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Stocking Rates and Herd Structures for Sustainable Grassland Utilisation in Uganda

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Improved herd structure often leads to a more efficient use of resources than does increasing the number of animals. This paper highlights the role of adjusting stocking rates and herd structures for sustainable utilisation of grasslands in the production of animal protein and milk. The authors combine official data with data obtained by census survey of cattle farms stratified into traditional farms and improved farms. They report a series of simulation experiments using a demand-driven milk production model based on herd dynamics.

The nutrition of the majority of ruminants in Uganda mainly involves the animals harvesting their own herbage by way of grazing, and this is unlikely to change in the near future. Whereas this system of feeding has a number of economic benefits, it has the disadvantage that the animals can only derive nutrients from the herbage available to them.

The herbage is largely under the control of climate and thereby varies both in quantity and quality throughout the year. Animals are subjected to periodic nutritional deficiencies. The stresses caused by these deficiencies depend, among other factors, on the prevailing stocking rates. There are various technical approaches that can be applied to ameliorate the effects of feed deficiency in a grazing system but the costs and risks involved and the sustainability of these innovations have to be borne in mind.

A sustainable grazing system like other agricultural systems aims at maintaining output at an acceptable and increasing level that satisfies prevailing and future needs; it also aims to increase the future carrying capacity of the resource base and other worthwhile human needs (Okigbo, 1991). It follows that sustainability can only be achieved when resources, inputs and technologies are within the capabilities of the farmer to own, hire, maintain and manage with increasing efficiency, in order to achieve desirable levels of productivity with minimal or no adverse effects on the resource base, human life or environmental quality.

Stocking rate is now recognised (White, 1987) as one of the most powerful management tools available to a livestock producer, allowing him to regulate the amount of herbage available to his animals throughout the year. Because livestock production in Africa is often confined to marginal areas which are often overstocked, increasing livestock production should entail emphasising appropriate stocking rates and promoting changes in herd structures (Smith, 1986).

The above approaches, however, are likely to be limited by the communal ownership of feed and water resources, and also the rearing of a mixture of animal species on common grazing (Koen, 1987). The carrying capacity on communal grasslands, therefore, depends on the number and composition of the animal species, their expected productivity, the watering regime and the range management strategy (Pratt, 1984).

In view of the ever-increasing human population with the accompanying pressure on land resources, there is a great temptation to emphasise maximum production per hectare and thus maximum stocking rates. But it is noteworthy that the stocking rate at which the gross margin per hectare is maximised is lower than that at which production is maximised. Besides, high stocking rates have the following other major disadvantages:

1. Increasing the stocking rate reduces the available feed per animal and so reduces production per animal (Hodgson, 1971).
2. Stocking rate can affect the botanical composition and productivity of the pastures, the structure and fertility of the soil and as a result, animal output (White, 1987).
3. Higher stocking rates often increase the proportion of less palatable species in the pasture and legumes are particularly reduced leading to decreased nitrogen-fixing (White,1987).

It is becoming increasingly evident that most traditional farmers are not willing to reduce the size of their herds. This is mainly because large herds are an insurance against the high mortality rates in the presence of low reproductive rates. Under such circumstances efficient herd structures may be more appealing than reducing herd sizes.

Herd structures are the complex expression of many factors which describe both the environmental conditions and the human management of the livestock (Bille, 1981). It is now recognised that whereas improvement is often sought in increased numbers of animals, improved herd structure may result in a more efficient use of resources (Methewman and Perry, 1985; Uys, Hearne and Colvin, 1985). Rigorous culling of nonbreeders and males, for example, can increase fertility rates by making more grazing land available to the breeding herd.

The grasslands of Uganda are used among other things to produce the much-needed animal protein for the ever-increasing human population. The quantity and quality of feed available within a production system is a major constraint upon the rate at which livestock populations expand and the rate at which they produce (Gartner and Hallam, 1984). There is, therefore, a need for a quantitative investigation of the feed-resource constraint upon product output. This paper seeks to highlight the role of adjusting stocking rates and herd structures for sustainable utilisation of grasslands for the purpose of producing animal protein and milk. A demand driven model is interfaced with a feed accounting model to illustrate this point.

Materials and Methods

Available data (UASS, 1986/87) at the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) were used to describe the economic activities of households in Uganda and to establish the agricultural land-use patterns for the different land resource zones.

The above information was supplemented with data obtained from the milk-shed areas of Uganda (Mbuza, 1991). The milk-shed areas are considered to be the districts where it is financially viable to collect and market surplus milk. These areas contain more than 75 percent of all the cattle and more than 95 percent of all the improved and exotic cattle in Uganda. Furthermore, all the major urban centres are located within these districts.

The data in the milk-shed areas (Table 2) were obtained by using a census survey of cattle farms using a multistage, cluster sampling design with stratification into traditional and improved farms. Traditional farms were those households keeping indigenous cattle types on communal or unenclosed grazing. Improved farms were those households keeping exotic or improved cattle or those having enclosed pasture. Means, totals and proportions were calculated from the data and these formed the basis of estimations of the herd structures and age composition of the cattle populations in the milk-shed areas of Uganda.

Stocking rate is usually expressed as the number of animals per unit of land for a given time period. However, since animals vary in size and weight and nutrient requirements, it is better to use the metabolic body weight (BW) per hectare. Stocking rate is also expressed in terms of availability of grazing land which is the reciprocal of the above, i.e. hectares per animal, especially under range conditions.

Grazing pressure is the number of animals of a specified class per unit mass of herbage and its reciprocal is the herbage allowance. Grazing pressure is the single most important factor affecting plant succession.

The stocking rates of the cattle populations were considered by way of two concepts: the available grazing land (AGL) and the available range land (ARL). The AGL was estimated from the data of the Uganda Agricultural Sector Survey (UASS) of 1986/87. In that study, land owned by each household was estimated and partitioned into cultivated and grazing land. The ARL was taken to be all that land currently not utilised for crops, forests and game reserves, or for grazing sheep, goats and swine. By relating the ARL to the livestock densities the maximum number of cattle that can be estimated if the grasslands are to be sustained. The AGL represents the future situation when households will be limited to only their own pieces of land because of increasing human population.

Carrying capacity is the area of land required to feed a defined livestock unit for one year (Gartner & Hallam, 1984). The carrying capacity of grazing land varies considerably in the different regions of Uganda according to the predominant vegetation, degree of human settlement, amount of rainfall and its distribution, and the extent of improvement undertaken. Information concerning land resources and average carrying capacities in Uganda given by Langdale-Brown, Osmaston and Wilson (1964) and Ferguson (1971) is presented in Table 1.

The livestock density (LD) is the optimum stocking rate in terms of cattle per hectare. Standard stock units (SSU) were used to compute the grazing load of a herd on an equivalent basis (Gartner and Hallam, 1984). One reference SSU was specified as a mature Friesian female cow weighing 500 kg and then all other sex-maturity groups of the different breed categories were related to this unit depending on their estimated average liveweights as shown in Table 1. The average optimal stocking rate under communal grazing was put at 0.5 SSU per ha. and on improved grassland at 0.7 SSU per ha..

The estimates of the ARL, AGL and the optimum cattle populations in the milk-shed areas are given in Tables 2 and 3 (a and b).

The cattle population, the herd structures and composition in the milk-shed areas of Uganda for the year 1986/87 were used as the baseline data for a series of simulation experiments using a demand driven milk production model based on herd dynamics. By interfacing this model with a simplified feed accounting model, the extent of the feed resource constraint was investigated.

Results

Data from the UASS (1986/87) shows that livestock production is the second most common economic activity with up to 21 percent of Uganda's households keeping some livestock. Cattle are the most important livestock in monetary value and they form 90 percent of the domestic animal biomass. Table 4 shows the change in the cattle population in relation to the available land area in the different land resource zones of Uganda over a period of two decades. It is evident that in some areas the livestock density has increased tremendously especially in the Mount Elgon area, the Toro-Bunyoro grassland area, and the Ankole Masaka grassland. It is also noteworthy that some relatively low potential areas have very high livestock densities (e.g. the Ankole Masaka grassland).

In the milk-shed area only 10 percent of the available grazing acreage is improved as shown in Table 5 and when the total rangeland is considered, it is found that some areas have already exceeded their potential cattle population (Table 6).

When the ARL is related to herd dynamics and the current growth rates, land is not a serious constraint, but when the AGL was used, land becomes a very serious constraint especially in the traditional sector. This shows that extreme caution should be exercised in encouraging traditional farmers to enclose their land without other accompanying programmes of animal management and husbandry, because the ARL shrinks and productivity per animal drops. Also if growth rates increase in response to some technologies that ignore improvement of land resources, the AGL would constrain further growth. The soil erosion evident on communal rangelands in Mbarara District could be due to drastic reduction of communal grazing by fencing.

Given the current annual growth rates of cattle (Table 7), an additional 656,000 SSU are required to meet the current demand of 437 million litres of milk. These require an additional more than one million hectares of land unless the productivity of land resources is tremendously improved.

The tables show that the required long-term growth rates are unachievable under the prevailing socioeconomic environment. But more importantly, they show that there is potential for increasing the AGL without changing the herd sizes, by increasing the offtake.

Sensitivity analysis showed that milk output per hectare was more sensitive to reproductive than lactation and herd fitness parameters. This implies that in a situation where grazing land is the most limiting factor, more attention should be paid to reproduction. Sensitivity analysis also showed that productivity per hectare is more critical than productivity per animal unit.

Table 8 shows the overall herd structure and composition of the cattle population in the milk-shed areas of Uganda. It is evident that the proportion of males in the herds is large in both sectors.

Table 9 shows the growth rates and the bull: cow ratios in the two sectors by breed categories. It is evident that it is possible to increase the male offtake rates in both sectors.

Table 10 shows the additional female cattle (SSU) and the corresponding additional milk supply possible by increasing offtake rates of male cattle by 15 and 50%, respectively, in the traditional and improved sectors. The amount of additional milk that would result from such a policy is equivalent to what Uganda has been importing, in form of skimmed milk powder and butter oil.

Conclusion

Some of the grasslands in the milk-shed areas of Uganda are already overstocked especially in the Mbarara area. Yet these are the areas currently producing most of the milk in Uganda. There is great scope for attaining sustainable self-sufficiency in milk production with minimal or no adverse effects to our grasslands by adopting a strategy that will ensure efficient herd structures. Such a strategy will involve improvement of livestock marketing and strengthening extension services to educate the farmers on herd structures and stocking rates.

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Appendix

Table 1. *Derivation of standard stock units (SSU)*

Class	Mean liveweight, kg	SSU
Exotic cow	500	1.00
Crossbred cow	400	0.80
Indigenous cow	300	0.60
Exotic heifer	380	0.76
Crossbred heifer	280	0.56
Indigenous heifer	180	0.36
Exotic calf (0–1 year)	100	0.20
Crossbred calf (0–1 year)	70	0.14
Indigenous calf (0–1 year)	55	0.11
Exotic bull (1–3 years)	450	0.90
Crossbred bull (1–3 years)	350	0.70
Indigenous bull (1–3 years)	150	0.30
Exotic bull (>3 years)	600	1.20
Crossbred bull (>3 years)	500	1.00
Indigenous bull (>3 years)	350	0.70

Table 2. *Estimates of available grazing land (AGL) and carrying capacity in the milk-sheds*

	Traditional	Improved	Total
AGL (1000 ha)	2,210.00	242.50	2,452.00
Livestock density (SSU/ha)	0.50	0.70	0.52
Optimum cattle population (1000 SSU)	1,105.00	161.70	1,266.70

SSU=Standard Stock Units

Table 3a. *Estimation of Available range land in the milk-sheds of Uganda*

	Land area (1000 ha)
Total land area	7,311
Cultivated land	1,548
Land for other livestock	53
Other land	1,175
Available range land	4,535

Source: FAO/East Africa Livestock Survey, (EALS), 1967 vol. II Table XIII-7. From the UASS (1986/87) the milk-sheds contain 319,893 sheep and goats; 296,039 swine. These are equivalent to 39,303 cattle units assuming 1.2 ha of land per cattle unit. FAO/EALS (1967) estimates for forest and game reserves, townships, and tsetse-infested area.

Table 3b. *Estimation of the carrying capacity of the available range land in the milk-sheds*

	Traditional	Improved	Total
Available range land (1000 ha)	4,292.5	242.5	4,535.00
Livestock density (SSU per ha)	0.5	0.7	0.51
Optimum cattle population (1000 SSU)	2,146.0	161.7	3,307.70

Table 4. *Uganda cattle population in the different land resource zones for the years 1968 and 1987*

Land resource zone	Cattle 1968 (1000)	Area 1968 (1000 ha)	Cattle 1987 (1000)	Area 1987 (1000 ha)	% change 68–87
I. Mountain Grassland					
a. Mount Elgon	31	14	99	4	220
b. Kigezi highlands	81	3	52	5	-36
c. Rwenzori highlands	-	-	53	4	-
Total/Average	112	6	203	4	81
II. Elephant Grassland					
a. Fertile Crescent	369	4	373	4	1.2
b. Toro-Bunyoro	66	35	174	13	164.0
Total/Average	435	9	548	7	26.0
III. Moist Hyparrhenia					
a. Bukedi plain	350	3	373	3	28
b. Central ridge	392	5	237	8	40
c. Ankole uplands	180	4	187	4	4
Total/Average	922	4	871	4	6
IV. Dry Hyparrhenia					
a. North Teso	587	1	146	5	-75
b. North Buganda	349	8	555	5	59
c. North Acholi	142	15	103	20	-27
d. W. Nile/Madi	182	8	149	10	-18
Total/Average	1260	6	954	7	-24
V. Ankole-Masaka grassland	326	5.3	947	2	191
VI. Loudetia kagerensis	10	21	18	12	81
VII. Karamoja	700	4	308	9	-56
UGANDA	3148	6	3849	5	22

Source: 1968 according to optimates by Ferguson (1971)

Table 5. *The estimated composition of grazing area in the milk-sheds (1000 ha)*

District	Total*	Improved**	Grazing acreage (1000 ha)	
			Communal***	%Improved
Kampala	10	6,6	3,4	66,0
Mpigi	152	2,6	149	2,0
Luwero	378	1,5	375	0,5
Mukono	117	7,3	100	6,0
Kampala	657	18,0	637,4	2,7
Mbarara	595	38,2	557	6,4
Bushenyi	260	135,7	124	52,0
Kabale	8	2,8	5	38,0
Rukungiri	28	1,9	26	7,0
Mbarara	891	178,6	712	20,0
Rakai	110	1,6	108	2,0
Masaka	185	8,5	176	5,0
Mubende	291	7,1	284	2,4
Masaka	586	17,2	569	3,0
Jinja	8	0,4	8	5,0
Iganga	87	7,7	79	9,0
Kamuli	49	5,7	43	12,0
Tororo	167	2,9	164	2,0
Mbale	8	2,0	6	25,0
Mbale	319	18,7	300	6,0
All the milk-sheds	2453	242,5	2210	10,0

* UASS (1986/87).
** Veterinary Department Annual report (1989).
*** Total grazing area minus area under improved farms.

Table 6. *The land-use and grazing potential in the milk-sheds (1000)**

District	Total surface area	Total land area	Cropped land area	Potential grazing area**	Potential cattle popn.***	Present cattle popn.****
Kampala	59	49	-	-	-	14
Mpigi	1,538	1,109	167	942	471	118
Luwero	2,273	2,110	161	1,949	975	89
Mukono	3,519	1,135	379	756	378	109
Kampala	7,389	4,403	707	3,647	1,824	330
Mbarara	2,678	2,616	286	2,030	342	696
Bushenyi	1,333	1,212	184	1,028	687	145
Kabale	615	572	175	397	677	52
Rukungiri	680	639	83	556	185	55
Mbarara	5,306	5,039	728	4,011	1,891	948
Rakai	1,229	961	236	725	242	164
Masaka	4,035	1,474	610	864	288	257
Mubende	2,548	2,427	561	1,866	622	268
Masaka	7,812	4,862	1,407	3,407	1,152	689
Jinja	181	167	24	144	171	15
Iganga	3,241	1,192	162	1,030	72	129
Kamuli	1,074	823	93	731	515	123
Tororo	1,125	961	533	428	171	249
Mbale	629	619	101	518	259	69
Mbale	6,250	3,762	913	2,851	1,188	585
All the milk-sheds	26,757	18,066	3,755	13,964	6,055	2,552

* Land area in thousand acres and cattle population in thousands.
** Total land area minus cultivated acreages (assumes that all uncultivated land can be grazed).
*** Estimated from the carrying capacities of the different districts as given by Ferguson (1971) provided all areas suited for grazing were to be made available by bush clearing and tsetse control.
**** According to the UASS (1986/87) data.

Table 7. *Annual growth rates of the cattle numbers*

Sector	Current 1991	Required 1991	Required 2000
Traditional	3.7	10.2	15.7
Improved	1.2	7.6	12.6
Overall	3.4	9.9	15.3

Table 8. *The overall herd structure and composition of the cattle population*

	Weighted mean percentages for the sectors			
	Traditional sector	Improved sector		
Category	Local breeds	Local breeds	Cross breeds	Exotic breeds
Calves	20	19	23	26
Heifers	24	22	22	26
Cows	40	41	43	46
Bulls	6	4	3	5
Steers	10	14	9	3
Calves: Cows (%)	50	46	53	57
Total females*	74	73	77	79
Total males*	26	28	23	21

* including calves

Table 9. *The simulated annual growth rates of cattle herds in the two sectors (percent)*

	Traditional	Improved		
Parameter	Local	Local	Crosses	Exotics
1. GROWTH RATES*				
Total cattle	3.7	-3.7	5.6	12.7
Female cattle	2.9	-4.0	5.1	8.9
Male cattle	6.1	-2.8	17.3	27.0
2. BULL: COW RATIO (%)**	5.9	4.7	2.7	3.7

* From herd growth simulation results using the STS model and real cattle numbers (not SSU).
** From STS herd-growth simulation assuming a stable population.

Table 10. *Additional female cattle (SSU) that can be carried and the corresponding additional milk by increasing offtake rates of male cattle by 15% and 50% in the traditional and improved sectors respectively*

	Traditional		Improved		
Year	TCFT (1000)	CMYT *	CFCS (1000)	TMYCS *	Total TMYU*
1986	0	,00	0	,00	,00
1988	12,829	2,95	1,203	,96	3,91
1991	26,100	6,94	4,311	3,71	10,65
1994	35,995	9,00	6,499	6,07	15,07
1997	41,267	10,40	7,282	7,26	17,66
2000	42,042	10,50	8,028	8,46	18,98

TCFT: total female cattle in traditional sector
CFCS: total female cattle in improved sector
TMYU: total milk yield in both sectors.
CMYT: total milk yield from traditional sector
TMYCS: total milk yield from improved sector
* 10^6 l