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Ecology of xerophytic savannah of Griqualand West, with special reference to grazing

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ANNEXURE 10.

LIVEWEIGHT GAINS AND LOSSES AND LIVE-WEIGHT MAINTAINED IN LBS. T.D.N. ON LIMEVELD

AND CONTRIBUTION OF THESE FACTORS TO T.D.N. OBTAINED PER MORGEN.

Seasons.	Rainfall (mm.)	Cattle or Sheep.	Expt.13 L – One unit to 9 morgen. Liveweight maintained	Gains	T.D.N.	Loss.	Net T.D.N.	Expt.14 L – One unit to 12 morgen. Liveweight maintained	Gains	T.D.N.	Loss.	Net T.D.N.	Expt.15 L – One unit to 15 morgen. Liveweight maintained	Gains	T.D.N.	Loss.	Net T.D.N.
1952/53.	418	C	295	78	373	51	322	216	79	295	30	265	230	73	303	26	277
		S	115	56	171	15	156	132	38	170	14	156	82	41	123	3	120
1953/54.	378	C	250	71	321	5	268	233	86	319	26	293	223	69	292	38	254
		S	174	40	214	8	206	101	38	139	7	132	128	25	153	4	149
1954/55.	459	C	259	84	343	50	293	212	67	279	49	230	207	88	295	32	263
		S	192	37	229	25	204	119	22	141	13	128	115	14	129	11	118
1955/56.	563	C	261	76	337	29	308	240	77	317	20	297	205	77	282	13	269
		S	130	28	158	14	144	102	27	129	5	124	82	26	108	7	101
1956/57.	427	C	295	124	419	32	387	266	100	366	35	331	225	85	310	21	289
		S	75	33	108	19	89	63	29	92	23	69	49	20	69	17	52
Mean per season.	449	C	272	87	359	43	316	233	82	315	32	283	218	78	296	26	270
		S	137	39	176	16	160	103	31	134	12	122	91	25	116	8	108
Per cent.		C	76	24	100	12	88	74	26	100	10	90	74	26	100	9	91
		S	78	22	100	18	82	77	23	100	9	91	78	22	100	7	93

ANNEXURE 11.

LIVEWEIGHT GAINS AND LOSSES AND LIVEWEIGHT MAINTAINED IN LBS. T.D.N. ON DOLOMITE/VELD

AND CONTRIBUTION OF THESE FACTORS TO TOTAL T.D.N. OBTAINED PER MORGEN.

Seasons.	Rainfall. (m.)	Cattle or Sheep	Expt.13 D - One unit to 9 morgen. Liveweight maintained	Gains	T.D.N.	Loss.	Net T.D.N.	Expt.14 D - One unit to 12 morgen. Liveweight maintained	Gains	T.D.N.	Loss.	Net T.D.N.	Expt.15 D - One unit to 15 morgen. Liveweight maintained	Gains	T.D.N.	Loss.	Net T.D.N.
1952/53.	418	C	366	136	502	51	451	269	98	367	24	343	314	48	362	30	332
		S	149	75	224	2	222	113	53	166	0	166	90	47	137	2	135
1953/54.	378	C	339	143	482	32	450	255	106	361	27	334	252	98	350	28	322
		S	207	41	248	8	240	161	29	190	5	185	127	3	130	5	125
1954/55.	459	C	321	94	415	58	357	257	72	329	49	280	214	62	276	29	247
		S	136	47	183	6	177	99	38	137	10	127	75	24	99	10	89
1955/56.	563	C	335	135	470	33	437	242	104	346	13	333	237	74	311	13	298
		S	143	49	192	6	186	112	36	148	7	141	88	30	118	5	113
1956/57.	427	C	365	126	491	37	454	270	86	356	25	331	237	71	308	24	284
		S	90	28	118	28	90	70	21	91	15	76	54	14	68	15	53
Mean per annum.	449	C	345	127	472	42	430	259	93	352	28	324	241	80	321	25	296
		S	145	48	193	10	183	111	35	146	7	139	87	23	110	7	103
Per cent.		C	73	27	100	9	91	74	26	100	8	92	75	25	100	8	92
		S	75	25	100	5	95	76	24	100	5	95	79	21	100	7	93

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.

Experiment No.		Particulars.
16 L.	Limeveld:	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.*	:	System VII: Four units to 48 morgen : 1 beast to 4 sheep.
19 D.	Dolomiteveld:	System VI : Four units to 48 morgen : 1 beast to 4 sheep.
14 D.*	:	System VII: Four units to 48 morgen : 1 beast to 4 sheep.

* = These experiments were used in Chapter V (A).

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).../183

(1) PLANT COUNTS:

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

TABLE LVII.../184

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 System IV		Expt.17 L System VII		Expt.19 L System VI		Expt.14 L System VII	
	1952	1957	1952	1957	1952	1957	1952	1957
CLIMAX SPECIES:								
Themeda triandra.....	23	28	35	40	30	29	9	18
Chrysopogon montanus.....	38	43	29	34	5	15*	20	14
Digitaria eriantha.....	0	6*	1	9**	19	9	8	10
Fingerhuthia africana.....	13	29**	15	17	26	9**	16	4**
Cymbopogon plurinodis.....102		94	46	61	6	3	18	2**
Aristida vestita.....	25	10**	8	6	0	0	1	0
Eustachys paspaloides.....	6	0**	3	2	8	0**	5	0**
Sporobolus fimbriatus.....	0	0	21	14	7	7	29	0**
Aristida uniplumis.....	0	1	0	0	0	0	0	0
Heteropogon contortus.....	0	0	0	2	0	0	0	0
Panicum coloratum.....	0	0	0	0	15	0**	0	0
SERAL SPECIES:								
Eragrostis lehmanniana....	80	216**	74	187**	172	186	142	222**
E. echinochloidea.....	0	0	0	8**	0	19**	0	2
E. denudata.....	0	0	0	0	1	0	0	0
Cropetium capense.....	6	51**	13	78**	46	127**	50	147**
Cynodon incompletus.....	0	0	0	0	11	21*	0	0
Tragus koelerioides.....	2	0	7	0**	21	0**	14	0**
PIONEER SPECIES:								
Enneapogon brachystachyus.	79	36**	54	46	58	122**	48	134**
Aristida curvata.....	37	2**	13	15	14	41**	23	36
Tragus racemosus.....100		6**	68	3**	32	6**	56	3**
WEEDS:								
Geigeria africana.....	53	88**	48	116**	156	177	132	207**
Chrysocoma tenuifolia.....	29	39	5	19**	18	24	9	5
Tribulus terrestris.....	0	0	2	2	0	1	0	4
KARROID SPECIES:								
Indigofera patens.....	0	0	0	3	3	6	6	6*
Aster muricatus.....	10	18	4	15**	14	15	37	62**
Monechma divaricatum.....	0	4	0	10**	4	32**	1	16**
OTHER SPECIES:								
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, Pachonanthus 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.../185

TABLE LVIII.

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

	Frequency per 300 Quadrats(s). One Beast and Four Sheep.			
	Expt. 19 D. System VI		Expt. 14 D. System VII	
	1952	1957	1952	1957
CLIMAX SPECIES:				
Sporobolus fimbriatus	6	0**	3	4
Chrysopogon montanus	16	8	22	20
Digitaria eriantha	17	9	20	13
Heteropogon contortus	2	0	2	5
Themeda triandra	1	0	8	4
Cymbopogon plurinodis	3	3	2	1
Fingerhuthia africana	1	1	0	0
Panicum coloratum	1	0	0	0
SERAL SPECIES:				
Eragrostis lehmanniana	189	247**	207	219**
E. obtusa	8	36**	0	11*
E. echinochloidea	0	53**	0	13*
E. denudata	20	0**	16	13*
Cropetium capense	101	171**	165	228**
Brachiaria eruciformis	0	2	0	0
Enneapogon scoparius	0	0	6	7
PIONEER SPECIES:				
Enneapogon brachystachyus	71	61	139	102**
Aristida curvata	34	25*	70	29**
Tragus racemosus	64	22**	64	12**
WEEDS:				
Geigeria africana	27	63**	0	20**
Chrysocoma tenuifolia	10	24	2	8
Tribulus terrestris	1	1	0	1
KARROID SPECIES:				
Aster muricatus	6	14	1	8*
Indigofera patens	1	1	4	4
OTHER SPECIES:				
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, Sericorema, Pharnaceum, Oxalis, Rhenharis and Moraea.

* = Denotes significant difference at P = 0.05.

** = Denotes significant difference at P = 0.01.

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

Themeda.../186

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 Geigeria 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.../187

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 mucronata, Rhus lancea, R. ciliata, Royena 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.../188

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 watercourses, 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.../189

TABLE LVIX.

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

	One Beast to one sheep.						One Beast to Four Sheep.					
	Expt.16L-Syst. IV			Expt.17L-Syst.VII			Expt.19L-Syst. VI			Expt.14L-Syst.VII		
Soil horizon (inches).	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	7.78
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)	.0021	.0008	.0008	.0023	.0008	.0004	.0031	.0008	.0004	.0018	.0009	.0005
C.(%)	0.95	0.69	0.53	0.86	0.75	0.57	0.96	0.90	0.66	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.	.0007	.0008	.0006	.0009	.0008	.0005	.0010	.0009	.0006	.0011	.0010	.0029
K.	.0006	.0006	.0002	.0011	.0009	.0003	.0010	.0012	.0005	.0015	.0010	.0005
Ca.	.0048	.0048	.0030	.0046	.0033	.0020	.0050	.0059	.0054	.0037	.0024	.0022
Mg.	.0009	.0008	.0002	.0002	.0007	.0003	.0005	.0011	.0003	.0007	.0003	.0045
HCO_3.	.0156	.0164	.0090	.0160	.0109	.0080	.0151	.0224	.0064	.0142	.0085	.0178
Cl.	.0024	.0018	.0021	.0018	.0030	.0024	.0041	.0030	.0024	.0030	.0030	.0027

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

(z) = 1% Citric acid solution.

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

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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.

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TABLE LX.

MECHANICAL AND CHEMICAL ANALYSES(s) OF SOILS UNDER TWO GRAZING SYSTEMS WITH CATTLE AND SHEEP ON DOLOMITEVELD AT KOOPMANSFONTEIN.

	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)	.0044	.0071	.0018	.0036	.0038	.0056
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.	10.0:1	9.5:1	8.7:1	8.7:1	9.8:1	8.5:1
Water-soluble salts (%)(n):						
Na.	.0009	.0010	.0017	.0010	.0010	.0009
K.	.0011	.0003	.0003	.0008	.0006	.0003
Ca.	.0063	.0052	.0052	.0026	.0026	.0031
Mg.	.0001	.0009	.0014	.0002	.0002	.0004
HCO_3.	.0179	.0195	.0193	.0077	.0090	.0107
Cl.	.0032	.0021	.0027	.0027	.0024	.0024

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

(z) = 1% Citric acid solution.

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

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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) LIVEWEIGHT:

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 LXI.../193

TABLE LXII.

GAINS AND LOSSES PER STEER(m) AND PER SHEEP(m); LIVEWEIGHT MAINTAINED AND T.D.N. OBTAINED IN POUNDS PER MORGEN FROM TWO GRAZING SYSTEMS ON DOLO-MITEVELD AT KOOPMANSFONTEIN.

			Expt. 19 D - System VI.					Expt. 14 D - System VII.				
Seasons.	Total Rainfall (mm.)	Cattle or Sheep	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	Net T.D.N. per morgen	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	Net T.D.N. per morgen
1952/53.	418	C	281	67	214 (r)	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 (x)	20014	296	354	56	298	21048	333
		S	30	11	19	9125	130	31	8	23	9733	141
1956/57.	427	C (t)	267	75	192	22957	325	294	122	172	23440	331
		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	9[illegible]	139

(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

Regarding.../1[illegible]

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 LIVEWEIGHT-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.../196

TABLE LXIII.

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

Period on Experiment.	STEERS. One Beast to one Sheep. Expt. 16 L. System IV. Steer No.	Area	Expt. 17 L. System VII. Steer No.	Area	Calculated values of z	P	Significant Difference P ≤ 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.
	SHEEP(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.

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TABLE LXIV.

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

	STEERS. One Beast to four Sheep.						
	Expt. 19 L. System VI.		Expt. 14 L. System VII.		Calculated values of		
Period on Experiment	Steer No.	Area	Steer No.	Area	t 19L/14L	P 19L/14L	Significant Difference P≤ 0.010
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.
2.7.52-12.7.55	E. 2	26105	763	25613	0.56	0.290	N.S.
16.7.53-10.7.56	263	25493	266	21282	3.22	<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.
	SHEEP(a)						
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.

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

N.S. = Not significant.

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TABLE LXV.

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

Period on Experiment.	Expt. 19 D. System VI. Steer: No.	Area.	Expt. 14 D. System VII. Steer: No.	Area.	Calculated values of z	P	Significant Difference P ≥ 0.010.
			STEERS. One Beast to four Sheep.				
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.
			SHEEP(a)				
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.

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

N.S. = Not significant.

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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 livoweight-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.

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TABLE LXVI.

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

	Limeveld.			Dolomiteveld.			
	1 Beast to 1 Sheep		1 Beast to 4 Sheep		1 Beast to 4 Sheep		
	Expt.16L: Syst. IV	Expt.17L: Syst.VII	Expt.19L: Syst. VI	Expt.14L: Syst.VII	Expt.19D: Syst. VI	Expt.14D Syst.VII	
Liveweight in pounds.	1026	1034	901	903	972	1001	
Warm carcase-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.

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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 seral, 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

/grass

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

The increase of Chrysocoma, Aster and Monechma 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 palatibility, especially to sheep, to be often overgrazed and to be replaced by Aristidas 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 bared 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 woods 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

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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 spared veld would provide abundant quantity,

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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 carcase 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

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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 DOLOMITEVELD AND CONTRIBUTION OF THESE FACTORS TO T.D.N.OBTAINED PER MORGEN.

Seasons.	Rainfall (mm.)	Cattle or Sheep	One beast to four Sheep. Expt. 19 D - System VI. Liveweight maintained	Gains	T.D.N.	Loss.	Net T.D.N.	Expt. 14 D - System VII. Liveweight maintained	Gains	T.D.N.	Loss.	Net T.D.N.
1952/53.	418	C	208	83	291	15	276	269	98	367	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

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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.

Experiment no.	Particulars.
	Limeveld:
18 L.	System VII - 8 steers and 4 sheep on 88 morgen.
17 L.(n)	- 4 steers and 4 sheep on 48 morgen.
14 L.(n)	System VI - 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.
	Dolomitevold:
14 D.(n)	System VI - 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 dolomitevold.

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

(1) Plant counts,

(2) Grazing observations,

(3) Soil analysis,

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(4) Liveweights,

(5) Area of the liveweight-curve, and

(6) Geigeria-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.

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TABLE LXVIII.

PLANT RESPONSE TO DIFFERENT RATIOS OF CATTLE AND SHEEP ON LITE-VELD AT KOOPMANSFONTEIN.

	Frequency(s) per 300 Quadrats.						Number of plants(r) in 15 Quadrats.		Frequency(s) per 300 Quadrats.	
Experiment no.	18 L.		17 L.		14 L.		9 L.		19 L.	
Ratio Cattle : Sheep.	2 / 1		1 / 1		1 / 4		1 / 8		1 / 16	
Seasons.	1952	1957	1952	1957	1952	1957	1947	1953	1952	1957
CLIMAX SPECIES:										
Chrysopogon montanus.....	20	19	29	34	20	14	26	13	5	15*
Cymbopogon plurinodis.....	17	17	46	61	18	22	11	10	6	3
Themeda triandra.....	14	0**	35	40	9	18	11	6	30	29
Digitaria eriantha.....	6	17*	1	9*	8	10	16	4	19	9*
Aristida vestita.....	2	1	8	6	1	0	0	1	0	0
Heteropogon contortus.....	0	0	0	2	0	0	0	0	0	0
Sporobolus fimbriatus.....	2	0	21	14	29	0**	17	9	7	7
Eustachys paspaloides.....	0	0	3	2	5	0*	7	3	8	0*
Fingerhuthia africana.....	0	0	15	7	16	4**	33	0	26	9**
Panicum coloratum.....	0	0	0	0	0	0	0	0	0	15**
SERAL SPECIES:										
Eragrostis lehmanniana.....	83	169**	74	187**	142	222**	72	201	172	186
E. echinochloidea.....	0	5*	0	8**	0	2	7	48	0	15**
Cropetium caponse.....	0	109**	13	78**	45	147**	0	11	46	127**
Cynodon incompletus.....	4	0	0	0	0	0	0	0	11	21
Tragus koeleroidea.....	0	0	7	0**	14	0**	37	5	21	0**
Enneapogon scoparius.....	0	1	0	0	0	0	0	0	0	0
PIONEER SPECIES:										
Enneapogon brachystachyus....	281	141**	54	46**	48	134**	161	1905	58	122**
Tragus racemosus.....	10	35**	68	3**	56	3**	6	457	32	6**
Aristida curvata.....	0	22**	13	15	23	36*	19	22	14	41**
WEEDS:										
Geigeria africana.....	120	128	48	116**	132	207**	10	183	156	177
Chrysocoma tenuifolia.....	25	17	5	19**	9	5	8	24	18	24
Tribulus terrestris.....	17	1**	2	2	0	4	24	35	0	1
KARROID SPECIES:										
Monechma divaricatum.....	8	11	0	10**	1	16**	3	0	4	32**
Aster muricatus.....	8	9	4	15**	37	62**	0	2	14	15
Indigofera patens.....	4	6	0	3	6	6	0	1	3	6
Pentzia sphaerocephala.....	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	58	155**

Woody species comprise the genera Rhus and Euclea.

Herbaceous species comprise the genera Barleria, Hermannia, Sericorema, Euphorbia, Stachys, Pharnaceum, Scilla, Walafrida, Commelina, Atriplex, Sutera and Berkheya.

* = Significant difference at P = 0.05.

** = Significant difference at P = 0.01.

(s) = Surveys according to the method by Von Broembsen (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 DOLOMITEVELD AT KOOPMANSFONTEIN.

	Frequency(s) per 300 Quadrats.					
Experiment no.	14 D.		9 D.		19 D.	
Ratio Cattle : Sheep.	1 / 4		1 / 8		1 / 16	
Seasons.	1951	1957	1951	1957	1951	1957
CLIMAX SPECIES:						
Chrysopogon montanus	22	20	28	23	16	8
Heteropogon contortus	2	5	27	19*	2	0
Themeda triandra	8	4	21	7	1	0
Digitaria erianthe	20	13	17	29	17	9
Cymbopogon plurinodis	2	1	12	7	3	3
Sporobolus fimbriatus	3	4	9	5	6	0*
Fingerhuthia africana	0	0	2	4	1	1
Panicum coloratum	0	0	0	0	1	0
SERAL SPECIES:						
Eragrostis lehmanniana	207	219	112	243**	189	247**
Cropetium capense	165	228**	35	140**	101	171**
Brachiaria cruciformis	0	0	20	7*	0	2
Cynodon incompletus	0	0	0	4	0	0
Eragrostis obtusa	0	11**	0	49**	8	36**
E. echinochloidea	0	13**	0	31**	0	53**
E. denudata	16	13	0	0	20	0*
Tragus koeleriides	0	0	0	0	0	0
Ennaeagron scoparius	6	7	14	10	0	0
PIONEER SPECIES:						
Ennaeagron brachystachyus	139	102**	80	93**	71	61
Aristida curvata	70	29**	197	28**	34	25**
Tragus racemosus	64	12**	130	8**	84	22**
WEEDS:						
Geigeria africana	0	20**	0	25**	27	63**
Chrysocoma tenuifolia	2	8	0	8**	10	24
Tribulus terrestris	0	1	0	0	1	1
KARROID SPECIES:						
Aster muricatus	1	8*	0	3*	6	14
Indigofera patens	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 Tarchonanthus, Euclea, Maytenus and Rhus.

Herbaceous species comprise the genera Oxalis, Pulbostylis, Stachys, Commelina, Hermannia, Cyperus, Sericocoma, Anacanthus, Pharnaceum, Euphorbia, Barleria and Blepharis.

* = Significant difference at P = 0.05.

** = Significant difference at P = 0.01.

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

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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. Ennsapogon 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, Eustachys paspaloides and Fingerhuthia were not able to tolerate grazing by cattle and sheep. In addition Tragus koelericides 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 seral, 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.

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(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 Chrysocoma 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 stocked 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 dolomiteveld respectively.

TABLE LXX.../214

TABLE LXX.

MECHANICAL AND CHEMICAL ANALYSES(s) OF SOILS FROM LIEBEVELD UNDER DIFFERENT GRAZING RATIOS WITH CATTLE AND SHEEP AT KOOPMANSFONTEIN.

	Expt. 13 L. 2 B : 1 S.			Expt. 17 L. 1 B : 1 S.			Expt. 14 L. 1 B : 4 S.			Expt. 9 L. 1 B : 8 S.			Expt. 19 L. 1 B : 16 S.		
Soil horizon (inches).	0-3	3-6	6-12	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.	7.26	7.18	6.80	7.20	6.95	6.63	6.78	6.70	6.35	7.18	6.52	7.00	7.43	6.75	6.50
Resistance at 60°F.	1180	1240	1150	1720	1500	1520	1360	1450	1470	1250	1450	990	1450	1650	1500
Mechanical analysis(%):															
Sand (>0.02 mm.)	79.33	83.11	77.63	83.36	81.87	78.85	82.56	82.82	77.29	82.88	80.36	77.88	84.14	81.95	77.95
Silt (0.02 - 0.002 mm.)	6.44	4.49	4.25	5.59	3.91	4.85	7.54	6.22	7.78	6.33	6.32	5.65	7.46	7.56	8.39
Clay (<0.002 mm.)	14.23	12.40	18.12	11.05	14.22	16.30	9.90	10.96	14.93	10.79	13.32	16.47	8.40	10.49	13.66
$CaCO_3$.(%)	0.38	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00
P.(%)(z)	.0017	.0012	.0004	.0023	.0008	.0004	.0018	.0009	.0005	.0017	.0007	.0007	.0031	.0008	.0004
C.(%)	0.86	0.75	0.54	0.86	0.75	0.57	0.99	0.89	0.81	0.89	0.75	0.68	0.96	0.90	0.66
N.(%)	0.10	0.10	0.06	0.10	0.08	0.07	0.11	0.09	0.08	0.10	0.09	0.07	0.11	0.10	0.08
C : N ratio.	9.1:1	7.8:1	8.7:1	8.8:1	9.0:1	8.6:1	8.8:1	9.6:1	10.1:1	8.8:1	8.8:1	10.1:1	9.1:1	9.0:1	8.7:1
Water-soluble salts(%)(n):															
Na.	.0008	.0008	.0006	.0009	.0008	.0005	.0011	.0010	.0029	.0009	.0010	.0009	.0010	.0009	.0006
K.	.0011	.0002	.0002	.0011	.0009	.0003	.0015	.0010	.0005	.0008	.0007	.0002	.0010	.0012	.0005
Ca.	.0046	.0037	.0037	.0046	.0033	.0020	.0037	.0024	.0022	.0039	.0022	.0046	.0050	.0059	.0024
Mg.	.0008	.0010	.0001	.0002	.0007	.0003	.0007	.0003	.0005	.0010	.0006	.0006	.0005	.0011	.0003
HCO_3.	.0160	.0123	.0107	.0160	.0109	.0080	.0142	.0085	.0118	.0128	.0066	.0149	.0151	.0224	.0064
Cl.	.0021	.0024	.0021	.0018	.0030	.0024	.0030	.0030	.0027	.0038	.0032	.0041	.0041	.0030	.0024

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

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

(z) = 1% Citric acid solution.

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

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 LXXI.../216

TABLE LXXI.

MECHANICAL AND CHEMICAL ANALYSES(a) OF SOILS FROM DOLOMITEVELD UNDER DIFFERENT GRAZING RATIOS WITH CATTLE AND SHEEP AT KOOPMANSFONTEIN.

	Expt. 14 D. 1 B : 4 S.			Expt. 9 D. 1 B : 8 S.			Expt. 19 D. 1 B : 8 S.		
Soil horizon (inches).	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 (<0.002mm.)	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)	.0036	.0038	.0056	.0030	.0027	.0077	.0044	.0071	.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 (%)(n):									
Na.	.0010	.0010	.0009	.0009	.0008	.0016	.0009	.0010	.0017
K.	.0008	.0006	.0003	.0010	.0005	.0015	.0011	.0003	.0003
Ca.	.0026	.0026	.0031	.0046	.0041	.0052	.0063	.0052	.0052
Mg.	.0002	.0002	.0004	.0013	.0013	.0011	.0001	.0009	.0014
HCO_3.	.0077	.0090	.0107	.0187	.0177	.0191	.0179	.0195	.0193
Cl.	.0027	.0024	.0024	.0018	.0024	.0047	.0032	.0021	.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.

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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) LIVEWEIGHTS:

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

TABLE LXXII.../218

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 LIVEWEIGHT-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 LXXIV.../221

TABLE LXXV.

AREA BELOW THE LIVEWEIGHT-CURVE OF CATTLE AND SHEEP GRAZING DOLICHOLVELD ACCORDING TO THREE LARGE TO SMALL STOCK RATIOS.

STEERS.

Ratio of Cattle to Sheep:	Expt. 14 D. 1 B : 4 S		Expt. 9 D. 1 B : 8 S		Expt. 19 D. 1 B : 16 S	
Period on Experiment.	Steer no.	Area.	Steer no.	Area.	Steer no.	Area.
8.6.48 - 5.1.51.	2363	35458	-	-	2453	35788
8.6.48 - 14.8.51.	2481	41817	-	-	2408	41910
6.1.51 -1.7.52.	-	-	191	24693	280	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	-	-

SHEEP (s).

8.6.48 - 23.5.50	2253	-	1968
24.5.50 - 17.6.52.	2254	2049	2149
18.6.52 - 13.7.54.	2688	2492	-
14.7.54 - 12.7.55.	912	823	-
13.7.55 - 19.2.57.	1436	1286	-

H*	Calculated values of z: 14D/9D	9D/19D	14D/19D	Calculated values of P: 14D/9D	9D/19D	14D/19D	Significant Differences P ≤ 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.
-	-	-	2.42	-	-	0.008	14D>19D.
8.15	-	-	-	-	-	-	N.S.
-	0.98	-	-	0.164	-	-	N.S.
-	2.49	-	-	0.006	-	-	14D>9D.
-	2.96	-	-	0.002	-	-	14D>9D.

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

N.S. = Not significant.

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Significant differences between the areas of the liveweight-curve of steers on limeveld 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 lime, 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 : 8 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) GENERAL-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 lime, five sheep died as a result of poverty on the 1 : 4 ratio experiment. Another died on the widest ratio on lime, hydrocyanic-poisoning being suspected as the cause.

Undue significance cannot be attached to stock removals from the experiments 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 lime experiments, the accompanying decrease in climax grasses under the wider ratio experiments and the overall increase in soral, weed, karroid.../224

karroid 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, Aristida 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

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

The decline in the numbers of Tragus koeleroides in these experiments is contrary to the experience of Loubser (1958) in the Orange Free State. This author found T. koeleroides 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 Knopjiesfontein conditions, this species is most susceptible to trampling. On limeveld 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 Tarchonanthus 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 koeleroides.

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 subclimax. 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.../226

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 grasses 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

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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 a 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

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in autumn. This occurred out of need and not out of preference. Shrubs are known to be protein-rich, Henrici (1940) finding the protein in Tarchonanthus minor to vary between 11.29 and 12.50 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.../229

bean 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 militates against postulating conclusions. Nevertheless, co[illegible]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 livestock class.

The rate of grazing and the ratio of large to small stock appeared 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 effect as a close ratio under severe grazing. The susceptibility of vegetation to certain [illegible] types of grazers also deserves consideration. 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 dolomite 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 morgen. Apparently sheep had not yet reached their ceiling gain. The increase in summer gain from twenty

through.../230

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 devotion 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 sheep 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 competo with each other. The nature of the mutual interrelationships are not 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.

ANNEXURE 15.

LIVEWEIGHT GAINS AND LOSSES AND LIVEWEIGHT MAINTAINED IN LBS. T.D.N. ON D-LOWVELD AND CONTRIBUTION OF THESE FACTORS TO T.D.N. OBTAINED PER HORSEN.

Expt. no.			14 D. 1 : 4					9 D. 1 : 8					19 D. 1 : 16				
Seasons.	Rainfall (mm.)	Cattle or Sheep.	Liveweight maintained:	Gains:	T.D.N.:	Losses:	Net T.D.N.:	Liveweight maintained:	Gains:	T.D.N.:	Losses:	Net T.D.N.:	Liveweight maintained:	Gains:	T.D.N.:	Losses:	Net T.D.N.:
1948/49.	151	C	246	44	290	28	262	-	-	-	-	-	139	37	176	14	162
		S	121	29	150	9	141	-	-	-	-	-	191	33	224	9	215
1949/50.	588	C	364	142	506	41	465	-	-	-	-	-	215	70	285	22	263
		S	106	35	141	5	136	-	-	-	-	-	201	61	262	9	253
1950/51.	470	C	253	98	351	11	340	210	73	283	9	274	121	30	151	9	142
		S	73	91	164	2	162	98	28	126	1	125	137	25	162	0	162
1951/52.	288	C	301	77	378	49	329	210	68	278	48	230	139	47	186	25	161
		S	115	27	142	8	134	155	40	195	3	192	213	45	258	14	244
1952/53.	413	C	269	98	367	24	343	217	114	331	25	306	-	-	-	-	-
		S	113	53	166	0	166	168	86	254	7	247	-	-	-	-	-
1953/54.	378	C	255	106	361	27	334	208	86	294	17	277	-	-	-	-	-
		S	161	29	190	5	185	227	46	273	9	264	-	-	-	-	-
1954/55.	459	C	257	72	329	49	280	213	52	265	32	233	-	-	-	-	-
		S	92	38	137	10	127	134	41	175	12	163	-	-	-	-	-
1955/56.	563	C	242	104	346	13	333	217	77	294	6	288	-	-	-	-	-
		S	112	36	148	7	141	153	35	188	7	181	-	-	-	-	-
1956/57.	427	C	270	86	356	25	331	214	59	273	11	262	-	-	-	-	-
		S	70	21	91	15	76	90	34	124	22	102	-	-	-	-	-
Mean per annum.	416	C	273	92	365	30	335	213	75	288	21	267	153	46	199	17	182
		S	108	40	148	7	141	146	44	190	8	182	185	41	226	8	218
Per cent.		C	75	25	100	8	92	74	26	100	7	93	77	23	100	9	91
		S	73	27	100	5	95	77	23	100	5	95	82	18	100	4	96

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CHAPTER VI.

FINAL CONCLUSIONS.

1. A series of grazing experiments was conducted with cattle and sheep in Tarchonanthus 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 seral, weed, 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 concomittant 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 Geigeria and Hydrocyanic-poisoning only of secondary importance.

6. The climax grasses Themeda triandra, Chrysopogon montanus, Digitaria eriantha and Sporobolus fimbriatus, and the seral 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

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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

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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 dolomitevald did not differ much as grazing for steers. Sheep, however, reacted more favourably to dolomite than to limevald.

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 Geigeria-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 of 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

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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 Tarchonanthus 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.

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

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APPENDIX.



Plate 1. All-summer rested Tarchonanthus veld of the Ghaap 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 Tarchonanthus veld with Cymbopogon pluri-nodis left ungrazed in the lower righthand corner. Shrubs are mainly Tarchonanthus minor. In the left background Rhus lyrcides and on the horizon Olea 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.

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Plate 5. Lower view of Terchonanthus 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. Chrysocoma 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 cana and Tarchonanthus camphoratus var. lilakunensis, neither species which is relished by livestock.



Plate 9. Parchmanthus 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 Sourveld 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

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TABLE XXXIX.

PLANT RESPONSE TO FIVE GRAZING SYSTEMS WITH SHEEP ON DOLOMITEVELD AT KOOPMANSFONTEIN.

	Frequency per 180 quadrats.(s)				Number of plants per 15 quadrats.(n)				Frequency per 300 quadrats.(s)	
	Expt. 1 D.		Expt. 2 D.		Expt. 3 D.		Expt. 4 D.		Expt. 5 D.	
	Syst. I		Syst. II		Syst. III		Syst. IV		Syst. V	
	1951	1957	1951	1957	1947	1953	1947	1953	1951	1957
CLIMAX SPECIES:										
Digitaria eriantha	18	10	23	52**	69	74	17	35	52	67
Chrysopogon montanus	8	13	20	18	16	15	14	40	13	9
Heteropogon contortus	66**	47*	73	52*	14	1	56	7	8	5
Sporobolus fimbriatus	0**	7	10	7	0	0	0	4	2	1
Cymbopogon plurinodis	0	2	0	3	0	0	1	0	1	0
Themeda triandra	3	5	5	7	12	8	2	4	1	0
Tristachya pubescens	0	0	0	0	0	0	0	0	1	0
Aristida uniplumis	18	13	0	0	0	0	0	0	0	0
Panicum coloratum	0*	5	3	0	0	0	0	0	0	0
Fingerhuthia africana	3	0	0	0	1	0	22	0	0	0
Aristida vestita	5	13	0	0	0	0	5	4	0	0
Eustachys paspaloides	0	0	0	0	0	0	5	1	0	0
Sub-total					112	98	116	95		
SUCCESSIONAL SPECIES:										
Eragrostis lehmanniana	158	270**	123	267**	48	627	68	463	139	206**
E. echinocloidea	0	0	0	0	0	0	0	0	0	4
E. denudata	0	23**	0	5	30	12	43	95	112	115
Tragus koelericides	0	0	0	0	19	0	1	0	0	0
Oropetium capense	20	70**	15	73**	0	187	0	0	41	130
Cynodon dactylon	0	0	4	4	0	0	0	0	0	0
Enneapogon scoparius	10	3*	15	15	11	11	42	47	18	18
Pogonarthia squarrosa	0	0	0	0	0	0	0	0	7	0**
Sub-total					108	837	154	605		
PIONEER SPECIES:										
Enneapogon brachystachyus	15	35**	58	93**	50	448	15	333	7	21**
Aristida curvata	12	3*	3	25**	15	16	12	15	24	0**
A. congesta	0	15**	0	2	0	0	0	0	1	43**
Tragus racemosus	13	8	13	20	58	665	24	224	25	18
Sub-total					123	1129	51	572		
WEEDS:										
Geigeria africana	42	77**	32	83**	1	61	6	84	11	18
Chrysocoma tenuifolia	27	10**	28	13	1	3	5	2	7	1*
Tribulus terrestris	0	0	0	3	14	29	4	17	0	0
Ornithoglossum glaucum	0	0	0	0	0	0	0	0	0	1
Sub-total					16	93	15	103		
KARROID SPECIES:										
Indigofera patens	2	3	0	8**	0	0	0	0	2	1
Aster muricatus	0	2	0	8**	3	10	0	0	2	0
Sub-total...					3	10	0	0		
OTHER SPECIES:					6	20	0	0		
Woody	5	3	12	3*	11	7	10	16	3	4
Herbaceous	25	233**	28	202**	28	55	12	36	34	130**
Sub-total					39	62	22	52		
GRAND TOTAL					404	2229	358	1427		

Woody species comprise the genera Rhus, Tarchonanthus, Royena, Asparagus, Euclea, Ehretia and Maytenus.
Herbaceous species comprise the genera Barleria, Atriplex, Sericorema, Pharnaceum, Walafrida, Oxalis, Cyperus, Hibiscus, Hermannia, Monsonia, Linum, Urginea, Scilla, Sesamum and Stachys.

* = Significant difference at P = 0.05
** = Significant difference at P = 0.01

(s) = Surveys according to the method by Von Broembsen (1951).
(n) = Surveys according to the method by Raunkiaer as described by Murray (1946).

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TABLE XLII.

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

		Expt. 1 L - System I.					Expt. 2 L - System II.					Expt. 3 L - System III.				
Seasons.	Rainfall in mm.	Summer Gains	Spring Losses	Net Gains	Liveweight maintained: Per morgen	Net T.D.N. per morgen	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	Net T.D.N. per morgen	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	Net T.D.N. per morgen
1945/46.	268	12	15	-3	34372	396	18	17	1	37296	446	21	24	-3	33936	398
1946/47.	300	26	16	10 (t)	41245	521	21	17	4 (t)	37932	463	18	19	1 (t)	33027	391
1947/48.	466	25	5	20 (e)	31581	437	17	18	-1 (e)	31132	368	32	15	17 (e)	24616	429
1948/49.	151	16	9	7	22792	294	16	7	9	21252	281	12	10	2 (t)	23716	287
1949/50.	588	32	15	17	28800	403	35	21	14 (s_2)	30240	425	34	21	13	32760	439
1950/51.	470	14	3	11 (t)	21879	292	18	4	14	20111	284	20	4	16	23205	326
1951/52.	288	30	11	19 (vk)	15606	255	26	2	24	16524	277	31	7	24 (vp)	15912	273
1952/53.	418	26	14	12	28908	386	28	16	12	28512	382	28	17	11	26496	362
1953/54.	378	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1954/55.	459	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1955/56.	563	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1956/57.	427	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean per morgen per season.	398	23	11	12	28148	373	22	13	9	27875	366	25	15	10	26708	362

	Expt. 4 L - System IV.					Expt. 5 L - System V.				
	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	Net T.D.N. morgen	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	Net T.D.N. morgen
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	- (p)	-	-
	37	5	32	22081	370	34	5	29	21148	349
	21	2	19	21658	317	15	2	13	20111	279
	18	7	1 (np)	29988	348	18	11	7 (p_4)	28152	356
	24	-	15	26530	366	26	15	11 (p)	22794	299
	19	1	5 (p_5)	47916	396	27	11	16 (p_3)	31037	422
	19	19	0 (pv_2)	47085	375	22	24	-2 (p_3v_5)	31937	378
	15	8	7 (p_2)	35490	260	16	1	-1 (p_2)	24752	293
	21	15	6	20160	187	22	11	11	13776	207
	22	11	11	31364	327	23	12	11	24213	323

(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.

s_1, p_2, v_5 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.

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TABLE XLIII.

GAINS AND LOSSES PER SHEEP(m): LIVEWEIGHT MAINTAINED AND TOTAL DIGESTIBLE NUTRIENTS OBTAINED IN POUNDS PER MORGEN UNDER FIVE SYSTEMS OF GRAZING MANAGEMENT ON DOLOMITEVELD.

Seasons.	Rainfall in mm.	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.				
		Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	Net T.D.N. per morgen	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	Net T.D.N. per morgen	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	Net T.D.N. per morgen	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	Net T.D.N. per morgen	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	Net T.D.N. per morgen
1945/46.	268	-	-	-	-	-	-	-	-	-	-	13	15	-2	33936	395	17	13	4	35616	433	13	17	-4	34104	390
1946/47.	300	-	-	-	-	-	-	-	-	-	-	20	14	6	34989	433	24	15	9	39092	389	24	19	5 (t)	35480	439
1947/48.	466	-	-	-	-	-	-	-	-	-	-	32	11	21 (m)	30408	432	28	3	25 (z)	32942	469	29	5	24 (w)	28779	419
1948/49.	151	-	-	-	-	-	-	-	-	-	-	20	9	11 (m)	24948	333	33	18	15 (p)	28465	394	23	9	14 (p)	27972	376
1949/50.	588	12	3	9	9438	142	12	2	10 (s)	9438	145	35	15	20	34560	459	38	11	27	36822	527	35	8	27	35280	407
1950/51.	470	17	2	15	17901	260	21	2	19	18122	277	19	4	15	24973	343	16	5	11	26741	350	22	19	3	25194	311
1951/52.	288	24	12	12	25092	340	18	10	8	26622	343	32	6	26	16524	287	31	4	27 (p)	16524	288	30	3	27	17595	297
1952/53.	418	37	6	31	26220	416	42	5	37	27740	452	29	3	26	33264	476	36	4	32	34848	516	34	2	32	35640	527
1953/54.	378	26	7	19	34485	515	27	8	19	37026	498	-	-	-	-	-	-	-	-	-	-	28	2	26	27588	409
1954/55.	459	17	19	-2	36500	427	21	27	-6 (p)	37595	432	-	-	-	-	-	-	-	-	-	-	22	17	5 (p)	31390	393
1955/56.	563	25	2	23	26208	384	17	9	8 (p_2)	23296	303	-	-	-	-	-	-	-	-	-	-	24	13	11 (p_2)	25298	338
1956/57.	427	27	29	-2	15232	191	18	16	2	13440	164	-	-	-	-	-	-	-	-	-	-	17	15	2	14224	182
Mean per morgen per season.	398	23	10	13	23885	334	22	10	12	24160	327	25	10	15	29200	395	28	9	19	31381	420	25	11	14	28212	378

(s) = 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.

(p_2) = 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.

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AREA(s) BELOW THE LIVEWEIGHT-CURVE OF SHE

Period on Experiment.	Area of the liveweight-curve. Expt.1 System	D. Expt.2 System I	D. Expt.3 System II	D. Expt.4 System III	D. Expt.5 System IV	D. System V
5.2.46-25.5.48.	-	-	3141	3407	3186	
26.5.48-14.8.51.	-	-	3590	3794	3648	
15.8.51-15.7.53.	-	-	1764	1827	1862	
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 DOLOMITEVELD UNDER FIVE GRAZING MANAGEMENT SYSTEMS.

	Calculated values of z										P										Significant Differences P ≤ 0.010.
H*	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)	(n)	(n)				(n)	(n)	(n)												
9.84	74.0	92.5	99.5	-	-	-	0.002	0.02	0.02	-	-	-	1D > 2D								

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ANNEXURE 8.

LIVEWRIGHT 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.

		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.				
Seasons.	Rainfall (mm.)	Liveweight maintained	Gains	Total T.D.N.	Loss.	Net T.D.N.	Liveweight maintained	Gains	Total T.D.N.	Loss.	Net T.D.N.	Liveweight maintained	Gains	Total T.D.N.	Loss.	Net T.D.N.	Liveweight maintained	Gains	Total T.D.N.	Loss.	Net T.D.N.	Liveweight maintained	Gains	Total T.D.N.	Loss.	Net 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

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ANNEXURE 9.

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

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

PRODUCED PER MORGEN.

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

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TABLE LXI.

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

Seasons.	Total Rainfall (mm.)	Cattle or Sheep.	Expt. 16 L – System IV. Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen.	Net T.D.N. per morgen.	Expt. 17 L – System VII. Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen.	Net T.D.N. per morgen.	Expt. 19 L – System VI. Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen.	Net T.D.N. per morgen.	Expt. 14 L – System VII. Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen.	Net T.D.N. per morgen.
1952/53.	418	C	388	51	337	21883	354	355	74	281	23646	359	244	113	131 (x)	16427	235	269	137	132 (x)	18744	265
		S	40	3	37	1869	29	44	0	44	2274	39	34	10	24	11273	160	32	15	17 (s)	11499	156
1953/54.	378	C	354	85	269	22295	341	386	94	292	25319	383	279	156	123	18966	265	291	116	175	20268	293
		S	32	8	24	3176	43	34	3	31	3600	50	30	10	20	8349	122	32	8	24 (s_3)	8833	132
1954/55.	459	C	246	132	114	23451	312	277	195	82	25215	327	238	153	85	21231	279	227	216	11	18433	230
		S	23	14	9	1977	27	32	3	29	2160	43	21	12	9	10220	131	19	14	5	10342	128
1955/56.	563	C	282	54	228	25003	359	279	83	196	25155	352	267	70	197	21809	313	262	86	176	20835	297
		S	31	6	25	2402	37	26	3	23	2312	34	34	6	28 (p_2)	9003	138	23	6	17 (s)	8862	124
1956/57.	427	C	318	90	228	24556	355	316	99	217	22776	333	347	95	252	24676	364	339	156	183	23168	331
		S(t)	23	28	-5	2443	29	22	26	-4	2353	28	15	18	-3	9291	109	25	25	0	5525	69
Mean per season.	449	C	318	82	236	–	–	323	109	214	–	–	275	117	158	–	–	278	142	136	–	–
		S	30	12	18	–	–	32	7	25	–	–	27	11	16	–	–	26	14	12	–	–
Mean per morgen per season.		C	27	7	20	23438	344	27	9	18	24422	351	23	10	13	20622	291	23	12	11	20290	283
		S	25	1	15	2372	33	26	0.5	2.1	2540	38	9	4	5	2627	132	9	5	4	9016	122

(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 Geigeria-poisoning 27/1/56, 9/7/56.

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

(p_2) = Sub-notation denotes the number of animals involved.

ANNEXURE 12.

LIVEWEIGHT GAINS AND LOSSES AND LIVEWEIGHT MAINTAINED IN POUNDS T.D.N. ON LIMEVELD AND CONTRIBUTION OF THESE FACTORS TO T.D.N. OBTAINED PER MORGEN.

Seasons.	Rainfall (mm.)	Cattle or Sheep	One Beast to one Sheep. Expt. 16 L - System IV. Liveweight maintained	Gains	T.D.N.	Loss.	Net T.D.N.	Expt. 17 L - System VII. Liveweight maintained	Gains	T.D.N.	Loss.	Net T.D.N.	One Beast to one Sheep. Expt. 19 L - System VI. Liveweight maintained	Gains	T.D.N.	Loss.	Net T.D.N.	Expt. 14 L - System VII Liveweight maintained	Gains	T.D.N.	Loss.	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

ANNEXU

TABLE LXXII.

GAINS AND LOSSES PER STEER(m) AND PER SHEEP(m): LIVEWEIGHT MAINTAINED AND T.D.N. OBTAINED IN POUNDS PER MORGEN UNDER DIFFERENT RATIOS OF LARGE TO SMALL STOCK ON LITTLEVELD AT KOOPMANSFONTEIN.

Expt. no.				18 L.					17 L.					14 L.					9 L.					19 L.				
C : S Ratio.				2 : 1					1 : 1					1 : 4					1 : 8.					1 : 16.				
Seasons.	Rainfall (mm.)	Cattle or Sheep	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	T.D.N. per morgen	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	T.D.N. per morgen	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	T.D.N. per morgen	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	T.D.N. per morgen	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	T.D.N. per morgen
1945/46.	307	C						-	-	-	-	-	-	-	-	-	-	475	235	240	37002	491	-	-	-	-	-
		S						-	-	-	-	-	-	-	-	-	-	40	19	21	14420	196	-	-	-	-	-
1946/47.	290	C						-	-	-	-	-	-	-	-	-	-	67	94	-27	8260	94	-	-	-	-	-
		S						-	-	-	-	-	-	-	-	-	-	6	14	-8	9324	101	-	-	-	-	-
1947/48.	432	C						-	-	-	-	-	-	-	-	-	-	339	89	250	17601	262 (n)	-	-	-	-	-
		S						-	-	-	-	-	-	-	-	-	-(o)	30	9	21	10531	148	-	-	-	-	-
1948/49.	151	C						189	127	62	22540	286	252	115	137	17402	236	211	70	141	13671	180(k)					
		S						23	8	15	9360	127 (o)	19	13	6	7952	102	13	12	1	17056	198(k)					
1949/50.	588	C						448	182	266	33600	477	460	225	235	25335	355	476	171	305	19995	281					
		S						36	9	27	9840	147	36	10	26	8640	132	31	11	20	18000	260					
1950/51.	470	C						276	69	207	20424	300	194	41	153	15484	214	240	17	223	10635	155					
		S						22	0	22	6794	103 (x)	23	1	22	6332	99 (t)	18	1	17	12081	178(P)					
1951/52.	288	C	-	-	-	-	-	238	185	53	24107	205 (x)	232	157	75	15230	199	320	158	162	10680	152					
		S	-	-	-	-	-	30	26	4	9792	124 (x) (s)	26	16	10	9792	128	22	13	9	19380	251					
1952/53.	418	C	272	12	260	12682	230	355	74	281	23646	359	269	137	132	18744	265 (x) (s)	306	111	195	17766	253	-	-	-	-	-
		S	32	6	26	848	19	44	0	44	2274	39	32	5	17	11499	156	15	7	8	14279	175	-	-	-	-	-
1953/54.	378	C	306	79	227	21483	325	386	94	292	25319	383	291	116	175	20268	293 (s3)	-	-	-	-	-	-	-	-	-	-
		S	28	3	25	1881	26	34	3	31	3600	50	32	8	24	8833	132	-	-	-	-	-	-	-	-	-	-
1954/55.	459	C	242	133	109	24090	322	277	195	82	25215	327	227	216	11	18433	230	-	-	-	-	-	-	-	-	-	-
		S	25	5	20	1061	15	32	3	29	2160	43	19	14	5	10342	128	-	-	-	-	-	-	-	-	-	-
1955/56.	563	C	275	44	231	25849	374	279	83	196	25155	352	262	86	176	20835	257 (s)	-	-	-	-	-	-	-	-	-	-
		S	36	12	24	1343	20	26	3	23	2312	34	23	6	17	8882	124	-	-	-	-	-	-	-	-	-	-
1956/57.	427	C	284	90	194	26755	377	316	99	217 (z)	22776	333	339	156	183 (z)	23168	331	-	-	-	-	-	-	-	-	-	-
		S	23	20	(z)3	1497	18	22	26	-4	2353	28	25	25	0	5525	69	-	-	-	-	-	-	-	-	-	-
Mean per season.		C	276	72	204	-	-	323	109	224	-	-	282	142	140	-	-	291	133	158	-	-	312	129	203	-	-
		S	29	9	20	-	-	32	7	25	-	-	27	12	15	-	-	224	11	13	-	-	21	9	12	-	-
Mean per morgen per season.		C	25	7	18	22172	326	27	9	18	2442	351	24	12	12	20235	309	18	8	10	19260	263	13	5	8	13745	192
		S	1.3	0.4	0.9	1326	20	2.6	0.5	2.1	254	38	9	4	5	8975	123	12	6	6	10159	135	14	6	8	16628	222

(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 10/1/50.

(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.

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

(s_3) = Sub-notation denotes the number of animals involved.

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TABLE LXXIII.

GAINS AND LOSSES PER STEER(n) AND PER SHEEP(n): LIVEWEIGHT MAINTAINED AND T.D.N. OBTAINED IN POUNDS PER MORGEN UNDER THREE RATIOS OF LARGE TO SMALL STOCK ON DOLLITEVELD AT KOOPMANSFONTEIN.

Expt. no.			14 D.					9 D.					19 D.				
C : S Ratio.			1 : 4.					1 : 8.					1 : 16.				
Seasons.	Rainfall (mm.)	Cattle or Sheep	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	T.D.N. per morgen	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	T.D.N. per morgen	Summer Gains	Spring Losses	Net Gains	Liveweight maintained per morgen	T.D.N. per morgen
1948/49.	151	C	150	124	26	21433	262 (b)	-	-	-	-	-	252	119	133	12679	162 (c)
		S	25	8	17	10530	141 (b)	-	-	-	-	-	14	5	9	16640	215 (c)
1949/50.	588	C	484	181	303	31680	465	-	-	-	-	-	475	190	285	18735	263
		S	30	6	24	9240	136	-	-	-	-	-	26	5	21	17520	253
1950/51.	470	C	332	49	283	21971	340	330	53	277	18260	274	203	75	128	10562	142
		S	26	2	24	6409	162	16	1	15	8569	125	21	0	21	11934	162
1951/52.	288	C	261	215	46	26213	329	230	210	20	18280	230	320	217	103	12120	161 (c)
		S	23	9	14	9996	134	23	2	21	13464	192	19	6	13	18564	244 (c)
1952/53.	418	C	332	105	227	23403	343	368	112	276	18831	306	-	-	-	-	-
		S	45	0	45	9854	166 (v)	49	5	44	14592	247	-	-	-	-	-
1953/54.	378	C	360	120	240	22204	334	390	98	292	18127	277 (v)	-	-	-	-	-
		S	25	6	19	14036	185	26	7	19	19784	264	-	-	-	-	-
1954/55.	459	C	245	219	26	22387	280	234	189	45	18547	233					
		S	32	11	21	8638	127	23	9	14	11680	163					
1955/56.	563	C	354	56	298	21048	333	350	38	312	18889	288					
		S	31	8	23	9733	141	20	5	15	13323	181					
1956/57.	427	C	294	122	172	23440	331	266	66	200	18575	262					
		S	18	17	1	6123	76	19	16	3	7840	102					
Mean per season.	416	C	312	132	180	-	-	312	109	203	-	-	312	150	162	-	-
		S	28	7	21	-	-	25	6	19	-	-	20	4	16	-	-
Mean per morgen per season.		C	26	11	15	23755	335	20	7	13	18501	267	13	6	7	13524	182
		S	2	2	7	9395	141	12	3	9	12750	182	13	2	11	16165	218

(n) = 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.

(c) = Steers removed 30/1/52 up to [illegible] due to herbage shortage.

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

TABLE LXXIV.

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

STEERS.

Ratio of Cattle to Sheep	Expt. 18 L.		Expt. 17 L.		Expt. 14 L.		Expt. 9 L.		Expt. 19 L.		Calculated z.										values of P.									Significant Differences
	2 : 1		1 : 1		1 : 1		1 : 4		1 : 8		1 : 16																			$P \leq 0.010$
Period or Experiment.	Steer: no.	Area.	Steer: no.	Area.	Steer: no.	Area.	Steer: no.	Area.	Steer: no.	Area.	Steer: no.	Area.	H*	18L/17L	18L/14L	17L/9L	17L/14L	14L/19L	14L/9L	9L/19L	18L/17L	18L/14L	17L/9L	17L/14L	14L/19L	14L/9L	9L/19L		
8.6.48-5.1.51.	-	-	-	-	2355	36070	-	-	2361	40375	-	-	-	-	-	3.43	-	-	-	<0.001	-	-	19L > 14L.
8.6.48-14.8.51.	-	-	-	-	1	39762	-	-	2445	42975	-	-	-	-	-	1.64	-	-	-	0.052	-	-	N.S.
6.1.51-1.7.52.	-	-	-	-	2478	23432	2323	21895	E.28	18678	33.31	-	-	-	-	5.04	2.53	4.20	-	<0.001	0.006	<0.001	14L > 9L > 19L.
6.5.51-15.7.53.	-	-	-	-	E.32	27490	E.14	31836	-	-	-	-	-	-	-	-	4.49	-	-	-	<0.001	-	9L > 14L.
15.8.51-15.7.53.	-	-	-	-	E.30	13070	E.15	13941	-	-	-	-	-	-	-	-	1.50	-	-	-	0.067	-	N.S.
2.7.52-15.7.53.	-	-	091	11215	-	-	E.13	6037	-	-	-	-	-	-	-	4.51	-	-	-	-	-	-	17L > 9L.
2.7.52-13.7.54.	89	13702	E.68	24570	E.33	16593	-	-	-	-	-	-	34.13	5.87	1.17	-	5.04	-	-	-	<0.001	0.121	-	<0.001	-	-	-	17L > 18L;14L.
2.7.52-12.7.55.	87	23398	E.32	39095	763	25613	-	-	-	-	-	-	59.77	6.82	0.35	-	6.44	-	-	-	<0.001	0.363	-	<0.001	-	-	-	17L > 18L;14L.
16.7.53-10.7.56.	245	27851	226	26675	266	21282	-	-	-	-	-	-	25.64	0.03	4.15	-	4.32	-	-	-	0.488	<0.001	-	<0.001	-	-	-	17L > 18L;14L.
16.7.53-10.7.56.	212	27317	269	28297	-	-	-	-	-	-	-	-	-	1.29	-	-	-	-	-	-	0.099	-	-	-	-	-	-	N.S.
14.7.54-6.7.57.	420	34610	406	33217	411	30072	-	-	-	-	-	-	7.77	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N.S.
14.7.54-6.7.57.	404	32993	-	-	418	25508	-	-	-	-	-	-	-	-	-	5.08	-	-	-	-	-	<0.001	-	-	-	-	-	19L > 14L.
13.7.55-6.7.57.	521	20313	508	17110	519	17086	-	-	-	-	-	-	4.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N.S.
11.7.56-6.7.57.	605	8345	612	6975	650	7417	-	-	-	-	-	-	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N.S.
11.7.56-6.7.57.	634	7979	637	6967	-	-	-	-	-	-	-	-	6.88	-	-	-	-	-	-	-	0.169	-	-	-	-	-	-	N.S.

SHEEP(s).

8.6.48-23.5.50.	-	-	2193	1753	2015	20.45	-	-	-	-	-	-	2.19	4.45	4.16	-	-	-	-	0.014	<0.001	<0.001	14L;19L > 9L.
24.5.50-1.7.52.	-	-	2319	2278	2144	8.61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N.S.
2.7.52-13.7.54.	2406	2513	-	-	-	-	0.77	-	-	-	-	-	-	-	-	-	-	-	-	0.221	-	-	N.S.
14.7.54-12.7.55.	825	918	1097	-	-	18.30	2.05	3.90	-	3.08	-	-	-	-	-	-	-	-	-	0.020	<0.001	-	14L > 17L;18L.
13.7.55-19.2.57	1492	1360	1305	-	-	10.29	1.92	3.27	-	1.17	-	-	-	-	-	-	-	-	-	0.027	<0.001	-	18L > 14L.

(s) = The area of the liveweight-curve was calculated from the average liveweight 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.

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Author Ebersohn J P
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