on similar work under East African conditions where the Dorper grazing Kikuyu grass was used.

Results obtained when cattle were used were similar to those of sheep. The use of cattle in animal response stocking rate studies seems to be more popular than sheep in tropical Africa. As a result, more work has been done on cattle than on sheep.

In Malawi, Addy and Thomas (1978) conducted a 3 year investigation on the performance of Malawi Zebu steers grazing on Rhodes grass. Addy _et al_. (1978) had used stocking rates of 2.5, 5.0 and 7.5 livestock units per hectare (1 L.U. = 342 kg liveweight). Results showed that 5.0 and 7.5 L.U. per hectare with lower availability of pasture and less opportunity for selection gave the highest output per hectare, but lowest gain per steer. Harker and McKay (1962) while investigating the carrying capacity of rough pastures in Uganda found similar results on selective behaviour of grazing steers.

The Commonwealth Scientific Industrial Research Organization, (C.S.I.R.O.) (1979) conducted a 3 year grazing experiment in Australia. Steers were stocked at 0.7, 1.2, 1.7, 1.9 and 2.2 per hectare. Results showed that there were no significant differences in annual liveweight gain between stocking rates. In the dry season, liveweight decreased with increasing stocking rate, but in the wet season, the trend was reversed. The pasture composition remained constant. At low stocking rates, only patches of the pasture were grazed in the wet season. Forty five percent was grazed at 1.2 steers and 29% at 0.7 steers per hectare. Guinea grass, one of the species in the sward became over grazed at 2.2 steers per hectare.

In Malaysia, Eng, Mannetje and Chen (1978) measured animal production for 3 years at stocking rates of 2, 4 and 6 cow per hectare. Results showed that stocking rate significantly affected liveweight gain with negative linear relationship between liveweight gain per cow and stocking rate.

In Australia, Colman and Holder (1968) showed that bufferfat production of dairy cows and heifers tended to decline with increasing stocking rate but these changes were not significant. Production per hectare increased significantly as stocking rate was increased. Hancock (1958) had earlier on found that the intake of dry matter was reduced at the high stocking rate. This caused a reduction in milk yield per cow but gave marked increases in yield per hectare.

Bird, Cayley and Watson (1978) investigated the performance of yearling Hereford steers in Australia. The steers were stocked at 1.8, 2.4, 3.0 and 3.27 per hectare on pasture containing subterranean clover and ryegrass. Results showed that liveweight gain per steer decreased as stocking rate increased.

In Rhodesia (Zimbabwe), Atkinson (1963) investigated the performance of steers grazing on Kikuyu grass/white clover pasture. The experiment lasted 150 days, beginning on 7th December, 1962. Results showed that the initial stocking rate of 2 steers per acre (4.94 steers per hectare) was too high to carry the animals for 150 days. The stocking rate was reduced to 3.70 steers per hectare. An average gain of 38.59 kg per steer was achieved. It was concluded that 0.405 hectare was able to carry 3 sheep and 1 steer in summer.

In United States of America, Oliver (1975) conducted a grazing trial on sandy upland soil. The pasture was composed of Bermuda grass c.v. coastal pasture. Steers were stocked at 3.95 and 7.16 per hectare. Results showed that the steers at the lighter stocking rate gained an average of 122.58 kg. The heavier rate gained 148.0 kg liveweight per hectare more than the ligher stocking rate.

The response of cattle to stocking rate showed that increasing stocking rate decreased production per head but increased production per hectare, irrespective of geographical location, sward composition and grazing system among other factors.

2. PASTURES

Edwards (1936) made a report on grassland improvement in Kenya. His studies showed that Kikuyu grass grows favourably in areas relatively with high moisture content and low temperature conditions of the higher altitudes ranging from 1,982.5 to 1,2745 metres above sea level. Annual precipitation ranging from 1016 to 1524 mm and fairly distributed was considered optimum. Edwards (1943) showed that after 6 years of severe treatment by monthly cuttings, Kikuyu grass growing in its natural habitat had a ground cover of 84 to 98% as compared to 68% ground cover by Rhodes grass.

Atkinson (1963) and O'Reilly (1975) reported that Kikuyu grass forms a hard wearing sward which does not develop bare patches due to rhizometous and stoloniferous rooting system.

Kikuyu grass has been reported to be outstanding among other tropical grass species not only on its prolific growth habits but also on its nutritive value. Edwards (1936); Said (1970) and O'Reilley (1975) showed that the crude fibre contents were 12.9% and 26.2% respectively in 5 week regrowth samples.

Observations made by previous workers showed that Kikuyu grass had prolific growth habits and was more tolerant to defoliation by cutting than Rhodes grass among other tropical grass species of similar growth habits.

3. MATERIALS AND METHODS

The experiment was conducted at the Kabete Campus of the University of Nairobi (Lat. 1^{o}S. Long. 36^{o} 44^{o}E and 1,931.93 metres altitude). The total rainfall for each month during the experiment and the corresponding mean rainfall based on 9 to 10 years data are shown in Table 1.

1. PASTURES

1.1 Sward composition and site preparation

The pasture was composed of Kikuyu grass (*Pennisetum clandestinum*) as the dominant species. There were also clusters of herbs and forbs such as *Ocimum americanum*, *Bidens pilosa* and *Tegetes minuta* among others. The pasture sward was growing in its natural habitat and undisturbed in terms of ploughing and replanting. However, the pasture had been subjected to about 25 years of grazing. There had been no application of inorganic fertilizers to the pasture.

Prior to the commencement of the experiment, the pasture was rested for 3 months. Variation in tiller height after 3 months of regrowth was reduced by mowing to approximately 5 cm. above the ground, using a tractor propelled rotating blade mower on 14th November, 1980.

TABLE 1: MEAN (± S.D.) AND TOTAL RAINFALL OF EACH MONTH (mm) FOR 1971-1980 AND 1981 RESPECTIVELY.

MONTH	MEAN ± S.D. (1971-1980)	TOTAL 1981
January	60.50 ± 57.179[a]	2.7
February	64.80 ± 59.728[a]	6.8
March	92.30 ± 96.086[a]	123.8
April	220.90 ±102.466[b]	506.0
May	148.20 ±117.285[b]	213.7
June	45.80 ± 36.350[b]	10.5
July	27.40 ± 30.178[b]	18.0

[a]means based on 9 years

[b]means based on 10 years

2. PASTURE MEASUREMENTS

2.1 Assessment of pasture height and erection of exclosures

Each experimental unit here after referred to as plot, was subdivided into approximately 10 metre square sub plots. There were no physical barriers of the sub plots but wooden pegs were driven into the ground along fence lines of each plot delineating these sub plots. The purpose of the sub plots was to assess each one of them in terms of average tiller height of the dominant species by using a ruler. The classification of tiller height was in 3 categories:- Very good ≥ 13 cm; $5 \geq$ Good ≤ 13 cm and $1.0 \geq$ Fair ≤ 5.0 cm.

Three locations for the cages were selected at random corresponding to the 3 categories mentioned already. Inside each cage, an area approximately 0.19 metre square was demarcated. Pasture samples were cut from these delineated areas as a way of reducing cage effects. Hand shears were used to cut pasture samples approximately at ground level. Cages were moved to new locations at the onset of the wet period, on 4th April, 1981. Assessment of tiller height in each sub plot and cutting of pasture samples from the exclosures were done at monthly intervals, on the same day.

2.2 Botanical composition and foliage cover

Three plots were selected at random, one for each stocking rate. Three line transects, one in each plot were laid down by driving a total of 10 wooden pegs into the ground at equal distances from each other. A point frame with 10 vertical pins as described by Tinney, Aamodt and Ahlgen (1937) was moved systematically 10 times from one end of each line transect to the other end. The frame was put in an upright position at each peg on a line transect. Pins which moved freely up and down through holes of the frame were in the first instance moved up. As the pins were pushed down, first hits on any part of plant material or bare ground were recorded for each pin. The total hits on a line transect was 100. Botanical composition was expressed in percentage, as number of hits on any part of each sward species out of the total hits in a line transect.

2.3 Estimate of available dry matter

Estimate of available dry matter in each plot was made by using dry matter data from the exclosures. Separate totals from each category of tiller height sub plots were calculated. Plot totals were found by summation of sub plot totals.

3. ANIMALS

3.1 Breed, source and liveweight

Thirty-six Dorper wethers with a mean liveweight of 25.36 ± 3.861 kg (S.D.) and ranging in age from 9 to 10 months were used. The sheep were purchased from a ranch owned by a statutory body, at Sultan Hamud, about 100 km.

South West of Nairobi, on Mombasa road. The pasture at the ranch was Themeda and Hyparrhenia grasslands. The sheep were checked for physical fitness and dentition. They had been regularly dipped and dosed against ticks and helminths respectively. The sheep were also vaccinated against Clostridium welchii, B, C and D and Clostridium tetani before purchase.

3.2 Sheep Measurements

Initial liveweights were not taken until 4th February, 1981. Weighing and the assessment of body condition were done at weekly intervals between 10.00 to 11.00 hours. This time was approximately 3 hours after grazing began. The sheep were weighed to the nearest 0.5 kg. Body condition was assessed by palpation of the lumbar region as shown in Table A7.

The sheep were sleeping in a night enclosure. They were taken out of the enclosure every morning around 8.00 hours and taken back around 18.00 hours. This system was adopted due to the presence of predators.

3.3 Routine Management Practices

The sheep were initially vaccinated against Clostridium welchii, B, C and D and Clostridium tetani on 29th December, 1981. This was repeated before the wet period began, on 23rd March, 1981. Anthelmintics, "Ranide" and "Thiabenzole" were administered alternately at fortnightly intervals.

"Mansonil" for the control of tapeworms was used once. Ticks were controlled with "Delnav" at weekly interval. Mineral supplements in granular form were given once in 2 days. Water was given *ad libitum*.

4. DESIGN

The experimental design was completely randomized. Eachp plot was set stocked with 3 sheep and there were 4 replicates. There were 3 sizes of plots, approximately 0.0867, 0.0650 and 0.0433 hectares corresponding to stocking rates of 34.6, 51.8 and 69.1 sheep per hectare, hereafter referred to as the low, medium and high stocking rates respectively.

5. DURATION

The sheep were put in the plots on 30th December, 1980. The first 7 weeks to 23rd February, 1981 was pre-experimental period. The period was for acclimatization and to wait for the delivery of a scale. The experiment ended on 13th July, 1981.

6. METHODS OF ANALYSES

6.1 Dry matter determination

Fresh pasture samples cut from each exclosure were weighed separately. Dry matter content for each sample was determined by using standard procedures as described by the

Association of Official Analytical Chemists, (A.O.A.C.) (1975).

6.2 Proximate analyses for crude protein and crude fibre content

Dried pasture samples were ground in Gallenkamp Beater Cross mill which had sieve diameter of 0.01 mm. crude protein and crude fibre contents were determined by using standard procedures as described by the Association of Official Analytical Chemists, (A.O.A.C.) (1975).

6.3 Statistical analysis

Covariance analysis was used to analyse the liveweight changes per head and per hectare for the various stocking rates, details of which are shown in Steel and Torrie (1960). Three periods were considered, here after referred to as the overall (20 weeks), dry (5 weeks) and wet 15 weeks) periods respectively.

4. RESULTS

1. SHEEP LIVEWEIGHT

1.1 WEIGHT GAIN PER PLOT

Overall period (20 weeks)

The mean weight gain of the sheep was 7.19, 5.56 and 3.79 kg per head at the low, medium and high stocking rates respectively. There were significant differences in weight gain between stocking rates ($P < 0.05$), between the low and high stocking rates as shown in Tables 2 and 3. There was a significant negative linear relationship between stocking rate and average daily gain (gm per day) ($P < 0.05$) as shown in Figure 1. The mean squares of the experimental and sample errors were similar. This indicates that there was little variation bteween the sheep and that differences in weight gain between stocking rates were mainly due to treatment effects.

Dry period (5 weeks)

There was a trend for sheep performance to follow seasonal conditions as shown in Figure 2. During the first 3 weeks, sheep at all the stocking rates gained weight similarly. Thereafter, there was weight loss at all the stocking rates for 2 weeks. The net effect was a mean weight gain of 0.54 kg per head at the low stocking rate. Sheep in the medium and high stocking rates lost a

TABLE 2: MEAN (± S.D.) LIVEWEIGHT GAIN (kg) PER SHEEP PER PLOT FOR THE OVERALL PERIOD (20 weeks)

STOCKING RATE	GENERAL MEAN ± S.D. (kg)	ADJUSTED FOR INITIAL WEIGHT (kg)
34.6 sheep/ha	7.19 + 2.326	7.15[a]
51.8 " "	5.56 ± 2.716	5.54[ab]
69.1 " "	3.79 ± 1.702	3.84[b]

Means with different superscripts are significantly different.

TABLE 3: ANALYSIS OF VARIANCE OF LIVEWEIGHT GAIN (kg) PER SHEEP PER PLOT FOR THE OVERALL PERIOD (20 weeks)

SOURCE OF VARIATION	DEGREE OF FREEDOM	MEAN SQUARES
Initial weight	1	0.12 n.s.
Stocking rate	2	24.35*
Sample error	24	5.43
Experimental	8	5.26

*P < 0.05.

n.s. not significant at P > 0.05 level.

mean weight of 0.54 kg per head as shown in Table 4. However, there were no significant differences in weight loss between stocking rates ($P > 0.05$) as shown in Table 5.

No attempt was made to draw a regression line because while there was weight gain at the low stocking rate, there were weight losses at the medium and high stocking rates.

Wet period (15 weeks)

There was a further weight loss for 1 week after the end of the dry period at all the stocking rates after the emergence of pastures as shown in Figure 2. Thereafter, sheep at all the stocking rates gained weight. The net effect was mean weight gain of 6.65, 6.10 and 4.33 kg per head at the low, medium and high stocking rates respectively, as shown in Table 6. However, there were no significant differences in weight gain between stocking rates ($P > 0.05$) as shown in Table 7. There was a linear relationship between stocking rate and average daily gain but it was not significant ($P > 0.05$).

1.2 WEIGHT GAIN PER HECTARE

Overall period (20 weeks)

Weight gain per hectare increased from the low to the medium stocking rate, then decreased. The mean weight gains were 248.69, 288.14 and 262.0 kg per hectare at the low, medium and high stocking rates respectively as shown in Table 8. The graphical presentation is shown in Figure 3.

However, there were no significant differences in weight gain between stocking rates ($P > 0.05$) as shown in Table 9.

Dry period (5 weeks)

There was a mean weight gain of 18.75 kg per hectare at the low stocking rate. However, there were mean weight losses of 28.06 and 37.43 kg per hectare at the medium and high stocking rates respectively, as shown in Table 10. However, there were no significant differences in weight loss between stocking rates ($P > 0.05$) as shown in Table 11.

Wet period (15 weeks)

Increasing stocking rate increased weight gain per hectare to the maximum, the medium stocking rate, then decreased. The mean weight gains were 229.95, 319.84 and 229.43 kg per hectare at the low, medium and high stocking rates respectively as shown in Table 12 and graphically presented in Figure 3. However, there were no significant differences in weight gain between stocking rates ($P > 0.05$) as shown in Table 13.

TABLE 4: MEAN (± S.D.) LIVEWEIGHT GAIN (kg) PER SHEEP PER PLOT FOR THE DRY PERIOD (5 weeks)

STOCKING RATE	GENERAL MEAN ± S.D. (kg)
34.6 sheep/ha	0.54 + 0.620
51.8 " "	- 0.54 ± 0.542
69.1 " "	- 0.54 ± 0.620

TABLE 5: ANALYSES OF VARIANCE OF LIVEWEIGHT GAIN (kg) PER SHEEP PER PLOT FOR THE DRY PERIOD (5 weeks)

SOURCE OF VARIATION	DEGREES OF FREEDOM	MEAN SQUARES
Initial weight	1	0.14 n.s.
Stocking rate	2	3.81 n.s.
Sample error	24	0.79
Experimental error	8	1.07

n.s. not significant at P > 0.05 level.

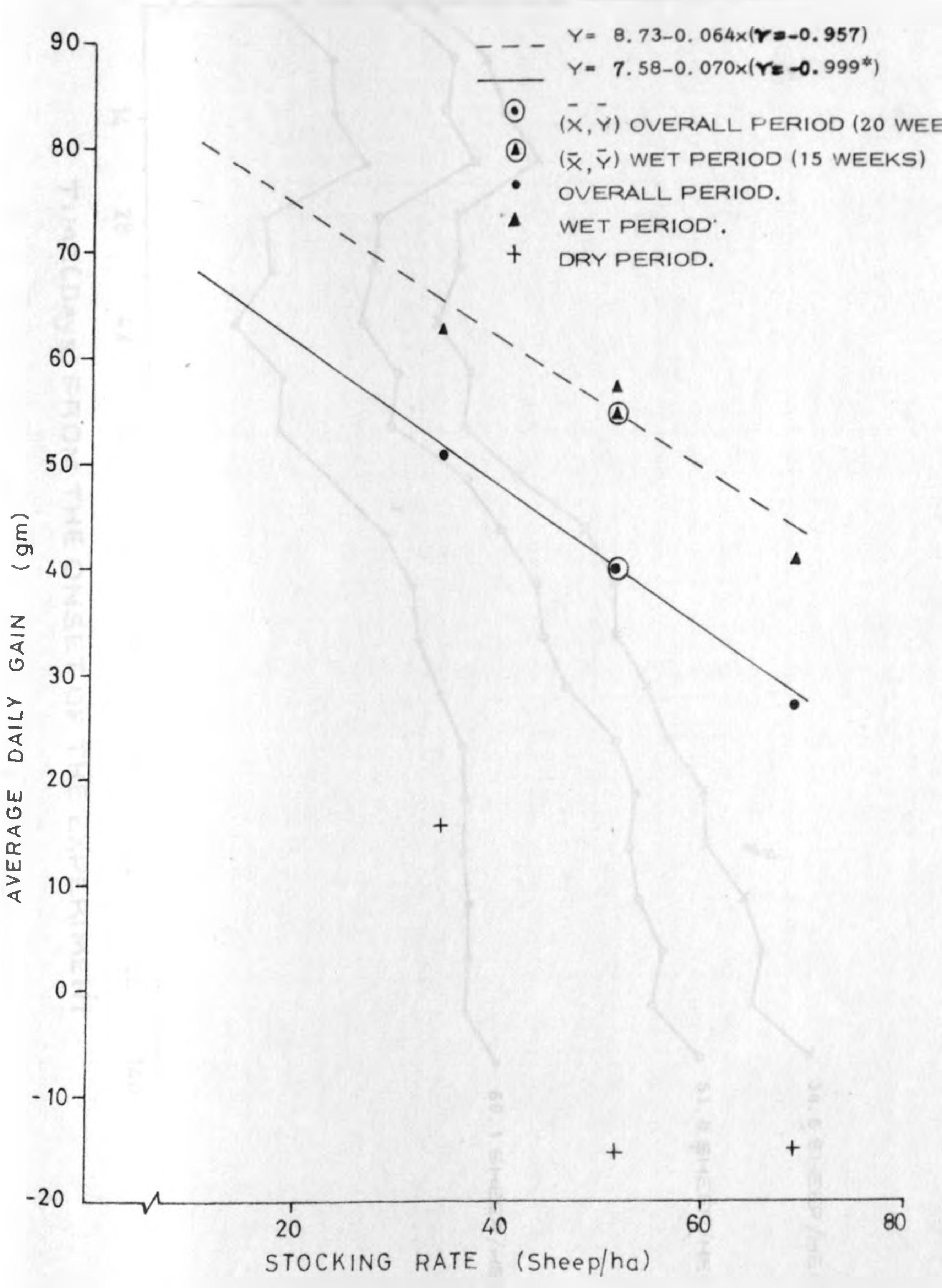

FIG. 1. REGRESSION OF AVERAGE DAILY GAIN ON STOCKING RATE.

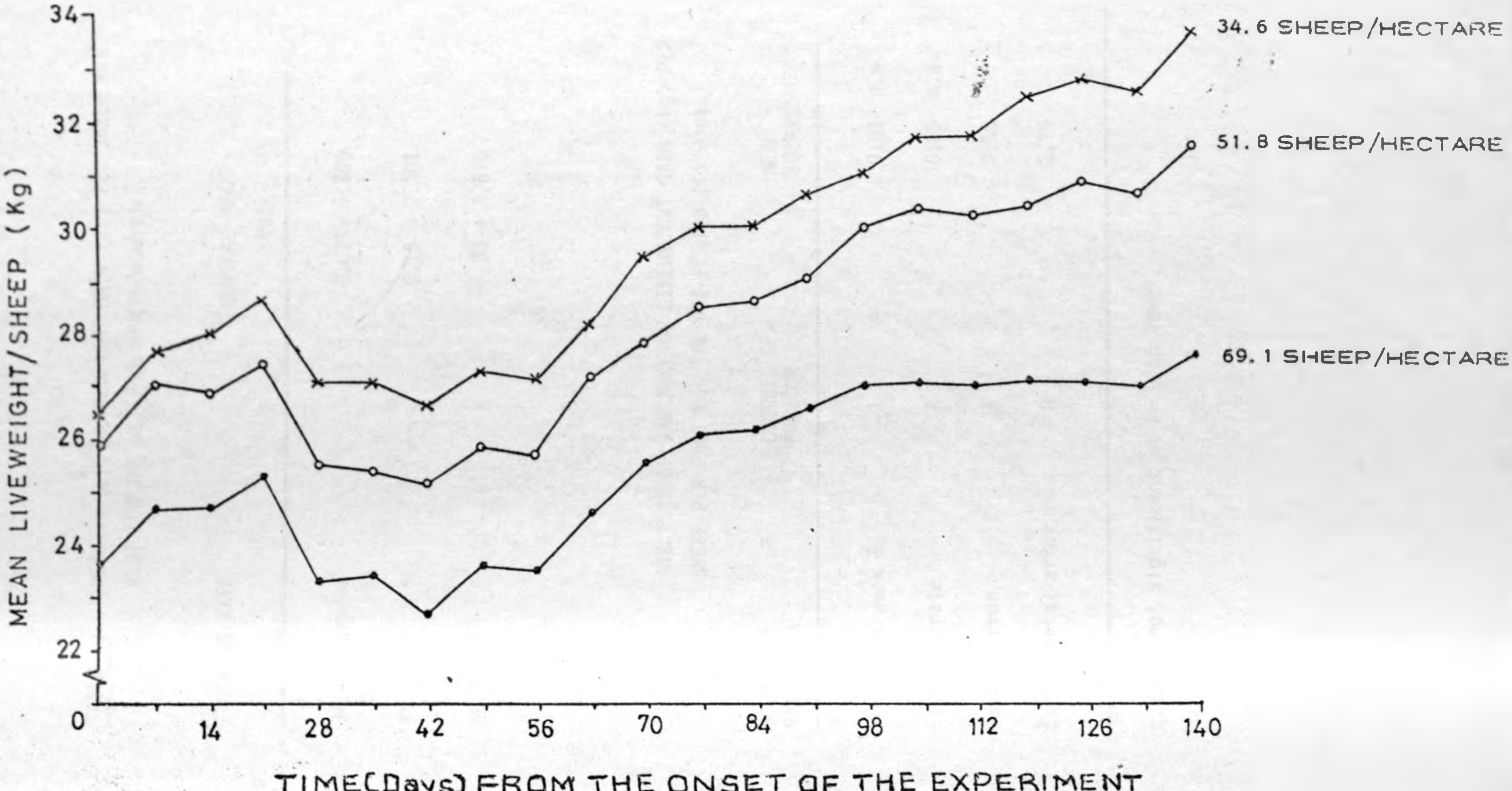

FIG. 2: CHANGES IN MEAN LIVEWEIGHT / SHEEP / STOCKING RATE WITH TIME.

TABLE 6: MEAN (+ S.D.) LIVEWEIGHT GAIN (kg) PER SHEEP PER PLOT FOR THE WET PERIOD (15 weeks)

STOCKING RATE	GENERAL MEAN ± S.D.) (kg)
34.6 sheep/ha	6.67 ± 1.899
51.8 " "	6.10 ± 2.101
69.1 " "	4.33 ± 1.516

TABLE 7: ANALYSIS OF VARIANCE OF LIVEWEIGHT GAIN (kg) PER SHEEP PER PLOT FOR THE WET PERIOD (15 weeks)

SOURCE OF VARIATION	DEGREES OF FREEDOM	MEAN SQUARES
Weight at week 5	1	0.01 n.s.
Stocking rate	2	10.89 n.s.
Sample error	24	3.50
Experimental error	8	3.75

n.s. not significant at P> 0.05 level.

TABLE 8: MEAN (± S.D.) LIVEWEIGHT GAIN (kg) OF SHEEP PER HECTARE FOR THE OVERALL PERIOD (20 weeks)

STOCKING RATE	GENERAL MEAN ± S.D. (kg)
34.6 sheep/ha	248.69 ± 21.626
51.8 " "	288.14 ± 69.456
69.1 " "	262.00 ± 109.30

TABLE 9: ANALYSIS OF VARIANCE OF LIVEWEIGHT GAIN (kg) PER HECTARE FOR THE OVERALL PERIOD (20 weeks)

SOURCE OF VARIATION	DEGREES OF FREEDOM	MEAN SQUARES
Initial weight	1	335.76 n.s.
Stocking rate	2	527.68 n.s.
Sample error	24	1323.62
Experimental error	8	2112.94

n.s. not significant at $P > 0.05$ level.

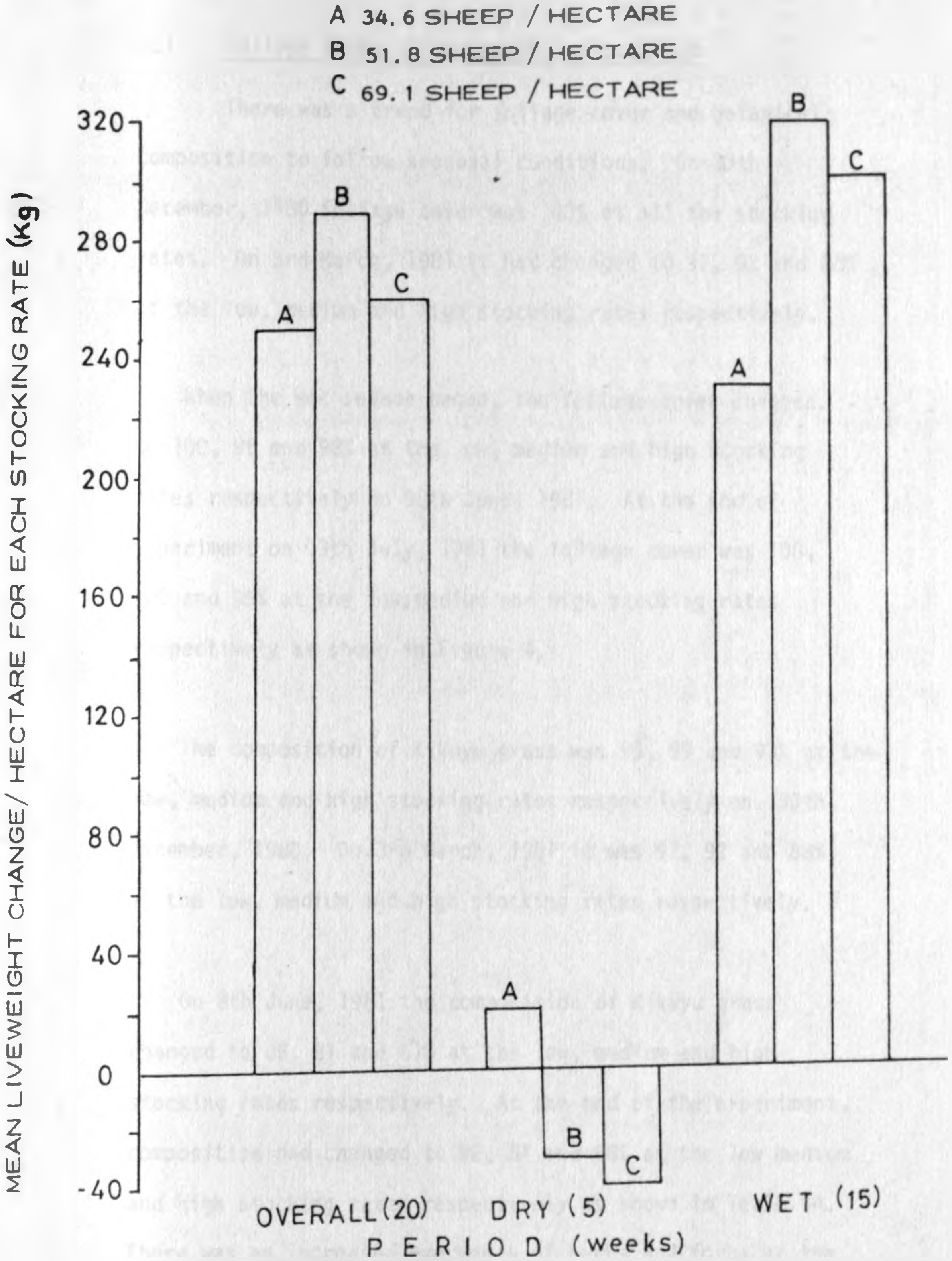

FIG. 3: CHANGES IN MEAN LIVEWEIGHT GAIN /HECTARE FOR EACH STOCKING RATE AND PERIOD.

2. PASTURES

2.1 Foliage cover and botanical composition

There was a trend for foliage cover and botanical composition to follow seasonal conditions. On 30th December, 1980 foliage cover was 100% at all the stocking rates. On 3rd March, 1981 it had changed to 97, 92 and 88% at the low, medium and high stocking rates respectively.

When the wet season began, the foliage cover changed to 100, 98 and 98% at the low, medium and high stocking rates respectively on 98th June, 1981. At the end of experiment on 13th July, 1981 the foliage cover was 100, 100 and 96% at the low, medium and high stocking rates respectively as shown in Figure 4.

The composition of Kikuyu grass was 95, 99 and 93% at the low, medium and high stocking rates respectively on 30th December, 1980. On 3rd March, 1981 it was 97, 92 and 88% at the low, medium and high stocking rates respectively.

On 8th June, 1981 the composition of Kikuyu grass changed to 85, 81 and 61% at the low, medium and high stocking rates respectively. At the end of the experiment, composition had changed to 92, 81 and 68% at the low medium and high stocking rates respectively as shown in Table 14. There was an increased emergence of herbs and forbs at the high stocking rate in the wet period.

TABLE 10: MEAN (+ S.D.) LIVEWEIGHT GAIN (kg) OF SHEEP PER HECTARE FOR THE DRY PERIOD (5 weeks)

STOCKING RATE	GENERAL MEAN ± S.D. (kg)
34.6 sheep/ha	18.75 ± 17.218
51.8 " "	- 28.06 + 27.639
69.1 " "	- 37.43 ± 28.792

TABLE 11 ANALYSIS OF VARIANCE OF LIVEWEIGHT GAIN (kg) OF SHEEP PER HECTARE FOR THE DRY PERIOD (5 weeks)

SOURCE OF VARIATION	DEGREES OF FREEDOM	MEAN SQUARES
Initial weight	1	176.71 n.s.
Stocking rate	2	444.44 n.s.
Sample error	24	258.24
Experimental error	8	334.93

n.s. not significant at P > 0.05 level

TABLE 12: MEAN (± S.D.) LIVEWEIGHT GAIN (kg) OF SHEEP PER HECTARE FOR THE WET PERIOD (15 weeks)

STOCKING RATE	GENERAL MEAN ± S.D. (kg)
34.6 sheep/ha	229.95 ± 17.676
51.8 " "	319.84 ± 51.785
69.1 " "	299.43 ± 92.730

TABLE 13: ANALYSIS OF VARIANCE OF LIVEWEIGHT GAIN (kg) OF SHEEP PER HECTARE FOR THE WET PERIOD (15 weeks)

SOURCE OF VARIATION	DEGREES OF FREEDOM	MEAN SQUARES
Weight at week 5	1	64.81 n.s.
Stocking rate	2	1216.69 n.s.
Sample error	24	863.14
Experimental error	8	1441.03

n.s. not significant at P> 0.05 level.

2.2 Dry matter, crude protein and crude fibre contents

The dry matter, crude protein and crude fibre contents tended to follow seasonal conditions. The mean dry matter content increased from 31.51% on 30th December, 1980 to 80.61% on 3rd March, 1981. When the wet period began, the dry matter content decreased and was lowest, 17% on 8th June, 1981. At the end of the experiment, the dry matter content increased to 21.32% as shown in Figure 5 and Table 15.

The mean crude protein content remained fairly constant (6.78 to 6.79%) from 30th December, 1980 to 2nd April, 1981. On 7th May, 1981, the crude protein content had increased to 13.12%. At the end of the experiment, on 13th July, 1981 the crude protein content increased further to 15.96% as shown in Figure 5 and Table 15.

The crude fibre content followed the pattern of dry matter content changes. The mean crude fibre content increased from 34.08% on 30th December, 1980 to 37.65% on 3rd March, 1981. The crude fibre content then decreased at the on set of the wet period and was lowest, 29.81%, on 13th July, 1981 as shown in Figure 5 and Table 15.

TABLE 14: PROPORTIONAL BOTANICAL COMPOSITION OF THE PASTURE SWARD (%)

DATE	SPECIES	STOCKING RATE		
		Low	Medium	High
30/12/80	K	95	99	93
	O	5	1	7
2/2/81	K	95	99	90
	O	5	1	5
3/3/81	K	97	92	88
	O	1	0	3
2/4/81	K	92	94	81
	O	7	5	14
7/5/81	K	92	94	81
	O	8	3	15
8/6/81	K	85	81	61
	O	15	17	37
13/7/81	K	92	81	68
	O	8	19	28

Low - 34.6 sheep per hectare
Medium -51.8 " " "
High -69.1 " " "

O - Others comprised of *Ocimum americanum*, *Tegetes minuta*, *Sedges*, *Trifolium repens*, *Bidens pilosa*, *Cucumis* spp., *Cynodon dactylon*, *Dicanthum inscapltum* and unknown spp.

K - Kikuyu grass.

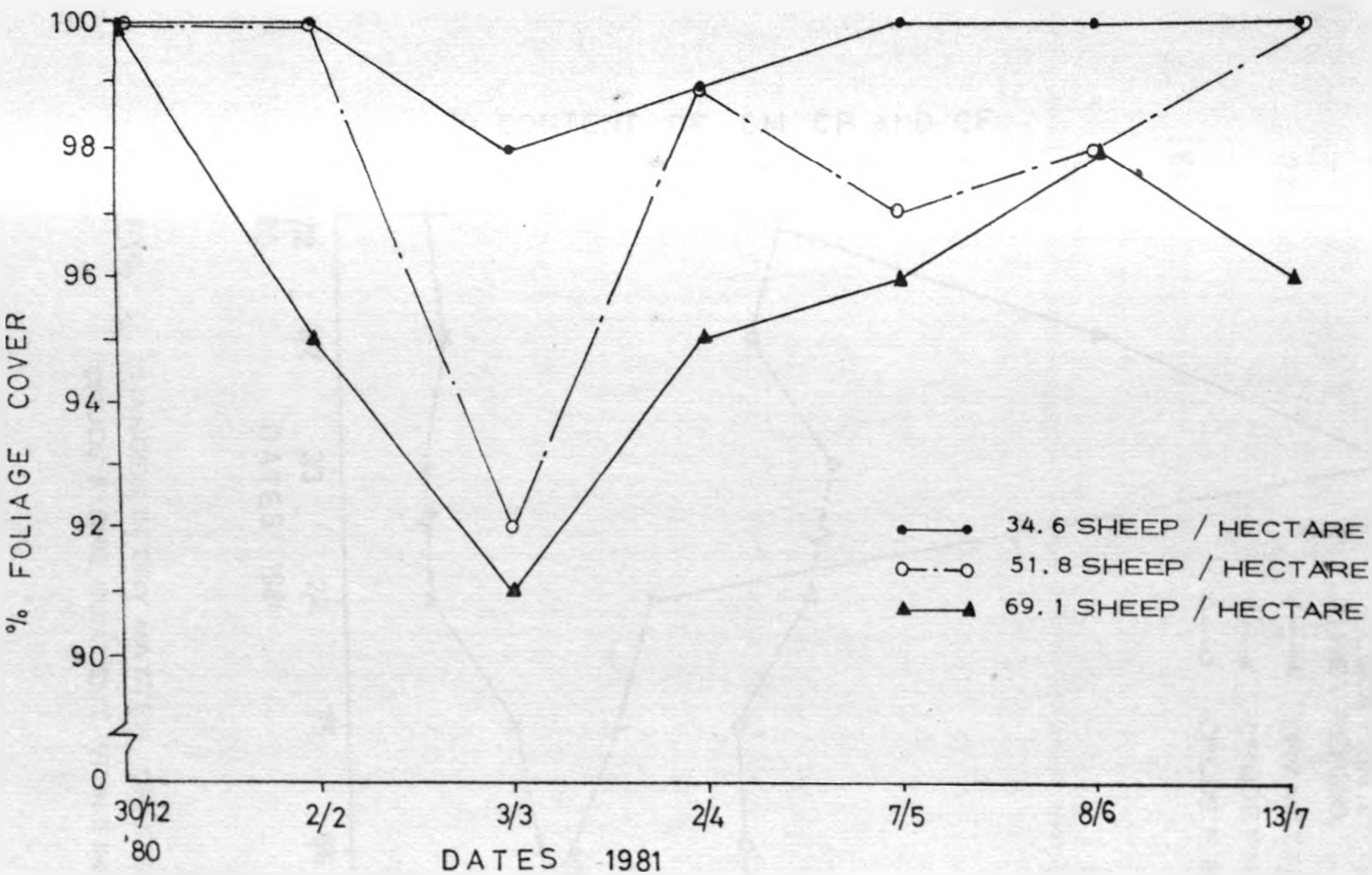

FIG. 4: CHANGES IN FOLIAGE COVER WITH TIME.

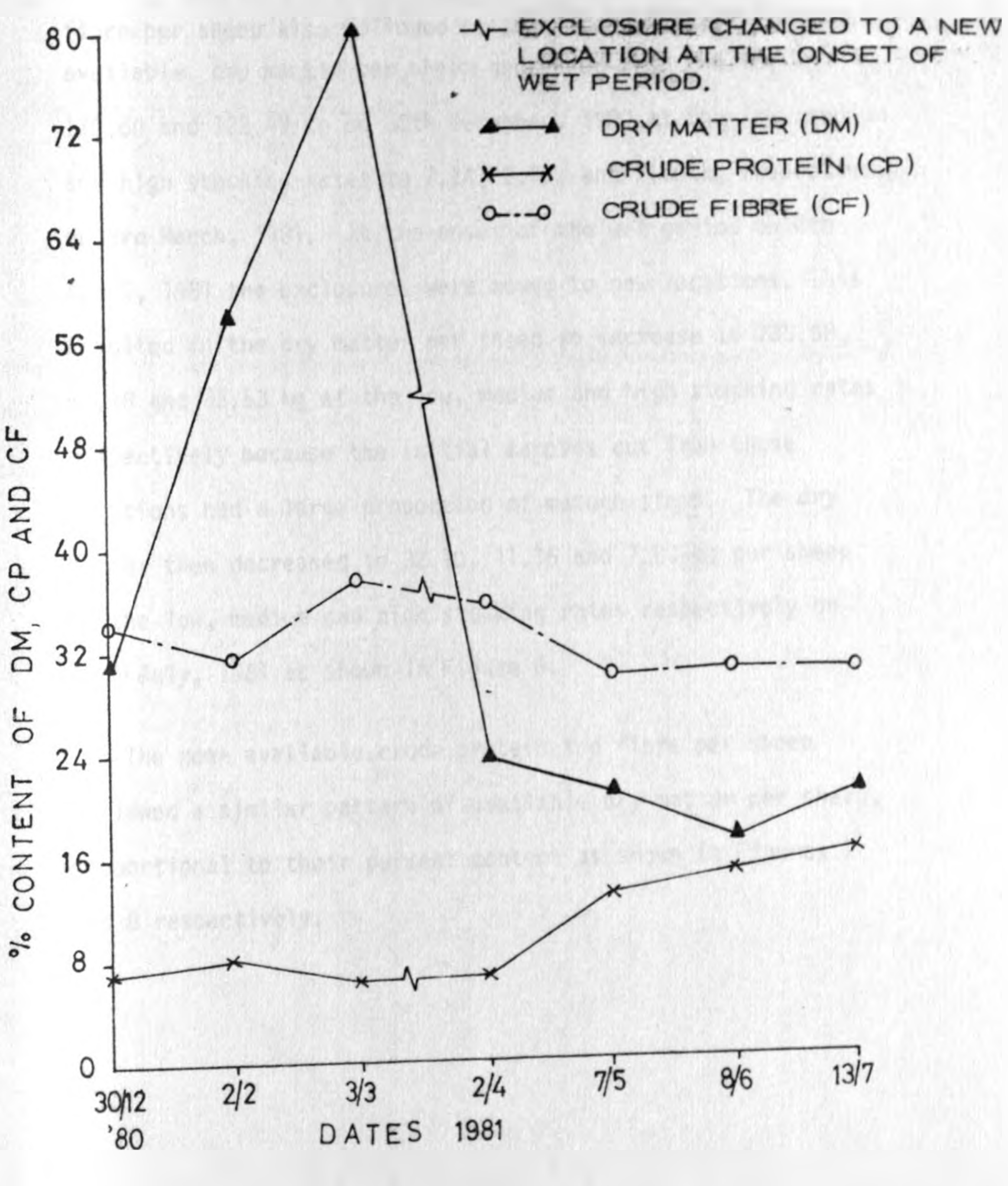

FIG. 5: CHANGES IN DRY MATTER, CRUDE PROTEIN AND CRUDE FIBRE CONTENT WITH TIME.

2.3 Available dry matter, crude protein and crude fibre

The mean available dry matter, crude protein and crude fibre per sheep also followed seasonal conditions. The mean available dry matter per sheep decreased from 206.16, 130.60 and 122.49 kg on 30th December, 1980 at the low, medium and high stocking rates to 7.24, 2.72, and 2.20 kg respectively on 3rd March, 1981. At the onset of the wet period on 4th April, 1981 the exclosures were moved to new locations. This resulted in the dry matter per sheep to increase to 138.68, 56.18 and 33.53 kg at the low, medium and high stocking rates respectively because the initial samples cut from these locations had a large proportion of mature stems. The dry matter then decreased to 32.10, 11.15 and 7.23 kg per sheep at the low, medium and high stocking rates respectively on 13th July, 1981 as shown in Figure 6.

The mean available crude protein and fibre per sheep followed a similar pattern of available dry matter per sheep, proportional to their percent content as shown in Figures 7 and 8 respectively.

TABLE 15: MEAN (± S.D.) DRY MATTER, CRUDE PROTEIN AND CRUDE FIBRE CONTENTS (%) OF KIKUYU GRASS

DATE	DRY MATTER (± S.D.)	CRUDE PROTEIN (± S.D.)	CRUDE FIBRE (± S.D.)
30/12/80	31.57±3.658	6.78±0.931	34.08±3.110
2/2/81	58.02±8.393	7.84±3.252	31.64±0.763
3/3/81	80.61±5.110	6.36+2.470	37.72±0.945
2/4/81	23.39±5.910	6.79±1.406	35.72±0.562
7/5/81	21.31±3.140	13.12±3.925	29.96±0.949
8/6/81	17.00±3.876	14.71±2.347	30.18±1.189
3/7/81	21.32±5.492	15.96±3.075	29.81±2.171

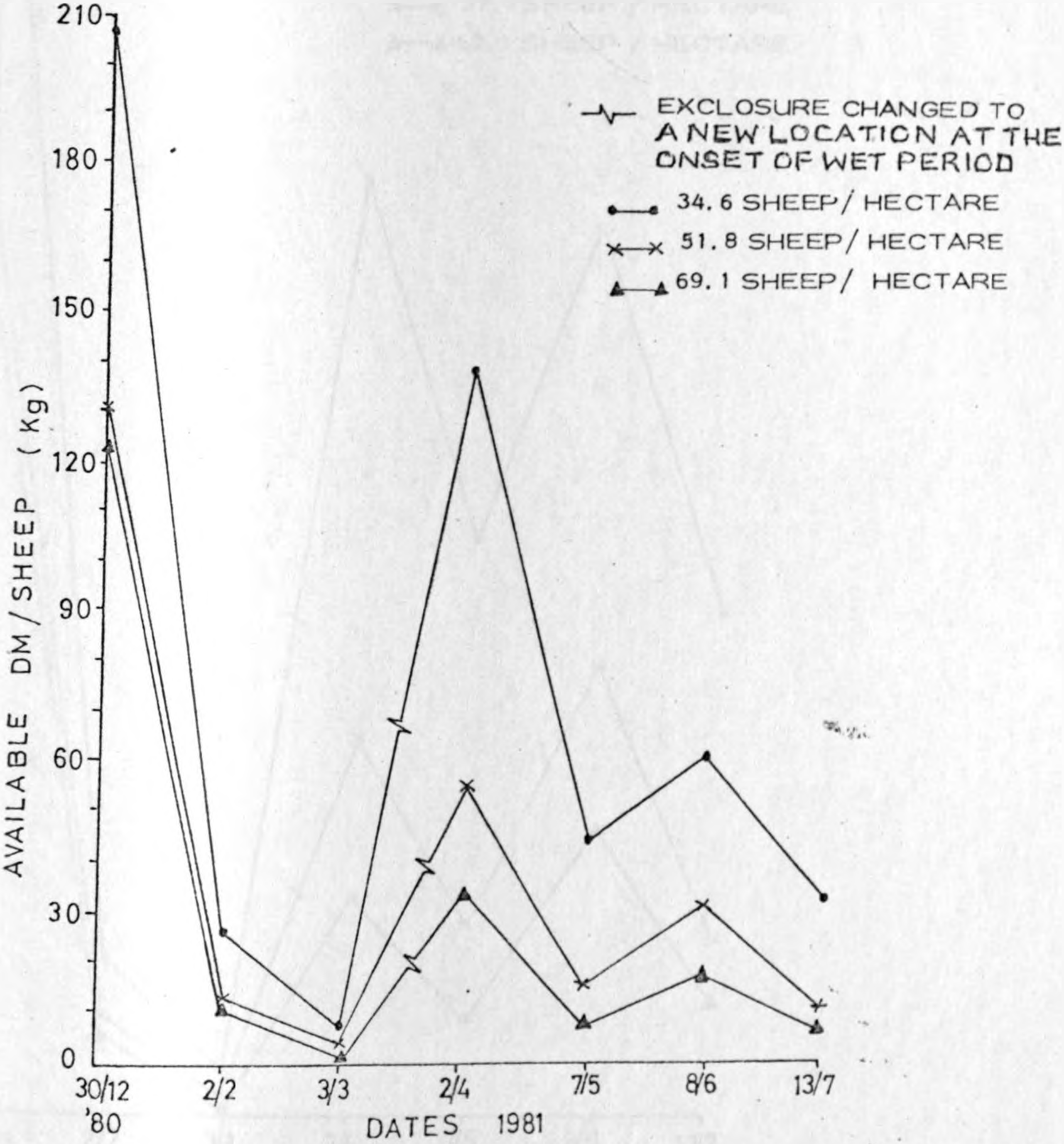

FIG. 6 : CHANGES IN AVAILABLE DRY MATTER / SHEEP WITH TIME

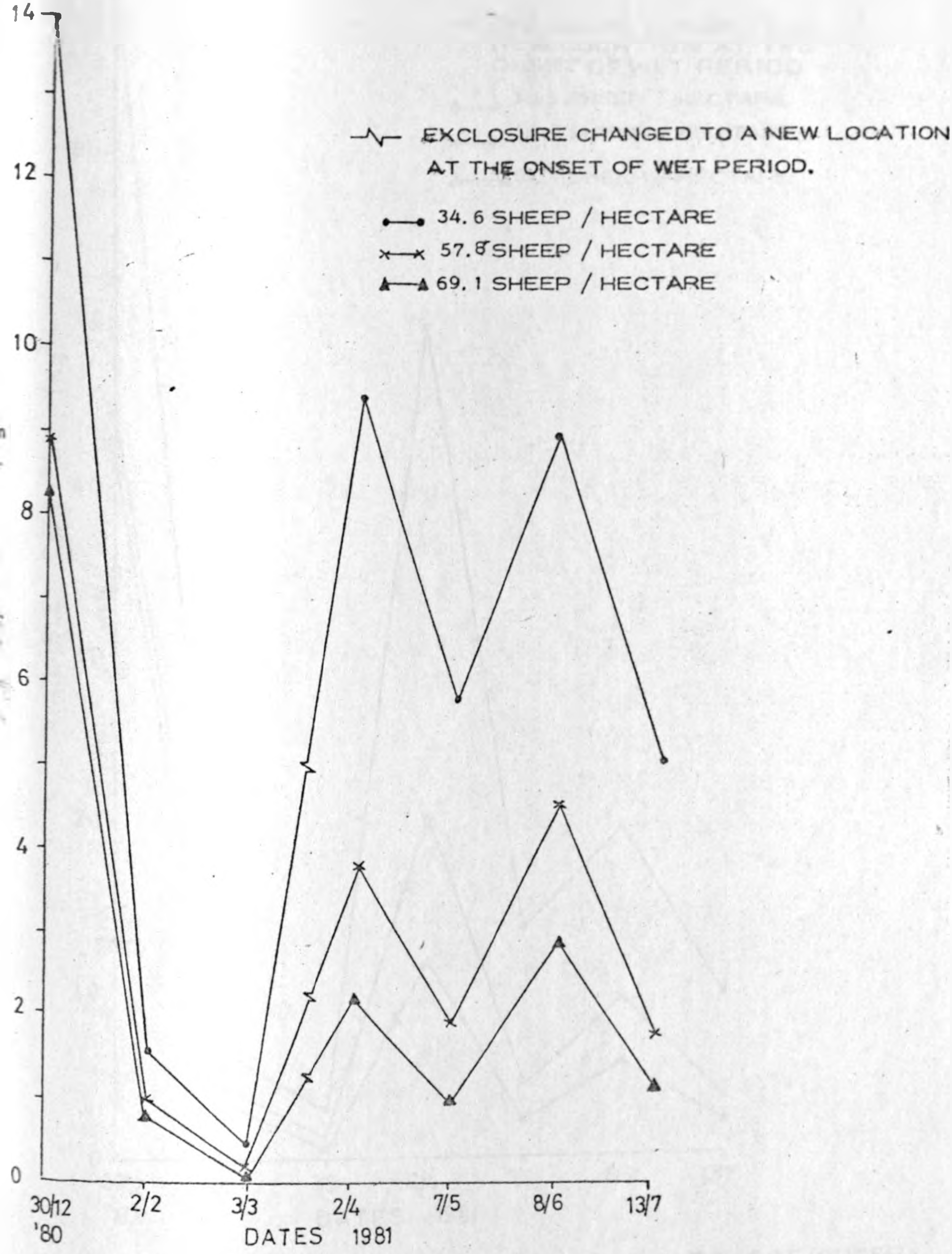

FIG. 7 : CHANGES IN AVAILABLE CRUDE PROTEIN / SHEEP WITH TIME.

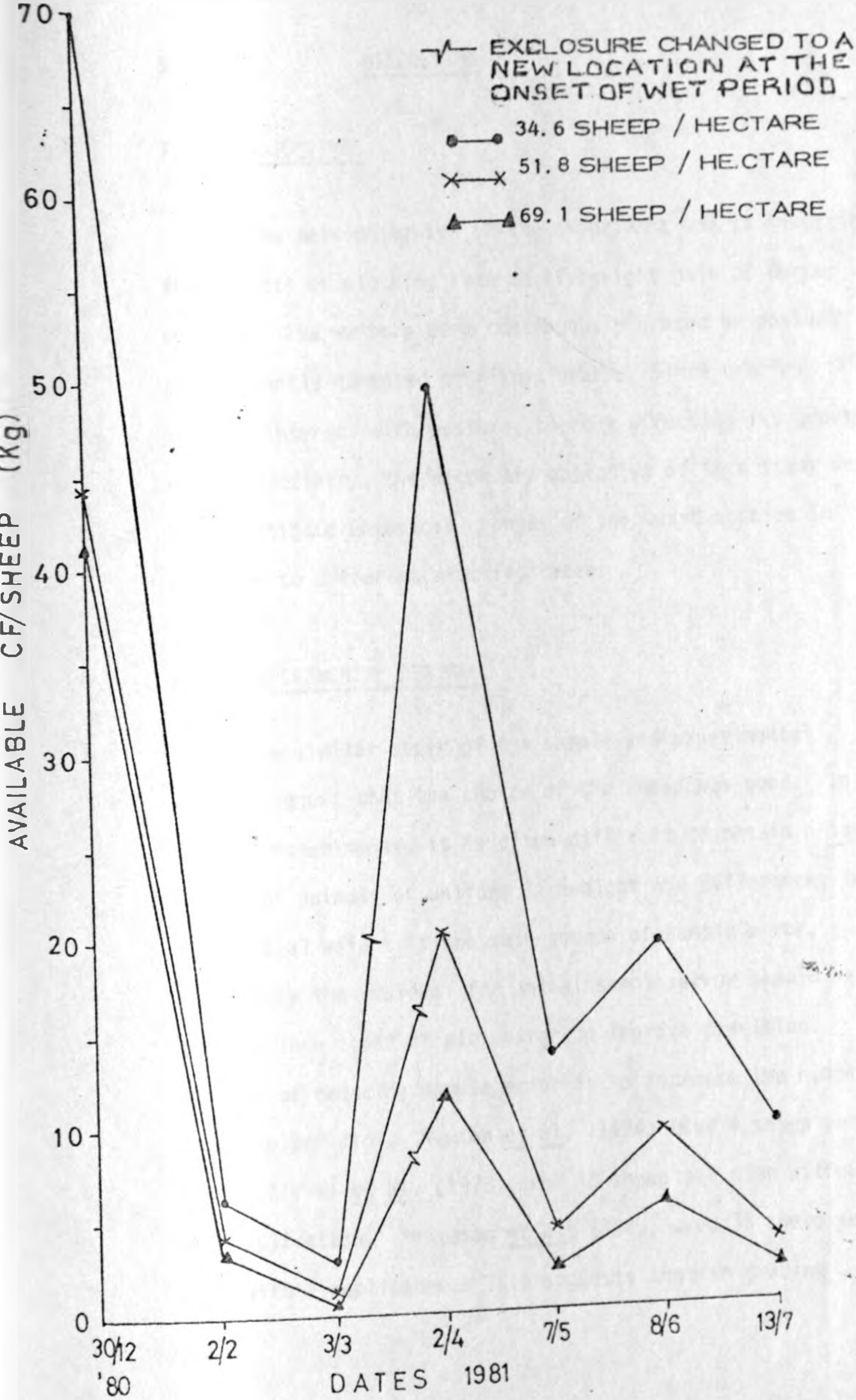

FIG. 8: CHANGES IN AVAILABLE CRUDE FIBRE/SHEEP WITH TIME

5. DISCUSSION

1. OBJECTIVES

The main objective of the experiment was to investigate the effects of stocking rate on liveweight gain of Dorper wethers. The wethers were continuously grazed on pasture predominantly composed of Kikuyu grass. Since grazing animals interact with pasture, thereby affecting its growth and productivity, the secondary objective of this study was to investigate botanical changes of the sward species in response to different stocking rates.

2. EXPERIMENTAL DESIGN

The similar order of the sample and experimental errors suggest that the choice of the sheep was good. In grazing experiments, it is often difficult to obtain a large number of animals of uniform liveweight and differences in the initial weight is the main source of sample error. Preferably the residual for animal sample error should be greater than that of plot error to improve precision. One way of reducing sample error is to increase the number of sheep per plot. Newton et al. (1974) used 9 sheep per plot. Birrel et al. (1978) used 12 sheep per plot without any replication. Robinson et al. (1975) used 13 sheep per plot with 2 replicates. This suggests that in grazing experiments, replicates play a less important role than number of sheep per replicate. It is recommended that in future studies, a minimum of 6 sheep per plot should be used.

The large differences in weight gain per plot at the medium and high stocking rates suggests that there was uneven herbage availability to the sheep between plots treated alike. Morley (1966) stated that differences in productivity of plots treated alike thus tended to increase if grazing pressure was near a critical point. Grazing experiments thus tended to generate non homogeneity because of the biological interaction of plant and animal. He added further that a heavily grazed pasture was in rather precarious equilibrium.

3. LIVEWEIGHT CHANGES

The relationship between weight gain and stocking rate in the overall period followed a negative linear trend suggested by Riewe (1961) and shown by Colman *et al.* (1968). Colman *et al.* (1968) had grazed lactating Guernsey and Jersey cows on Kikuyu grass pasture for 301 days. The cows were stocked at sheep equivalent (S.E.) stocking rates of 18.0, 23.18 and 35.68 per hectare (1 S.E. = 25.36 kg). The cows produced butterfat of 118, 111 and 99 kg per head respectively. Although the relationship between stocking rate and weight gain per head in the overall period was significant, Colman *et al.* (1968) did not observe significant differences. One possible explanation is that stocking levels used by Colman *et al.* (1968) were lower than the ones used in this study. This implies that differences in weight gain per head between stocking rates will be small at low stocking rates because of adequate forage yield for maximum weight gain. However, a similar non significant linear relationship between stocking rates and weight gain per head was observed in the wet period, for similar reasons.

It appears as if the performance of Dorper sheep on pasture declines sharply after 8 months of age. The average daily gain of 0.05 and 0.06 kg per head at the low stocking rate in the overall and wet periods respectively, in this study, was approximately 5.0 and 4.0 times less than that reported by Ebersöhn (1953) of 0.23 kg per head respectively. Ebersöhn had grazed Dorper sheep in a semi arid region of Desert shrubs and tall grass. Ebersöhn concluded that the best growth was in the first 20 weeks after lambing and that little was gained by deferring marketing beyond 8 months. It is therefore, recommended that in future studies, lambs of about 3 months of age should be used with caution of possible effects of stress.

It appears as if weight losses in the dry period were associated with the low quality and quantity of herbage available per sheep. This suggests that the intake of total digestible nutrients may have been inadequate. Previous workers have shown that liveweight losses in the dry period were mainly due to low nutritive value of pasture. Said (1970) reported that the crude protein content of Kikuyu grass growing in its natural habitat decreased from 23.7% in 5 weeks regrowth samples to 13.7% in 12 week regrowth samples. The corresponding crude fibre contents during the same periods were 26.2 to 32.2% respectively. Brockington (1960) and Bembridge (1963) found similar results on the deteriorating nutritive value of Hyparrhenia as the wet season diminished.

There were indications that the relationship between weight loss per head and stocking rate would have followed a negative linear trend as reported by other workers, Smith (1966) and the Commonwealth Scientific Industrial Research Organization

(C.S.I.R.O.) (1978). Differences may have been due to variation between years as shown by Smith. In his first year of study, Smith had used Zebu oxen with an initial weight of 227 kg per head. The oxen were grazed on Hyparrhenia grassland and lost a sheep equivalent mean weight of 3.55, 2.63 and 3.55 kg per head at 39.38, 56.39 and 69.82 sheep equivalent per hectare respectively, while in this study weight losses were 0.54 kg per head at the medium and high stocking rate.

However, in the second year of his studies, Smith found a significant linear relationship between stocking rate and weight loss per head and yet he had used similar stocking rates. These similar and contrasting results indicate the importance of between years variation in stocking rate experiments. Further work is required for at least a minimum of 2 years in this experiment for adequate comparison.

The weight gain at the low stocking rate may have been due to the short duration of the dry period. Wright (1974) had observed that wethers grazing on Kikuyu grass pasture at a stocking rate of 24.69 per hectare lost a mean weight of 11.21 kg per head in the dry season of 6 months. Although the experiment was conducted in Australia under different but tropical climate, it is still a fair comparison on the effects of dry season on sheep production on Kikuyu grass pastures.

In the wet period, there were indications that herbage production at the low and medium stocking rates did not limit weight gain per head. However, estimate of available dry matter per sheep at the low stocking rate was always higher than at the medium stocking as shown in Figure 6. One possible explanation for the close weight gain of sheep at the low and medium stocking rates is herbage quality. A heavier stocking rate is analogous to more frequent defoliation than a lighter stocking rate, thus the quality of pasture tends to improve. The advantage of a heavier stocking rate to increase animal production per head has a limit because the intake of total digestible nutrients may diminish as shown by the performance of the sheep at the high stocking rate.

Maynard and Loosli (1969) reported that a 36 kg non-lactating yearling sheep required a dry matter intake of approximately 1.0 kg per day for maintenance and weight gain. Total digestible nutrients and digestible crude protein had to constitute 62 and 5.5% of this amount respectively. In this study, the water content of Kikuyu grass on 8th June, 1981 was 83%. This implies that each sheep would have ingested approximately 6.0 kg of fresh pasture per day to satisfy its nutrient requirements. This amount of pasture appears large for a sheep to consume in a day, especially if it is too short to be grazed as the case was at the high stocking rate. Stobbs (1973) reported that bite size would be reduced if a pasture is too short with low yield or if mature sward with high yield has a high moisture content. Although increased biting rate could compensate for bite size, fatigue sets an upper limit for such compensation.

The difference in weight gain of 1.77 kg per head in the wet period, between the medium and high stocking rates, when weight losses were equal in the dry period, may have been due to greater seasonal effects at the high stocking rate. The similar order in weight gain between the medium and low stocking rates suggests that stocking rate may have had little effects at the medium and low levels, due to the adequate availability of nutritious herbage for maximum weight gain and that stocking rate had greater effects at high levels.

Liveweight gain per hectare in this study showed that the high stocking rate was less productive under the continuous grazing system. Figures 1 and 3 show the inverse relationship between gain per sheep and per hectare on Kikuyu grass. The increase in gain per hectare at the medium stocking rate may have been due to greater utilization of the pasture while relatively nutritious during the wet period.

These results agree with findings of some workers. Harlan (1958) observed that weight gain per animal and per hectare dropped sharply at very high stocking rates. Nolan (1975) who had used similar stocking rates to those used in this study, showed that weight gain of lambs increased from 173.15 to 197.58 kg and then decreased to 159.58 kg per hectare respectively. Hull, Mayer and Kromann (1961) also found similar results with Hereford steers. However, Colman et al. (1968) did not observe the maximum point in butterfat production per hectare when cows were grazed on Kikuyu grass pasture, probably because they had used lower stocking rates. Their lowest and highest stocking rates were 18.0 and 35.68 sheep equivalent per hectare respectively.

4. ANIMAL PRODUCTION OBJECTIVES

The aim in animal production is to produce a reasonably young, well finished carcass for sale, hence the opposing creteria of performance per animal and per hectare must be balanced in the choice of maximum stocking rate. The medium stocking rate increased gain per hectare by a factor of 1.4 in the wet period when compared with the low stocking rate. However, when the sheep were graded in situ to evaluate whether they were ready for slaughter at the end of the experiment, 6, 3 and 1 sheep at the low, medium and high stocking rates had reached the slaughter stage. The assumption was that the sheep were ready for slaughter at approximately 35 kg per head and having attained a grade of 4. There were indications that 67% of the sheep at the low stocking rate would have reached the finishing stage by at least September, 1981 suggesting that the low stocking rate was marginally unable to finish off all the sheep. There were no indications that more sheep at the low stocking rate would have reached the finishing stage beyond September, 1981 because rainfall, which is largely responsible for pasture regrowth had tailed off by July, 1981. There were no indications that more sheep would have reached the finishing stage at the high stocking rate earlier than the next wet season which starts in November, as a result of severe defoliation of the pasture and reduced rainfall. However, there were indications that 33% of the sheep would have reached the finishing stage at the medium stocking rate by September, 1981.

Although assessment of sheep in situ was appropriate to find the finishing stage at different stocking rates, there were no comparison with other mutton breeds, preferably indigenous ones. Comparison with other mutton breeds is worth while in order to ascertain the superiority or inferiority of the breed being investigated. It is therefore recommended that in future studies, preferably, a minimum of 2 breeds should be used, within land and financial constraints.

5. CHANGES IN BOTANICAL COMPOSITION AND GROUND COVER

There were trends to show that there was an increased emergence of herbs and forbs at the high stocking rate in the wet period, probably due to preferential selection of the grass and increased levels of excreta. Brockman, Rope and Stevens (1971) stated that 75 to 95% of the nitrogen consumed by grazing animals was returned in excreta. Gillard (1969) showed that increased levels of nitrogen encouraged the emergence of more nutritious species such as *Eragrostis curvula* and *Cynodon dactylon* when pasture predominantly composed of *Trachypogon spicatus* was grazed with steers at 2.3 per hectare for 8 years. There was no evidence in this study of the herbs and forbs being more nutritious than Kikuyu grass. It is recommended that in future studies a chemical analysis of the herbs and forbs should be made so as to ascertain their nutritive value and possible effects on animal production.

Changes in foliage cover showed that Kikuyu grass was tolerant to the effects of heavy grazing. Edwards (1943) reported that Kikuyu grass was more tolerant to severe defoliation by monthly cuttings for 6 years than Rhodes grass. However, there were signs that continuous rainfall is required, if over grazing has to be averted at the high stocking rate, if animals are first stocked in the dry period under the continuous grazing system used in this study.

6.0 CONCLUSION

The experimental design showed that a minimum of 4 replicates and 6 sheep per plot could be used as long as the choice of the sheep was of similar order to the one used in this study, considering financial and land constraints. In mutton production, weight losses in the dry period could be allowed as long as the body condition of the sheep does not go below a grade of 2. The medium stocking rate gave the maximum weight gain per hectare, hence could be suitable under the continuous grazing system used in this study. However, the medium stocking rate should be used with caution, in light of its inability to finish off 80% of the sheep at the end of the wet period. Kikuyu grass showed signs of overgrazing at 69.1 sheep per hectare at the end of the experiment lasting 20 weeks.

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A P P E N D I C E S

TABLE A1: LIVEWEIGHT GAIN (kg) OF SHEEP PER PLOT FOR THE OVERALL PERIOD (20 weeks)

STOCKING RATE	PLOT NUMBER				GENERAL MEAN
	1	2	3	4	
34.6 sheep/ha	21.75	23.50	22.00	19.00	7.19
51.8 " "	22.50	16.25	14.25	13.75	5.56
69.1 " "	15.25	13.50	4.50	12.25	3.79

TABLE A2: LIVEWEIGHT GAIN (kg) OF SHEEP PER PLOT FOR THE DRY PERIOD (5 weeks)

STOCKING RATE	PLOT NUMBER				GENERAL MEAN
	1	2	3	4	
34.6 sheep/ha	0	3.50	2.00	1.00	0.54
51.8 " "	0.50	-3.50	-3.00	-0.50	-0.54
69.1 " "	-2.00	-1.50	-3.50	-0.50	-0.54

TABLE A3: LIVEWEIGHT GAIN (kg) OF SHEEP PER PLOT FOR THE WET PERIOD (15 weeks)

STOCKING RATE	PLOT NUMBER 1	2	3	4	GENERAL MEAN
34.6 sheep/ha	22.00	20.00	20.00	18.00	6.67
51.8 " "	22.00	19.75	17.25	14.25	6.10
69.1 " "	17.25	15.00	8.00	11.75	4.33

TABLE A4: LIVEWEIGHT GAIN (kg) OF SHEEP PER HECTARE FOR THE OVERALL PERIOD (20 weeks)

STOCKING RATE	PLOT NUMBER 1	2	3	4	GENERAL MEAN
36.6 sheep/ha	250.84	271.03	253.14	219.13	248.69
54.8 " "	338.50	280.59	246.06	237.42	288.14
69.1 " "	357.25	310.95	103.65	282.16	262.00

TABLE A5: LIVEWEIGHT GAIN (kg) OF SHEEP PER HECTARE FOR THE DRY PERIOD (5 weeks)

STOCKING RATE	PLOT NUMBER 1	2	3	4	GENERAL MEAN
34.6 sheep/ha	0.01	40.37	23.07	11.63	18.75
51.8 " "	8.63	-60.43	-51.79	-8.63	-28.06
69.1 " "	-46.07	-34.55	-80.62	11.52	-37.43

TABLE A6: LIVEWEIGHT GAIN (kg) OF SHEEP PER HECTARE FOR THE WET PERIOD (15 weeks)

STOCKING RATE	PLOT NUMBER 1	2	3	4	GENERAL MEAN
34.6 sheep/ha	250.85	230.67	230.67	207.60	229.95
51.8 " "	379.87	341.02	297.85	260.60	319.84
69.1 " "	397.33	345.49	184.27	270.64	299.43

TABLE A7: A SCORING CHART FOR ASSESSING BODY CONDITION

SCORE	DESCRIPTION
0	STARVING - Extremely emaciated and on the point of death.
1	POOR STORE CONDITION - The backbone is prominent and sharp with vitually no meat covering the bones. The end of the lumbar processes are sharp and fingers will easily pass under them. It is possible to feel each bone. The eye muscle is very thin and there is no fat. The skin is thin and possibly lacking in colour.
2	AVERAGE STORE CONDITION - The backbone is prominent but smooth. It is possible to feel between the bones but only as fine corrugations. The ends of the lumbar processes are smooth and rounded and it is possible to pass the fingers under them with little pressure. The eye muscle has moderate depth and there is little fat. The skin is thin.
3	FORWARD STORE CONDITION - The backbone has only small elevation. It is smooth and rounded over the top so that the individual bones are only found with pressure. The ends of the lumbar processes are smooth and well covered and it requires firm pressure to fill the ends. The eye muscle is full with a moderate fat cover. The skin is medium thickness.

TABLE A7 Cont..

4	FAT - The backnone can just be felt with pressure as a hard line between the eye muscle. The lumbar processes cannot be felt as they are thickly covered and feel like a block of meat. The eye muscles are full with a thick fat coverage.
5	VERY FAT - The backbone cannot be felt. There is a depression between the layers of fat where the backbone would normally be. The ends of the lumbar processes cannot be felt. The eye muscle is full with a thick coverage which may be flabby. There are often lumps of fat accumulated over the tail.

TABLE A8: DRY MATTER CONTENT (%) OF KIKUYU GRASS

DATE	EXCLOSURE CAGE NUMBER			GENERAL MEAN
	1	2	3	
30/12/80	28.68	30.34	35.68	31.57
2/2/81	48.60	60.77	64.70	58.02
3/3/81	75.00	81.82	85.00	80.61
2/4/81	20.33	19.64	30.20	23.39
7/5/81	18.50	20.74	24.70	21.31
8/6/81	14.13	15.43	21.40	16.99
13/7/81	18.55	17.77	27.65	21.32

TABLE A9: CRUDE FIBRE CONTENT (%) OF KIKUYU GRASS

DATE	EXCLOSURE CAGE NUMBER			GENERAL MEAN
	1	2	3	
30/12/80	30.61	35.00	36.62	34.08
2/2/81	30.76	32.00	32.15	31.64
3/3/81	37.67	36.69	38.58	37.65
2/4/81	35.67	35.19	36.04	35.72
7/5/81	29.26	29.58	31.04	29.96
8/6/81	30.95	28.81	30.78	30.18
13/7/81	31.09	27.30	31.03	29.81

TABLE A10: CRUDE PROTEIN CONTENT (%) OF KIKUYU GRASS

DATE	EXCLOSURE CAGE NUMBER			GENERAL MEAN
	1	2	3	
30/12/80	7.73	6.74	5.87	6.78
2/2/81	11.56	6.45	6.45	7.84
3/3/81	9.19	4.64	4.64	6.36
2/4/81	6.42	8.34	5.60	6.79
7/5/81	17.04	13.13	9.19	13.12
8/6/81	14.47	17.16	12.49	14.71
13/7/81	16.63	18.65	12.61	15.96

TABLE A11: AVAILABLE DRY MATTER (kg) PER PLOT ON 30th DECEMBER, 1980

STOCKING RATE	PLOT NUMBER				GENERAL MEAN
	1	2	3	4	(± S.D.)
34.6 sheep/ha	560.20	541.79	216.08	1155.90	618.50±391.588
51.8 " "	429.85	429.85	202.01	505.53	391.81±131.467
69.1 " "	241.69	429.31	159.52	639.52	367.47±213.619

TABLE A12: AVAILABLE DRY MATTER (kg) PER PLOT ON 2nd FEBRUARY, 1981

STOCKING RATE	PLOT NUMBER				GENERAL MEAN
	1	2	3	4	(± S.D.)
34.6 sheep/ha	60.26	48.96	27.64	111.10	61.99±35.424
51.6 " "	41.93	41.93	19.35	51.22	38.61±13.565
69.1 " "	20.82	33.11	13.69	61.45	32.27±21.044

TABLE A13: AVAILABLE DRY MATTER (kg) PER PLOT ON 3rd MARCH, 1981

STOCKING RATE	PLOT NUMBER				GENERAL MEAN
	1	2	3	4	(± S.D.)
34.6 sheep/ha	10.90	17.29	7.38	51.28	21.71±20.134
51.8 " "	25.19	20.07	4.18	3.17	8.15±11.149
69.1 " "	12.32	15.84	3.30	4.90	6.59±5.974

TABLE A14: AVAILABLE DRY MATTER (kg) PER PLOT ON 2nd APRIL 1981

STOCKING RATE	PLOT NUMBER				GENERAL MEAN
	1	2	3	4	(± S.D.)
34.6 sheep/ha	318.40	307.14	227.50	811.12	416.04± 266.476
51.8 " "	129.40	255.99	144.40	144.40	168.55± 58.722
69.1 " "	72.24	113.98	90.30	125.82	100.59± 23.982

TABLE A15: AVAILABLE DRY MATTER (kg) PER PLOT ON 7th MAY, 1981

STOCKING RATE	PLOT NUMBER				GENERAL MEAN
	1	2	3	4	(± S.D.)
34.6 sheep/ha	99.30	175.00	60.95	194.56	132.45±62.927
51.8 " "	54.05	58.76	31.34	31.34	43.87±14.598
69.1 " "	22.20	24.76	12.80	30.74	22.62± 7.464

TABLE A16: AVAILABLE DRY MATTER (kg) PER PLOT NUMBER ON 9th JUNE, 1981

STOCKING RATE	PLOT NUMBER				GENERAL MEAN
	1	2	3	4	(± S.D.)
34.6 sheep/ha	162.80	204.08	175.67	191.10	183.39±17.991
51.6 " "	100.13	98.62	69.55	100.13	92.11±15.055
69.1 " "	43.92	54.90	54.90	54.90	58.19± 5.490

TABLE A17: AVAILABLE DRY MATTER (kg) PER PLOT ON 13th JULY 1981

STOCKING RATE	PLOT NUMBER				GENERAL MEAN
	1	2	3	4	(± S.D.)
34.6 sheep/ha	58.41	110.38	66.56	145.80	95.29±40.680
51.8 " "	25.15	44.08	25.15	39.47	33.46± 9.781
69.1 " "	15.88	19.85	19.85	31.15	21.68± 6.583