

ANNEXURE

LIVESTOCK GAINS AND LOSSES AND LIVE-
AND CONTRIBUTION OF THESE

10.

WEIGHT MAINTAINED IN LBS. T.D.M. ON LIVEVELD

FACTORS TO T.D.M. OBTAINED PER MORGAN.

		: : Expt. 13 L - One unit to 9 morgan. : :									
Seasons.	Rainfall (in.)	Cattle: or Sheep	Liveweight: maintained	Gains: T.D.M.	Losses: T.D.M.	Net T.D.M.					
1952/53.	418	C	295	78	373	51	322				
		S	115	56	171	15	156				
1953/54.	378	C	250	71	321	5	268				
		S	174	40	214	8	206				
1954/55.	459	C	259	84	343	50	293				
		S	192	37	229	25	204				
1955/56.	563	C	261	76	337	29	308				
		S	130	28	158	14	144				
1956/57.	427	C	295	124	419	32	387				
		S	75	33	108	19	89				
Mean per season.	449	C	272	87	359	43	316				
		S	137	39	176	16	160				
Per cent.		C	76	24	100	12	88				
		S	78	22	100	18	82				

		: : Expt. 14 L - One unit to 12 morgan. : : Expt. 15 L - One unit to 15 morgan. : :									
Seasons.	Rainfall (in.)	Cattle: or Sheep	Liveweight: maintained	Gains: T.D.M.	Losses: T.D.M.	Net T.D.M.					
1952/53.	418	C	216	79	295	30	265	230	73	303	26
		S	132	38	170	14	156	82	41	123	3
1953/54.	378	C	233	86	319	26	293	223	69	292	38
		S	101	38	139	7	132	128	25	153	4
1954/55.	459	C	212	67	279	49	230	207	88	295	32
		S	119	22	141	13	128	115	14	129	11
1955/56.	563	C	240	77	317	20	297	205	77	282	13
		S	102	27	129	5	124	82	26	108	7
1956/57.	427	C	266	100	366	35	331	225	85	310	21
		S	63	29	92	23	69	49	20	69	17
Mean per season.	449	C	233	82	315	32	283	218	78	296	26
		S	103	31	134	12	122	91	24	116	8
Per cent.		C	74	26	100	10	90	74	26	100	9
		S	77	23	100	9	91	78	22	100	7

ANNEXURE

11.

LIVESTOCK GAINS AND LOSSES AND LIVELIGHT

MAINTAINED IN LES. T.D.N. ON DOLMITREVELD

AND CONTRIBUTION OF THESE

FACTORS TO TOTAL T.D.N. OBTAINED PER MORGEN.

Season.	Rainfall. (in.)	Cattle: or : Liveweight: : Sheep : maintained :	Expt. 13 D - One unit to 9 morgen.				Expt. 14 D - One unit to 12 morgen.				Expt. 15 D - One unit to 15 morgen.			
			Gains:	T.D.N.:	Losses:	Net :	Gains:	T.D.N.:	Losses:	Net :	Gains:	T.D.N.:	Losses:	Net :
1952/53.	418	C : 366	136	502	51	451	269	98	367	24	343	314	48	362
		S : 142	75	224	2	222	113	53	166	0	166	90	47	137
1953/54.	378	C : 339	143	482	32	450	255	106	361	27	334	252	98	350
		S : 207	41	248	8	240	161	29	190	5	185	127	3	130
1954/55.	459	C : 321	94	415	58	357	257	72	329	49	280	214	62	276
		S : 136	47	183	6	177	99	38	137	10	127	75	24	99
1955/56.	563	C : 335	135	470	33	437	242	104	346	13	333	237	74	311
		S : 143	49	192	6	186	112	36	148	7	141	88	30	118
1956/57.	427	C : 365	126	491	37	454	270	86	356	25	331	237	71	308
		S : 90	28	118	28	90	70	21	91	15	76	54	14	68
Mean per season.	449	C : 345	127	472	42	430	259	93	352	28	324	241	80	321
		S : 145	46	193	10	183	111	35	146	7	139	87	23	110
Per cent.		C : 73	27	100	9	91	74	26	100	8	92	75	25	100
		S : 75	25	100	5	95	76	24	100	5	95	73	21	100

B. GRAZING SYSTEMS.

Table LVI gives details of the six grazing system experiments where both cattle and sheep were used as grazers of veld. No duplicates for Experiments 16 L and 17 L existed on dolomite.

TABLE LVI.GRAZING SYSTEMS WITH CATTLE AND SHEEP ON VELD.

<u>Experiment No.</u>	<u>Particulars.</u>
16 L.	<u>Limeveld:</u> System IV : Four units to 48 morgen : 1 beast to 1 sheep.
17 L.	: System VII: Four units to 48 morgen : 1 beast to 1 sheep.
19 L.	: System VI : Four units to 48 morgen : 1 beast to 4 sheep.
14 L. ^m	: System VII: Four units to 48 morgen : 1 beast to 4 sheep.
19 D.	<u>Dolomiteveld:</u> System VI : Four units to 48 morgen : 1 beast to 4 sheep.
14 D. ^m	: System VII: Four units to 48 morgen : 1 beast to 4 sheep.

 m - These experiments were used in Chapter V (A).
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Experiments 16 L and 17 L were commenced in August 1952 and Experiments 19 L, 14 L, 19 D and 14 D were initiated in July 1952. All experiments were concluded in July 1957.

Veld and livestock interaction was measured by means of:

- (1) Plant counts,
- (2) Field observations,
- (3) Soil analysis,
- (4) Liveweights,
- (5) Area of the liveweight-curve,
- (6) Slaughter particulars, and
- (7) Geigeria-poisoning and other losses.

(1) PLANT COUNTS:

Tables LVII and LVIII give species frequency as an indication of veld change for lime and dolomiteveld respectively.

TABLE LVII.

PLANT RESPONSE TO THREE GRAZING SYSTEMS WITH CATTLE
AND SHEEP ON LIMEVELD AT KOOPMANSFONTEIN.

	Frequency per 300 Quadrats ^(s) .							
	1 Beast & 1 Sheep.				1 Beast & 4 Sheep.			
	Expt.16 L		Expt.17 L		Expt.19 L		Expt.14 L	
	System IV		System VII		System VI		System VI	
	1952	1957	1952	1957	1952	1957	1952	1957
<u>CLIMAX SPECIES:</u>								
<i>Themeda triandra</i>	23	28	35	40	30	29	9	18
<i>Chrysopogon montanus</i>	38	43	29	34	5	15	20	14
<i>Digitaria oriantha</i>	0	6	1	9	19	9	8	10
<i>Fingerhuthia africana</i>	13	29	15	17	26	9	16	4
<i>Cymbopogon plurinodis</i>	102	94	46	61	6	3	13	2
<i>Aristida vestita</i>	25	10	8	6	0	0	1	0
<i>Eustachys paspaloides</i>	6	0	3	2	8	0	5	0
<i>Stenobolus fimbriatus</i>	0	0	21	14	7	7	29	0
<i>Aristida uniplumis</i>	0	1	0	0	0	0	0	0
<i>Heteropogon contortus</i>	0	0	0	2	0	0	0	0
<i>Panicum coloratum</i>	0	0	0	0	15	0	0	0
<u>SERAL SPECIES:</u>								
<i>Eragrostis lehmanniana</i>	80	216	74	187	172	186	142	222
<i>E. echinoclodea</i>	0	0	0	8	0	19	0	2
<i>E. denudata</i>	0	0	0	0	1	0	0	0
<i>Crotopetium capense</i>	6	51	13	78	46	127	50	147
<i>Cynodon incompletus</i>	0	0	0	0	11	21	0	0
<i>Tragus koelerioides</i>	2	0	7	0	21	0	14	0
<u>PIONEER SPECIES:</u>								
<i>Eragrostis brachystachyus</i>	79	36	54	46	58	122	48	134
<i>Aristida curvata</i>	37	2	13	15	14	41	23	36
<i>Tragus racemosus</i>	100	6	68	3	32	6	56	3
<u>WEEDS:</u>								
<i>Geigeria africana</i>	53	88	48	116	156	177	132	207
<i>Chrysocoma tenuifolia</i>	29	39	5	19	18	24	9	5
<i>Tribulus terrestris</i>	0	0	2	2	0	1	0	4
<u>KARROID SPECIES:</u>								
<i>Indigofera patens</i>	0	0	0	3	3	6	6	6
<i>Aster muricatus</i>	10	18	4	15	14	15	37	62
<i>Monochina divaricatum</i>	0	4	0	10	4	32	1	16
<u>OTHER SPECIES:</u>								
Woody.....	8	6	1	0	4	3	4	2
Herbaceous.....	31	86	16	117	58	155	25	145

Woody species comprise the genera *Euclea*, *Asparagus*, *Dorchoanthus* and *Rhus*.

Herbaceous species comprise the genera *Commelina*, *Barleria*, *Stachys*, *Scilla* and *Hibiscus*.

* = Denotes significant difference at $P = 0.05$.

** = Denotes significant difference at $P = 0.01$.

(s) = Surveys according to the method by Von Broembsen (1951).

TABLE LVIII.

PLANT RESPONSE TO TWO GRAZING SYSTEMS WITH CATTLE
AND SHEEP ON DOLONITEVELD AT KOOPMANSFONTEIN.

	Frequency per 300 Quadrats ⁽²⁾			
	One Beast and Four Sheep.			
	Expt. 19 D.		Expt. 14 D.	
	System VI		System VII	
	1952	1957	1952	1957
<u>CLIMAX SPECIES:</u>				
<i>Sporobolus fimbriatus</i>	6	0 ^{***}	3	4
<i>Chrysogon. montanus</i>	16	8	22	20
<i>Digitaria eriantha</i>	17	9	20	13
<i>Heteropogon contortus</i>	2	0	2	5
<i>Themeda triandra</i>	1	0	8	4
<i>Cymbopogon plurinodis</i>	3	3	2	1
<i>Fingerhuthia africana</i>	1	1	0	0
<i>Panicum coloratum</i>	1	0	0	0
<u>SERAL SPECIES:</u>				
<i>Eragrostis lehmanniana</i>	189	247 ^{***}	207	219 ^{***}
<i>E. obtusa</i>	8	36 ^{***}	0	11 ^{***}
<i>E. echinochloidea</i>	0	53 ^{***}	0	13 ^{***}
<i>E. denudata</i>	20	0 ^{***}	16	13 ^{***}
<i>Uropetium curense</i>	101	171 ^{***}	165	228 ^{***}
<i>Brachiaria eruciformis</i>	0	2	0	0
<i>Enneapogon scoparius</i>	0	0	6	7
<u>PIONEER SPECIES:</u>				
<i>Enneapogon brachystachyus</i>	71	61	139	102 ^{***}
<i>Aristida curvata</i>	34	25 ^{***}	70	29 ^{***}
<i>Tragus racemosus</i>	54	22 ^{***}	64	12 ^{***}
<u>WEEDS:</u>				
<i>Geigeria africana</i>	27	63 ^{***}	0	20 ^{***}
<i>Chrysocom tenuifolia</i>	10	24	2	8
<i>Tribulus terrestris</i>	1	1	0	1
<u>KAREOID SPECIES:</u>				
<i>Aster muricatus</i>	6	14	1	8 ^{***}
<i>Indigofera patens</i>	1	1	4	4
<u>OTHER SPECIES:</u>				
Woody.....	8	8	5	5 ^{***}
Herbaceous.....	36	214 ^{***}	11	158 ^{***}

Woody species comprise the genera *Asparagus*, *Euclea* and *Rhus*.

Herbaceous species comprise the genera *Scilla*, *Stachys*, *Hermannia*, *Hibiscus*, *Sericocoma*, *Pharnaceum*, *Oxalis*, *Elephantaria* and *Moraea*.

* = Denotes significant difference at P = 0.05.

*** = Denotes significant difference at P = 0.01.

(s) = Surveys according to Von Broembsens (1951) method.

Themeda triandra, Chrysopogon montanus and Digitaria eriantha proved tolerant to grazing under all systems of grazing and on both lime and dolomiteveld. Cymbopogon plurinodis and Heteropogon contortus were kept in check wherever they occurred.

On lime, Eustachys paspaloides and also Fingerhuthia africana, under the wider ratios of cattle to sheep, proved intolerant to grazing. In addition, Sporobolus fimbriatus could not withstand the grazing under system VII. On dolomite, however, no change in the frequency of this species took place under this system, but a perceptible decrease under system VI.

Irrespective of the grazing system, climax grasses not only withstood grazing under the conditions of experiments 16 L and 17 L, but Digitaria and Fingerhuthia even increased. Under the other experiments a decrease of climax grasses occurred. Seral, karroid and herbaceous species all show a decided increase under all systems.

The marked degree of variation in the seasonal incidence of Cenchrus africana precludes any significance being attached to the counts of this species when obtained over two seasons only. There is a tendency for Chrysocoma tenuifolia to increase under all systems except under the wider ratio of system VII on limeveld, where a tendency to decrease is evident. Aster muricatus increased in all experiments, significantly so in some.

As regards plant frequency, there is little to choose between the effect of the different systems on the veld composition and resultant changes.

(2) FIELD OBSERVATIONS:

Tragus racemosus, Aristida curvata and a few Digitaria eriantha preferred colonizing and growing in pans and deeper soil sites. Sporobolus fimbriatus favoured growing on south and south-eastern sides of bushes. Enneapogon brachystachyus were most abundantly found colonizing bare rocky ground, where perennial grasses were never trampled or grazed short to the same extent as on bare, softer-ground areas.

Eragrostis lehmanniana, Themeda triandra and Chrysopogon montanus were among the earliest grasses to sprout in spring. Cymbopogon plurinodis was also fairly early in sprouting, and this species persisted in sprouting long after other species had ceased to do so. Carry-over moisture enabled Enneapogon brachystachyus to sprout from autumn tufts and sheep took these sprouts readily. New sprouts appeared on grasses from mid-August onwards and shoots on the shrubs from about mid-September.

In general, both sheep and cattle preferred Themeda, E. lehmanniana, Fingerhuthia africana and Chrysopogon in that order, and the leaves of grasses to their stems. Stock also preferred the perennial grasses to the annuals when both were matured. On entering a spared camp, cattle took inflorescences of grasses first. This was followed by leaves, and stems were last before they commenced browsing. Enneapogon scoparius was grazed well by sheep in late-winter, but cattle seldom made any use of this grass.

Cattle seldom made use of Cymbopogon, Aristida vestita and Heteropogon, except during droughts. Sheep however, made excellent use of these grasses in late-spring, when they took the green sprouts emerging from the matured and old tufts. Of all shrubs, Tarchonanthus minor was most readily taken by sheep, even when dry grasses were still available. Cattle on the other hand, grazed off most grasses first before concentrating on shrubs. Shrubs like Zizyphus macronata, Rhus lancea, R. ciliata, Rovena hirsuta and others were readily browsed once T. minor was finished.

In early summer sheep grazed all herbage available, including annual grasses and weeds. Cattle made some use of shrubs in early-summer before grasses were in full leaf. Sheep were observed to graze Tragus racemosus in early-summer thereby preventing it from seeding. The same applies to cattle where they grazed Aristida curvata in early-summer. On occasion, when out-of-season rains occurred in August or September, grass became abundantly available and little browsing took place.

Perennial grasses benefited immensely by all-summer resting of camps as evidenced by vigorous sprouting the next spring and production of an abundance of leaf the following growing period. Under either early- or late-summer resting of camps, only Cymbopogon, Heteropogon and E. lehmanniana managed to seed.

By 1952, most of the shrubs had recovered fully from severe browsing during the 1949 drought. A notable exception was Tarchonanthus minor, which only reached full recovery by 1955.

Following the 1949 drought, large areas, especially in water-courses, pans, depressions and areas around the perimeter of shrubs, were denuded of all permanent grasses and became covered by Aristida curvata. This species gave way to E. lehmanniana after being in possession of the bare areas for one season.

In many instances single bushes or shrub associations provided the last remaining foothold of many perennial grasses,

Except for the narrow ratio experiments 16 L and 17 L, the grazing rate in the other experiments appeared too severe in that fair utilization occurred by the end of September. From then on sheep dug up the crowns of grass tufts and cattle broke off thick branches from the shrubs. Out-of-season rains in October or November aided in tiding these animals over some of the lean periods.

(3) SOIL ANALYSIS:

In Tables LVIX and LX details are given of mechanical and chemical analyses of soils obtained from experiments on lime and dolomiteveld respectively.

TABLE LVIX.

MECHANICAL AND CHEMICAL ANALYSES^(s) OF SOILS FROM LIME-VELD UNDER DIFFERENT GRAZING SYSTEMS WITH CATTLE AND SHEEP AT KOOP-MANSFONTEIN.

Soil horizon (inches).	One beast to one sheep.						One Beast to Four Sheep.					
	Expt. 161-Syst. IV:			Expt. 171-Syst. VII:			Expt. 191-Syst. VI:			Expt. 141-Syst. VII:		
	0-3	3-6	6-12	0-3	3-6	6-12	0-3	3-6	6-12	0-3	3-6	6-12
pH.	7.27	7.23	7.12	7.20	6.95	6.63	7.43	6.75	7.50	6.78	6.70	6.35
Resistance at 60°F.	1500	1100	1180	1720	1500	1550	1450	1650	1560	1360	1450	1470
Mechanical analysis (%):												
Sand (>0.02 mm.)	83.79	79.75	79.32	83.36	81.87	78.85	84.14	81.95	77.95	82.56	82.82	77.29
Silt (0.02 - 0.002 mm.)	5.48	4.97	4.60	5.59	3.91	4.85	7.46	7.56	8.39	7.54	6.22	7.73
Clay (<0.002 mm.)	11.05	14.22	16.30	14.07	14.13	14.66	8.40	10.49	13.66	9.90	10.96	14.93
CaCO ₃ (%)	0.20	0.00	0.00	0.10	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00
P. (%) (z)	0.021	0.008	0.008	0.023	0.008	0.004	0.031	0.008	0.004	0.018	0.009	0.005
C. (%)	0.95	0.69	0.53	0.86	0.75	0.57	0.96	0.90	0.86	0.99	0.89	0.81
N. (%)	0.11	0.09	0.06	0.10	0.08	0.07	0.11	0.10	0.08	0.11	0.09	0.08
C : N ratio.	8.8:1	8.1:1	8.3:1	8.8:1	9.0:1	8.6:1	9.1:1	9.0:1	8.7:1	8.8:1	9.6:1	10.1:1
Water-soluble salts (%) ⁽ⁿ⁾ :												
Na.	0.007	0.008	0.006	0.009	0.008	0.005	0.010	0.009	0.006	0.011	0.010	0.029
K.	0.006	0.006	0.002	0.011	0.009	0.003	0.010	0.012	0.005	0.015	0.010	0.005
Ca.	0.048	0.048	0.030	0.046	0.033	0.020	0.050	0.059	0.054	0.037	0.024	0.022
Mg.	0.009	0.008	0.002	0.002	0.007	0.003	0.005	0.011	0.003	0.007	0.003	0.005
HCO ₃ .	0.156	0.164	0.090	0.160	0.109	0.080	0.151	0.224	0.064	0.142	0.085	0.172
Cl.	0.024	0.018	0.021	0.018	0.030	0.024	0.041	0.030	0.024	0.030	0.030	0.027

(s) = Analyses by D.F.M. Claassen.

(z) = 1% Citric acid solution.

(n) = Soil : Water :: 1 : 2.

In these soils, the pH, sand fraction and phosphorus, carbon and nitrogen content tended to decrease with depth while the clay fraction increased in the deeper horizons. Soils from the narrow ratio experiments have appreciably higher clay and lower silt fractions in all horizons than soils from the wider ratio experiments.

TABLE LX.

MECHANICAL AND CHEMICAL ANALYSES^(s) OF SOILS UNDER TWO GRAZING
SYSTEMS WITH CATTLE AND SHEEP ON DOLOMITTEVELD AT KOOPMANSPOORTJIN.

		: One Beast to four Sheep. :					
		: Expt. 19D-Syst. VI: Expt. 14D-Syst. VII: :					
Soil horizon (inches).		0-3	3-6	6-12	0-3	3-6	6-12
pH.		7.72	7.81	7.77	7.43	7.57	7.73
Resistance at 60° F.		820	1170	980	1250	1050	950
Mechanical analysis (%):							
Sand (>0.02 mm.)		69.69	72.32	66.81	81.44	81.04	77.21
Silt (0.02 - 0.002 mm.)		16.98	16.05	18.17	8.28	8.47	13.15
Clay (<0.02 mm.)		13.33	11.63	15.02	10.28	10.49	9.64
CaCO ₃ (%)		7.05	5.80	8.52	0.00	0.21	4.62
P. (%) ^(z)		0.044	0.071	0.018	0.036	0.038	0.056
C. (%)		1.02	0.96	0.84	0.90	1.02	0.86
N. (%)		0.10	0.10	0.10	0.10	0.10	0.10
C : N ratio.		10.0	9.5	8.7	8.7	9.8	8.5
Water-soluble salts (%) ⁽ⁿ⁾							
Na.		0.0009	0.0010	0.0017	0.0010	0.0010	0.0009
K.		0.0011	0.0003	0.0003	0.0008	0.0006	0.0003
Ca.		0.0063	0.0052	0.0052	0.0026	0.0026	0.0031
Mg.		0.0001	0.0009	0.0014	0.0002	0.0002	0.0004
HCO ₃ .		0.0179	0.0195	0.0193	0.0077	0.0090	0.0107
Cl.		0.0032	0.0021	0.0027	0.0027	0.0024	0.0024

(s) - Analyses by D.F.M. Claassen.

(z) - 1% Citric acid solution.

(n) - Soil : Water :: 1 : 2.

The depth tendencies and quantitative analyses of soils from the two grazing systems were very similar except that soil from system VI had lower sand and higher silt and clay fractions than soil from system VII.

(4) LIVWEIGHT:

In Tables LXI and LXII liveweight gains, losses and maintenance and total digestible nutrients obtained are given for the different systems of grazing on lime and dolomiteveld respectively.

TABLE LXII.

GAINS AND LOSSES PER STEER ^(m) AND PER SHEEP ^(m); LIVELIGHT

IN POUNDS PER MORGEN FROM TWO GRAZING SYSTEMS ON DOLO-

MAINTAINED AND T.D.N. OBTAINED

MITEVELD AT KOOPMANSFONTEIN.

Expt. 19 D - System VI.										Expt. 14 D - System VII.									
Seasons.	Total (mm.)	Cattle or Sheep	Summer Gains	Spring Losses	Net Gains	Liveweight per morgen	T.D.N. per morgen	Net T.D.N.		Summer Gains	Spring Losses	Net Gains	Liveweight per morgen	T.D.N. per morgen	Net T.D.N.				
1952/53.	418	C	281	67	214	18063	276			332	105	227	23403	343					
		S	51	2	49	9880	171			45	0	45	9854	166					
1953/54.	378	C	405	130	275	23535	360			360	120	240	22204	334					
		S	33	10	23	13915	190			25	6	19	14036	185					
1954/55.	459	C	228	203	25	23421	290			245	219	26	22387	280					
		S	25	10	15	8030	112			32	11	21	8638	127					
1955/56	563	C	288	82	206	20014	296			354	56	298	21048	333					
		S	30	11	19	9125	130			31	8	23	9733	141					
1956/57.	427	C	267	75	192	22957	325			294	122	172	23440	331					
		(t) S	21	19	2	9171	113			18	17	1	6123	76					
Mean per season.	449	C	294	111	183	-	-			317	124	193	-	-					
		S	32	10	22	-	-			30	8	22	-	-					
Mean per season per morgen.		C	25	10	15	21598	309			26	10	16	22496	324					
		S	11	4	7	10024	144			10	3	7	9177	132					

(m) - Weights are the mean of four steers and sixteen sheep.

(r) - One sheep died from unknown causes 22/5/53.

(x) - One sheep died from HCN-poisoning 12/1/55.

(t) - Season for sheep of eight months' duration only.

195.

Regarding liveweight gains there is little to choose between the different grazing systems. However, spring liveweight losses of steers on limeveld under system VII were consistently heavier than under system IV, resulting in better gains in the case of the latter system. This tendency is reversed in respect of liveweight maintenance and total digestible nutrients obtained.

In the case of the narrow ratio, sheep did better under system VII than under system IV, higher summer gains and lower spring losses being responsible.

Concerning the wider ratio of one beast to four sheep, stock under system VI as against system VII, lost less condition in spring and therefore yielded better net gains.

On dolomite, sheep under system VI made bigger summer gains but also lost more weight in spring and as a result had the same net gains as sheep under system VII. Cattle, in turn did a little better under system VII than under system VI. Liveweight maintenance and total digestible nutrients obtained confirm this tendency.

From none of the experiments is there any tendency for gains, liveweight maintenance or for total digestible nutrients either to increase or decrease between 1952 and 1957.

(5) AREA OF THE LIVELIGHT-CURVE:

In Tables LXIII, LXIV and LXV the area below the liveweight-curve of paired groups of sheep and paired steers are given for stock grazing lime and dolomiteveld respectively according to the different grazing systems.

TABLE LXIII.

AREA BELOW THE LIVEWEIGHT-CURVE OF CATTLE AND SHEEP GRAZING
LIMEVELD UNDER DIFFERENT GRAZING SYSTEMS AT KOOPMANSFONTEIN.

S T E E R S.									
One Boast to one Sheep.									
Calculated values of									
Signifi-									
cant									
Period on	Steer	Steer							Difference
Experiment	No.	Area	No.	Area	16L/17L	16L/17L	P		$P \leq 0.010$
26.8.52-15.7.53	354	11912	B.41	9593	2.77	<0.003		16L > 17L.	
26.8.52-15.7.53	B.62	10523	091	9274	2.05	0.020		N.S.	
26.8.52-13.7.54	E.71	19577	E.68	23530	2.60	0.005		17L > 16L.	
26.8.52-12.7.55	E.72	28524	E.67	37973	5.10	<0.001		17L > 16L.	
16.7.53-10.7.56	264	26163	269	28297	1.58	0.057		N.S.	
16.7.53-10.7.56	267	27967	226	26675	0.84	0.201		N.S.	
14.7.54-6.7.57	414	34720	406	33217	0.86	0.195		N.S.	
13.7.55-6.7.57	501	18117	508	17110	2.60	0.005		16L > 17L.	
11.7.56-6.7.57	645	7838	612	6975	1.69	0.046		N.S.	
11.7.56-6.7.57	632	7460	637	6967	0.98	0.161		N.S.	
S H E E P ^(a)									
26.8.52-15.7.53	907		904		1.21	0.113		N.S.	
16.7.53-13.7.54	1275		1339		1.39	0.082		N.S.	
14.7.54-12.7.55	834		918		2.03	0.021		N.S.	
13.7.55-6.7.57	1426		1360		1.32	0.093		N.S.	

(a) - The area of the liveweight-curve was calculated from the average liveweight of four sheep in each experiment.

N.S. = Not significant.

TABLE LXIV.

AREA BELOW THE LIVELIGHT-CURVE OF CATTLE AND SHEEP GRAZING
LIMEVELD UNDER DIFFERENT GRAZING SYSTEMS AT KOOPMANSFONTEIN.

S T E E R S.									
One Beast to four Sheep.									
Calculated values of									
Expt. 19 L.: Expt. 14 L.: values of									
System VI.: System VII.: z P Signifi-									
cant									
Period on	Steer:	Area:	Steer:	Area:	19L/14L:	19L/14L:	P	Difference	
Experiment:	No.		No.						
2.7.52-15.7.53	E.29	8917	E.32	11412	3.09	0.001		14L > 19L.	
2.7.52-13.7.54	F.28	15530	E.33	16593	1.46	0.072		N.S.	
2.7.54-12.7.55	E. 2	26105	763	25613	0.56	0.290		N.S.	
16.7.53-10.7.56	263	25493	266	21282	3.21	0.001		19L > 14L.	
14.7.54-6.7.57	412	32202	411	30072	1.76	0.039		N.S.	
13.7.55-6.7.57	509	17572	519	17086	0.72	0.236		N.S.	
11.7.56-6.7.57	626	7837	650	7417	1.13	0.129		N.S.	
S H E E P (s)									
2.7.52-15.7.53		1233		1311	2.40	0.008		19L > 14L.	
16.7.53-12.7.55		1979		2023	0.98	0.164		N.S.	
13.7.55-6.7.57		1342		1305	0.78	0.218		N.S.	

(s) - The area of the liveweight-curve was calculated from the average liveweight of 16 sheep in each experiment.

N.S. - Not significant.

TABLE LXV.

AREA BELOW THE LIVELINE-CURVE OF CATTLE AND SHEEP GRAZING
IN THE LEVEL UNDER DIFFERENT GRAZING SYSTEMS AT KOOPMANSPONTJEN.

S T E E R S.									
One Beast to four Sheep.									
Calculated values of									
Expt. 19 D. Expt. 14 D.									
System VI. System VII.									
Significant									
Period on Experiment.	Steers No.	Area.	Steers No.	Area.	19D/14D	19D/14D	P	Difference	
2.7.52-15.7.53	280	14347	290	16207	3.50	<0.001		14D > 19D.	
2.7.52-13.7.54	E.12	19360	E.51	18828	0.51	0.305		N.S.	
2.7.52-12.7.55	E.47	29403	E.48	29752	0.46	0.323		N.S.	
2.7.52-12.7.55	E.19	29964	E.50	28004	1.51	0.066		N.S.	
16.7.53-10.7.56	210	25028	206	23465	1.71	0.044		N.S.	
14.7.54-6.7.57	421	29543	403	28777	0.92	0.179		N.S.	
13.7.55-6.7.57	514	16102	507	16945	1.52	0.064		N.S.	
13.7.55-6.7.57	512	16263	517	17927	2.05	0.020		N.S.	
11.7.56-6.7.57	613	7108	630	7385	1.13	0.129		N.S.	
S H E E P (s)									
1.7.52-13.7.54		2586		2688	0.21	0.417		N.S.	
14.7.54-12.7.55		950		912	2.09	0.018		N.S.	
13.7.55-6.7.57		1344		1436	2.01	0.022		N.S.	

(s) = The area of the liveweight-curve was calculated from the average liveweight of 16 sheep in each experiment.

N.S. = Not significant.

Regarding the narrow ratio of cattle to sheep on limeveld, system IV resulted in the larger area of the liveweight-curve in the case of seven paired steers and two sheep groups. Significance was only established in the case of two sets of paired steers. System VII yielded the biggest liveweight-curve in three instances with steers, two of which were significant, and in two sheep groups.

Where the ratios of large to small stock were wider on limeveld, system VI had the bigger liveweight-curve area in five instances in the case of steers, two of which were significant. In the case of sheep, system VI resulted in the larger area in two cases, one of which was significant. System VII had the larger area in two instances with cattle, one of which was significant, and in one instance with sheep.

On dolomite, system VI was responsible for the larger liveweight-curve area in two cases with sheep and in four instances with cattle. In turn, system VII yielded the biggest liveweight-curve area in four cases with steers, one being significant, and in one case with sheep.

(6) SLAUGHTERINGS:

In Table LXVI particulars of capital investment, net profit, rate of interest and slaughterings are given for the different grazing systems on lime and dolomiteveld. Since sheep were disposed of at stock fairs, slaughter particulars of steers only were available.

TABLE LXVI.

SLAUGHTER DETAILS AND FINANCIAL RETURNS OF STEERS (m) UNDER DIFFERENT GRAZING SYSTEMS WITH CATTLE AND SHEEP AT KOOPMANSFONTEIN.

	Limeveld.				Dolomiteveld.			
	11 Beest to 1 Sheep: 1 Beest to 4 Sheep: 1 Beest to 1 Sheep							
	:: Expt. 16L: Expt. 17L: Expt. 19L: Expt. 14L: Expt. 19D: Expt. 14D							
	:: Syst. IV: Syst. VII: Syst. VI: Syst. VII: Syst. VI: Syst. VII							
Liveweight in pounds.	1026	1034	901	903	972	1001		
Warm carcass-weight in pounds.	533	551	456	449	489	520		
Dressing percentage.	52	53	51	49	50	52		
Grade.	I	I	II	II	II	I		
Wet hide-weight in pounds.	69	68	60	55	65	65		
Capital investment.								
Land at R12 per morgen.	R576	576	576	576	576	576		
Steers at R24 each.	R216	216	216	216	216	216		
Licks and Inoculations.	R 40	40	40	40	40	40		
Total capital investment.	R832	832	832	832	832	832		
Gross return from 9 steers over 5 years.	R497.8	538.5	404	375.9	420.7	466		
Less stock expenditure.	R256	256	256	256	256	256		
Excess of gross return over expenditure.	R241.8	282.5	148	119.9	164.7	210		
Profit per morgen per year.	100c	117c	62c	50c	68c	88c		
Interest rate per annum(%).	5.8	6.8	3.6	2.9	4.0	5.1		

(m) = Slaughter details are the mean of nine steers for every experiment.

Both on the narrow ratio lime and on dolomite system VII proved better than either system IV or system VI, with lime superior to dolomite. Under the wider ratio on limeveld, system VI proved little better than system VII. Under a comparable ratio of large to small stock, dolomite led to better returns.

(7) GEIGERIA-POISONING AND OTHER LOSSES:

No losses were sustained under systems IV and VI where a close ratio of large to small stock was in use. Under conditions of the wider ratio of one beast to four sheep, system VII was responsible for five sheep dying from poverty on lime and one death due to hydrocyanic-poisoning on dolomite. Two *Geigeria*-poisoning deaths on lime and one death from unknown causes on dolomiteveld ensued from system VI.

The wide ratio experiments on lime both failed to carry their animals through the 1952/53 seasonal drought and steers and sheep were removed from the experiments for a period of seven weeks in the early-summer of 1953.

DISCUSSION:

The decline in frequency of climax grasses on veld of wide ratio experiments and the increase in Cereal, weed, karroid and herbaceous species in all experiments between 1952 and 1957, on both veld types, are interpreted as indicating a rearrangement of the component species towards a biotic sub-climax under joint grazing by cattle and sheep. This adaptation to grazing by domestic livestock is similar regardless of the grazing system employed. A similar result was mentioned in earlier chapters where reference was made to cattle which were grazed according to three different systems of grazing and also where sheep were grazed in accordance with the requirements of five different grazing systems. Moisture availability and degree of defoliation, as against season of leaf removal, are suggested as being of more importance to the survival of perennial

grasses in arid zones than alternate resting and grazing prescribed by conventional grazing systems.

The increase of Chrysocoma, Aster and Monochma suggests a drier habitat, conducive to Karoo-encroachment, under the biotic sub-climax. Intolerance to grazing shown by Fingerhuthia africana and Eustachys paspaloides make these grasses particularly valuable as indicators of the severity of grazing. In fact, Eustachys appears to be the most susceptible and this is closely followed by Fingerhuthia. Mostert (1958) found Fingerhuthia africana, because of its high palatability, especially to sheep, to be often overgrazed and to be replaced by Aristida in limeveld of the Bloemfontein and Brandfort districts.

It is fortunate that none of the grasses were consistently rejected by stock and that otherwise unpalatable grasses like Cymbopogon, Aristida vestita and Heteropogon were well cropped in spring. Defoliation of newly-formed sprouts no doubt assisted in keeping down the numbers of these species. A fortunate coincidence is the rapid colonization by Eragrostis lehmanniana of bare ground and the high preference stock showed for this species. Due to its relative abundance and the fact that all classes of stock preferred it when green, and readily grazed it when matured, Eragrostis lehmanniana is regarded as the most important herbage species in these veld types.

Examples of concentrated browsing on Tarchonanthus minor are abundant throughout the experiments and it is regrettable that no estimates of its frequency changes were available. Grazing of annuals and weeds and browsing in early-summer, for a short while after the onset of rains, no doubt drew off grazing from the perennial grasses at a most critical time. This allowed these grasses to attain sufficient leaf area before grazing commenced. In this way perennial grasses survived the severe use they were exposed to.

Sustained sprouting in spring of Cymbopogon and Heteropogon is a direct consequence of the rarity with which these two species were ever grazed during the active growing season. They would

therefore possess well-developed and unimpaired root systems. With a maximum amount of stored root reserves they would be able to continue sprouting for a lengthy period in spring, in contrast with grasses that were grazed in summer.

Half-a-summer rest was not of sufficiently long duration to allow preferred species and slower growing grasses to run into seed. If continued long enough half-a-summer grazing will eventually lead to deterioration of veld to a condition in which less acceptable species predominate. A general lowering in productivity of the veld would ensue. All-summer use in one year followed by all-summer rest in the following year is suggested as meeting most of the requirements for sustained plant vigour and propagation and of maximal production of mutton and beef.

The complementary way in which cattle and sheep used veld was illustrated by the fact that many grass stems remained uneaten where sheep constituted the only grazing factor. Cattle in turn, made good use of such stems, whether green or dry. Again, whereas steers would not browse early in winter and after abundant spring rains when grasses were plentiful, sheep did in fact browse the shrubs in such cases. Cattle preferred Aristida curvata, while sheep exhibited a strong preference for Tragus racemosus in early summer. In much the same way on veld grazed by cattle only, the control of hardy, unpalatable species like Cymbopogon and Heteropogon presented difficulties. Cattle avoided these species, but sheep went for the fresh sprouts in spring and in that way inflicted damage which aided in controlling these plants.

The out-of-season occurrence of rain between July and October yielded green grass early in spring, stock preferring such herbage to browse. This eased the browsing on the shrubs and enabled them to recuperate at a time when they would normally be expected to supply sustenance to stock. All-summer resting of some camps is suggested to bridge the late-winter and spring period of herbage scarcity for stock. The spare veld would provide abundant quantity,

and with vigorous sprouting, fair quality of herbage to maintain stock in good condition.

The rough nature of the veld appears to favour the retention of a number of climax grasses in cracks between slabs or among rocks. Along with that from grasses remaining under shrubs, a source of grass seeds would be available. As a result, succession on bare areas would not be impeded by a lack of seed-supply and might be expected to proceed rapidly if given a fair chance.

As regards the reaction of livestock, there appears to be little to choose between the various grazing systems used. At the time of initiating system VII it was reasoned that the availability of all veld in winter and spring could possibly lead to better maintenance of condition in this period of herbage minima. This was decidedly the outcome in respect of carcass quality, return per morgen and rate of interest earned on investment in two experiments. As regards liveweight gains, just the opposite appears to have taken place in that spring-loss in liveweight of both steers and sheep was, if anything, aggravated by system VII.

A likely reason why the different systems failed to lead to widely diverging liveweight gains could be that the times of camp changes and the length of the grazing and rest periods were not limiting factors in stock production. These factors appeared to be rather unimportant and subordinate to other factors of grazing management, for instance, intensity of grazing.

A total number of six deaths occurring under system VII as against three deaths on system VI is not considered sufficient evidence for preferring one system to the other.

Relating the information obtained from these grazing system experiments over the experimental period of five years to farming practice, elaborate grazing systems do not appear to benefit either the veld or the livestock grazing on such veld. Continuous grazing would do as well, and at less cost. In an effort to overcome the serious loss in condition in late-winter and spring, one camp in two

might be put aside from the commencement of post-winter greening-up of the veld up to the occurrence of the first severe frosts the next winter. Both camps are then made available to stock until the close of the dormant season when the grazing and resting of the previous growing season is reversed, and so forth.

A large number of camps on a farm have many other uses and may bring other benefits, e.g. closure of camps for restoration of vegetation around waterpoints and for reducing the aimless wandering of animals. This is of special importance in the arid west where the sand is most vulnerable to trampling by livestock and blows easily. Withdrawal of some camps from grazing may also become necessary as a result of a high incidence of plants poisonous to livestock or for some other reasons. For economical grazing management a minimum of two camps per herd or flock appears to be all that will be needed.

ANNEXURE 13.

LIVEWEIGHT GAINS AND LOSSES AND LIVEWEIGHT MAINTAINED IN POUNDS T.D.N. ON DOLANTEVELD AND CONTRI-
BUTION OF THESE FACTORS TO T.D.N. OBTAINED PER MORGAN.

Expt. 19 D - System VI.										Expt. 14 D - System VII.									
Seasons.		Rainfall:	Cattle:	Liveweight:	Gains:		T.D.N.:	Losses:	Net	Liveweight:		Gains:	T.D.N.:	Losses:	Net				
		(mm.)	or	maintained:					T.D.N.:										
			Sheep																
1952/53.	418		C	208	83	291	15	276		269	98	357	24	343					
			S	113	60	173	2	171		113	53	116	0	166					
1953/54.	378		C	271	119	390	30	360		255	106	361	27	334					
			S	160	39	199	9	190		161	29	190	5	185					
1954/55.	459		C	269	67	336	46	290		257	72	329	49	280					
			S	92	29	121	9	112		99	38	137	10	127					
1955/56.	563		C	230	85	315	19	296		242	104	346	13	333					
			S	105	35	140	10	130		112	36	148	7	141					
1956/57.	427		C	264	78	342	17	325		270	86	356	25	331					
			S	105	25	130	17	113		70	21	91	15	76					
Mean per season.	449		C	248	86	334	25	309		259	93	352	28	324					
			S	115	38	153	9	144		111	35	146	7	139					
Per cent.			C	74	76	100	8	92		74	26	100	8	92					
			S	75	25	100	6	94		76	24	100	5	95					

C. CATTLE AND SHEEP RATIOS.

Details of the eight grazing experiments where both cattle and sheep were used as grazers of veld at different ratios of large to small stock are given in Table LXVII. The data from experiment 14 L formed part of the material of a thesis submitted by the author to the University of the Witwatersrand for the degree of Master of Science.

TABLE LXVII.

RATIOS OF CATTLE TO SHEEP ON VELD.

<u>Experiment no.</u>	<u>Particulars.</u>
<u>Lineveld:</u>	
18 L.	<u>System VII</u> - 8 steers and 4 sheep on 88 morgen.
17 L. (n)	- 4 steers and 4 sheep on 48 morgen.
14 L. (n)	<u>System VI</u> - 4 steers and 16 sheep on 48 morgen.
9 L.	- 3 steers and 24 sheep on 48 morgen.
19 L. (n)	- 2 steers and 32 sheep on 48 morgen.
<u>Dolomiteveld:</u>	
14 D. (n)	<u>System VI</u> - 4 steers and 16 sheep on 48 morgen.
9 D.	- 3 steers and 24 sheep on 48 morgen.
19 D. (n)	- 2 steers and 32 sheep on 48 morgen.

(n) = These experiments were used in Parts A and B of this Chapter.

Experiment 9 L was commenced in February 1946; and 14 L, 19 L, 14 D and 19 D in June 1948. Experiment 9 D was initiated in August 1950 and 17 L and 18 L in August 1952. No duplicates for the close ratio experiments 17 L and 18 L existed on dolomiteveld.

The interaction between vegetation and livestock were measured by means of:

- (1) Plant counts,
- (2) Grazing observations,
- (3) Soil analysis,

- (4) Livoweights,
- (5) Area of the livoweight-curve, and
- (6) Goigeria-poisoning and other losses.

Due to the fact that the experiments did not run concurrently, a comparison of slaughter data would not be justified and were therefore omitted.

(1) PLANT COUNTS:

In Tables LXVIII and LXIX species frequency and plant numbers which occur per quadrat are given for lime and dolomiteveld respectively.

TABLE LXVIII.

PLANT RESPONSE TO DIFFERENT RATIOS OF CATTLE AND SHEEP ON LIMB-							VELD AT KOOPMANSFONTEIN.			
Experiment no.	Frequency (s)		per 300		Quadrats.	Number of plants in 15 Quadrats.	Frequency per (s)		300 Quadrats.	
	18 L.		17 L.				14 L.			
	2 / 1		1 / 1				1 / 4			
Seasons.	1952	1957	1952	1957	1952	1957	1947	1953	1952	1957
CLIMAX SPECIES:										
<i>Chrysopogon montanus</i>	20	19	29	34	20	14	26	13	5	15
<i>Cymbopogon plurinodis</i>	17	17	46	61	18	22	11	10	6	3
<i>Themeda triandra</i>	14	0	35	40	9	18	11	6	30	29
<i>Digitaria oriantha</i>	6	17	1	9	8	10	16	4	19	9
<i>Aristida vestita</i>	2	1	3	6	1	0	0	1	0	0
<i>Heteropogon contortus</i>	0	0	0	2	0	0	0	0	0	0
<i>Sporobolus fimbriatus</i>	2	0	21	14	29	0	17	9	7	7
<i>Eustachys paspaloides</i>	0	0	3	2	5	0	7	3	8	0
<i>Fingerhuthia africana</i>	0	0	15	7	16	4	33	0	26	9
<i>Panicum coloratum</i>	0	0	0	0	0	0	0	0	0	15
SERIAL SPECIES:										
<i>Eragrostis lehmanniana</i>	83	169	74	187	142	222	72	201	172	186
<i>E. echinoclados</i>	0	5	0	8	0	2	7	48	0	19
<i>Crotopetium capense</i>	0	109	13	78	45	147	0	11	46	127
<i>Cynodon incompletus</i>	4	0	0	0	0	0	0	0	11	21
<i>Tragus koelerioides</i>	0	0	7	0	14	0	37	5	21	0
<i>Enneapogon scoparius</i>	0	1	0	0	0	0	0	0	0	0
PIONEER SPECIES:										
<i>Enneapogon brachystachyus</i>	281	141	54	46	48	134	161	1905	58	122
<i>Tragus racemosus</i>	10	35	68	3	56	3	6	457	32	6
<i>Aristida curvata</i>	0	22	13	15	23	36	19	22	14	41
WEEDS:										
<i>Geigeria africana</i>	120	128	48	116	132	207	10	183	156	177
<i>Chrysocoma tenuifolia</i>	25	17	5	19	9	5	8	24	18	24
<i>Tribulus terrestris</i>	17	1	2	2	0	4	24	35	0	1
KARROID SPECIES:										
<i>Monochna divaricatum</i>	8	11	0	10	1	16	3	0	4	32
<i>Aster muricatus</i>	8	9	4	15	37	62	0	2	14	15
<i>Indigofera patens</i>	4	6	0	3	6	6	0	1	3	6
<i>Pontzia sphaeroccephala</i>	1	0	0	0	0	0	0	0	0	0
OTHER SPECIES:										
Woody.....	0	3	1	0	4	2	3	3	4	3
Herbaceous.....	77	66	16	117	25	145	10	73	56	155

Woody species comprise the genera *Rhus* and *Euclea*.

Herbaceous species comprise the genera *Barleria*, *Hermannia*, *Sarcocolla*, *Raphanistrum*, *Stachys*, *Pharbitis*, *Scilla*, *Walafrida*, *Camelina*, *Atriplex*, *Sutera* and *Barkhaya*.

• = Significant difference at P = 0.05.

•• = Significant difference at P = 0.01.

(s) = Surveys according to the method by Von Broombsen (1951).

(r) = Surveys according to a method by Raunkiaer, given by Murray (1946).

TABLE LXIX.

PLANT RESPONSE TO DIFFERENT RATIOS OF CATTLE AND SHEEP
ON DOLCHTEVELD AT KOOPLANSFONTEIN.

Experiment no. Ratio Cattle : Sheep. Seasons.	Frequency ^(a) per 300 Quadrats.					
	1:1 D.		9 D.		19 D.	
	1 / 4		1 / 8		1 / 16	
	1951	1957	1951	1957	1951	1957
CLIMAX SPECIES:						
<i>Chrysopogon montanus</i>	22	20	28	23	16	8
<i>Heteropogon contortus</i>	2	5	27	19 ^{***}	2	0
<i>Themeda triandra</i>	8	4	21	7	1	0
<i>Digitaria ariantha</i>	20	13	17	29	17	2
<i>Cymbopogon plurinodis</i>	2	1	12	7	3	3
<i>Sporobolus fimbriatus</i>	3	4	9	5	6	0 ^{***}
<i>Fingerhuthia africana</i>	0	0	2	4	1	1
<i>Panicum coloratum</i>	0	0	0	0	1	0
SERIAL SPECIES:						
<i>Eragrostis lehmanniana</i>	207	219	112	243 ^{***}	189	247 ^{***}
<i>Cropetium capense</i>	165	228 ^{***}	35	140 ^{***}	101	171 ^{***}
<i>Brachiaria eruciformis</i>	0	0	20	7	0	2
<i>Cynodon incompletus</i>	0	0	0	4	0	0
<i>Eragrostis obtusa</i>	0	11 ^{***}	0	49 ^{***}	8	36 ^{***}
<i>E. echinochloidea</i>	0	13 ^{***}	0	31 ^{***}	0	53 ^{***}
<i>E. denudata</i>	16	13	0	0	20	0
<i>Tragus koelerioides</i>	0	0	0	0	0	0
<i>Enneapogon scoparius</i>	6	7	14	10	0	0
PIONEER SPECIES:						
<i>Enneapogon brachystachyus</i>	139	102 ^{***}	80	93 ^{***}	71	61
<i>Aristida curvata</i>	70	29 ^{***}	197	28 ^{***}	34	25 ^{***}
<i>Tragus racemosus</i>	64	12 ^{***}	130	8 ^{***}	84	22 ^{***}
WEEDS:						
<i>Geigeria africana</i>	0	20 ^{***}	0	25 ^{***}	27	63 ^{***}
<i>Chrysocoma tenuifolia</i>	2	8	0	8 ^{***}	10	24
<i>Tribulus terrestris</i>	0	1	0	0	1	1
KARROID SPECIES:						
<i>Aster muricatus</i>	1	8 ^{***}	0	3 ^{***}	6	14
<i>Indigofera patens</i>	4	4	0	5 ^{***}	1	1
OTHER SPECIES:						
Woody.....	5	5 ^{***}	12	10 ^{***}	8	8
Herbaceous.....	11	158 ^{***}	129	206 ^{***}	30	214 ^{***}

Woody species comprise the genera *Tarchananthus*, *Euclea*, *Maytenus* and *Rhus*.

Herbaceous species comprise the genera *Oxalis*, *Bulbostylis*, *Stachys*, *Commelina*, *Hermannia*, *Cyperus*, *Sericocoma*, *Anacardium*, *Pharmacosum*, *Euphorbia*, *Barleria* and *Elephantia*.

* = Significant difference at P = 0.05.

*** = Significant difference at P = 0.01.

(a) = Surveys according to the method by Von Broembsen (1951).

Owing to methods of plant counts being inadequate, in that too few quadrats, of an unnecessarily large size, at too distant intervals were used, large changes only in the frequency of species will be considered. As in previous experiments, Chrysopogon, Themeda, Digitaria and Sporobolus, except for the last-mentioned species under the 1 : 4 ratio on limeveld, proved tolerant to grazing under all ratios on both veld types. Enneapogon scoparius and Fingerhuthia also withstood grazing on dolomite. On this veld type, tolerance to grazing tended to diminish with wider ratios of large to small stock.

Cymbopogon, Heteropogon and Aristida vestita were kept in check in all cases. On limeveld, Eustachya paspaloides and Fingerhuthia were not able to tolerate grazing by cattle and sheep. In addition Tragus koelerioides disappeared completely from the veld.

A decline in climax species took place where ratios wider than one beast to one sheep were practised. In the close ratio experiments the status quo of climax species was maintained. Under all ratios an increase in sward, weed, karroid and herbaceous species occurred. The increase was least in counts from close ratio experiments on limeveld.

Counts of Geigeria africana were taken in beginning and end seasons only. The high degree of variation in numbers from season to season makes it impossible to attach significance to the counts of two seasons only. The encroachment of Chrysocoma tenuifolia proceeded unencumbered on dolomite and also under the 1 : 1 and 1 : 8 ratios of cattle and sheep on limeveld. Aster muricatus also increased in all experiments.

Under the closer ratios both lime and dolomiteveld were maintained at a higher successional stage than under the wider ratios. Dolomiteveld was able to withstand wider ratios of cattle to sheep than limeveld was able to tolerate.

(2) GRAZING OBSERVATIONS:

The same order of sprouting, preferences, discriminations and maturation evidenced under experiments previously described, were observed to be in force here.

Under the closer ratios of large to small stock shrubs were seldom browsed, in contrast with browsing from autumn through to spring in the widest ratios. In addition, most perennial grasses managed to seed with a late-summer rest where the ratios were close, while under the widest ratios some species failed to seed even during a complete summer rest.

Under the widest ratios Chrysopsis tenuifolia was taken by sheep on occasion, but never in the case of the closer ratios. Sprouting from tuft grasses was more vigorous and was kept up for a much longer time under the 1 : 4, 1 : 1 and 2 : 1 ratios of cattle to sheep than under the wider ratios.

At the time of the onset of summer rains, camps under the wide ratios were denuded of most of their ground vegetation, and shrubs were stripped bare of all leaf, while in some cases thick branches were broken off. Under the narrower ratios most species were evenly grazed down and shrubs were moderately thinned out. The impression was gained that veld under the wide ratios was much heavier stock than veld under the close ratios.

(3) SOIL ANALYSIS:

In Tables LXX and LXXI particulars are given of mechanical and chemical analyses of soil obtained from the different large to small stock ratio experiments on lime and dolomite veld respectively.

TABLE LXX.

MECHANICAL AND CHEMICAL ANALYSES (s) OF SOILS FROM

WITH CATTLE AND SHEEP AT

	Expt. 13 L.	Expt. 17 L.
	2 B + 1 S.	1 B + 1 S.
Soil horizon (inches).	0-3 : 3-6 : 6-12:	0-3 : 3-6 : 6-12:
pH.	7.26: 7.18: 6.80:	7.20: 6.95: 6.63:
Resistance at 60°F.	1180: 1240: 1150:	1720: 1500: 1520:
Mechanical analysis(%):		
Sand (>0.02 mm.)	79.33: 83.11: 77.63:	83.36: 81.87: 78.85:
Silt (0.02 - 0.002 mm.)	6.44: 4.49: 4.25:	5.53: 3.91: 4.85:
Clay (<0.002 mm.)	14.23: 12.40: 18.12:	11.15: 14.22: 16.30:
CaCO ₃ .(%)	0.38: 0.00: 0.00:	0.20: 0.00: 0.00:
P.(%) ^(z)	0.017: 0.012: 0.004:	0.023: 0.008: 0.004:
C.(%)	0.86: 0.75: 0.54:	0.86: 0.75: 0.57:
H.(%)	0.10: 0.10: 0.06:	0.10: 0.08: 0.07:
C : H ratio.	9.1: 7.8: 8.7:	8.8: 9.0: 8.6:
Water-soluble salts(%) ⁽ⁿ⁾ :		
Na.	0.008: 0.008: 0.006:	0.009: 0.008: 0.005:
K.	0.011: 0.002: 0.002:	0.011: 0.009: 0.003:
Ca.	0.046: 0.037: 0.037:	0.046: 0.033: 0.020:
Mg.	0.008: 0.010: 0.001:	0.002: 0.007: 0.003:
HCO ₃ .	0.160: 0.123: 0.107:	0.160: 0.109: 0.080:
Cl.	0.021: 0.024: 0.021:	0.018: 0.030: 0.024:

2 B : 1 S = Two heifers to one sheep.

(s) = Analyses by D.F.M. Clineason.

(z) = 1% Citric acid solution.

(n) = Soil : Water = 1 : 2.

LIVESTOCK UNDER DIFFERENT GRAZING RATIOS

KOPPELSTADT.

Expt. 14 L. :: Expt. 9 L. :: Expt. 19 L. ::	1 B : 4 S. :: 1 B : 8 S. :: 1 B : 16 S. ::	
0-3 : 3-6 : 6-12 : 0-3 : 3-6 : 6-12 : 0-3 : 3-6 : 6-12 :		
6.78 : 6.70 : 6.35 : 7.18 : 6.52 : 7.00 : 7.43 : 6.75 : 6.50 :		
1360 : 1450 : 1470 : 1250 : 1450 : 990 : 1450 : 1650 : 1500 :		
82.56 : 82.82 : 77.29 : 82.88 : 80.36 : 77.88 : 84.14 : 81.95 : 77.95 :		
7.54 : 6.22 : 7.78 : 6.33 : 6.32 : 5.65 : 7.46 : 7.56 : 8.39 :		
9.90 : 10.96 : 14.93 : 10.79 : 13.32 : 16.47 : 8.40 : 10.49 : 13.66 :		
0.00 : 0.00 : 0.00 : 0.00 : 0.00 : 0.00 : 0.15 : 0.00 : 0.00 :		
0.018 : 0.009 : 0.005 : 0.017 : 0.007 : 0.007 : 0.031 : 0.008 : 0.004 :		
0.99 : 0.89 : 0.81 : 0.89 : 0.75 : 0.68 : 0.96 : 0.90 : 0.66 :		
0.11 : 0.09 : 0.08 : 0.10 : 0.09 : 0.07 : 0.11 : 0.10 : 0.08 :		
8.8 : 11.9 : 6.1 : 11.1 : 8.8 : 11.1 : 9.1 : 11.1 : 8.7 :		
0.011 : 0.010 : 0.029 : 0.009 : 0.010 : 0.009 : 0.010 : 0.009 : 0.006 :		
0.015 : 0.010 : 0.005 : 0.008 : 0.007 : 0.002 : 0.010 : 0.012 : 0.005 :		
0.037 : 0.024 : 0.022 : 0.039 : 0.022 : 0.046 : 0.050 : 0.059 : 0.024 :		
0.007 : 0.003 : 0.005 : 0.010 : 0.006 : 0.006 : 0.005 : 0.011 : 0.003 :		
0.142 : 0.085 : 0.118 : 0.128 : 0.066 : 0.149 : 0.151 : 0.224 : 0.064 :		
0.030 : 0.030 : 0.027 : 0.038 : 0.032 : 0.041 : 0.041 : 0.030 : 0.024 :		

The pH, sand and silt fractions, phosphorus, carbon and nitrogen, potassium, and to some extent calcium, bicarbonates and chlorine contents decreased, while the clay fraction increased with depth.

In the topsoil, the sand and silt fractions were lower under the close ratios and higher under the wider ratios. In respect of the clay fraction, the reverse applied.

TABLE LXI.
MECHANICAL AND CHEMICAL ANALYSES^(a) OF SOILS FROM DOLMITEVELD
UNDER DIFFERENT GRAZING RATIOS WITH CATTLE AND SHEEP AT
KOOPIANSFONTEIN.

Soil horizon (inches).	Expt. 14 D.			Expt. 9 D.			Expt. 19 D.		
	1 B	4 S		1 B	8 S		1 B	8 S	
	0-3	3-6	6-12	0-3	3-6	6-12	0-3	3-6	6-12
pH.	7.43	7.57	7.73	7.78	7.80	7.80	7.72	7.81	7.77
Resistance at 60 F.	1250	1050	950	1120	1170	1020	820	1170	980
Mechanical analysis (%)									
Sand (>0.02 mm.)	81.44	81.04	77.21	76.44	75.40	75.15	69.69	72.32	66.81
Silt (0.02-0.002 mm.)	8.28	8.47	13.15	9.49	10.47	10.19	16.98	16.05	18.17
Clay (<0.002 mm.)	10.28	10.49	9.64	14.07	14.13	14.66	13.33	11.63	15.02
CaCO ₃ (%)	0.00	0.21	4.62	3.77	3.40	4.25	7.05	5.80	8.52
P. (%) ^(z)	0.0036	0.0038	0.0056	0.0030	0.0027	0.0077	0.0044	0.0071	0.0018
C. (%)	0.90	1.02	0.86	0.68	0.57	1.02	1.02	0.96	0.84
N. (%)	0.10	0.10	0.10	0.09	0.08	0.11	0.10	0.10	0.10
C : N ratio.	8.7:1	9.8:1	8.5:1	7.6:1	7.5:1	9.5:1	10.0:1	9.5:1	8.7:1
Water-soluble salts (%)									
Na.	0.0010	0.0010	0.0009	0.0009	0.0008	0.0016	0.0009	0.0010	0.0017
K.	0.0008	0.0006	0.0003	0.0010	0.0005	0.0015	0.0011	0.0003	0.0003
Ca.	0.0026	0.0026	0.0031	0.0046	0.0041	0.0052	0.0063	0.0052	0.0052
Mg.	0.0002	0.0002	0.0004	0.0013	0.0013	0.0011	0.0001	0.0009	0.0014
HCO ₃ .	0.0077	0.0090	0.0107	0.0187	0.0177	0.0191	0.0179	0.0195	0.0193
Cl.	0.0027	0.0024	0.0024	0.0018	0.0024	0.0047	0.0032	0.0021	0.0027

1 B : 4 S = One beast to 4 sheep.

(a) = Analyses by D.F.M. Claassen.

(z) = 1% Citric acid solution.

(n) = Soil : Water :: 1 : 2.

No characteristic pattern existed in the depth tendencies of dolomite soils from three ratios of large to small stock. The sand fraction decreased while the silt fraction increased with depth, particularly in the topmost horizon.

(4) LIVWEIGHTS:

Summer gains, spring losses, net gains, liveweight maintained and total digestible nutrients obtained under five ratios of cattle and sheep on linevold and three ratios on dolomite are given in Tables LXXII and LXXIII respectively.

Considering firstly the 1 : 4, 1 : 8 and 1 : 16 ratios of large to small stock, both steers and sheep reacted in opposite ways to the same ratios. A widening large to small stock ratio led to increased steer gains but to depressed sheep gains. On a per morgen basis, a wider ratio resulted in a decrease in gains from steers but to an enhancement of gains from sheep. Liveweight maintenance and total digestible nutrients obtained followed the same tendency.

Under experiments 17 L and 18 L where close ratios of large to small stock were used, the best steer, sheep and per morgen gains, liveweight maintenance and total digestible nutrients, emanated from the one beast to one sheep ratio. Regarding the total digestible nutrients obtained by sheep and steers, the wider ratios on dolomite led to less nutrients while on limeveld the closer ratios resulted in less nutrients.

There was no tendency for either gains, liveweight maintenance or total digestible nutrients obtained either to increase or diminish over the period the experiments were in existence. From Annexures 14 and 15 there appears to be a tendency for a widening cattle to sheep ratio from 2 : 1 to 1 : 16 on lime and from 1 : 4 to 1 : 16 on dolomite, to result in both cattle and sheep devoting progressively more of the nutrients obtained to maintenance and less to gains.

(5) AREA OF THE LIVWEIGHT-CURVE:

The area below the liveweight-curve of paired steers and paired groups of sheep grazing lime and dolomiteveld under different ratios of large to small stock are given in Tables LXXIV and LXXV.

TABLE 1

THE LIVES/RIGHT-CURVE OF CATTLE AND SHEEP GRAZING

Period in Experiment.	Steer no.	Area.	Steer no.	Area.	9 D. :: Expt.	9 D. :: Expt.	19 D. ::
8.6.48 - 5.1.51.	2363	35458	-	-	4 S. :: 1 B. :: 8 S. :: 1 B. :: 16 S. ::	1 B. :: 8 S. :: 1 B. :: 16 S. ::	16 S. ::
8.6.48 - 14.8.51.	2481	41817	-	-			
6.1.51 - 1.7.52.	-	-	191	24693			18184 ::
6.1.51 - 15.7.53.	290	37975	212	38625			-
15.8.51 - 13.7.54.	E.51	24172	E.66	25525			-
2.7.52 - 12.7.55.	E.50	28004	E.64	31255			-
16.7.53 - 10.7.56.	206	23465	247	31095			-
14.7.54 - 6.7.57.	403	28777	408	32618			-
13.7.55 - 6.7.57.	507	16945	502	19740			-
11.7.56 - 6.7.57.	630	7385	643	7185			-

Difficulty (5)

8.6.48 - 23.5.50	2253	1968
24.5.50 - 17.6.52	2254	2149
18.6.52 - 13.7.54	2688	-
14.7.54 - 12.7.55	912	-
13.7.55 - 19.2.56	1426	-

(s) = The area of the liveweight-curve was calculated from the average liveweight of 16, 24 and 32 sheep for Experiments 14 D, 9D and 19D respectively.

$$= H\text{-Requirement} = 9.21 \text{ at } P = 0.010 \text{ (2 D.F.)}$$

N.S. = Not significant.

	Calculated	value	of	Significant		
	χ^2		P	Differences		
H^{10}	14D/9D	9D/19D	14D/19D	9D/19D	14D/19D	$P \leq 0.010$
-	-	-	1.13	-	0.129	N.S.
-	-	-	0.38	-	0.352	N.S.
-	-	5.43	-	-	<0.001	9D>19D.
-	0.89	-	-	0.187	-	N.S.
-	0.84	-	-	0.201	-	N.S.
-	1.97	-	-	0.024	-	N.S.
-	3.87	-	-	<0.001	-	9D>14D.
-	1.90	-	-	0.029	-	N.S.
-	2.88	-	-	0.002	-	9D>14D.
-	3.09	-	-	<0.001	-	14D>9D.

8.15	-	2.42	-	0.003	1.4D > 19D.
-	-	-	-	-	N.S.
-	-	-	0.164	-	N.S.
-	0.98	-	-	-	1.4D > 9D.
-	2.49	-	0.006	-	1.4D > 9D.
-	2.96	-	0.002	-	1.4D > 9D.

Significant differences between the areas of the liveweight-curve of steers on lineveld were established in 13 out of 27 comparisons. Of these, the one beast to one sheep combination led to the largest areas in six instances. In the remaining seven instances the other four ratios gave rise to the biggest areas. Out of 13 comparisons with sheep on line, only five attained significance at the required level of probability. Of these, the one beast to four sheep ratio resulted in the largest area in three instances and the 2 : 1 and 1 : 16 ratio in only one instance each.

Of ten areas of the liveweight-curve comparisons, using steers on dolomite, significance was established in four instances. In these, the 1 : 3 ratio resulted in the biggest area in three cases and the 1 : 4 ratio in one case only. As regards sheep on dolomite, significant differences between the liveweight-curve area were established in three out of seven comparisons. In all of these the 1 : 4 ratio gave rise to the largest areas.

(6) GEIGERIA-POISONING AND OTHER LOSSES:

"Vermeersiekte" among sheep occurred only during the 1948/49 season. However, after stock were transferred to other camps they were cured. Two deaths from unknown causes took place among sheep on dolomite, one each on the 1 : 4 and 1 : 8 ratio experiments. On line, five sheep died as a result of poverty on the 1 : 4 ratio experiment. Another died on the widest ratio on line, hydrocyanic-poisoning being suspected as the cause.

Undue significance cannot be attached to stock removals from the experiment's as this was done haphazardly and was afterwards deemed not to have been necessary at all.

DISCUSSION:

The maintenance of climax grass frequency under the close ratio line experiments, the accompanying decrease in climax grasses under the wider ratio experiments and the overall increase in soral, weed,

karrvid and herbaceous species suggest a re-arrangement of the component species towards a biotic sub-climax under joint grazing by cattle and sheep. The maintained frequency in climax grasses is ascribable to the small number of sheep kept under the close ratios. Sheep never overgrazed the climax grasses and this resulted in the vigour of grasses being maintained. The grazing did not lead to bare areas on which colonization of pioneer species was possible.

With widening ratios of cattle and sheep, fewer climax grasses and more pioneer species were present in the biotic sub-climax. This suggested vulnerability of climax grasses to grazing by large numbers of sheep, in particular susceptibility to intensity of defoliation rather than the interval between successive defoliations. The reason for the consistent tolerance shown by Chrysopogon, Digitaria, Themeda, Sporobolus and others under the diversity of large to small stock ratios is not clear. The maintained frequencies of these grasses may be due to the animals favouring pioneer and seral grasses immediately following the first summer rains. This enabled these species to make their initial growth unimpaired by precipit grazing and allowed them to progress beyond the critical leaf area stage before animals took to grazing them.

Brougham (1955) attached so much importance to adequate leaf area that he envisaged, "an understanding of the dynamics of pasture growth during the intervals between successive defoliations." He regarded this as essential to the understanding of the effects of frequency and intensity of defoliation on pasture growth.

By the time the pioneer and seral grasses and herbs had lost their attraction for stock, which might be two to three weeks after the first summer rains, the perennial tuft grasses had grown appreciably and more leaf was produced than could be grazed off by stock. The intolerance of Fingerhuthia, Tragus koelerioides and Eustachys to grazing could be attributed to these species having the same early-season preference rating as the other seral, pioneer and herbaceous species. Recurring defoliation early in the growing season

was no doubt instrumental in depleting root reserves and in preventing these species from seeding.

The decline in the numbers of Tragus koelerioides in these experiments is contrary to the experience of Mostert (1958) in the Orange Free State. This author found T. koelerioides to be most common on overgrazed "Kalkveld", and more common on grazed than on rested veld. Under some grazing treatments he even found an increase in this species.

As an explanation for this anomaly it is tentatively suggested that, in addition to its high preference rating under Koopmansfontein conditions, this species is most susceptible to trampling. On lime-veld stones comprised more than half the surface cover. Livestock grazing on such veld tended to avoid the stones. Consequently, trampling was more than twice as severe on limeveld as on "Kalkveld". The subtle difference in the reaction of this grass to grazing seems to be that under Eriochloa shrub Bushveld conditions, trampling leads to its decrease, while under Orange Free State conditions overgrazing of the more palatable Themeda triandra cover is responsible for the increase of Tragus koelerioides.

In all experiments where sheep were kept the control of Heteropogon and Cymbopogon was brought about. This could be ascribed, as was indicated in previous chapters, to sheep grazing the emerging new shoots of these grasses in spring from in among the old dry tufts. As a result, the root reserves of these species were continually depleted at a most critical time. However, these grasses were not killed out because stock were not disposed to take them in summer. This rest enabled them to recuperate again.

The preponderance of Chrysocoma and Aster could in part be assigned to the lower incidence of perennial grasses in the biotic sub-climax. These grasses have a high moisture demand in late-summer. When they decreased in frequency, moisture was made available for growth and a consequent increase in the number of these encroaching plants. Late-summer and autumn rains, occurring at a time when seral

grasses could make little use of it, might have been co-responsible for the increase in karroid species. .

There is little evidence that one class of grazing animal was more potent than the other in aiding the encroachment of karroid species. Of 18 experiments in which an increase in Chrysocoma took place, four were grazed by cattle, five by sheep and nine by both classes of stock. In 17 experiments in which Chrysocoma decreased, six were grazed by cattle, seven by sheep and four by both cattle and sheep.

Far from being regarded as poor and unpalatable grasses, Cymbopogon and Heteropogon, and in some situations Aristida vestita and Enneapogon scoparius, were most valuable. The sustained sprouting of these in spring supplied much needed herbage during the most critical nutritional season for livestock.

The maintained frequency of Chrysopogon, Themeda and Sporobolus under grazing, in spite of their early sprouting, suggests that the critical grazing period of these grasses is not in spring. It might well occur in early summer immediately following rains. At that stage there is an insufficiency of leaf area for metabolism to exceed the loss of stored reserves caused by sprouting in spring.

The abundance of short grass left over under the close cattle to sheep ratios at the time of commencement of summer rains, suggested that more sheep could be kept with advantage to utilize such herbage. On the other hand, the fact that the ground was not denuded of all growth but that most grasses had some leaf left and crowns were not unduly exposed to frost and sun might be the very reason for persistence of climax grasses under such close ratios. Shrubs being in leaf right down to the ground suggested that the closer ratios did not lead to optimum utilization of shrubs.

Under the close ratio experiments, grasses seeded with half-a-summer rest, either late or early. Against this, growth was slower and a full summer's rest was needed for grasses to seed under the wider ratios of large to small stock. It is most likely that the

larger number of sheep under wider ratios constantly kept the preferred grasses too short during the half-a-season's grazing period. This caused the grasses to be impoverished and as a result seeding could not take place once the veld was spared.

It augers well that all grasses, even when matured, were made some use of. Also, that under the close ratios tuft grasses continued sprouting until the commencement of summer rains. Sufficient bulk from dry grass and ample green sprouts is bound to arrest extreme loss in animal condition during the lean spring months. All-summer use causing a lowering in the vigour of plants, with all-summer resting causing a restoration of their vitality suggests a system of alternate summer grazing and resting. The preference shown by sheep for grass leaves when they commenced grazing upon entering a camp, and that shown by cattle for the inflorescences, may be skilfully turned to the advantage of the vegetation. Should a seed crop be required on a camp, sheep could be turned into such a camp before the seeds ripened. They would graze leaves first and seedheads would be left to mature. On the other hand, should building up of reserves be the main requirement, cattle could be put into a camp first. This would enable the translocation of nutrients in the leaves to take place to the roots before cattle took to grazing the leaves. Sheep fitted well into the utilization of grass-bush savannah in that they made greater use of shrubs than cattle did.

Chrysocoma tenuifolia must be regarded as useless in this veld because it was rarely grazed to any extent. Moisture, nutrients, light and space were used by this plant which otherwise might have been more profitably taken up by nutritious and acceptable herbage species.

The failure of many climax grasses under wide ratios to flower in even normal rainy seasons speaks against the use of such ratios.

It does not auger well for cattle, after grazing down all grasses, to commence browsing shrubs early in winter and in some cases even

in autumn. This occurred out of need and not out of preference. Shrubs are known to be protein-rich, Honrici (1940) finding the protein in Tarchonanthus minor to vary between 11.29 and 12.00 in autumn and early-winter. Energy-rich herbage is needed at this time to offset the cold.

The veld would be easily reclaimable for the reason that both single shrubs and bush clumps harboured many grasses. Since sources of seed of the endemic grasses were always available, all that would be needed would be to be given an opportunity to propagate themselves.

The need for a balance to be struck between use and abuse is clear. When sheep dug up grass roots and cattle broke off thick branches, optimum utilization has passed and misuse has set in. To claim such use of tufts or thick branches to be symptomatic of good utilization is not acceptable. Long-continued, severe browsing was beyond doubt at the root of the damage observed on some shrubs, particularly on Tarchonanthus minor.

The high incidence of Aristida curvata after the 1949 drought, especially in pans, depressions, watercourses and around shrubs, was a direct result of many perennial grasses dying during the drought and the tufts of others being trampled out. Secondary succession commenced with A. curvata on these areas. Trampling on rocky veld probably has a far greater effect upon the vegetation and its deterioration than is generally realized. Add to a stone cover of 60 per cent the inherent proficiency of cattle and sheep to avoid trampling on rocks and stones, and add to that a shrub ground cover of 20 per cent. All trampling then takes place on the remaining 20 per cent of the area which harbours the herbaceous vegetation.

Immunity to the effects of excessive trampling could be one of the reasons for the high degree of tolerance exhibited by Chrysopogon and other grasses. These species were able to withstand a large amount of trampling owing to their growth form being low and flat on the ground. Dolomiteveld was even more rocky and this might have

been a reason for this veld type tolerating grazing better than lime-
veld similarly treated. It might also explain why, even under the
wider ratios, a full summer rest completely restored vigour to the
plants on dolomite.

The greater vigour of perennial grasses growing among rocks, in
contrast to that of the same species growing on the flats, might
also be attributable to better moisture conditions existing among
rocks, especially when impervious. Also, because of the physical
difficulty stock experienced in moving among rocks, trampling and
grazing could never be as severe among rocks as on the flats.

The fact that the experiments did not run simultaneously mili-
tates against postulating conclusions. Nevertheless, certain ten-
dencies were evident. The diverging reaction of cattle and sheep to
different ratios was expected since fewer of the one and more of the
other class of stock were kept. In fact, different ratios imply
different grazing intensities per unit area for that particular live-
stock class.

The rate of grazing and the ratio of large to small stock appear-
ed to be interdependent. Light grazing with a wide ratio of large
to small stock will not have the same effect upon the vegetation which
a severe intensity, employing the same ratio, will have. Conversely,
a narrow ratio under a light stocking rate will not have the same ef-
fect as a close ratio under severe grazing. The susceptibility of
vegetation to certain types of grazers also deserves consi-
deration. Wider ratios have more sheep per se and fewer cattle.
Closer ratios have fewer sheep and more cattle per unit area.

Identical summer gains of steers under all three ratios on dolo-
mite suggests that where four steers and sixteen sheep were kept as
in experiment 14 D, steers had already reached their ceiling gain in
summer. A reduction of steer numbers to three in the one case and
to two in the other did not result in increased gain per steer but in
a lower weight increment per herd. Apparently sheep had not yet
reached their ceiling gain. The increase in summer gain from twenty

through twenty-five to twenty-eight pounds per season for the different ratios proved this to be the case. Spring losses in liveweight of sheep were greatest where the smallest number of sheep was kept and least where the largest number of sheep was grazed. This suggested a competitive effect from increased numbers of steers which went hand in hand with closer ratios.

The deviation of progressively more to digestible nutrients to maintenance and less to gains with widening large to small stock ratios, might be attributed to the greater sheer numbers. Sheep not only caused the herbage for themselves to be in short supply, but also forced cattle to graze out further in search of herbage. In doing this, more energy was expended in maintenance and less nutrients left for gains.

The main conclusion to be drawn from these experiments is that cattle and sheep, when jointly grazed on veld, may either supplement or compete with each other. The nature of the mutual interrelationships are now at all well understood. Much will depend upon the ratio in which they are kept. Also, the availability of herbage acceptable to each class of livestock will be of importance. The intensity of grazing is closely related to the large to small stock ratio in use.

Relating this information to farming practice, it appears that both classes of stock could profitably be kept with substantial financial and vegetational benefit. On limeveld the ratio of cattle to sheep would have to be close while on dolomiteveld a much wider ratio of large to small stock could be practiced.

APPENDIX

15.

LIVESTOCK GAINS AND LOSSES AND LIVELIGHT
CONTRIBUTION OF THESE FACTORS

Expt. no.			14 D.			
			1	2	3	4
Seasons.	Cattle: Rainfall: (mm.) Shoes: Liveweight: Gains: Losses: Net					
1948/49.	151	246	44	290	28	262
1949/50.	588	364	142	506	41	465
1950/51.	470	106	35	141	5	136
1951/52.	288	301	77	378	49	329
1952/53.	413	115	27	142	8	134
1953/54.	378	269	98	367	24	343
1954/55.	459	113	53	166	0	166
1955/56.	563	242	101	346	13	333
1956/57.	427	270	86	356	25	331
Mean per house.	416	273	92	365	30	335
Per cent.		108	40	148	7	141
		75	25	100	5	92
		73	27	100	5	95

MAINTAINED IN LES. T.D.N. ON DOLPHINWELD AND
TO T.D.N. OBTAINED PER POUND.

		9 D.				19 D.			
		1	2	3	4	1	2	3	4
Liveweight:	Gains: V.D.K.: Losses: T.D.N.: Maintained: Gains: V.D.N.: Losses: T.D.N.: Net:								
-	-	-	-	-	-	139	37	176	14
-	-	-	-	-	-	191	33	224	9
-	-	-	-	-	-	215	70	285	22
-	-	-	-	-	-	201	61	262	9
210	73	283	9	274	30	121	30	151	9
98	28	126	1	125	25	137	25	162	0
210	68	278	48	230	47	133	47	186	25
155	40	195	3	192	45	213	45	258	14
217	114	331	25	306	-	-	-	-	-
168	86	254	7	247	-	-	-	-	-
208	86	294	17	277	-	-	-	-	-
227	46	273	9	264	-	-	-	-	-
213	52	265	34	233	-	-	-	-	-
134	41	175	12	163	-	-	-	-	-
217	77	294	6	288	-	-	-	-	-
153	35	188	7	181	-	-	-	-	-
214	59	273	11	262	-	-	-	-	-
90	24	124	22	102	-	-	-	-	-
213	75	288	21	267	46	153	46	199	17
146	44	190	8	182	41	185	41	226	8
74	26	100	7	93	23	77	23	100	9
77	23	100	5	95	18	82	18	100	4

CHAPTER VI.

FINAL CONCLUSIONS.

1. A series of grazing experiments was conducted with cattle and sheep in *Tarchoanthus* Shrub Bushveld. The object was to determine how much stock the veld could carry and whether various grazing systems and ratios of large to small stock would influence the stability of the veld.
2. An increase in sereal, wood, karroid, pioneer and other species took place in all experiments. This was accompanied by a decrease of climax grasses. A re-arrangement of constituent species towards a biotic sub-climax under grazing is suggested.
3. The sub-climax stage proved to be as productive as the climax stage and production was more or less maintained over the years.
4. The soil analyses are interpreted to indicate that concomitant with reversion of the constituent species to the biotic sub-climax, the percentage clay in soils diminished and a corresponding increase in the percentage sand and silt took place.
5. Continuous, moderate and severe grazing accounted for the majority of sheep losses while severe grazing was responsible for all cattle losses. Poverty was the main cause of death with Goiteria and Hydrocyanic-poisoning only of secondary importance.
6. The climax grasses *Themeda triandra*, *Chrysopogon montanus*, *Digitaria ariantha* and *Sporobolus fimbriatus*, and the sereal species, *Eragrostis lehmanniana*, in spite of being sought after by both cattle and sheep, were highly tolerant to grazing.
7. *Fingerhuthia africana* and *Eustachys paspaloides* can be regarded as sensitive indicators of grazing pressure in that these grasses

were preferred by stock and were intolerant to any but the lightest grazing.

8. Although Cymbopogon plurinodis, Heteropogon contortus and Aristida vestita were discriminated against by both classes of animals, consistent grazing in spring of their green sprouts from in among old grass in the tufts kept these grasses under control.
9. The preference of stock for seral and pioneer grasses and other herbaceous species, immediately following the first early-summer rains, had the effect of easing the grazing pressure on the perennial grasses, benefiting these grasses at a most critical time.
10. The browsing of shrubs, especially Tarchonanthus minor in late-winter and spring, contributed materially to the supply of herbage at times of nutritional ebb. Although these drought resistant plants continually absorbed excesses of grazing pressure, they should nevertheless be regarded primarily as a fodder reserve. Consequently, in seasons with normal and above normal rainfall shrubs should never be severely grazed. They should rather be spared as a reserve to be used in dry years and during protracted droughts.
11. On both the lime and dolomite components of Tarchonanthus Shrub Bushveld, the normal grazing pattern over a year was as follows: For some time after the occurrence of the first summer rains, stock continued browsing until green grass became freely available. Throughout summer and autumn grasses were grazed; in early-winter animals started taking shrubs along with grasses; in late-winter both cattle and sheep browsed more heavily on the shrubs. In spring, new grass sprouts were cropped and new leaves on the shrubs were browsed until after the commencement of summer rains when stock again concentrated on the grasses.
12. The effect of drought, both incidental and prolonged, on species

frequency in *Tarchonanthus* Shrub Bushveld is not known and is deserving of thorough investigation.

13. A stocking intensity in harmony with summer growth, resulted in overgrazing in winter and spring and consequent damage to the vegetation. Severe loss in stock condition and even deaths as a result of poverty ensued. On the other hand, a stocking intensity in accordance with winter and spring availability of herbage, caused under-utilization of available grazing in summer, selective use and a waste of herbage.
14. Lime and dolomiteveld did not differ much as grazing for steers. Sheep, however, reacted more favourably to dolomite than to limeveld.
15. Animals devoted three times as much total digestible nutrients to maintenance than to liveweight gain. Spring loss in liveweight accounted for up to ten per cent loss in total digestible nutrients.
16. The results are interpreted as indicating that under severe grazing rates less non-poisonous herbage was available for sheep and Colgeria-poisoning resulted.
17. For the period over which the experiments were in being, it is evident that apart from stock measures, a lower spring liveweight loss under camp systems is about the only advantage such systems offer over continuous grazing. It is doubtful whether the cost of two or more additional fences will be offset by a lower spring loss.
18. This work suggests a re-appraisal of grazing systems under arid conditions, since there appears to be no justification, either from the vegetation or from the livestock point of view, for using elaborate fixed grazing systems. Continuous grazing would do as well and be much cheaper. At most a two-camp

system may be implemented whereby camps are alternately grazed and rested in successive growing seasons and both are opened up during dormancy of the veld. Under such a system the previous growing season's rest camp becomes the present season's grazing camp.

19. A variable stocking rate in numbers and in kind, as heavy as will maintain stock in good condition, appears to be called for. This may amount to disposal of older steers and sheep in autumn or early-winter and carrying only half the number through spring. Weaners may again be acquired when rains set in.
20. A variable grazing intensity may also be accomplished by mating cows and ewes so that parturition and the first months of lactation are synchronized with the period of flush on the veld. In addition, the earlier disposal of marketable cows, heifers, ewes and lambs will have to be considered.
21. Grazing rates of one morgen per dry sheep on lime and two-thirds of a morgen on dolomite, and a grazing rate of eight morgen per steer, irrespective of the veld type, seem to be the lower limits at which veld is maintained and at which sustained animal production takes place. For veld improvement the stocking rate will have to be lighter.
22. Grazing both cattle and sheep seems to be desirable in order to make the best use of available herbage in *Eurochloa* shrub Bushveld. On lime the ratios will have to be closer while on dolomite they may be wider.
23. Some aspects of grazing management in xerophytic savannah are not well understood. The effect of frequency and intensity of defoliation on the rate of growth of tops, and the determination of the physiological stage at which defoliation is most harmful to the plant, merit attention.

24. Provided essential adjustments are made to grazing management practices, so that a vigorous cover of grasses and well-leaved shrubs of a variety highly acceptable to stock are available, Tarchonanthus Shrub Bushveld may be both successfully and permanently farmed.

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Plate 1. All-summer wooded *Eurhynchanthus* veld of the Ghanp plateau showing the distinct two layered nature of the vegetation. Grasses up to three feet in height in the foreground and shrubs up to ten feet high in the background.



Plate 2. All-summer grazed *Eurhynchanthus* veld with *Cymbopogon pluri-*
nodis left ungrazed in the lower righthand corner. Shrubs are mainly
Eurhynchanthus minor. In the left background *Rhus pyricides* and on
the horizon *Clea africana* is seen above the other shrubs.



Plate 3. Panoramic view of Tarchonanthus veld of the Ghaap plateau, with typical bush clumps and open spaces supporting perennial grasses in between.



Plate 4. View of Dolomiteveld, indicating the stoniness of the ground, close cropping of perennial grasses growing in seams between rock slabs, Tarchonanthus minor in severely browsed condition and Rhus ciliata thicket in the background.



Plate 5. Lower view of Tarchonanthus minor showing the characteristic multiple trunk mode of growth and new shoots emerging from buds on old trunks. The rocky nature of the surface may be gauged from the amount of limestone under the shrub and in the background.



Plate 6. Chrysopsis tenuifolia heavily encroached on severely trampled limeveld near a stock watering point.



Plate 7. The severe grazing intensity of a sheep to two-thirds of a morgen resulted in Tarchonanthus minor being excessively browsed as high as sheep could reach, and also in the disappearance of perennial grasses.



Plate 8. Tarchonanthus minor damaged by steers, who were as effective as sheep in destroying this valuable shrub. Shrubs in the background are Grewia can. and Tarchonanthus camphoratus var. litt-
kunensis, neither species which is relished by livestock.



Plate 9. Marchantia minor under moderate grazing by cattle showing a continuous leafy cover from the ground upwards. Cymbopogon plurinodis tuft left ungrazed in the right foreground.



Plate 10. Limeveld after a full summer rest under one beast and four sheep to 15 . rgen. An abundance of matured, perennial leafy grasses constituted valuable spring grazing.



Plate 11. Close up view of dolomiteveld after 15 years of isolation from fire and grazing, when Heteropogon contortus became dominant. Under proper management, this species was kept in check, mainly as a result of spring grazing of green sprouts by sheep.



Plate 12. During drought tufts of Heteropogon contortus were well grazed down on dolomiteveld under a grazing intensity of one sheep per morgen.



Plate 13. A stocking rate on dolomiteveld of one sheep to two-thirds of a morgen was too severe and resulted in the disappearance of tuft grasses.



Plate 14. Close up view of Themeda triandra in seed after a full-summer rest. This grass is an important constituent of Tarchonanthus veld. It is both highly preferred by stock and at the same time most tolerant to grazing.



Plate 15. Dolomiteveld.



Plates 16. Limeveld. Plates 15 and 16: Under most grazing systems, stocking intensities and ratios of large to small stock & archonanthus veld reverted to a biotic sub-climax in which less climax grasses occurred but with more seral species, especially Eragrostis lehmanniana.

ECOLOGY OF XEROPHYTIC
SAVANNAH

BY

Johan Plof Ebersöhn, B.Sc. (Soil Cons.) M.Sc. [Rand]

TABLE XXXIX.

DOLOMITTEVELD		AT KOOPMANSPORTJEIN.			
Number of plants per 15 quadrats.		(n) : Frequency per 300 quadrats.		(s)	
Expt. 3 D.		Expt. 4 D.		Expt. 5 D.	
Syst. III		Syst. IV		Syst. V	
1947	1953	1947	1953	1951	1957
69	74	17	35	52	67
16	15	14	40	13	9
14	1	50	7	8	5
0	0	0	4	2	1
0	0	1	0	1	0
12	8	2	4	1	0
0	0	0	0	1	0
0	0	0	0	0	0
0	0	0	0	0	0
1	0	22	0	0	0
0	0	5	4	0	0
0	0	5	1	0	0
112	98	116	95		
48	627	68	463	139	206 ³⁹⁸
0	0	0	0	0	4
30	12	43	95	112	115
19	0	1	0	0	0
0	187	0	0	41	130
0	0	0	0	0	0
11	11	42	47	18	18 ³⁹⁸
0	0	0	0	7	0
108	837	154	605		
50	448	15	333	7	21 ³⁹⁸
15	16	12	15	24	0 ³⁹⁸
0	0	0	0	1	43 ³⁹⁸
58	665	24	224	25	18
123	1129	51	572		
1	61	6	84	11	18 ³⁹⁸
1	3	5	2	7	1 ³⁹⁸
14	29	4	17	0	0
0	0	0	0	0	1
16	93	15	103		
0	0	0	0	2	1
3	10	0	0	2	0
3	10	0	0		
6	20	0	0		
11	7	10	16	3	4 ³⁹⁸
28	55	12	36	34	130 ³⁹⁸
39	62	22	52		
404	2229	358	1427		

Asparagus, Euclea, Ehretia and Maytenus.
Pharmaceum, Walafride, Oxalis, Cyperus, Hibiscus,
 (s) = Surveys according to the method by Von Br
 (n) = Surveys according to the method by Raunk
 Murray (1946). Be

TABLE XLII.

GAINS AND LOSSES PER SHEEP^(m), LIVELINE MAINTAINED AND TOTAL DIGESTIBLE NUTRIENTS OBTAINED IN POUNDS PER MORGEN UNDER FIVE SYSTEMS OF GRAZING MANAGEMENT ON LIMEVELD.

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(t) = Sheep sick from Geigeria-poisoning but camp change cured them.

(p) = Sheep died from poverty.

(n) = Sheep removed 11/11/52 - 10/2/53 due to herbage shortage.

s₁, p₂, v₅ etc. = Sub-notation denotes the number of animals involved.

(v) = Sheep died from Geigeria-poisoning.

(e) = Sheep removed 15/10/49 - 10/1/50, no herbage left.

(k) = Sheep removed 28/1/53 - 10/2/53, no herbage left.

(s) = Sheep died from HCN-poisoning.

(x) = Ewes replaced wethers on the trials from this season onwards.

(m) = Weights are the mean of 10, 10, 12, 12 and 24 sheep for Expts. 1 L, 2 L, 3 L, 4 L and 5 L respectively.

TABLE XLIII.
GAINS AND LOSSES PER SHEEP^(m): LIVELINE MAINTAINED AND TOTAL DIGES-
TIBLE NUTRIENTS OBTAINED IN POUNDS PER MORGEN UNDER FIVE SYSTEMS OF
GRAZING MANAGEMENT ON DOLOMITESVELD.

Seasons.	Expt. 1 D - System I.					
	Rainfall in mm.	Summer: Gains	Spring: Losses	Net Gains	Liveweight: per morgen	T.D.N.: per morgen
1945/46.	268	-	-	-	-	-
1946/47.	300	-	-	-	-	-
1947/48.	466	-	-	-	-	-
1948/49.	151	-	-	-	-	-
1949/50.	588	12	3	9	9438	142
1950/51.	470	17	2	15	17901	260
1951/52.	288	24	12	12	25092	340
1952/53.	418	37	6	31	26220	416
1953/54.	378	26	7	19	34485	515
1954/55.	459	17	19	-2	36500	427
1955/56.	563	25	2	23	26208	384
1956/57.	427	27	29	-2	15232	191
Mean per morgen per season.	398	23	10	13	23885	334

(a) = Sheep died from HCN-poisoning.

(x) = Ewes replaced wethers on the trials from this season onwards.

(m) = Sheep removed 26/10/49 to 10/1/50 due to herbage shortage.

(t) = Sheep sick from Geigeria-poisoning and change of camp cured them.

(p₂) = Sub-notation denotes the number of animals involved.

(w) = Sheep removed 25/11/49 to 10/1/50 due to herbage shortage.

(z) = Sheep removed 8/11/49 to 10/1/50 due to herbage shortage.

(p) = Sheep died from poverty.

(m) = Weights are the mean of 10, 10, 12, 12 and 24 sheep for Expts. 1 D, 2 D, 3 D, 4 D and 5 D respectively.

Expt. 2 D - System II.						Expt. 3 D - System III.					
			Net						Net		
			Liveweight:T.D.N.:						Liveweight:T.D.N.:		
Summer:Spring:	Net	maintained: per	Summer:Spring:	Net	maintained: per	Summer:Spring:	Net	maintained: per	Summer:Spring:	Net	maintained: per
Gains:Losses:	Gains:	per morgen:	morgen:	Gains:	Losses:	Gains:	per morgen:	morgen:	Gains:	per morgen:	morgen:
-	-	-	-	-	13	15	-2	33936	395	-	-
-	-	-	-	-	20	14	6	34989	433	-	-
-	-	-	-	-	52	11	21 (m)	30408	432	-	-
-	-	-	-	-	20	9	11	24948	333	-	-
12	2	10	9438	145	35	15	20	34560	459	-	-
21	2	19 (s)	18122	277	19	4	15	24973	343	-	-
18	10	8	26622	343	32	6	26	16524	287	-	-
42	5	37	27740	452	29	3	26	33264	476	-	-
27	8	19	37026	498	-	-	-	-	-	-	-
21	27	-6 (p)	37595	432	-	-	-	-	-	-	-
17	9	8 (p ₂)	23296	303	-	-	-	-	-	-	-
18	16	2 ²	13440	164	-	-	-	-	-	-	-
22	10	12	24160	327	25	10	15	29200	395	-	-

Expt. 4 D - System IV.						Expt. 5 D - System V.					
Summer: Gains	Spring: Losses	Net Gains	Liveweight: per morgen	T.D.N.: per morgen	Net Gains	Summer: Gains	Spring: Losses	Net Gains	Liveweight: per morgen	T.D.N.: per morgen	Net Gains
17	13	4	35616	433	13	17	-4	34104	390	-	-
24	15	9	39092	389	24	19	5	35480	439	-	-
28	3	25	32942	469	29	5	24	28779	479	-	-
33	18	15	28465	394	23	9	14	27972	376	-	-
38	11	27	36822	527	35	8	27	35280	407	-	-
16	5	11	26741	350	22	19	3	25194	311	-	-
31	4	27	16524	288	30	3	27	17595	297	-	-
36	4	32	34848	516	34	2	32	35640	527	-	-
-	-	-	-	-	28	2	26	27588	409	-	-
-	-	-	-	-	22	17	5	31390	393	-	-
-	-	-	-	-	24	13	11	25298	338	-	-
-	-	-	-	-	17	15	2	14224	182	-	-
28	9	19	31381	420	25	11	14	28212	378	-	-

AREA^(s) BELOW THE LIVELIGHT-CURVE OF SHEEP

Area of the liveweight-curve.						
Period on Experiment.	System I	System II	System III	System IV	System V	
5.2.46-25.5.48.	-	-	3141	3407	1186	
26.5.48-14.8.51.	-	-	3590	3794	3648	
15.8.51-15.7.53.	-	-	1764	1827	1822	
15.8.50-17.6.52.	1878	1932	-	-	-	
18.6.52-12.7.55.	3488	3670	-	-	-	
16.7.53-12.7.55.	-	-	-	-	2096	
13.7.55-19.2.57.	1258	1125	-	-	1224	

N.S. = Not significant.

(s) = The area of the liveweight-curve was calculated from the average liveweight of 10, 10, 12, 12 and 24 sheep for Experiments 1 D, 2 D, 3 D, 4 D and 5 D respectively.

* = H-requirement = 9.21 at P = 0.010 (2 D.F.).

(n) = Values given are Mann-Whitney values of U and Siegel's (1956) Table K values for probability ($n_1=n_2=19$).

TABLE XLV.

GRAZING DOLOMITVELD UNDER FIVE GRAZING MANAGEMENT SYSTEMS.

Calculated values of												Significant Differences P ≤ 0.010.	
H ^{3c}	Z					P							
	1D/2D	2D/5D	1D/5D	3D/4D	4D/5D	3D/5D	1D/2D	2D/5D	1D/5D	3D/4D	4D/5D	3D/5D	
30.26	-	-	-	4.18	3.22	1.33	-	-	-	<0.001	<0.001	0.092	4D > 3D; 5D.
7.86	-	-	-	-	-	-	-	-	-	-	-	-	N.S.
1.17	-	-	-	-	-	-	-	-	-	-	-	-	N.S.
-	1.05	-	-	-	-	-	0.147	-	-	-	-	-	N.S.
-	1.45	-	-	-	-	-	0.074	-	-	-	-	-	N.S.
-	(n)	(n)	(n)	-	-	-	(n)	(n)	(n)	-	-	-	-
9.84	74.0	92.5	99.5	-	-	-	0.002	0.02	0.02	-	-	-	1D > 2D

ANNEXURE 8.

LIVEWEIGHT GAINS AND LOSSES AND LIVEWEIGHT MAINTAINED IN LB. T.D.N.
ON LIMEVELD AND CONTRIBUTION OF THESE FACTORS TO T.D.N.

PRODUCED PER MORGEN.

PRODUCED PER MORGEN.																																																	
Expt. 1 L - System I.										Expt. 2 L - System II.										Expt. 3 L - System III.										Expt. 4 L - System IV.										Expt. 5 L - System V.									
		Liveweight:		Net		Liveweight:		Net		Liveweight:		Net		Liveweight:		Net		Liveweight:		Net		Liveweight:		Net		Liveweight:		Net		Liveweight:		Net																	
Seasons.	Rainfall (mm.)	maintained:	Gains:	T.D.N.:	Loss:	T.D.N.:	maintained:	Gains:	T.D.N.:	Loss:	T.D.N.:	maintained:	Gains:	T.D.N.:	Loss:	T.D.N.:	maintained:	Gains:	T.D.N.:	Loss:	T.D.N.:	maintained:	Gains:	T.D.N.:	Loss:	T.D.N.:	maintained:	Gains:	T.D.N.:	Loss:	T.D.N.:																		
1945/46.	268	395	42	437	41	396	428	64	492	46	446	390	74	464	66	398	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-																	
1946/47.	300	473	92	565	44	521	435	74	509	46	463	379	64	443	52	391	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-																	
1947/48.	466	363	88	451	14	437	357	60	417	49	368	357	113	470	41	429	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-																	
1948/49.	151	262	56	318	24	294	244	56	300	19	281	272	42	314	27	287	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-																	
1949/50.	588	331	113	444	41	403	358	124	482	57	425	376	120	496	57	439	253	131	384	14	370	243	120	363	14	349	-	-	-	-	-	-																	
1950/51.	470	251	49	300	8	292	231	64	295	11	284	266	71	337	11	326	249	74	323	6	317	231	53	284	5	279	-	-	-	-	-	-																	
1951/52.	288	179	106	285	30	255	190	92	282	5	277	183	109	292	19	273	344	64	408	60	348	323	63	386	30	356	-	-	-	-	-	-																	
1952/53.	418	332	92	424	38	386	327	99	426	44	382	304	99	403	46	357	304	85	389	23	366	262	90	352	53	299	-	-	-	-	-	-																	
1953/54.	378	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	367	67	434	38	396	356	95	451	29	422	-	-	-	-	-	-																	
1954/55.	459	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	360	67	427	52	375	367	76	443	65	378	-	-	-	-	-	-																	
1955/56.	563	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	272	31	303	43	260	284	55	339	46	293	-	-	-	-	-	-																	
1956/57.	427	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	154	74	228	41	187	158	78	236	29	207	-	-	-	-	-	-																	
Mean per season.	398	323	80	403	30	373	321	79	400	34	366	316	86	402	40	362	288	74	362	35	327	278	79	357	34	323	-	-	-	-	-	-																	
Per cent.		80	20	100	7	93	80	10	100	9	91	79	21	100	10	90	80	20	100	10	90	78	22	100	9	91	-	-	-	-	-	-																	

ANNEXURE 9.

LIVEWEIGHT GAINS AND LOSSES AND LIVEWEIGHT MAINTAINED IN LB. T.D.N.

ON DOLOMITTEVELD AND CONTRIBUTION OF THESE FACTORS TO T.D.N.

PRODUCED PER MORGAN.

PRODUCED PER ACRE.																																				
Expt. 1 D - System I.						Expt. 2 D - System II.						Expt. 3 D - System III.						Expt. 4 D - System IV.						Expt. 5 D - System V.												
Seasons.	Rainfall (mm.)	Liveweight maintained:	Gains:T.D.N.:	Losses:T.D.N.:	Net	Liveweight maintained:	Gains:T.D.N.:	Losses:T.D.N.:	Net	Liveweight maintained:	Gains:T.D.N.:	Losses:T.D.N.:	Net	Liveweight maintained:	Gains:T.D.N.:	Losses:T.D.N.:	Net	Liveweight maintained:	Gains:T.D.N.:	Losses:T.D.N.:	Net	Liveweight maintained:	Gains:T.D.N.:	Losses:T.D.N.:	Net											
1945/46.	268	-	-	-	-	-	-	-	-	390	46	436	41	395	409	60	469	36	433	392	44	436	46	390	345	85	430	41	389	407	85	492	53	439		
1946/47.	300	-	-	-	-	-	-	-	-	401	71	472	39	433	378	99	477	8	469	380	101	481	12	469	327	116	443	49	394	319	80	399	23	376		
1947/48.	466	-	-	-	-	-	-	-	-	349	113	462	30	432	423	134	557	30	527	405	124	429	22	407	307	56	363	13	350	286	76	362	51	311		
1948/49.	151	-	-	-	-	-	-	-	-	286	71	357	24	333	190	109	299	11	288	202	106	308	11	297	400	127	527	11	516	409	120	529	7	522		
1949/50.	588	108	42	150	8	142	108	42	150	5	145	376	124	500	41	459	-	-	-	317	97	414	5	409	-	-	-	-	-	-	-	-	-			
1950/51.	470	205	60	265	5	260	208	74	282	5	277	287	67	354	11	333	-	-	-	360	79	439	46	393	-	-	-	-	-	-	-	-	-			
1951/52.	288	288	85	373	33	340	306	64	370	27	343	190	113	303	16	287	-	-	-	290	83	373	35	338	-	-	-	-	-	-	-	-	-			
1952/53.	418	301	131	432	16	416	318	148	466	14	452	382	102	484	8	476	-	-	-	163	60	223	41	182	-	-	-	-	-	-	-	-	-			
1953/54.	378	396	138	534	19	515	425	95	520	22	498	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
1954/55.	459	419	60	479	52	427	432	74	506	74	432	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
1955/56.	563	301	88	389	5	384	267	60	327	24	303	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
1956/57.	427	175	95	270	79	191	154	64	218	44	164	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Mean per season.	398	274	87	361	27	334	277	78	355	28	327	333	88	421	26	395	347	98	445	25	420	328	88	406	28	378	78	22	100	6	94	80	20	100	7	93
Per cent.		77	23	100	8	92	78	22	100	8	92	79	21	100	6	94																				

TABLE LXI.

GAINS AND LOSSES PER STEER^(m) AND PER SHEEP^(m) : LIVEWEIGHT MAINTAINED
AND T.D.N. OBTAINED IN POUNDS PER MORGEN UNDER DIFFERENT GRAZING
SYSTEMS ON LIMEVELD AT KOOPMANSPONTJIN.

Expt. 16 L - System IV.										Expt. 17 L - System VII.										Expt. 19 L - System VI.										Expt. 14 L - System VII.									
Seasons.	Total	Cattle:	Summer:		Spring:	Net	Liveweight:		Not	Summer:	Spring:	Net	Liveweight:		Not	Summer:	Spring:	Net	Liveweight:		Not	Summer:	Spring:	Net	Liveweight:		Not	Summer:	Spring:	Net	Liveweight:		Not						
	Rainfall:	or	Gains:	Losses:	Gains:	per	per	T.D.N.:	Gains:		Losses:	Gains:	per	per	T.D.N.:		Gains:	Losses:	Gains:	per	per		T.D.N.:	Gains:	Losses:	Gains:	per		per	T.D.N.:	Gains:	Losses:	Gains:	per	per	T.D.N.:			
	(mm.)	Sheep:	Gains:	Losses:	Gains:	per	per	T.D.N.:	Gains:	Losses:	Gains:	per	per	T.D.N.:	Gains:	Losses:	Gains:	per	per	T.D.N.:	Gains:	Losses:	Gains:	per	per	T.D.N.:	Gains:	Losses:	Gains:	per	per	T.D.N.:							
1952/53.	418	C	388	51	337	21883	354		355	74	261	23646	359	244	113	131	16427	235																					
		S	40	3	37	1869	29		44	0	44	2274	39	34	10	24	11273	160																					
1953/54.	378	C	354	85	269	22295	341		386	94	292	25319	383	279	156	123	18966	265																					
		S	32	8	24	3176	43		34	3	31	3600	50	30	10	20	8349	122																					
1954/55.	459	C	246	132	114	23451	312		277	195	82	25215	327	238	153	85	21231	279																					
		S	23	14	9	1977	27		32	3	29	2160	43	21	12	9	10220	131																					
1955/56.	563	C	282	54	228	25003	359		279	83	196	25155	352	267	70	197	21809	313																					
		S	31	6	25	2402	37		26	3	23	2312	34	34	6	20	9003	138																					
1956/57.	427	C	318	90	228	24556	355		316	99	217	22776	333	347	95	252	24676	364																					
		S ⁽⁺⁾	23	28	-5	2443	29		22	26	-4	2353	28	15	18	-3	9291	109																					
Mean per season.	449	C	318	82	236	-	-		323	109	214	-	-	275	117	158	-	-																					
		S	30	12	18	-	-		32	7	25	-	-	27	11	16	-	-																					
Mean per morgen		C	27	7	20	23438	344		27	9	18	24422	351	23	10	13	20622	291																					
per season.		S	25	1	15	2372	33		26	0.5	2.1	2540	38	9	4	5	2627	132																					

(m) = Weights are the mean of four steers and four sheep (Expts. 16L and 17L) and four steers and 16 sheep Expts. 19L and 14L).

(x) = Stock removed 3/1/53 - 24/2/53, no herbage left.

(s) = Sheep died from poverty 27/1/53.

(p) = Sheep died from Gelgeria-poisoning 27/1/56, 9/7/56.

(t) = Season for sheep of only eight months' duration.

(p₂) = Sub-notation denotes the number of animals involved.

ANNEXURE 12.

LIVEWEIGHT GAINS AND LOSSES AND LIVEWEIGHT MAINTAINED										IN POUNDS T.D.N. ON LIVEWELD AND CONTRIBUTION OF THESE FACTORS TO T.D.N.										OBTAINED PER MORGAN.																			
Expt. 16 L - System IV.										Expt. 17 L - System VII.										Expt. 19 L - System VI.										Expt. 14 L - System VII									
Seasons.	Rainfall: (in.)	Cattle: or Sheep	Liveweight: maintained	Gains:	T.D.N.:	Loss:	T.D.N.:	Net	T.D.N.:	Liveweight: maintained	Gains:	T.D.N.:	Loss:	T.D.N.:	Net	T.D.N.:	Liveweight: maintained	Gains:	T.D.N.:	Loss:	T.D.N.:	Net	T.D.N.:	Liveweight: maintained	Gains:	T.D.N.:	Loss:	T.D.N.:	Net	T.D.N.:									
1952/53.	418	C	252	114	366	12	354			272	104	376	17	359	189	72	261	26	235				216	79	295	30	265												
		S	21	9	30	1	29			26	13	39	0	39	129	40	169	9	160				128	38	170	14	156												
1953/54.	378	C	256	104	360	19	341			291	113	404	21	383	218	82	300	35	265				233	86	319	26	293												
		S	36	9	45	2	43			41	10	51	1	50	96	35	131	9	122				101	38	139	7	132												
1954/55.	459	C	270	72	342	30	312			290	81	371	44	327	244	70	314	35	279				212	67	279	49	230												
		S	23	7	30	3	27			35	9	44	1	43	117	25	142	11	131				119	22	141	13	128												
1955/56.	563	C	288	83	371	12	359			289	82	371	19	352	251	78	329	16	313				240	77	317	20	297												
		S	29	9	38	1	37			27	8	35	1	34	103	40	143	5	138				102	27	129	5	124												
1956/57.	427	C	282	93	375	20	355			262	93	355	22	333	284	102	386	22	364				266	100	366	35	331												
		S	28	7	35	6	29			27	7	34	6	28	107	18	125	16	109					29	92	23	69												
Mean per season.	449	C	269	94	363	19	344			281	95	376	25	351	237	81	318	27	291				27	82	315	32	283												
		S	27	8	35	22	33			31	9	40	2	38	110	32	142	10	132				103	31	134	12	122												
Per cent.		C	74	26	100	5	95			75	25	100	7	93	75	25	100	8	92				74	26	100	10	90												
		S	77	23	100	3	93			77	23	100	4	96	78	22	100	7	93				77	23	100	9	91												

- (x) = Stock removed 3/1/53 - 24/2/53, due to herbage shortage.
- (s) = Sheep died from poverty 27/1/53 and 1/9/55.
- (n) = Sheep sick from Geigeria-poisoning 22/10/48 and change of camp cured them.
- (t) = Sheep grazed over all the camps of this trial, herbage short and fences could not keep them in.
- (k) = Stock removed (15/10/49 - Cattle, 21/11/49 - Sheep) to 10/1/50 due to herbage shortage.
- (p) = Sheep died from HCN-poisoning 1/2/50.

(o) = Stock removed (Cattle - 8/11/49, Sheep - 6/12/49) due to herbage shortage, up to 1c/1/50.

(r) = Cattle removed from 30/1/52 to 12/2/52, no herbage left.

(m) = Liveweights are the means of 8 steers and 4 sheep - Expt. 18 L.

4	"	"	4	"	-	"	17 L.
4	"	"	16	"	-	"	14 L.
3	"	"	24	"	-	"	9 L.
2	"	"	32	"	-	"	19 L.

(2) = The low net gains in this season was due to the experiments being terminated before sheep could regain condition.

(s₃) = Sub-notation denotes the number of animals involved.

RATIOS OF LARGE TO SMALL STOCK

(u) = Liveweights are the means of 4 steers and 16 sheep-Expt. 14 D.
3 " " 24 " -Expt. 9 D.
2 " " 32 " -Expt. 19 D.

(v) = Sheep died from unknown causes 22/5/53.

(b) = Stock removed (Cattle 8/11/49) and Sheep (21/11/49) up to 10/1/50 due to herbage shortage.

(c) = Stock removed (Cattle 15/10/49) and Sheep (21/11/49) up to 10/1/50 due to herbage shortage.

(e) = Steers removed 30/1/52 up to 10/1/53 due to herbage shortage.

(z) = The low net gains registered in this season are due to the experiments being terminated before sheep could regain condition.

(c) = Stock removed (Cattle 15/10/49) and Sheep(21/11/49) up to 10/1/50 due to herbage shortage.

(2) = The low net gains registered in this season are due to the experiments being terminated before sheep could regain condition.

TABLE LXXIV.

AREA BELOW THE LIVELINE-CURVE OF CATTLE AND SHEEP GRAZING
LIVELINE ACCORDING TO FIVE LARGE TO SMALL STOCK RATIOS.

STEERS.									
Calculated									
Ratio of Cattle to Sheep	Expt. 18 L.	Expt. 17 L.	Expt. 14 L.	Expt. 9 L.	Expt. 19 L.	P.			
Period on Experiment	Steers: no.	Steers: no.	Steers: no.	Steers: no.	Steers: no.	18L/17L	18L/14L	17L/9L	17L/14L
8.6.48-5.1.51.	2355	3607	0	0	2361	3.43	-	-	-
8.6.48-1.8.51.	1397	62	-	-	2445	1.64	-	-	-
6.1.51-1.7.52.	2478	2343	2323	21895	E.28	18678	33.31	5.04	2.53
6.5.51-15.7.53.	E.32	27490	E.14	31836	-	-	-	4.49	-
15.8.51-15.7.53.	E.30	13070	E.15	13941	-	-	-	1.50	-
2.7.52-15.7.53.	091	11215	E.13	6137	-	-	-	4.51	-
2.7.52-13.7.54.	89	13702	E.68	24570	-	34.13	5.87	1.17	5.04
2.7.52-12.7.55.	87	23398	E.32	39095	-	59.77	6.82	0.35	6.44
16.7.53-10.7.56.	245	27851	226	26675	-	25.64	0.03	4.15	4.32
16.7.53-10.7.56.	212	27317	269	28297	-	-	1.29	-	-
14.7.54-6.7.57.	420	34610	406	33217	-	7.77	-	-	-
14.7.54-6.7.57.	404	32993	-	-	-	-	5.08	-	-
13.7.55-6.7.57.	521	20313	508	17110	-	4.80	-	-	-
11.7.56-6.7.57.	605	8345	612	6975	-	1.90	-	-	-
11.7.56-6.7.57.	634	7979	637	6967	-	-	6.88	-	-
SHEEP (s).									
8.6.48-23.5.50.	-	-	-	2193	2015	20.45	-	-	2.19
24.5.50-1.7.52.	-	-	-	2319	2144	8.61	-	-	-
2.7.52-13.7.54.	2406	2513	-	-	-	0.77	-	-	-
14.7.54-12.7.55.	825	918	1097	-	-	18.30	2.05	3.90	3.08
13.7.55-19.2.57.	1492	1360	1305	-	-	10.29	1.92	3.27	1.17

(s) = The area of the livelime-curve was calculated from the average livelime of 4, 4, 16, 24 and 32 sheep for Experiments 18 L, 17 L, 14 L, 9 L and 19 L respectively.

* = H-requirement = 9.21 at P = 0.010 (2 D.F.)

N.S. = Not significant.

Author Ebersohn J P

Name of thesis Ecology of Xerophytic Savannah of Griqualand west with special reference to grazing 1962

PUBLISHER:

University of the Witwatersrand, Johannesburg

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